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IPPU SECTOR USERS' GUIDEBOOK

IPCC Inventory Software, version 2.95

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This Guidebook is prepared by IPCC TFI TSU. It has not been subject to the formal IPCC review process. Please submit your feedback to ipcc-software@iges.or.jp

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Abbreviations

Revised 1996 IPCC Guidelines	Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories
2006 IPCC Guidelines	2006 IPCC Guidelines for National Greenhouse Gas Inventories
2019 Refinement	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
AD	activity data
AFOLU	agriculture, forestry and other land use
BFG	blast furnace gas
BOF	blast oxygen furnace
DRI	direct reduced iron
CH ₄	methane
CKD	cement kiln dust
CO ₂	carbon dioxide
COG	coke oven gas
CS	country specific
EAF	electric arc furnace
EDC/VCM	ethylene dichloride/vinyl chloride monomer
EDC/VCM EF	emission factor
ETF	Enhanced Transparency Framework
F-gases	fluorinated gases
Gg GHG	gigagtam
	greenhouse gas
GJ	gigajoule
GWP	global warming potential
HFC	hydrofluorocarbon
IEF	implied emission factor
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
LKD	lime kiln dust
m ²	square meters
m ³	cubic meter
MPGs	Modalities, procedures and guidelines for the transparency framework for action and support
MPGS	referred to in Article 13 of the Paris Agreement
Nd	neodymium
NGHGI	national GHG inventory
NF ₃	nitrogen trifluoride
N ₂ O	nitrous oxide
NGHGI	national GHG inventory
ODS	ozone depleting substances
OHF	open hearth furnace
PFC	perfluorocarbons
RAC	refrigeration and air conditioning
RE	rare earth
s	second
SF ₆	sulphur hexafluoride
01.0	
TFI	IPCC Task Force on National Greenhous Gas Inventories
TJ	terajoule Technical Support Unit
TSU	Technical Support Unit
μg	microgram

Introduction

Goal

The guidebook for the IPCC Inventory Software (*Software*) is produced by the Technical Support Unit (TSU) of the IPCC Task Force on National Greenhous Gas Inventories (TFI) to support inventory compilers in the use of the *Software* for the preparation of national greenhouse gas (GHG) inventories through the description of the complete procedure from activity data (AD) organization and input to emission factors (EFs) selection and input, to GHG estimation and reporting.

Software users must be familiar with the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2006 IPCC Guidelines) methods and read the *Software* manual (downloadable from the "Help" menu) before going through this guidebook. This guidebook does not replace guidance provided in the 2006 IPCC Guidelines.

<u>Scope</u>

The guidebook covers all methodological tiers and approaches provided in the 2006 IPCC Guidelines. Elements of the 2019 Refinement¹ are introduced in limited cases, where needed to enable interoperability between the Software and the United Nations Framework Convention on Climate Change (UNFCCC) electronic reporting tool for common reporting tables (CRT) under the Enhanced Transparency Framework (ETF) of the Paris Agreement (hereafter referred to as the UNFCCC ETF Reporting Tool).

The Users' Guidebook is still under development. Detailed instructions are provided for estimating GHG emissions from 2.A Mineral Industry, 2.B Chemical Industry, 2.C Metal Industry, 2.D Non-Energy Products from Fuels and Solvents Use, 2.F Product Uses as Substitutes for Ozone Depleting Substances (ODS) (refrigeration and air conditioning, foam blowing agents and fire protection only) and 2.H Other (IPPU). The guidebook will be updated with detailed instructions for the remaining categories, although it should be noted that the general principles and approaches described in this existing manual may provide useful insight for these additional categories.

Structure

Inventory preparation for each category, and each associated GHG, is described in this guidebook. Each section provides practical information to help the user enter information and estimate GHG emissions and removals for one or more categories from the *2006 IPCC Guidelines*² Multiple categories (e.g. category 2.A.4. Other process uses of carbonates) are grouped together when the underlying instructions are the same for entering information in the Software. Table 1 below provides the definitions of categories included in the IPPU sector, as well as a hyperlink to the relevant section of the guidebook where further information may be found, if available.

Each section is then presented with a parallel structure. General information on the category and gas(es) covered is provided, along with the relevant equations from the 2006 IPCC Guidelines used to estimate GHG emission and removals in the *Software*. The section then introduces the worksheet(s) contained in the *Software* that are to be used to enter relevant activity data (AD), emission factors (EF) and other parameters with a "User's work Flowchart" to help illustrate the user's series of steps to enter this information. Data may be entered either within a single nation-wide aggregate (i.e. "country name" subdivision or "unspecified") or within a national disaggregation such as administrative units (e.g. provinces, regions, states) or production units (e.g. companies, facilities, or any other aggregation according to which the user collects AD). Finally, the guidebook elaborates on the relevant AD and EF input and highlights how results are presented.

Finally, a word on selection of Tiers.

Tiers

The *Software* provides functionalities -calculation worksheets and data managers- to prepare estimates according to any of the methodological tiers for which IPCC provides equations. Thus, in this Guidebook the following definitions are used to indicate the methodological tier of the relevant equations, and the correspondence with tiers in an NGHGI:

¹ Elements derived from the 2019 Refinement are clearly distinguishable because of magenta colour used to mark those.

² In few instances, denoted by magenta colour, from the 2019 Refinement.

IPCC Tier 1 refers to the IPCC Tier 1 equations and default EFs/parameters.

Furthermore, recognizing that the 2006 IPCC Guidelines allow reporting estimates produced with a Tier 3 user-specific¹ methodology, Tier 1 equations can be used to enter AD and implied emission factor(s) (IEFs), as calculated by dividing the Tier-3 estimated GHG emission with the underlying AD required by the IPCC Tier 1 equation(s), to reproduce the estimated Tier 3 emissions.

IPCC Tier 2 refers:

- ✓ either to the IPCC Tier 2 equations, with IPCC default values or user-specific EFs/parameters, different from IPCC Tier 1 equations in the level of stratification and/or in the variables/parameters;
- ✓ or, when a Tier 2 Equation is not provided, to the IPCC Tier 1 equation and user-specific EFs/parameters (e.g. category 2.B.7 Soda Ash Production).

IPCC Tier 3 is the IPCC methodology different in the level of stratification and/or in the variables/parameters, from the IPCC Tier 1 and Tier 2 methodologies.

<u>Tips</u>

Stratification² of variables³ used to calculate GHG emissions according to IPCC methodologies is a key element to promote accuracy and precision of estimates. Thus, the *Software* allows an unlimited input of elements for each of the variables and allows any combination of those.

Stratification is actually implemented in two ways: by subdividing the entire category, in segments (subdivisions) and applying a single methodological tier, or subdividing the category in segments and applying different methodological tiers to different segments. Which means that within a category, those segments for which data are available -e.g. a specific technology for which EFs are known- are singled out⁴ while all remaining are reported within a single aggregation⁵, as e.g. *unspecified*⁶.

However, the *Software* allows the user to enter each combination of variables, e.g. subdivision/product type/type of process in the case of ethylene dichloride and vinyl chloride monomer production, only once. A way to further disaggregate such a combination across the time series is through using the subdivision name with a time-prefix. For instance, where the carbon content of a fuel or the emission rate of a technology changes across time, in both cases the addition of a prefix that indicates the fuel or the technology before and after a certain date where the change in the carbon content or in the emission rate occurred, allows the user to implement such technological evolution within the current structure of stratification of the variables (e.g. *pre-year Y* and *post-year Y fuel X* or *Technology Z*).

Often worksheets have sub-layers that the user shall access to enter data. To do so, click on the element \boxplus on the left-hand side of worksheet. Once clicked the element \boxplus changes to \blacksquare .

Interoperability with the UNFCCC ETF Reporting Tool for the Common Reporting Tables

The *Software* has been upgraded for the IPPU sector to be interoperable with the UNFCCC ETF Reporting Tool for the CRT under the ETF of the Paris Agreement.⁷ In practice, that means that users of the *Software* can estimate GHG emissions and CO_2 removals for categories and gases that are required to be reported pursuant to the UNFCCC CRT. Once data are entered into the *Software*, users wishing to use these data to facilitate reporting to the

¹ User-specific methodologies need to be in accordance with IPCC good practice to satisfy the transparency, completeness, consistency, accuracy and thus comparability reporting principles.

² The larger the number of strata, the more accurate and precise the estimates are.

³ Stratification is the act of sorting data into distinct groups or layers.

⁴ By applying a higher tier method

⁵ By applying a lower tier method

⁶ This does not apply to variables required by IPCC Tier 1 method.

⁷ As requested by Parties in decision 5/CMA.3, paragraphs 19 and 20.

UNFCCC must generate a file in the *Software* (in JSON format) that may then subsequently, through a separate UNFCCC platform, be uploaded and further processed through the UNFCCC ETF Reporting Tool.

A separate Guidebook, titled <u>IPCC Inventory Software: UNFCCC Interoperability-CRT Export Quick Start</u> <u>Guide</u>, has been developed to assist users in generating the JSON file for upload to the UNFCCC ETF Reporting Tool. Categories that have been added to the *Software* from the *2019 Refinement* to enable interoperability are highlighted in magenta, and, where relevant, in the elaboration for individual categories of this Guidebook.

There are several unique considerations for the IPPU sector when preparing the visualized CRT in the *Software* for reporting to the UNFCCC. The issues are noted below for consideration while reviewing the manual for a particular category, and are elaborated in Annex I.

- For some categories of the IPPU sector, different Tiers for estimating GHG emissions rely on different types of AD (for example, for cement production, the Tier 1 and Tier 2 methods rely on clinker production, while the Tier 3 method is based on consumption of carbonates). While the use of different Tiers does not have an impact on the use of the *Software* to calculate GHG emissions (indeed it can be *good practice* to use higher tiers, even if only for a fraction of a country as long as completeness is ensured), this introduces challenges for aggregating the AD as it is not meaningful to different types of AD into a single value. When mapping to the visualized CRT and preparing a file for UNFCCC reporting, the *Software* ensures that only a single type of AD are added (e.g. the Tier 1 AD if available). This will however require the user to update the AD to reflect total national AD prior to submitting the file to the UNFCCC.
- The *Software* allows for estimation of GHG emissions for all gases with a global warming potential in an IPCC Assessment Report (the latest values included in the *Software* are from the 5th Assessment Report). AR5 includes additional gases, not included for reporting pursuant to the Modalities, procedures and guidelines for the transparency framework for action and support referred to in Article 13 of the Paris Agreement (MPGs), which is limited to CO₂, CH₄, N₂O, HFCs, PFCs, SF₆, and NF₃; Should users calculate GHG emissions for these additional gases (e.g. ethers) they may wish to explain the differences in the totals for these fluorinated gases (F-gases).
- Confidentiality Calculation of GHG emissions in the *Software* requires entry of AD, EFs and other parameters. In some cases, users may identify some input data as confidential. Although the data are required for calculation of GHG emissions in the calculation worksheets, users may designate some data as confidential (through use of the notation key "C") for purposes of reporting to the UNFCCC ETF Reporting Tool. There are multiple ways of designating information as confidential, which is further discussed in Annex I. Users are responsible for understanding how confidentiality is addressed in the *Software*. Also important to note; emissions labelled as confidential are still included in totals for transfer to the UNFCCC to ensure complete reporting.

Annex I illustrates the mapping of AD and GHG estimates for categories/gases from the *Software* to the corresponding UNFCCC CRT category/ies.

1. IPPU Sector – General Guidance

The Industrial Processes and Product Use (IPPU) sector covers GHG emissions occurring from industrial processes, from the use of GHGs in products, and from non-energy uses of fossil fuel carbon.

GHG emissions are produced from a wide variety of industrial activities. The main emission sources are releases from industrial processes that chemically or physically transform materials (for example, the blast furnace in the iron and steel industry, ammonia and other chemical products manufactured from fossil fuels used as chemical feedstock and the cement industry are notable examples of industrial processes that release a significant amount of CO_2). During these processes, many different GHGs, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), can be produced.

In addition, GHGs often are used in products such as refrigerators, foams or aerosol cans. For example, HFCs are used as alternatives to ozone depleting substances (ODS) in various types of product applications. Similarly, sulphur hexafluoride (SF₆) and N₂O are used in a number of products used in industry (e.g., SF₆ used in electrical equipment, N₂O used as a propellant in aerosol products primarily in the food industry) or by end-consumers (e.g., SF₆ used in running-shoes, N₂O used during anaesthesia). A notable feature of these product uses is that, in almost all cases, significant time can elapse between the manufacture of the product and the release of the greenhouse gas. The delay can vary from a few weeks (e.g., for aerosol cans) to several decades as in the case of rigid foams. In some applications (e.g., refrigeration) a fraction of the greenhouse gases used in the products can be recovered at the end of product's life and either recycled or destroyed. In addition, HFCs, PFCs, SF₆, NF₃, and several other fluorinated greenhouse gases may be used in and/or emitted by processes such as electronics manufacturing.

Product use is combined with the industrial process guidance because in many cases production and import/export data are needed to estimate emissions in products and because product use may also occur as part of industrial activities, apart from the non-industrial sectors (retail, services, households.) It is therefore desirable to link estimation of emissions associated with production and product use. The non-energy uses of fossil fuels encompass their uses as feedstock, reductants and as non-energy products in which their physical properties are used directly rather than combusted for energy purposes.

Table 1 lists all categories included from the IPPU sector of the 2006 IPCC Guidelines, as refined by the 2019 Refinement for those categories relevant for the interoperability with the UNFCCC ETF Reporting Tool. This Users' Guidebook is under development. Users may click on the category name to navigate to completed sections of the Users' Guidebook.

Categories	Definitions
2 INDUSTRIAL PROCESSES AND PRODUCT USE (IPPU)	Emissions from industrial processes and product use, excluding those related to energy combustion (reported under category 1.A), extraction, processing and transport of fuels (reported under category 1.B) and CO ₂ transport, injection and storage (reported under category 1.C).
2.A Mineral Industry	
2.A.1 Cement Production	Process-related emissions from the production of various types of cement (ISIC: D2694).
2.A.2 Lime Production	Process-related emissions from the production of various types of lime (ISIC: D2694).
2.A.3 Glass Production	Process-related emissions from the production of various types of glass (ISIC: D2610).
	Includes limestone, dolomite and other carbonates etc. Emissions from the use of limestone, dolomite
2.A.4 Other Process Uses	and other carbonates should be included in the industrial source category where they are used. For
of Carbonates	example, where a carbonate is used as a flux for iron and steel production, resultant emissions should be
	reported under category 2.C.1 Iron and Steel Production rather than this subcategory.
2.A.4.a Ceramics	Process-related emissions from the production of bricks and roof tiles, vitrified clay pipes, refractory
	products, expanded clay products, wall and floor tiles, table and ornamental ware (household ceramics),
	sanitary ware, technical ceramics, and inorganic bonded abrasives (ISIC: D2691, D2692 and D2693).
2.A.4.b Other Uses of Soda	Emissions from soda ash use that are not included elsewhere under an existing category (for example,
Ash	emissions from soda ash used in glass production are accounted for under 2.A.3 Glass production)
2.A.4.c Non-Metallurgical	Emissions from magnesia production that are not included elsewhere. For example, where magnesia
Magnesia Production	production is used for primary and secondary magnesium production, emissions should be reported in
	the relevant source category in Metals.

Table 1. Categories included in the IPPU sector of the 2006 IPCC Guidelines, as refined by the 2019 *Refinement* for those categories relevant for the interoperability with the UNFCCC ETF Reporting Tool.

Categories	Definitions
2.A.4.d Other (please specify)	Process-related emissions from all other miscellaneous uses of limestone, dolomite and other carbonates, except from uses already listed in the sub-categories above, and uses as fluxes or slagging agents in the Metals and Chemicals industries, or for the liming of soils and wetlands in Agriculture, Forestry and Other Land Uses (ISIC D269).
<u>2.A.5 Other</u>	Includes any other mineral industry emissions not otherwise included above or reported elsewhere in the GHG inventory.
2.B Chemical Industry	
2.B.1 Ammonia Production	Ammonia (NH ₃) is a major industrial chemical and the most important nitrogenous material produced. Ammonia gas is used directly as a fertilizer, in heat treating, paper pulping, nitric acid and nitrates manufacture, nitric acid ester and nitro compound manufacture, explosives of various types, and as a refrigerant. Amines, amides, and miscellaneous other organic compounds, such as urea, are made from ammonia. The main GHG emitted from NH ₃ production is CO ₂ . CO ₂ used in the production of urea, a downstream process, should be subtracted from the CO ₂ generated and accounted for in the AFOLU Sector.
2.B.2 Nitric Acid Production	Nitric acid is used as a raw material mainly in the manufacture of nitrogenous-based fertiliser. Nitric acid may also be used in the production of adipic acid and explosives (e.g., dynamite), for metal etching and in the processing of ferrous metals. The main GHG emitted from HNO ₃ production is N ₂ O.
<u>2.B.3 Adipic Acid</u> <u>Production</u>	Adipic acid is used in the manufacture of a large number of products including synthetic fibres, coatings, plastics, urethane foams, elastomers and synthetic lubricants. The production of Nylon 6.6 accounts for the bulk of adipic acid use. The main GHG emitted from adipic acid production is N ₂ O.
2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production	Most of the annual production of caprolactam (NH(CH ₂) ₅ CO) is consumed as the monomer for nylon-6 fibres and plastics, with a substantial proportion of the fibre used in carpet manufacturing. All commercial processes for the manufacture of caprolactam are based on either toluene or benzene. This subcategory also covers production of glyoxal (ethanedial) and glyoxylic acid production. The main GHG emitted from this subcategory is N ₂ O.
2.B.5 Carbide Production	The production of carbide can result in emissions of CO_2 , CH_4 , CO and SO_2 . Silicon carbide is a significant artificial abrasive. It is produced from silica sand or quartz and petroleum coke. Calcium carbide is used in the production of acetylene, in the manufacture of cyanamide (a minor historical use), and as a reductant in electric arc steel furnaces. It is made from calcium carbonate (limestone) and carbon-containing reductant (petroleum coke).
<u>2.B.6 Titanium Dioxide</u> <u>Production</u>	Titanium dioxide (TiO ₂) is the most important white pigment. The main use is in paint manufacture followed by paper, plastics, rubber, ceramics, fabrics, floor covering, printing ink, and other miscellaneous uses. The main production process is the chloride route, giving rise to CO ₂ emissions that are likely to be significant. This category also includes synthetic rutile production using the Becher process, and titanium slag production, both of which are reduction processes using fossil fuels and resulting in CO ₂ emissions. Synthetic rutile is the major input to TiO ₂ production using the chloride route.
2.B.7 Soda Ash Production	Social solution of the soluti
<u>2.B.8 Petrochemical and</u> <u>Carbon Black Production</u>	
2.B.8.a Methanol	Methanol production covers production of methanol from fossil fuel feedstocks [natural gas, petroleum, coal] using steam reforming or partial oxidation processes. According to Volume 1, chapter 8 of the 2006 IPCC Guidelines, production of methanol from biogenic feedstocks (e.g., by fermentation) is not included in this source category. It should be noted that users can enter in the <i>Software</i> information on the use of biogenic feedstocks. Consistent with the 2006 IPCC Guidelines, the <i>Software</i> does not include CO ₂ emissions from biogenic fuels in the national total, although any capture and subsequent storage of this CO ₂ are included
2.B.8.b Ethylene	Ethylene production covers production of ethylene from feedstocks at petrochemical plants by the steam cracking process. Production of ethylene from processes situation within the boundaries of petroleum refineries is not included in this source category. The GHGs produced from ethylene production are CO_2 and CH_4 .
2.B.8.c Ethylene Dichloride and Vinyl Chloride Monomer	Ethylene dichloride and vinyl chloride monomer production covers production of ethylene dichloride by direct oxidation or oxychlorination of ethylene, and the production of vinyl chloride monomer from ethylene dichloride. The GHGs produced from production of ethylene dichloride production and vinyl chloride monomer production are CO ₂ and CH ₄ .
2.B.8.d Ethylene Oxide	Ethylene oxide production covers production of ethylene oxide by reaction of ethylene and oxygen by catalytic oxidation. The GHGs produced from ethylene oxide production are CO ₂ and CH ₄ .
2.B.8.e Acrylonitrile	Acrylonitrile production covers production of acrylonitrile from ammoxidation of propylene, and associated production of acetonitrile and hydrogen cyanide from the ammoxidation process. The GHGs produced from production of acrylonitrile are CO ₂ and CH ₄ .

Categories	Definitions
2.B.8.f Carbon Black	Carbon black production covers production of carbon black from feedstocks (petroleum or coal-derived carbon black feedstock, natural gas, acetylene). It should be noted that users can enter in the <i>Software</i> information on the use of biogenic feedstocks. Consistent with the 2006 IPCC Guidelines, the Software does not include CO ₂ emissions from biogenic fuels in the national total, although any capture and subsequent storage of this CO ₂ are included
2.B.8.x Other petrochemical production	This category has been added to the <i>Software</i> (without a specific IPCC category code) to allow users to implement section 3.9.1 of chapter 3, volume 3 of the <i>2006 IPCC Guidelines</i> , which reads "There are a number of other petrochemical processes that emit small amounts of greenhouse gases for which specific guidance is not provided (e.g., styrene production)."
2.B.9 Fluorochemical Production	
2.B.9.a By-product Emissions	Fluorochemical Production covers the complete range of fluorochemicals, whether or not the principal products are GHGs. Emissions encompass HFCs, PFCs, SF ₆ and all other halogenated gases with global warming potentials (GWP) listed in IPCC assessment reports. The most significant by-product emission is that of HFC-23 from the manufacture of HCFC-22 and this is described separately.
2.B.9.b Fugitive Emissions	These are emissions of the principal product from the process to manufacture it and so fluorochemical production in this context is limited to HFCs, PFCs, SF ₆ and other halogenated gases with GWP listed in IPCC assessment reports.
2.B.10 Hydrogen Production	Emissions from hydrogen production when it is produced as a main product at a stand-alone facility. Also, emissions from production of hydrogen as a by-product or intermediate product at refineries, ammonia production facilities and at other chemical production facilities, insofar as the emissions are not reported under the respective sectors.
2.B.11 Other (Please specify)	Includes any other chemical industry emissions not otherwise included above. For example, gases with GWP listed in IPCC assessment reports that do not fall within any categories above could be reported here, if they are estimated.
2.C Metal Industry	
<u>2.C.1 Iron and Steel</u> <u>Production</u>	CO ₂ is the predominant gas emitted from the production of iron and steel. The sources of the CO ₂ emissions include that from carbon-containing reducing agents such as coke and pulverized coal, and, from minerals such as limestone and dolomite added.
2.C.2 Ferroalloys Production	Ferroalloys production covers emissions from primary metallurgical reduction production of the most common ferroalloys, i.e. ferro-silicon, silicon metal, ferro-manganese, silicon manganese, and ferro-chromium, excluding those emissions relating to fuel use. From the production of these alloys, CO ₂ , N ₂ O and CH ₄ originating from ore- and reductant raw materials, is emitted.
<u>2.C.3 Aluminium</u> <u>Production</u>	Aluminium production covers primary production of aluminium, except the emissions related to the use of fuel. CO_2 emissions result from the electrochemical reduction reaction of alumina with a carbon- based anode. Tetrafluoromethane (CF ₄) and hexafluoroethane (C ₂ F ₆) are also produced intermittently. No GHGs are produced in recycling of aluminium other than from the fuels uses for metal remelting. SF ₆ emissions are not associated with primary aluminium production; however, casting of some high magnesium containing alloys does result in SF ₆ emissions and these emissions are accounted for in Section 2.C.4, Magnesium Production.
<u>2.C.4 Magnesium</u> <u>Production</u>	Magnesium production covers GHG emissions related to both primary magnesium production as well as oxidation protection of magnesium metal during processing (recycling and casting), excluding those emissions relating to fuel use. In the primary production of magnesium, CO ₂ is emitted during calcination of dolomite and magnesite raw materials. Primary production of magnesium from non-carbonate raw materials does not emit carbon dioxide. In the processing of liquid magnesium, cover gases containing CO ₂ , SF ₆ , the hydrofluorocarbon HFC 134a or the fluorinated ketone FK 5-1-12 (C ₃ F ₇ C(O)C ₂ F ₅) may be used. Partial thermal decomposition and/or reaction between these compounds and liquid magnesium generates secondary compounds such as PFCs, which are emitted in addition to unreacted cover gas constituents.
2.C.5 Lead Production	Lead production covers production by the sintering/smelting process as well as direct smelting. CO ₂ emissions result as a product of the use of a variety of carbon-based reducing agents in both production processes.
2.C.6 Zinc Production	Zinc production covers emissions from both primary production of zinc from ore as well as recovery of zinc from scrap metals, excluding emissions related to fuel use. Following calcination, zinc metal is produced through one of three methods; 1-electro-thermic distillation, 2-pyro-metallurgical smelting or 3-electrolysis. If method 1 or 2 is used, CO ₂ is emitted. Method 3 does not result in CO ₂ emissions. Recovery of zinc from metal scrap often uses the same methods as primary production and may thus produce CO ₂ emissions, which is included in this section.
2.C.7 Rare Earths Production	Rare Earth Production covers primary production of rare earth metals and alloys, except the emissions related to the use of fuel. CO_2 emissions result from the electrochemical reduction reaction of rare earth oxides with a carbon-based anode. PFCs, mainly tetrafluoromethane (CF ₄) and hexafluoroethane (C ₂ F ₆), are also produced intermittently.
2.C.8 Other (please specify)	Includes any other metal industry emissions not otherwise included above.

Categories	Definitions
2.D Non-Energy Products	
from Fuels and Solvent	The use of oil products and coal-derived oils primarily intended for purposes other than combustion.
Use	
2.D.1 Lubricant Use	Lubricating oils, heat transfer oils, cutting oils and greases.
2.D.2 Paraffin Wax Use	Oil-derived waxes such as petroleum jelly, paraffin waxes and other waxes.
	NMVOC emissions from solvent use e.g. in paint application, degreasing and dry cleaning should be
<u>2.D.3 Solvent Use</u>	contained here. Emissions from the use of HFCs and PFCs as solvents should be reported under 2.F.5.
2.D.4 Other (please specify)	For example, CH ₄ , CO and NMVOC emissions from asphalt production and use (including asphalt blowing), as well as NMVOC emissions from the use of other chemical products than solvents should be contained here, if relevant.
2.E Electronics Industry	
2.E.1 Integrated Circuit or Semiconductor	Emissions of CF4, C ₂ F ₆ , C ₃ F ₈ , c-C ₄ F ₈ , C ₄ F ₆ , C ₄ F ₈ O, C ₅ F ₈ , CHF ₃ , CH ₂ F ₂ , NF ₃ and SF ₆ from uses of these gases in Integrated Circuit (IC) manufacturing in rapidly evolving ways and in varying amounts, which depend on product (e.g., memory or logic devices) and equipment manufacturer.
2.E.2 TFT Flat Panel Display	Uses and emissions of predominantly CF_4 , CHF_3 , NF_3 and SF_6 during the fabrication of thin-film transistors (TFTs) on glass substrates for flat panel display manufacture. In addition to these gases, C_2F_6 , C_3F_8 and $c-C_4F_8$ may also be used and emitted during the manufacture of thin and smart displays.
2.E.3 Photovoltaics	Photovoltaic cell manufacture may use and emit CF_4 and C_2F_6 among others.
2.E.4 Heat Transfer Fluid	Heat transfer fluids, which include several fully fluorinated carbon compounds (either in pure form or in
	mixtures) with six or more carbon atoms, used and emitted during IC manufacture, testing and assembly. They are used in chillers, temperature shock testers and vapour phase reflow soldering.
2.E.5 Other (please specify)	
2.F Product Uses as	
Substitutes for Ozone	
Depleting Substances	Refrigeration and air-conditioning systems are usually classified in six application domains or categories.
<u>2.F.1 Refrigeration and Air</u> <u>Conditioning</u>	These categories utilise different technologies such as heat exchangers, expansion devices, pipings and compressors. The six application domains are domestic refrigeration, commercial refrigeration, industrial processes, transport refrigeration, stationary air conditioning, mobile air-conditioning systems. For all these applications, various HFCs are selectively replacing CFCs and HCFCs. For example, in developed countries, HFC-134a has replaced CFC-12 in domestic refrigeration and mobile air conditioning systems, and blends of HFCs such as R-407C (HFC-32/HFC-125/HFC-134a) and R-410A (HFC-32/HFC-125) are replacing HCFC-22 mainly in stationary air conditioning. Other, non-HFC substances are used to replace CFCs and HCFCs such as iso-butane in domestic refrigeration or ammonia in industrial refrigeration. HFC-152a is also being considered for mobile air conditioning in several regions.
2.F.1.a Refrigeration and	The application domains are domestic refrigeration, commercial refrigeration, industrial processes,
Stationary Air Conditioning	transport refrigeration and stationary air conditioning.
2.F.1.b Mobile Air	The application domains are mobile air-conditioning systems used in passenger cars, truck cabins, buses,
Conditioning 2.F.2 Foam Blowing Agents	and trains. HFCs are being used as replacements for CFCs and HCFCs in foams, particularly in closed-cell insulation applications. Compounds that are being used include HFC-245fa, HFC-365mfc, HFC-227ea, HFC-134a, and HFC-152a. The processes and applications for which these various HFCs are being used include insulation boards and panels, pipe sections, sprayed systems and one-component gap filling foams. For open-cell foams, such as integral skin products for automotive steering wheels and facias, emissions of HFCs used as blowing agents are likely to occur during the manufacturing process. In closed-cell foam, emissions not only occur during the manufacturing phase, but usually extend into the in-use phase and often the majority of emission occurs at the end-of-life (de-commissioning losses). Accordingly, emissions can occur over a period of up to 50 years or even longer.
2.F.3 Fire Protection	There are two general types of fire protection (fire suppression) equipment that use GHGs as partial replacements for halons: portable (streaming) equipment, and fixed (flooding) equipment. The non- ozone depleting, industrial gases HFCs, PFCs and more recently a fluoroketone are mainly used as substitutes for halons, typically halon 1301, in flooding equipment. PFCs played an early role in halon 1301 replacement but current use is limited to replenishment of previously installed systems. HFCs in portable equipment, typically replacing halon 1211, are available but have achieved very limited market acceptance due primarily to their high cost. PFC use in new portable extinguishers is currently limited to a small amount (few percent) in an HCFC blend.
2.F.4 Aerosols	Most aerosol packages now contain hydrocarbon (HC) as propellants but, in a small fraction of the total, HFCs and PFCs may be used as propellants or solvents. Emissions from aerosols usually occur shortly after production, on average six months after sale. During the use of aerosols, 100% of the chemical is emitted. The five main sources are metered dose inhalers (MDIs), personal care products (e.g. hair care, deodorant, shaving cream), household products (e.g. air-fresheners, oven and fabric cleaners), industrial products (e.g. special cleaning sprays such as those for operating electrical contact, lubricants, pipe-freezers) and other general products (e.g. silly string, tire inflators, claxons), although in some regions the use of such general products is restricted. The HFCs currently used as propellants are HFC 134a, HFC 227ea, and HFC 152a. The substance HFC 43 10mee and a PFC, perfluorohexane, are used as solvents in industrial aerosol products.

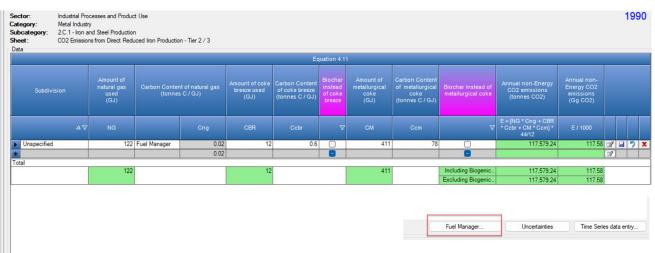
Categories	Definitions
2.F.5 Solvents	HFCs and, to a much lesser extent PFCs, are being used as substitutes for ODS (most notably CFC- 113). Typical HFCs used are HFC-365mfc and HFC-43-10mee. Use of these fluorinated replacements is much less widespread than the ODS they replace. Re-capture and re-use is also much more widely practiced The primary areas of use are precision cleaning, electronics cleaning, metal cleaning and deposition applications. Emissions from aerosols containing solvents should be reported under category 2.F.4 Aerosols rather than under this category.
2.F.6 Other Applications (please specify)	The properties of ODS have made them attractive for a variety of niche applications not covered in other sub-source categories. These include electronics testing, heat transfer, dielectric fluid and medical applications. The properties of HFCs and PFCs are equally attractive in some of these sectors and they have been adopted as substitutes. There are also some historical uses of PFCs, as well as emerging use of HFCs, in these applications. These applications have leakage rates ranging from 100% emissive in year of application to around 1% per annum.
2.G Other Product Manufacture and Use	
2.G.1 Electrical Equipment	Electrical equipment is used in the transmission and distribution of electricity above 1 kV. SF ₆ is used in gas-insulated switchgear (GIS), gas circuit breakers (GCB), gas-insulated transformers (GIT), gas-insulated lines (GIL), outdoor gas-insulated instrument transformers, reclosers, switches, ring main units and other equipment.
2.G.1.a Manufacture of Electrical Equipment	
2.G.1.b Use of Electrical Equipment	
2.G.1.c Disposal of	
Electrical Equipment 2.G.2 SF ₆ and PFCs from	
Other Product Uses	
2.G.2.a Military Applications	Military applications include AWACS, which are military reconnaissance planes of the Boeing E-3A type. In AWACS (and possibly other reconnaissance planes), the SF ₆ is used as an insulating gas in the radar system.
2.G.2.b Accelerators	Particle accelerators are used for research purposes (at universities and research institutions), for industrial applications (in cross-linking polymers for cable insulation and for rubber parts and hoses), and in medical (radiotherapy) applications.
2.G.2.c Other (please specify)	This source includes adiabatic uses, sound-proof glazing, PFCs used as heat transfer fluids in consumer and commercial applications, PFCs used in cosmetic and medical applications, and PFCs and SF ₆ used as tracers.
2G3 N ₂ O from Product Uses	
2.G.3.a Medical Applications	This source covers evaporative emissions of N_2O that arise from medical applications (anaesthetic use, analgesic use and veterinary use). N_2O is used during anaesthesia for two reasons: a) as an anaesthetic and analgesic and as b) a carrier gas for volatile fluorinated hydrocarbon anaesthetics such as isoflurane, sevoflurane and desflurane.
2.G.3.b Propellant for Pressure and Aerosol Products	This source covers evaporative emissions of nitrous oxide (N_2O) that arise from use as a propellant in aerosol products primarily in food industry. Typical usage is to make whipped cream, where cartridges filled with N_2O are used to blow the cream into foam.
2.G.3.c Other (Please specify)	
2.G.4 Other (Please specify)	
2.H Other	
2.H.1 Pulp and Paper Industry	
2.H.2 Food and Beverages Industry	

Note: The category tree in the *Software* reflects the categories included in the *2006 IPCC Guidelines*, as refined by the *2019 Refinement* for those categories relevant for interoperability with the UNFCCC ETF Reporting Tool, plus those added by the *Wetlands Supplement*. Categories from the *2019 Refinement* are shown in this Guidebook, and in the *Software*, in a magenta colour.

1.1 Cross-cutting issues

1.1.1 Fuel Manager

In the IPPU the data from Fuel Manager is used for several categories, including in Chemical Industry (e.g. 2.B.8 Petrochemical and Carbon Black Production) and Metal Industry (e.g. 2.C.1 Iron and Steel Production).



Example: Reference to the Fuel Manager for Iron and Steel Production

Before inputting data in the Energy and IPPU worksheets, the Fuel Manager shall be populated with all relevant

The Fuel Manager contains information on carbon content and calorific value for each fuel type used in the country. All IPCC default fuels are included here, and in addition users can input user-specific fuels and reductants and associated characteristics. To set the Fuel Manager the following steps are followed:

1. On the **Administrate** tab, click **Energy** and then **Fuel Manager**.

Note that the **Administrate** tab is available only to the Administrator. Other users may access the Fuel Manager by selecting **Fuel Manager** from the lower right-hand side of relevant worksheets relying on data from the Fuel Manager (e.g. from 2.C.1 Iron and Steel Production).

Application Database Inventory Year	Administra	te Work	sheets Tools	Export/In	nport Report	s Window	Help									- 5
6 IPCC Categories 2.D.1 - Lubricant Use 2.D.2 - Paraffin Wax Use		try/Territor	·	ses and P	2 F-Gas Emisi		F-Gas Emissio	ns - Tier 2b								1994
2.D.3 - Solvent Use 2.D.4 - Other (please specify)	Energ	у			uel Manager	ning	55									
2.E - Electronics Industry 2.E.1 - Integrated Circuit or Semiconducto 2.E.2 - TFF Flat Panel Display 2.E.3 - Photovoltaics 2.E.4 - Heat Transfer Fluid	IPPU AFOL Waste			th Rate	Gas hop (ho	p1 hop 2) Lifetime (d)		Chemical's Data	Destr	oyed (%)						
2.E.5 - Other (please specify)		- intentory					Equation 7.2	в					Inform	ation for UNFCC	C CRT	F
2F - Product Uses as Substitutes for Ozone D 2F - 1. Refrigeration and Air Conditioning 2F.1.a. Refrigeration and Stationary A 2F.1.b. Mobile Air Conditioning 2F.2 - Foam Blowing Agents		Year	Agent production (tonnes)	lgent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent in all equipment installed (tonnes)	
2.F.3 - Fire Protection 2.F.4 - Aerosols 2.F.5 - Solvents 2.F.5 - Solvents 2.F.6 - Other Applications (please specify) □ -2.G - Other Product Manufacture and Use		t ∆⊽	P	Ex	Ìm	D = P - Ex + Im	R = [L(t-(d-1)) - (L(t-(d-1)) * EF/100)] - [S_needed(t- d)) - S_done(t- d)]	F = R * (destroyed/100)	G = R - F	H = H(t-1) + D - R - I	I = M * EF/100	E = G + I	K = IF(D>I(t- 1), I(t-1), D)	L = D - K	M = Σ(L(t, t- (d-1))	
2.G.1 - Electrical Equipment		1990	10000	0	0	10000	0	0	0	8500	1500	1500	0	10000	10000	3
-2 G 1 a - Manufacture of Electrical Equ		1991	10000	0	0	10000			0	15725	2775	2775	1500	8500	18500	1

- 2. In the top of the window select either **NCV** (net calorific value) or **GCV** (gross calorific value) for the **Conversion Factor Type**. Note that:
 - ✓ For each IPCC default fuel, when NCV is selected, the **Calorific Value** and the **Carbon Content** are pre-filled with IPCC defaults for each fuel. These can be replaced with user-specific values.
 - ✓ For GCV no IPCC default values are available and so those need to be entered by the user.
- 3. To add user-specific fuels the following steps are performed for each new fuel entry:
 - ✓ Click on the asterisk in the bottom-most row to add the user-specific fuel,
 - ✓ Select **fuel type** from the drop-down list,
 - ✓ Enter the specific **fuel name**,

- ✓ Indicate (checkbox) if it is a **primary fuel**¹ or not,
- ✓ Enter its calorific value in TJ/Gg, (either NCV or GCV according to the selection made for the entire Fuel Manager),
- ✓ Enter the **carbon content** in kg C/GJ.

To see listed the user-defined fuels only, check the corresponding box on the top of the window.

Note: If the name of values assigned to a user-defined fuel added to the Fuel Manager are subsequently changed, such change is propagated by the *Software* to each calculation worksheet where that fuel is used.

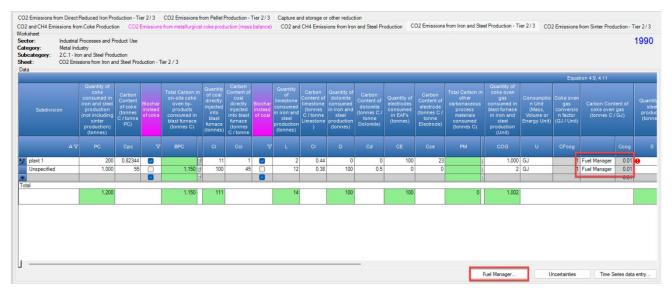
d Fuels	Aviation Gasoline			
			44.3	19.1
	Bitumen		40.2	2
	Crude Oil		42.3	20
	Ethane		46.4	16.8
	Gas/Diesel Oil	0	43	20.2
	Jet Gasoline		44.3	19.1
	Jet Kerosene		44.1	19.5
	Liquefied Petroleum Gases		47.3	17.2
	Lubricants		40.2	20
	Motor Gasoline		44.3	18.9
	Naphtha		44.5	20
	Natural Gas Liquids		44.2	17.5
	Orimulsion		27.5	2
	Other Kerosene		43.8	19.6
	Other Petroleum Products		40.2	20
	Paraffin Waxes	0	40.2	20
	Petroleum Coke		32.5	26.6
	Refinery Feedstocks	0	43	20
	Refinery Gas		49.5	15.7
	Residual Fuel Oil	0	40.4	21.1
	Shale Oil	0	38.1	20
	White Spirit and SBP	0	40.2	20
Fuels	Anthracite		26.7	26.8
	Blast Furnace Gas		2.47	70.8
	Brown Coal Briquettes		20.7	26.6
	Coal Tar		28	2

¹ Primary fuels are fuels found in nature such as coal, crude oil, and natural gas, while secondary fuels or fuel products are derived from primary fuels, such as gasoline and lubricants. A complete list of fuels is provided in Section 1.4.1.1 of the 2006 IPCC Guidelines.

Fuel Type	✓ Fuel Name	Primary Fuel V	Gross Calorific Value (TJ / Gg)	Carbon content (GCV) (kg C / GJ)
Liquid Fuels	Aviation Gasoline			19.1
	Bitumen	0		22
	Crude Oil			20
	Ethane			16.8
	Gas/Diesel Oil			20.2
	Jet Gasoline			19.1
	Jet Kerosene			19.5
	Liquefied Petroleum Gases			17.2
	Lubricants			20
	Motor Gasoline	0		18.9
	Naphtha			20
	Natural Gas Liquids			17.5
	Orimulsion			21
	Other Kerosene		2	19.6
	Other Petroleum Products	0		20
	Paraffin Waxes			20
	Petroleum Coke	0		26.6
	Refinery Feedstocks	0		20
	Refinery Gas	0		15.7
	Residual Fuel Oil			21.1
	Shale Oil	0		20
	White Spirit and SBP			20
Solid Fuels	Anthracite			26.8
	Blast Furnace Gas Brown Coal Briguettes			70.8
	Coal Tar			20.6
	I, e.g. dung, not covered in the definitions in table 1.1 (Vol.2, Cha ed in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPC0			
serspecific biomass-derived fue ser-specific fossil fuel not cover Manager				considered "waste derived" Save Undo Oor
serspecific biomass-derived fue ser-specific fossil fuel not cover Manager	ed in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC		r fossil fuels" ; these fuels are all	considered "waste derived" Save Undo Oor
serspecific biomass derived fue serspecific fossil fuel not cover Manager wersion Factor Type	ed in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC	Cuidelines) shall be classified as "Othe	r fossil fuels" ; these fuels are all e	Considered "waste derived" Save Undo Qot Carbon content (NCV)
serspecific biomass derived fue serspecific fossil fuel not cover Manager Iversion Factor Type Fuel Type	A finite definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC O NCV O GCV Show user-defined fuels only Fuel Name Diesel for off-road Diesel for trains	Cudelines) shall be classified as "Othe	r fossil fuels" ; these fuels are all Net Calorific Value (TJ / Gg)	Considered "waste derived" Save Undo Got Got Garbon content (NCV) (kg C / GJ) 38 1 40 1
serspecific biomass derived fue serspecific fossil fuel not cover Manager Iversion Factor Type Fuel Type	ed in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC NCV GCV GCV Fuel Name Diesel for off-road Diesel for rolins Lignite Power Plants	Couldelines) shall be classified as "Othe Primary Fuel T	r fossil fuels" : these fuels are all Net Catomic Value (TJ / Gg)	Carbon content (NCV) (kg C / GJ) (kg C / G
serspecific biomass derived fue serspecific fossil fuel not cover Manager Iversion Factor Type Fuel Type	ed in the definitions in table 1.1 (Vol 2, Chapter 1 of the 2006 IPCC NCV GCV Show user-defined fuels only Fuel Name Diesel for off-road Diesel for trains Lignite Power Plants Natural Gas Power Plants	Cudelines) shall be classified as "Othe Primary Fuel	r fossi fuels" ; these fuels are all v (TJ / Gg)	Carbon content (NCV) Qot Carbon content (NCV) (kg C / GJ) 38 11 40 11 12 33
serspecific biomass derived fue serspecific fossil fuel not cover Manager Iversion Factor Type Fuel Type	ed in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC NCV GCV GCV Fuel Name Diesel for off-road Diesel for rolins Lignite Power Plants	Cudelines) shall be classified as "Othe	r fossi fuels" ; these fuels are all v (TJ / Gg)	Carbon content (NCV) (kg C / GJ) 12 33 12 33 35 36 37 37 37 37 38 38 38 38 38 37 38 38 38 38 38 38 38 38 38 38
Manager Wersion Factor Type Fuel Type Other Fossil Fuels	ed in the definitions in table 1.1 (Vol 2, Chapter 1 of the 2006 IPCC NCV GCV Show user-defined fuels only Fuel Name Diesel for off-road Diesel for trains Lignite Power Plants Natural Gas Power Plants	Caudelines) shall be classified as "Othe Primary Fuel C C C C C C C C C	r fossi fuels" ; these fuels are all v (TJ / Gg)	Carbon content (NCV) Qot Carbon content (NCV) (kg C / GJ) 38 11 40 11 12 33
Manager Wersion Factor Type Fuel Type Other Fossil Fuels	ed in the definitions in table 1.1 (Vol 2, Chapter 1 of the 2006 IPCC NCV GCV Show user-defined fuels only Fuel Name Diesel for off-road Diesel for trains Lignite Power Plants Natural Gas Power Plants	Caudelines) shall be classified as "Othe Primary Fuel C C C C C C C C C	r fossi fuels" ; these fuels are all v (TJ / Gg)	Carbon content (NCV) Qot Carbon content (NCV) (kg C / GJ) 38 11 40 11 12 33

Then the data from the Fuel Manager can be used in the IPPU worksheets. See example below for 2.C.1 Iron and Steel.

Example: Use of data from Fuel Manager in IPPU



1.1.2 F-gases Manager

Fluorochemicals (including HFCs, PFCs, SF₆ and NF₃ collectively referred to as "F-gases") are produced (in category 2.B) and used in a variety of applications (categories 2.C, 2.E, 2.F, 2.G, 2.H). Further, two or more chemicals may be combined into a blend (GHG and non-GHG, ozone depleting substance (ODS) and non-ODS). The list of F-gases is substantial. Thus, there is a need to handle these gases efficiently.

For easy and convenient use of the *Software*, all F-gases consumed (including those imported) and/or exported in the country can be specified and organized to facilitate reporting, with the help of an F-gases Manager containing two components:

- i) F-gases Manager-Chemicals contains a list of the F-gases listed in the <u>5th Assessment Report</u>, and allows for the addition of country-specific F-gases.
- ii) F-gases Manager-Blends provides a list of the blends contained in <u>table 7.8</u> of volume 3, chapter 7 of the 2006 IPCC Guidelines, and allows for the addition of country-specific blends.

The overall approach to use of the F-gases Manager is that the user must first specify which of the F-gases/ blends are either produced or consumed within the country. Only the selected list of F-gases/blends will be available for emission calculations at an individual IPCC category (i.e. worksheet) level. Then, the user refines the list of chemicals/blends consumed (including imported) and/or exported at the category level to include only those gases relevant for an individual category.

Entering information on F-gases and blends at the country level

Users first need to populate the F-gases Manager to identify the relevant F-gases/blends in the country before being able to input AD in the relevant category worksheets to estimate F-gas emissions.

To enter the relevant F-gases/blends:

1. On the Administrate tab, click IPPU and then F-gases Manager - Chemicals.

Application Database Inver	ntory Year	Administrate Worksheets	Tools	Export/Import Reports Window Help		- 8
2006 IPCC Categories 🚽 🗸	F-Gas En	Users		Emissions - Tier 2a F-Gas Emissions - Tier 2b		
2.E - Electronics Industry 2.E.1 - Integrated Circuit or S 2.E.2 - TFT Flat Panel Displa 2.E.3 - Photovoltaics	Workshee Sector: Categor Subcate	CO2 Equivalents	,	e Depleting Substances Air Conditioning		1990
2.E.4 - Heat Transfer Fluid	Sheet:	IPPU		F-Gases Manager - Chemicals		
2.E.5 - Other (please specify □ 2.F - Product Uses as Substitute	Data Subdivi		•	F-Gases Manager - Blends	IY 1990 GR (%) 3 d (years) 15 EF (%) 15 X (%) 0	
2.F.1 - Refrigeration and Air 2.F.1 - Refrigeration an 2.F.1.b - Mobile Air Cond	I. Total C II. Total	Waste Delete Inventory	•	D) the time series) (Bank(t))	2.368.322312 0 Bank(t) + EE + EF 2.368.322312	
2.F.2 - Foam Blowing Agents 2.F.3 - Fire Protection		Chemical Agent Emissions (across the Chemical Agent Recovered/Destroy		es) (ΣE) ed from equipment at end of life (across the time series) (ΣF)	2.368.322312	

Then a new window will appear.

F-	Gases	Vanager - Chemicals	-		×
		Chemicals - definition and applicability at country level			
Γ		Chemical group			V
	Ð- 🕨	HFCs			
	±)	PFCs .			
		SF6			
		NF3			
		Ethers and Halogenated Ethers			
	±)-	Other GHGs			
		Save	Undo	Clos	
		Save	Undo	Clos	se

Click on the [+] symbol to expand each group of species and select all F-gases which are used in the country or those that were produced in the country and not used, but exported. <u>Note that by default, the F-gases listed in Table 7.1</u> of volume 3, chapter 7 of the 2006 IPCC Guidelines are checked.

Click **Save** after selecting all F-gases.

	Chemicals definition (and applicability at country level		
Cs	Cł	nemical group		
	∆ 🗸 Chemical	Formula	AR5 GWP E	sumed and Exported at ountry leve
HFCs listed in Table 7.1	HFC-23	CHF3	12400	9
	HFC-32	CH2F2	677	_
	HFC-43-10mee	CF3CHFCHFCF2CF3	1650	Sec.
	HFC-125	CHF2CF3	3170	S
	HFC-134a	CH2FCF3	1300	2
	HFC-152a	CH3CHF2	138	S
	HFC-143a	CH3CF3	4800	S
	HFC-227ea	CF3CHFCF3	3350	9
	HFC-236fa	CF3CH2CF3	8060	S
	HFC-245fa	CHF2CH2CF3	858	~
	HFC-365mfc	CH3CF2CH2CF3	804	2
Other HFCs with AR5 GWP	HFC-41	CH3F	116	
	HFC-134	CHF2CHF2	1120	
	HFC-143	CH2FCHF2	328	
	HFC-227ca	CF3CF2CHF2	2640	
	HFC-245ca	CH2FCF2CHF2	716	
	HFC-245cb	CF3CF2CH3	4620	
	HFC-245ea	CHF2CHFCHF2	235	
	HFC-245eb	CH2FCHFCF3	290	
	HFC-152	CH2FCH2F	16	
	HFC-161	CH3CH2F	4	
	HFC-236cb	CH2FCF2CF3	1210	
	HFC-236ea	CHF2CHFCF3	1330	
	HFC-263fb	CH3CH2CF3	76	
	HFC-272ca	CH3CF2CH3	144	

2. Users may add F-gases that are not listed in the **F-gases Manager-Chemicals**. They may add additional species for a particular group of chemics (e.g. user-defined HFCs) or for other groups not specifically listed.

To add a user-defined species, the user navigates to the bottom of the listed chemicals for that group (e.g. HFCs) and selects the asterisk. Information on the chemical name, formula and GWP value should be entered, and the box checked.

	(Z)-HFC-1336	CF3CH=CHCF3(Z)	2		
	HFC-1243zf	CF3CH=CH2	1		
	HFC-1345zfc	C2F5CH=CH2	1		
-	3,3,4,4,5,5,6,6,6-Nonafluorohex-1-ene	C4F9CH=CH2	1		
-	3,3,4,4,5,5,6,6,7,7,8,8,8-Tridecafluorooct-1-e	C6F13CH=CH2	1		
	3,3,4,4,5,5,6,6,7,7,8,8,9,9,10,10,10- Heptade	C8F17CH=CH2	1		
🐂 User-defined HFCs	User defined	User defined	1200		>
*				0	>
	Chemical gro	pup			~
PFCs					
PFCs SF6					
a second s					_
SF6					

To add a new type of chemical, users must click on the [+] symbol for Other GHGs and manually input information for the user-defined chemical and select **Save.** See example below.

		Chemical group		
PFCs				
SF6				
NF3				
Ethers and Halogenated Ethers				
Other GHGs				
	1	1	4	
				Consumed and/or Exported at country level
Other GHGs with AR5 GWP	Methylene bromide	CH2Br2	1	
	Chloroform	CHCI3	16	0
	1.2-Dichloroethane	CH2CICH2CI	1	
	Methyl chloride	CH3CI	12	
	Methylene chloride	CH2CI2	9	0
	2,2,2-Trifluoroethanol	(CF3)CH2OH	20	Ó
	2.2.3.3.3-Pentafluoropropan-1-ol	CF3CF2CH2OH	19	0
	1,1,1,3,3,3-Hexafluoropropan-2-ol	(CF3)2CHOH	182	0
	2,2,3,3,4,4,5,5-Octafluorocyclopentanol	-(CF2)4CH(OH)-	13	Ō
	Halon-1201	CHBrF2	376	0
	Halon-1202	CBr2F2	231	0
	Halon-1211	CBrCIF2	1750	0
	Halon-1301	CBrF3	6290	
	Halon-2301	CH2BrCF3	173	0
	Halon-2311 / Halothane	CHBrCICF3	41	ō
	Halon-2401	CHFBrCF3	41	0
	Halon 2402	CBrF2CBrF2	1470	0
	Sulphuryl fluoride	S02F2	4090	0
	Carbon tetrachloride	CCI4	1730	
	Methyl bromide	CH3Br	2	0
	Methyl chloroform	CH3CCI3	160	0
Other GHGs without AR5 GWP	Fluor	F2		Ö
	Carbonyl fluoride	COF2		ō
	C4F8O	C4F8O		0
	Perfluorotripropylamine	C9F21N		0
	Perfluorotributylamine	C12F27N		0
	Perfluoroisopropylmorpholine	C7F15NO		0
	Perfluoromethylmorpholine	C5F11NO		0
	Trifluoroiodomethane	CF3I		ō
	HFE-7300	1 1 1 2 2 3 4 5 5 5-decafluoro-3-methoxy-4-trifluoromethyl-pentane		0
	HFE-7500	3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-trifluoromethyl-hexane		ō
	Novec" 612	C3F7C(O)C2F5		
¥ User-defined Other GHGs	Add user-defined gas	Add formula	-	
*				

3. Then users can then proceed to enter information for the F-gases Manager-Blends via the Administrate tab, click IPPU and then F-gases Manager - Blends.

1990

A new window will appear.

4. Users need to select blends used (e.g. in the country if the inventory is being done at the national level). Note that: By default, the F-gases listed in <u>section</u> 7.5.1 of volume 3, chapter 7 of the 2006 IPCC Guidelines are checked. The full list of common blends is consistent with the blends identified in <u>Table 7.8</u>. Ideally, the AD used to estimate GHG emissions for categories that consume F-gases in calculation worksheets should be the individual chemical(s). In some cases, if information only on the blends consumed is known, they can be selected here and used for the purposes of calculating GHG emissions in the calculation worksheets. When emissions are calculated or reported for blends, the blends are broken down into constituents and thus emissions are calculated and reported for each constituent in the blend according to its % of composition (e.g. when emissions are calculated or reported for blend R-410A (figure below), 50% of emissions will be calculated and reported for HFC-32 and another 50% for HFC-125. The default composition is taken from table 7.8.

Care should be taken when estimating emissions to understand the source of AD and avoid double counting for a category. This could be possible if a user has information for consumption of two species of F-gas for the category, but those F-gases are then used to produce a blend, which is subsequently consumed. The user should not double count both consumption of the F-gases and the blend.

	Blends - definition a	and applicability at country level		
	∆⊽ Blend name	Composition	1	Consumed and/or Exported at country 7 level
Blends referenced in section 7.5.1 of the 2006 GL	R-410A	HFC-32/HFC-125 (50.0/50.0)		
Constituent		AR5 GWP	Composit (%)	ion
HFC-32		677	(76)	5
HFC-125		3170		5
11 0 120		500		-
	A √ Blend name	Composition		Consumed and/or Exported at country To level
Blends referenced in section 7.5.1 of the 2006 GL	R-404A	HFC-125/HFC-143a/HFC-134a (44.0/52)	0/4.0)	
	R-407C	HFC-32/HFC-125/HFC-134a (23.0/25.0/5	2.0)	
	R-507A	HFC-125/HFC-143a (50.0/50.0)		
Other blends	R-401A	HCFC-22/HFC-152a/HCFC-124 (53.0/13.0/3	4.0)	0
	R-401B	HCFC-22/HFC-152a/HCFC-124 (61.0/11.0/2	8.0)	
	R-401C	HCFC-22/HFC-152a/HCFC-124 (33.0/15.0/5	2.0)	0
	R-402A	HFC-125/HC-290/HCFC-22 (60.0/2.0/38.0)		0
	R-402B	HFC-125/HC-290/HCFC-22 (38.0/2.0/60.0)		0
	R-403A	HC-290/HCFC-22/PFC-218 (5.0/75.0/20.0)		0
	R-403B	HC-290/HCFC-22/PFC-218 (5.0/56.0/39.0)		0
	R-405A	HCFC-22/ HFC-152a/ HCFC-142b/PFC-318	(45.0/7.0/5.5/42.5)	0
	R-407A	HFC-32/HFC-125/HFC-134a (20.0/40.0/40.0)	0
	R-407B	HFC-32/HFC-125/HFC-134a (10.0/70.0/20.0)	0
	R-407D	HFC-32/HFC-125/HFC-134a (15.0/15.0/70.0)	0
	R-407E	HFC-32/HFC-125/HFC-134a (25.0/15.0/60.0)	0
	R-408A	HFC-125/HFC-143a/HCFC-22 (7.0/46.0/47.0)	0
	R-410B	HFC-32/HFC-125 (45.0/55.0)		0
	R-411A	HC-1270/HCFC-22/HFC-152a (1.5/87.5/11.0)	0
	R-411B	HC-1270/HCFC-22/HFC-152a (3.0/94.0/3.0)		0
	R-411C	HC-1270/HCFC-22/HFC-152a (3.0/95.5/1.5)		0
	R-412A	HCEC-22/PEC-218/HCEC-142b (70 0/5 0/25	0)	0

5. Also, users can input manually user-defined blends by clicking on the [+] symbol at the bottom of the window. To add a user-defined blend, the use must enter, row by row, each constituent of the blend, the GWP as taken from the AR5, and the composition of that constituent in the total blend. Only HFCs, PFCs, SF₆ and NF₃ contained in the blend that have a AR5 GWP need to be listed as constituents, and the respective % fraction of the entire blend recorded. Thus, the total composition need not equal 100%.

Example: Adding a user-defined blend

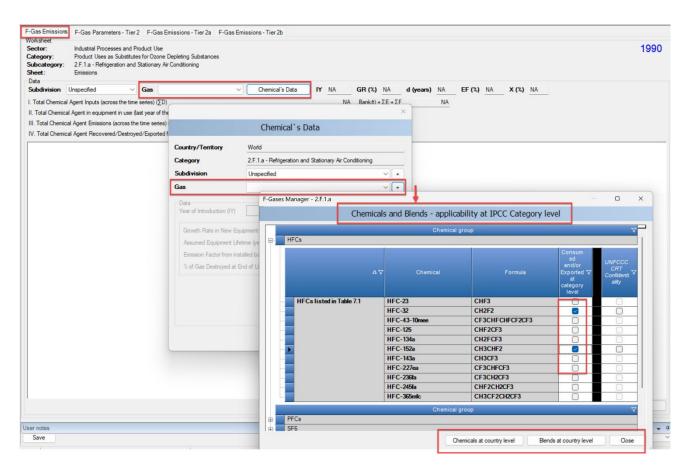
	siends - definition a	and applicability at country level			
ΔΥ	Biend name	Composition		onsumed and/or ported at country 5 level	7
	R-515A	HCFC-22/HFC-152a (82.0/18.0)			T
	R-515B	HCFC-22/HFC-152a (25.0/75.0)			T
	R-416A	HFC-134a/HCFC-124/HC-600 (59.0/39.5/1.5)			T
	R-417A	HFC-125/HFC-134a/HC-600 (46.6/50.0/3.4)			T
	R-418A	HC-290/HCFC-22/HFC-152a (1.5/96.0/2.5)			T
	R-419A	HFC-125/HFC-134a/HE-E170 (77.0/19.0/4.0)			T
	R-420A	HFC-134a/HCFC-142b (88.0/12.0)			T
	R-421A	HFC-125/HFC-134a (58.0/42.0)			1
	R-421B	HFC-125/HFC-134a (85.0/15.0)	1		1
	R-422A	HFC-125/HFC-134a/HC-600a (85.1/11.5/3.4)			1
	R-422B	HFC-125/HFC-134a/HC-600a (55.0/42.0/3.0)			+
	R-422C	HFC-125/HFC-134a/HC-600a (82.0/15.0/3.0)			_
	R-500	CFC-12/HFC-152a (73.8/26.2)			
	R-503	HFC-23/CFC-13 (40.1/59.9)			1
	R-504	HFC-32/CFC-115 (48.2/51.8)			+
	R-508A	HFC-23/PFC-116 (39.0/61.0)			+
	R-508B	HFC-23/PFC-116 (46.0/54.0)			+
	R-509A	HCFC-22/PFC-218 (44.0/56.0)			1
User-defined blends	hop	hop1 hop 2		\checkmark	
Constituent		AR5 GWP	Composition (%)		
		1		5	50
2,2,3,3,4,4,5,5-Octafluorocyclopentanol		13		5	50
*					
ΔΥ	Blend name	Composition		onsumed and/or ported at country ה level	7
*					

Entering information on F-gases and blends at the IPCC category level

Identifying the list of F-gases/blends relevant for the country is not sufficient to enter data on those chemicals and estimate GHG emissions, the user must then enter specific information in each category-level worksheet to identify the relevant F-gases for that category. After selecting the F-gases and blends relevant for the country in the Administrate tab, refinement of the list of F-gases/blends for consumption in a specific IPCC category level is carried out from within any relevant worksheet that handles calculations of F-gas emissions. In this step, the user may also flag if the consumption of an F-gas/blend for an individual category is considered confidential.

The figures below demonstrate how to identify the relevant F-gases for each category worksheet. There are two primary workflows to enter this information; one relevant for the tier 1 estimation methodology in category 2.F.1 Refrigeration and Air Conditioning and 2.F.2 Foams and for all tiers in 2.F.3 Fire Protection and one for all other categories.

Example: Identifying category level F gas and blend consumption: 2.F.1.and 2.F.2 (Tier 1 only) and 2.F.3



To identify the list of F-gases blends for Tier 1 in 2.F.1 and 2.F.2, and all of 2.F.3

- 1. Navigate to the relevant worksheet
- 2. The user will not see any available options for F-gases initial by selecting the drop-down menu
- 3. To identify the relevant F-gases /blends consumed, select Chemical's Data
- 4. In the Gas field, select the drop-down
- 5. The user will be presented with a list of all Chemicals and Blends identified at the country level. To view the list, select the [+] plus symbol. The user shall select, by checking the box, those F-gases and blends that are consumed in that category (in the figure above, for refrigeration and air conditioning Tier 1)
- 6. For users intending to use the GHG inventory information for purposes of reporting under the ETF of the Paris Agreement, and thus transmit information to the UNFCCC, they may indicate here if the consumption of gas in this application is considered Confidential. If designated as confidential, the AD on consumption will not be included in the JSON file submitted to the UNFCCC; and emissions will be transferred, along with any other confidential emissions of F-gases, in category 2.H. For more information, see Annex I.
- 7. The user may return to the main F-gases Manager by selecting "Chemicals at country level" or "Blends at country level" to add additional F-gases/blends for selection, other, **Close** the F-gases Manager here.

Example: Identifying category level F-gas and blend consumption: all other categories

2006 IPCC Categories 👻		Gas Emissions - Tier 2a F-Gas E	missions - Tier 2b			
2.D.3 - Solvent Use	Worksheet					
2.D.4 - Other (please specify)	Sector: Industrial Processes and Product					1990
- Electronics Industry	Category: Product Uses as Substitutes for O.					
2.E.1 - Integrated Circuit or Semiconductor	Subcategory: 2.F.1.a - Refrigeration and Station	ary Air Conditioning				
2.E.2 - TFT Flat Panel Display	Sheet: F-Gas Parameters - Tier 2					
2.E.3 - Photovoltaics	Data					
2.E.4 - Heat Transfer Fluid	F-Gases Manager 2					
2.E.5 - Other (please specify)						
- Product Uses as Substitutes for Ozone Depleting			Subdivisi	00		
2 F.1 - Refrigeration and Air Conditioning	F-Gases Manager - 2.F.1.a				— 🗆 X	3 2 1
2.F.1.a - Refrigeration and Stationary Air Conditioni						
2.F.1.b - Mobile Air Conditioning		Chemicals an	d Blends - applicability a	t IPCC Category level		
2.F.2 - Foam Blowing Agents	3					
2.F.3 - Fire Protection			Chemical group		4 V	
2 F.4 - Aerosols	HFCs					
2.F.5 - Solvents				1	Lange and the second seco	
2.F.6 - Other Applications (please specify)		47	Chemical	Formula	Consumed and/or Exported at	
- Other Product Manufacture and Use					category level	
2.G.1 - Electrical Equipment	HFCs listed in Table 7.1	HFC-23		CHF3		
2.G.1.a - Manufacture of Electrical Equipment	nr Cs listed in Table 7.1					
- 2.G.1.b - Use of Electrical Equipment		HFC-32		CH2F2		
2.G.1.c - Disposal of Electrical Equipment		HFC-43-	10mee	CF3CHFCHFCF2CF3		
2.G.2 - SF6 and PFCs from Other Product Uses		HFC-125		CHF2CF3		
-2.G.2.a - Military Applications		HFC-134		CH2FCF3		
- 2.G.2.b - Accelerators		1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1				
2.G.2.c - Other (please specify)		HFC-152		CH3CHF2		
2.G.3 - N2O from Product Uses		HFC-143	3	CH3CF3		
2.G.3.a - Medical Applications		HFC-227	80	CF3CHFCF3		
 2.G.3.a - Medical Applications 2.G.3.b - Propellant for pressure and aerosol produ 		HFC-236	a	CF3CH2CF3		
- 2.G.3.c - Other (Please specify)		HFC-245		CHF2CH2CF3		
2.G.4 - Other (Please specify)		HFC-365	nic	CH3CF2CH2CF3		
- Other			Chemical group			
2.H.1 - Pulp and Paper Industry	I DEC.		Crienical group			
2.H.2 - Food and Beverages Industry	PFCs					
2.H.3 - Other (please specify)	B SF6					
culture, Forestry, and Other Land Use	NF3					
- Livestock	Ethers and Halogenated Ethers					
3.A.1 - Enteric Fermentation	Other GHGs					
😑 3.A.1.a - Cattle						
- 3.A.1.a.i - Dairy Cows	Blends					
3.A.1.a.ii - Other Cattle						
- 3.A.1.b - Buffalo						
- 3.A.1.c - Sheep						
- 3.A.1.d - Goats						
				-		
Worksheet notes 👻	7			5		
				5		
	Us			•		
2000 (DOD 0 11)				· · · · · · · · · · · · · · · · · · ·		
Worksheet notes 2006 IPCC Guidelines				Chemicals at country level Blends a	t country level Close	
Worksheet notes 2006 IPCC Guidelines Country/Territory: World Inventory Year: 1990	dase year.			Chemicals at country level Biends a	t country level Close	12

To identify the list of F-gases blends for all other categories:

- 1. Navigate to the relevant worksheet
- 2. Select F-gases Manager
- 3. The user will be presented with a list of all Chemicals and Blends identified at the country level. To view the list, select the [+] plus symbol.
- 4. The user shall select, by checking the box, those F-gases and blends that are consumed in that category (in the figure above, for refrigeration and air conditioning Tier 2).
- 5. The user may return to the main F-gases Manager by selecting "Chemicals at country level" or "Blends at country level" to add additional F-gases/blends for selection, other, **Close** the F-gases Manager here.

<u>Note that</u>, unlike the case where the F-gases Manager was accessed through Chemical's Data, the user does not have the ability to indicate in this table if the F-gas/blend used in the application is confidential. This is because for the Tier 2 approach for Refrigeration and Air Conditioning (2.F1), and for Foams (category 2.F.2) further consumption is further broken down by application (e.g. domestic refrigeration or Polyurethane – Continuous panel). Confidentiality will be designated for these categories at the sub-application level (see sections 2.F.1 and 2.F.3 Refrigeration and Air Conditioning and 2.F.2 Foams (to be completed) for more information).

1.1.3 Use of multiple Tiers for reporting

The 2006 IPCC Guidelines provide methodological guidance to estimate anthropogenic GHG emission and removals according to three tier levels: Tier 1, Tier 2, Tier 3, where Tier 1 is the common default methodological approach that the IPCC Guidelines provide for all inventory compilers, while higher tiers are based on country-specific data on activity-dependant rates of GHG emissions and removals and likely have a higher spatial and temporal resolution of AD. Tier 2 may apply a different methodological approach¹, or the Tier 1 methodology approach with user-specific values for parameters and EFs and may further disaggregate the population of AD to apply condition-specific values of parameters and EFs. Tier 3 is generally² a country-specific methodological approach that, although consistent with IPCC good practice, has been designed specifically to better cope with the country-specific statistical population for which GHG emissions/removals are estimated or may be based on the direct monitoring of the source of GHG emissions.

¹E.g. cement production or iron and steel production.

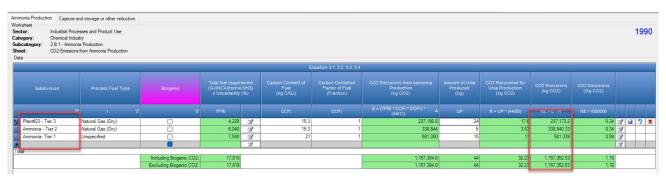
² In some cases, IPCC also provides a Tier 3 methodology, as for instance for HFC-23 emissions from HCFC-22 production.

Where a user-specific Tier 3 method, which cannot be calculated by the *Software*, is used to prepare estimates of GHG emissions that need to be included in the NGHGI for completeness, the user can use the relevant calculation worksheet(s) to report it as it follows:

- 1. enter in the Software the AD required by the IPCC default methodology.
- 2. back-calculate CO₂ and/or CH₄ and/or N₂O IEFs, as the total emissions of the relevant GHG calculated through the user-specific Tier 3 method divided by the AD required at bullet 1 above and enter those in the *Software*.
- 3. the *Software* then reproduces the user-specific Tier 3 GHG estimates.

A dedicated subdivision could be entered, e.g. specifically titled as "Tier 3" with any other identifying information, as appropriate. In doing so the user shall transparently describe in any accompanying inventory report the original methodology and the way it has derived the implied emission factor.

Given that the Software can calculate GHG emissions and removals for each source/sink category using any of the methodological tiers provided in the 2006 IPCC Guidelines, the user may apply a single methodological tier to the entire category or may use instead a combination of different tiers according to the significance of subcategories and data availability.



Example: Applying three different tiers¹

While the user may use a combination of Tiers within a single source/sink category, it may wish to apply multiple tiers to the same activity as a means of quality control through comparative analysis (e.g. Tier 1 vs Tier 2 or Tier 2 vs Tier 3). Although this is a legitimate use of the *Software*, those comparative analysis shall be done in a separate database not used for reporting the GHG inventory so avoiding double counting GHG emissions from a source category.

1.1.4 Reporting of Subdivisions

GHG inventories may be calculated at multiple levels of aggregation (e.g. facility, corporate, regional, national) to meet various domestic and international needs. Thus, *Subdivisions* can be entered for all source categories in the IPPU sector.

Where the user is interested in calculating GHG estimates at a single level of aggregation, e.g. national, in <u>Column</u> |S| either *Unspecified* is to be selected from the drop-down menu or the single univocal name/code is to be entered e.g. the *country name*. Where the user is interested in calculating GHG estimates for multiple subdivisions, the univocal name/code for each subdivision will be entered in <u>Column |S|</u>, users have full flexibility to name those subdivisions based on user-specific circumstances. Nevertheless, care shall be taken to ensure that subdivisions do not overlap so causing a double counting of some emissions.

Every calculation worksheet² includes filters to enable the user to view data entry, by subdivision.

¹ In this example, Tier 1 – estimating fuel requirement based on ammonia production, Tier 2 – total fuel requirement for each fuel type, Tier 3 – fuel requirement for each fuel type at a specific plant. ² Those can also be referred as TABs of the *Software*

Example: subdivisions and applying filter

tegory: Che bcategory: 2.8.	strial Processes a mical Industry 2 - Nitric Acid Pro) Emissions from I		L.								19)9
					Equatio	n 3.5, 3.6						
Subdivis	ion	Production proces	ss / technology	Nitric acid production from technology i (tonnes)	N2O emission factor for technology type i (kg N2O/tonne nitric acid produced)	Destruction factor for abatement technology type j (Fraction)	Abatement system utilisation factor for abatement technology type j (Fraction)	N2O Emissions (kg)	N2O Emissions (Gg)			
	۵Ţ		ΔŢ	NAPi				E=NAPi*EFi(1- DFj*ASUFj)	E/1000000			
Kanagawa		High pressure plan	its	10,000	9	0.8	0.9	25,200	0.03	2		T
		Medium pressure		1,000	7	0.8	0.9	1,960	0	2		T
Tokyo		Plants with proces	s-integrated o	100	2.5	0.9	0.9	47.5	0		-	I
Unspecified		Unspecified		200,000	9	0.8	0.9	504,000	0.5		2	1
	1									2		1
otal				011 100				504 007 C	0.52		 	_
				211,100				531,207.5	0.53			

Example: viewing filtered results

tegory: Chemical Industry bcategory: 2.B.2 - Nitric Acid	s and Product Use Production m Nitric Acid Production								199
			Equatio	n 3.5, 3.6					
Subdivision	Production process / technolog	Nitric acid production from technology i (tonnes)	N2O emission factor for technology type i (kg N2O/tonne nitric acid produced)	Destruction factor for abatement technology type j (Fraction)	Abatement system utilisation factor for abatement technology type j (Fraction)	N2O Emissions (kg)	N2O Emissions (Gg)		
Δ	v ij ∆*	7 NAPI				E=NAPi*EFi(1- DFj*ASUFj)	E/1000000		
	High pressure plants	10,000	9	0.8	0.9	25,200	0.03	3	
Kanagawa		. 1,000	7	0.8	0.9	1,960	0	3	
Kanagawa	Medium pressure combustion pl	. 1,000						2	

Example: Tiers and Subdivisions - Combination (Several Tiers in One Worksheet Table)

06 IPCC Categories 🗸 🗸	9 Glass Production - Tier 1/2 Class	Production - Tier 3 Capture an	d storage or other reduc	tion			
2 - Industrial Processes and Product Use ⊕ 2 A - Mineral Industry 2 A 1 - Cement production 2 A 2 - Lime production 2 A 2 - Lime production © 2 A 4 - Other Process Uses of Carbonates	Category: Mineral Industry Subcategory: 2.A.3 - Glass Pro	ses and Product Use duction om Glass Production - Tier 1 / 2					
-2.A.4.a - Ceramics -2.A.4.b - Other Uses of Soda Ash				Equation 2.10, 2.11			
−2.4.4.c - Non Metallurgical Magnesia Productio −2.4.4.d - Other (please specify) −2.4.5 - Other (please specify) ⊂2.8 - Chemical Industry −2.8.1 - Ammonia Production	Subdivision	Meited glass of type	Production of glass type (tonne)	Emission factor for manufacturing of glass type (tonnes CO2/tonne Glass)	Cullet ratio for manufacturing of glass type (Fraction)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
		Metted glass of type ত i ০০ জ	type (tonne)	manufacturing of glass type	manufacturing of glass type		
			type (tonne)	manufacturing of glass type (tonnes CO2/tonne Glass)	manufacturing of glass type (Fraction)	(tonnes CO2)	(Gg CO2)

Example: Tiers and subdivisions – multiple (several tiers in different worksheet tables)

006 IPCC Categories 👻 🖣		materials - Tier 3 CO2 Emissions summary - Tier			
1.B.3 - Other emissions from Energy Production	Cement Production - Tier 1 (1/2) Cement Production - Tier 1 (1/2)	roduction - Tier 1 (2/2) Clinker production - Tier 2	CO2 Emissions from carbonates -	Tier 3 CO2 Emissions from u	ncalcined CKD not recycled to the
 	Sector: Industrial Processes and Pr Category: Mineral Industry Subcategory: 2.A.1 - Cement production Sheet: CO2 Emissions from Cemen Data	roduct Use t production - Tier 1 (1 of 2)			
 1.C.2 - Injection and Storage 1.C.2 a - Injection 			Equation 2.1		
1.C.2.b - Storage 1.C.3 - Other - 1.C.3 - Other	Subdivision	Individual Type of Cement Produced	Mass of Individual Type of Cement Produced (tonne)	Clinker Fraction in Cement (Fraction)	Mass of Clinker in the Individua Type of Cement Produced (tonne)
□ 2 - Industrial Processes and Product Use □ 2.A - Mineral Industry			(termey		(torinie)
2.A.1 - Cement production		- 47			
- 2.A.2 - Lime production	🚺 Kanagawa	masonry cement	100,000 🥑	0.8	80,00
- 2.A.3 - Glass Production		portland cement	150,000 🥑	0.9	135,00
= 2.A.4 - Other Process Uses of Carbonates	Tokyo	Plant 213	1,000 🥑	0.352	35
-2.A.4.a - Ceramics	Unspecified	Plant 211	56,410 🥑	0.351	19,799.9
2.A.4.b - Other Uses of Soda Ash		Plant 212	23,541 🥑	0.655	15,419.35
-2.A.4.c - Non Metallurgical Magnesia Productio	*		a		
2.A.4.d - Other (please specify)	Total				
- 2.A.5 - Other (please specify)			330.951		250.571.26

1.1.5 Biogenic fuels, feedstocks and reductants

Biogenic fuels may be used in the IPPU sector as a feedstock or a reductant (e.g. biochar), particularly in the chemical and metal industry. CO_2 emissions from use of biogenic fuels in the IPPU sector are not included in reporting tables of national GHG inventories, however, there may nevertheless be interest in tracking the use of these biogenic fuels.

All source categories in the IPPU sector in which use of biogenic fuels is possible include a separate column(s), in magenta, to allow the user to indicate that the fuel input used in the process is of biogenic origin. In addition, for these categories, totals are provided including and excluding biogenic CO₂. Note that emissions of CO₂ from biogenic origin in the IPPU sector will not be included in any JSON file generated for UNFCCC reporting.

Ammonia Production Worksheet Capture and storage or other reduction 1990 Sector Industrial Processes and Product Use Category Subcategory Sheet: Chemical Industry 2.8.1 - Ammonia Production CO2 Emissions from Ammonia Production Data otal fuel requirements NUNCV)/tonne NH CO2 Emissions from Ammonia 02 Emissio (Gg CO2) of Fuel (kg C/GJ) E = (TFRi * CCFi * COEi) * (44/12) R = UP nmonia - Tier 2 Natural Gas (Dry) 15.3 338 840 33 0.34 412,470.67 7,550 412,481.6 0.41 📝 🛃 mmonia- Tier 1 Landfill Gas 14.9 Plant#23 - Tier 3 Natural Gas (Dry) 4,228 2 15.3 237,190.0 24 17.6 237,173.2 0.24 2 17.81 988.516.4 44 988,484 0.9 10 268 21.27 0.58 Excluding Bioge 576.034.8 29 576.013.53

Example: designation of biogenic fuels in a source category

For these same categories, the *Capture and storage or other reduction* worksheet provides a column to allow the user to indicate if the CO_2 captured is of biogenic origin. Unlike the case with emissions of CO_2 of biogenic origin, the capture of CO_2 of biogenic origin will be included in any JSON file generated for UNFCCC reporting.

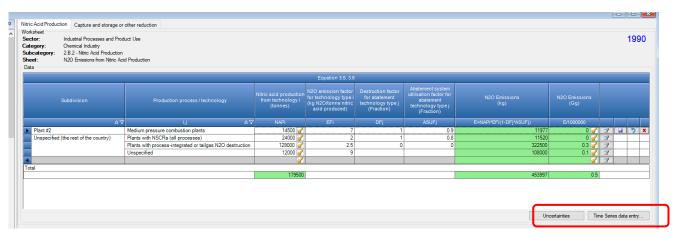
Example: Capture of biogenic CO₂

ector:	Industrial Processes and	Product Use									19	90
tegory:	Chemical Industry										10	~
bcategory:	2.B.1 - Ammonia Produc	tion										
eet:	Capture and storage or	other reduction										
sta												
as CARE	BON DIOXIDE (CO2)											
										_		
	Subdivision		Source		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	Biogenic			
	Subdivision	24	SRC	۵ . ۲	and stored				Biogenic ⊽			
Unspecifier	Subdivision	쇼 文 Unspecified	SRC	ΔV	and stored (tonne)	(tonne)	(tonne)	(Gg)		3	2	,
	Subdivision		SRC	^⊽	and stored (tonne)	(tonne)	(tonne)	(Gg)			2	

For more information on the reporting of emissions and removals of CO₂ of biogenic origin and reporting to the UNFCCC ETF Reporting Tool, see Annex I.

1.1.6 Uncertainty and Time Series data entry

To enter data on *Uncertainties* or to enter *Time Series data*, calculation worksheets have dedicated tabs that can be accessed through buttons placed at the lower right-hand side of the worksheet. Users may learn more about how to use these functionalities in the general *User Manual* of the *Software* ("Help" tab).



Example: tabs for uncertainties and time series data entry

Time series data entry

In each worksheet, there is a button *Time Series data entry* as shown in the screenshot below. After clicking on the tab *Time Series data entry* users can select the necessary parameters from the Parameters bar that can be exported/imported, depending on the information contained in each specific worksheet. To use this functionality, user must have the *Software* configured to include all inventory years in the time series, and each year must be populated with minimum identifying information (e.g. subdivision name and process technology/fuel, etc).

Example: Time series export/import

Nitric Acid Prode Worksheet Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Produ Chemical Industry	ct Use																					19	90
								Eq	uation 3.	.5, 3.6														
						Nitric acid p from tech (tonr	nology i	n for tech (kg N20	nission fi nnology f O/tonne i produce	type i nitric	Destructio for abat echnolog (Fract	ement gytypej	utilisa a techr	ement sys ition facto batement nology ty Fraction)	pej		N2O Emi (kg) Emission: (Gg)			
	ΔΥ	ij			ΔŢ	NA			EFi		DF	j		ASUFj		E=N	APi*EFi(1	-DFj*ASU			/1000000			
Plant #2 Unspecifit		Medium pressure combustion pl	ants		-		14500			7			1		0.9				1197			✓✓✓	J 7	X
Unspecifi	Time Series Data Entry																	- 1	o x	<		<u> </u>	-	+
	2.B.2 - Nitric Acid Production																					d 3 d 7		
Total	Category Chemical Ind Category code 2.B.2 - Nitric	Acid Production ns from Nitric Acid Production																		~		0.5		
	Subdivision	Production process / technology	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2007	2008	2009	2010	2020	tainti		Time Serie	a data entr	v
	Plant#2	Medium pressure combus	14500	14700	15000	14500	15700	16000	17800	18200	18600	19050	20000	19500	20500	21000	21500	25000	12000	Con ici		nine bene		
User notes	Unspecified (the rest of th.		24000		26000	27000			28900	29500	31500	31700	33600	33500		35000	36500	39000	19000					*
		Plants with process-integ	129000		135000					143300		138500	135650	138000	139000	135000	138000	145000	70000	-				_
		Unspecified	12000	12500	12900	13200	13400	13300	13100	13350	13600	13500	13100	13000	13500	14000	15000	16000	3000					
	This worksheet allows Ctrl+C/Ctrl+	V to copy/paste data. Only editabl	le cells ca	n be overwi	ritten wh	en pasting.						Exp	oort to Exc	cel	Import	from Exce	el 🛛	Save cu	urrent row					

To use this functionality users:

1. Select in TAB Application, sub-TAB Inventory Year, the time-period of the inventory and click on *Apply* to save it.

			1	Applicatio	on p	referer	nces			
General	Database	Worksheets	Reports	Inventory Y	'ear	Grid				
			Start inve	ntory year 2	005	•				
			End inve	ntory year 2	025	-				
	Base year fo	or assessment of	funcertain	ty in trend	005	-				
								ОК	Cancel	Apply

2. Ensure relevant identifying information is populated for each inventory year. The minimum information can be identified by selecting *Export to Excel* and noting the column headers. For example, for cement production, information on *Subdivision* and *Individual Type of Cement Produced* must be completed for each inventory year, while for nitric acid production, Subdivision and Production process/technology must be provided in order to be able to copy and paste underlying data into the exported data entry grids.

Example: Preparing for time series export/import

CO2 Emissions from carbon-bearing non-fuel m	aterials - Tier 3 (3/4)	CO2 Emissi	ons summ	ary - Tier	3 (4/4)	Capture	and storag	ge or othe	r reductio	n			
Cement Production (1/2) Compatible Production ((2/2) Clinker production	Tior 2	CO2 Emin	ninna fra	m anchan	ten Tier	2/1/4)	C025m	incione fr	om un only	ined CKE		lad to the ki
Time Series Data Entry											—		×
2.A.1 - Cement production													
Sector Industrial Processes and Proc	duct Use												
Category Mineral Industry													
Category code 2.A.1 - Cement production													
Sheet CO2 Emissions from Cement	production (1 of 2)												
Parameter Mass of Individual Type of Cemen	t Produced (tonne)												~
	Type of Cement 1988 oduced	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Unspecified Portland		2,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000

Industry Product Use Chemical Industry egory code 2.B.2 - Nitric Acid Production ameter Nitric acid production from technology i (tonnes) Subdivision Production process / technology 1988 1990 1991 1992 1993 1994 1996 1997 1998 1999 2000 2001 Kanagawa High pressure plants 10.000 Image: Colspan="6">Image: Colspan="6" Image: Colspan="6" Image: Colspan="6" Image: Colspan="6" Image: Colspan="6" Image: Colspan="6" Image: Col	2.B.2 - Nitric Acid Production														
Subdivision Production process / technology 1988 1990 1991 1992 1993 1994 1996 1997 1998 1999 2000 2001 Kanagawa High pressure plants 10.000	Sector Industrial P Category Chemical Ir Category code 2.B.2 - Nitri	rocesses and Product Use ndustry ic Acid Production													
Subdivision technology 1986 1990 1991 1993 1993 1994 1995 1996 2000 <th>arameter Nitric acid produ</th> <th>ction from technology i (tonnes)</th> <th></th>	arameter Nitric acid produ	ction from technology i (tonnes)													
Medium pressure combus 1,000 Image: Combust Comb	Subdivision		1988	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Tokyo Plants with process-integ 100 100 100 100 100 100 100 100 100	Kanagawa	High pressure plants		10,000											
		Medium pressure combus		1,000											
Unspecified Unspecified 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0 200.0	Tokyo	Plants with process-integ		100											
	Unspecified	Unspecified		200,0	200,0	200,0	200,0	200,0	200,0	200,0	200,0	200,0	200,0	200,0	200,0

- 3. Select the *Export to Excel* button, name and save the file.
- 4. Users can open this exported file and make changes directly there for various years. Users can make changes in all white cells.
- 5. Once changes are made, then users can import the modified file into the *Software* (by clicking the *Import from Excel* button).

Uncertainty

In some categories of the *Software* IPCC default uncertainty information for AD are automatically filled. For IPPU, further information on the underlying sources of uncertainty and the default uncertainty values that may be used when country-specific information is not available, can be found in the section titled "Uncertainty Assessment" of the 2006 IPCC Guidelines for each source category.

Please note that the Uncertainty Analysis has not yet been enhanced in this version, so this section will be revised in the next future.

Example: uncertainty data entry for AD and EFs

Nitric Acid Pr Worksheet Sector: Category: Subcatego Sheet: Data	Industrial Processes a Chemical Industry	duction											19	90
						Equation 3.5, 3.6								
	Subdivision	Production process / technology		cid production technology i (tonnes)	N2O emission factor for technology type i (kg N2O/tonne nitric acid produced)	Destruction factor for abatement technology type j (Fraction)	Abatement system utilisation factor for abatement technology type j (Fraction)		N2O Emissions (kg)	N2O Emissions (Gg)				
	ΔV	i,j ∆⊽		NAPi	EFi	DFj	ASUFj	E	=NAPi*EFi(1-DFj*ASUFj)	E/1000000				
Plant #		Medium pressure combustion pl		14000	7	1	0.0		11977		2		2	X
Unspec	cified (the rest of the coun	Plants with NSCRa (all processe Plants with process-integrated or	1	-				× 🔼	11520 322500	0 🥑 0.3 🥑	3			_
		Unspecified		-					322500	0.3 🥑				
*		Chapterned			U	Incertainties			100000					
User notes				Lower Emission Fa	2.B.2 - Nitric Acid Proc N2O Emissions from N a Uncertainties -2.00 % (*) ctors Uncertainties NITROUS OXIDE (N2 0.00 % (*)	itric Acid Production Upper XO)	+2.00 % 🔄	IITROL	453997		Fime Se	ries da	ta enti	ıy ▼ ₽
				OK	0.00 % 🔄	Upper	+0.00 % 🔄							

1.1.7 Capture and storage or other reduction

In the IPPU sector all categories include the worksheet *Capture and storage or other reduction*. It contains information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates) or other GHG (e.g. recovery or destruction). The default assumption is that there is no CO_2 capture and storage taking place.

Three notes of importance regarding information included in this worksheet:

- 1. This worksheet is only to include the amount not accounted previously in other worksheets for the category (e.g. Tier 2 and Tier 3 may contain EFs or methodology which imply reduction/control technologies).
- 2. The amount of CO_2 or other GHGs included in this worksheet must be either permanently stored, or if not, either excluded from this worksheet, or the user must ensure that subsequent emissions are included elsewhere in the GHG inventory.
- 3. Care is to be taken to avoid double counting capture of CO₂ between the IPPU and Energy sectors. Any methodology taking into account CO₂ capture should consider that CO₂ emissions captured in the process may be both combustion and process-related. In cases where combustion and process emissions are to be reported separately, e.g. for cement production, inventory compilers should ensure that the same quantities of CO₂ are not double counted.

Example: Capture and storage or other reduction

2 Emissions fro											
1.1		laterials - Tier 3 (3/4)	CO2 Emissions su	nmary - Tier 3 (4/4) Capture and	storage of other reduction						
rksheet											~
	Industrial Processes and Pro	Juct Use								1	99
	Mineral Industry										
category:	2.A.1 - Cement production										
et:	Capture and storage or other	reduction									
	N DIOXIDE (CO2)	~									
	N DIOXIDE (CO2)	~									
	IN DIOXIDE (CO2)	v									
s CARBO				Amount CO2 captured and	Other reduction	Total reduction	Total reduction				
s CARBO	N DIOXIDE (CO2) Subdivision		ource	stored	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)				
s CARBO	Subdivision	s		stored (tonne)	(tonne)	(tonne)	(Gg)		T		
s CARBO		s		stored (tonne) ·		(tonne) C = A + B					
CARBO	Subdivision	s		stored (tonne)	(tonne)	(tonne)	(Gg)	0.1		2	
CARBO	Subdivision	S V SR		stored (tonne) ·	(tonne)	(tonne) C = A + B	(Gg)	0.1		. ?	

2. IPPU Sector – Categories Guidance

2.A Mineral Industry

2.A.1 Cement Production

Information

Section 2.2 of the 2006 IPCC Guidelines provides three Tiers to estimate CO₂ emissions from Cement Production. Countries may gather AD based on cement production data and an assumed clinker fraction of cement (Tier 1), clinker production data (Tier 2) or carbonates used for cement production (Tier 3).

GHGs

The Software includes the following GHG for the Cement Production source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X						

IPCC Equations

- $\checkmark \quad \text{Tier 1: } \underline{\text{Equations 2.1}} \text{ and } \underline{2.4}$
- ✓ Tier 2: <u>Equations 2.2</u> and <u>2.5</u>
- $\checkmark \quad \text{Tier 3: } \underline{\text{Equation 2.3}}$

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

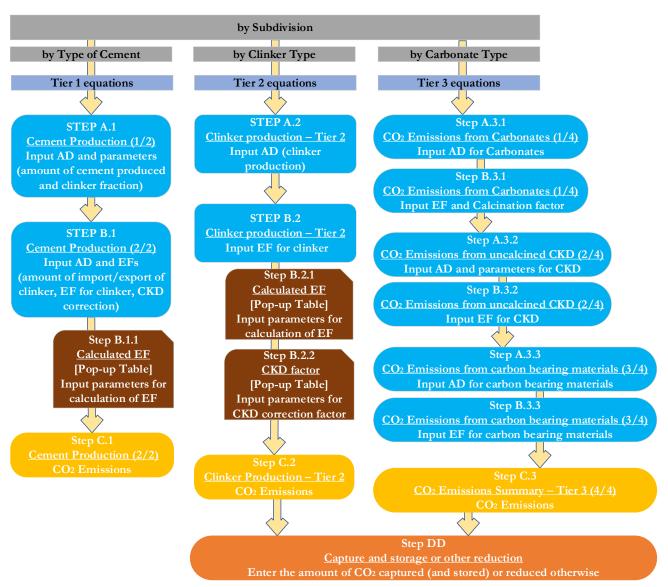
The *Software* calculates emissions of CO₂ from Cement Production using worksheets:

- ✓ Cement Production (1/2): contains for each subdivision and individual type of cement produced, information on the amount of cement produced and clinker fraction to estimate mass of clinker produced.
- ✓ **Cement Production (2/2):** contains for each subdivision information on import and export of clinker and the clinker CO₂ EF. The worksheet calculates the associated CO₂ emissions.
- ✓ Clinker Production Tier 2: contains for each subdivision information on the amount of clinker production, the clinker CO₂ EF and the correction factor for cement kiln dust (CKD), the latter which can be entered manually or calculated in the pop-window. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Carbonates Tier 3 (1/4): contains for each subdivision information on types of carbonates used: amount, CO₂ EF and fraction of calcination. The worksheet calculates the associated CO₂ emissions
- ✓ CO₂ Emissions from uncalcined CKD not recycled to the kiln Tier 3 (2/4): contains for each subdivision information on uncalcined carbonate in CKD not recycled to the kiln: amount of CKD and the weight fraction not recycled, calcination fraction and the CO₂ EF. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from carbon bearing materials Tier 3 (3/4): contains for each subdivision information on raw material types (additional carbon bearing materials): amount, carbon fraction and CO₂ EF. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions summary Tier 3 (4/4): this worksheet automatically sums up total emissions from the previous three worksheets of Tier 3
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision tree in <u>Figure 2.1</u> of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Cement Production.



Cement Production – flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Then, for each subdivision, if any:

When Tier 1 Equations are applied:

Step A.1, in the worksheets Cement Production (1/2), users collect and input in the *Software* information on the amount of each cement type produced and the clinker fraction of cement.

Step B.1, in the worksheet **Cement Production (2/2),** users enter in the amount of imported and exported clinker. The user then either calculates, using a pop-up table, or directly inputs the CO_2 EF for clinker and applies the CKD correction factor.

Step C.1, in the worksheet Cement Production (2/2), for each subdivision, CO₂ emissions are calculated in mass units (tonnes and Gg). In addition, total CO₂ emissions are calculated.

When Tier 2 Equations are applied:

Step A.2, in the worksheet Clinker Production – Tier 2, users collect and input in the *Software* information on the amount of each clinker type produced.

Step B.2, in the worksheet **Clinker Production – Tier 2,** users either calculate, using a pop-up table (**Step B.2.1**), or directly input the CO₂ EF for clinker. In **Tier 2** the information to estimate the correction factor for CKD not recycled to the kiln is also needed and is either calculated, using a pop-up table (**Step B.2.2**), or directly input.

Step C.2, in the worksheet **Clinker Production – Tier 2,** for each subdivision, CO₂ emissions are calculated in mass units (Gg). In addition, total CO₂ emissions are calculated.

When the Tier 3 Equation is applied:

Steps A.3 -A.3.3, in the three worksheets CO_2 Emissions from Carbonates – Tier 3 (1/4), CO_2 Emissions from uncalcined CKD not recycled to the kiln – Tier 3 (2/4), and CO_2 Emissions from carbon-bearing materials – Tier 3 (3/4), users collect and input in the *Software* information on types of carbonates used (amount and fraction of calcination), on uncalcined carbonate in CKD not recycled to the kiln (amount of carbonates, calcination fraction), and on raw materials types (additional carbon bearing materials – amount and carbon fraction).

Steps B.3.1-B.3.3, in the three worksheets CO_2 Emissions from Carbonates – Tier 3 (1/4), CO_2 Emissions from uncalcined CKD not recycled to the kiln – Tier 3 (2/4), and CO_2 Emissions from carbon bearing materials – Tier 3 (3/4), users input EFs based on carbonates used and for the uncalcined carbonate in CKD not recycled to the kiln.

Step C.3, in the worksheet CO_2 Emissions summary – Tier 3 (4/4), the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonnes and Gg). In addition, total CO_2 emissions are calculated.

Then, for Tier 2 and Tier 3, as appropriate:

Step DD, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates).

Activity data input

Section 2.2.1.3, Chapter 2, Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for cement production.

Input of AD for the Cement Production source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified)

Industrial Processes and Product U	Clinker production - Tier 2 CO2 Emissions from	carbonates - Tier 3 (1/4) CO2 Er	missions from uncalcined CKD not recycle	ed to the kiln - Tier 3 (2/4)				
Industrial Processes and Product U								
	se						19	990
Mineral Industry								
ory: 2.A.1 - Cement production								
CO2 Emissions from Cement produc	tion (1 of 2)							
		Equation 2.1						
	íi		30		-			_
			Olinius Essetion in Coment					
				(tonne)				
AX	A.V.			C-A/R		<u> </u>		
						-		L
ecified							-	
	Portland	2,000	0.95	1,900		_ lel	2	x
					3			
		3.000		2.650				
	CO2 Emissions from Cement produc	CO2 Emissions from Cement production (1 of 2) Subdivision Individual Type of Cement Produced	C02 Enissions from Cement production (1 of 2) Equation 2.1 Subdivision Individual Type of Cement Produced Cement Produced (Tonne) Cement Produced (Tonne) (Tonne) Cement Produced (Tonne) (Tonne) (Tonne) (Tonne) (Tonn	C02 Emissions from Cement production (1 of 2) Equation 2.1 Subdivision Individual Type of Cement Produced Mass of Individual Type of Cement Produced ((onn)) Mass of Individual Type of Cement Produced ((onn)) Mass of Individual Type of Cement Produced (fraction) Cilinker Fraction in Cement (fraction) Cilinker Fraction (fraction	Equation 2.1 Mass of Clinker In the Subdivision Individual Type of Cement Produced (torne) Clinker Fraction in Cement Produced (torne) Avg Avg Avg A B C-A/B Mass ory 1,000 0.75 7500 Portland 2,000 0.95 1,900	C02 Emissions from Cement production (1 of 2) Equation 2.1 Subdivision Individual Type of Cement Produced Inditing Indi	C02 Emissions from Cement production (1 of 2) Equation 2.1 Subdivision Individual Type of Cement Produced Mass of Individual Type of Cement Produced (Conne) Massory A T Mass of Individual Type of Cement Produced (Conne) Cement Produced Conney	Equation 2.1 Equation 2.1 Subdivision Individual Type of Cement Produced (torne) Subdivision Mass of Individual Type of Cement Produced (torne) Clinker Fraction in Cement (Fraction) Mass of Clinker in the Individual Type of Cement Produced (torne) Subdivision Mass of Clinker In the Individual Type of Cement Produced (torne) Clinker Fraction in Cement (Fraction) Mass of Clinker In the Individual Type of Cement Produced (torne) Mass of Mass o

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

2006 IPCC Categories 🗸 🗸	CO2 Emissions from carbon-bearing non-fuel	materials - Tier 3 (3/4) CO2 Emissions summary - Tier 3	3 (4/4) Capture and storage or oth	er reduction					
	Cement Production (1/2) Cement Production Worksheet Sector: Industrial Processes and Pro Category: Mineral Industry Subcategory: 2.A.1 - Cement production Sheet: CO2 Emissions from Cement Data		carbonates - Tier 3 (1/4) CO2 Er	nissions from uncalcined CKD not recycl	ed to the kiln - Tier 3 (2/4)			1	1990
I.C.2 - Injection and Storage I.C.2 a - Injection			Equation 2.1						
1.C.2.b - Storage 1.C.3 - Other Industrial Processes and Product Use	Subdivision	Individual Type of Cement Produced	Mass of Individual Type of Cement Produced (tonne)	Clinker Fraction in Cement (Fraction)	Mass of Clinker in the Individual Type of Cement Produced (tonne)				
2.A - Mineral Industry			A	8	C=A*B				
- 2.A.2 - Lime production	Kanagawa	Masonry	1,500	0.75	1,125	3			
- 2.A.3 - Glass Production	Unspecified	Masonry	1,000	0.75	750	3			
2.A.4 - Other Process Uses of Carbonates		Portland	2,000	0.95	1,900	3			
- 2.A.4.a - Ceramics	Tokyo	Portland	6,600	0.95	6.270	3	- Ini	2	×
-2.A.4.b - Other Uses of Soda Ash -2.A.4.c - Non Metallurgical Magnesia Produ	Totar					3			1
-2.A.4.d - Other (please specify) -2.A.5 - Other (please specify)			11,100		10.045				

When Tier 1 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Cement Production (1/2),** row by row, as follows:

- 1. <u>Column |Individual type of Cement Produced</u>]: select the type of cement produced from the drop-down menu, or, if unknown, select Unspecified (one row for each type of cement produced).
- 2. <u>Column |A|</u>: input the mass of individual type of cement produced, in tonnes.
- 3. <u>Column |B|</u>: select from the drop-down menu the clinker fraction in cement produced, fraction. If known, the user may directly enter an appropriate value. With this information, the worksheet calculates the clinker content of cement for each row.

Then, in worksheet Cement Production (2/2), for each subdivision:

1. <u>Column |A|</u>: automatically calculates the total clinker content for each subdivision.

Example: Automatic calculation of clinker content for each subdivision

rksheet sctor: Industrial Processes a tegory: Mineral Industry sbcategory: 2.A.1 - Cement produ seet: CO2 Emissions from C ata		2)								199
				 Equation 2						
		Imports for								
Subdivision	Mass of Clinker for Subdivision (tonne)	Consumption of Clinker (tonne)	Export of Clinker (tonne)		for the Clinker onne Clinker)		CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
Subdivision	Subdivision (tonne)	Consumption of Clinker				CKD correction				
	Subdivision (tonne)	Consumption of Clinker (tonne)	(tonne) C		onne Clinker)		(tonnes CO2)	(Gg CO2)	3	

2. <u>Column |B|</u>: input the amount of imported clinker, in tonnes.

3. <u>Column |C|:</u> input the amount of exported clinker, in tonnes.

When Tier 2 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Clinker production – Tier 2**, row by row, as follows:

- 1. <u>Column | Name of plant or type of clinker |</u>: Enter a name for plant/facility and/or type of clinker produced.
- 2. <u>Column | A |</u>: enter the amount of clinker production, in tonnes.

Example: **AD** for Tier 2 clinker production for each subdivision

orksheet		n - Tier 2 CO2 Emission	ns from carbonates - Tier	3 (1/4) CO2 Emissions	from uncalcined CKD not recycled to the kilr	n - Tier 3 (2/4)
ector: Industrial Processes an	nd Product Use					
ategory: Mineral Industry						
LA.1 - Cement product CO2 Emissions from Cli	tion nker Production - Tier 2					
ata	nker Production - Tier 2					
A.a.						
			Equa	ation 2.2		
Subdivision	Name of plant or type of clinker	Clinker production (tonnes)		mission Factor s CO2/tonne Clinker)	Correction Factor for Cement Kiln Dust (CF ckd) (dimensionless)	CO2 Emissions (Gg CO2)
7	A 2	A		В	с	D = A*B*C/10^3
Kanagawa prefecture	Plant #214	1,000	Specified	0.52	1.02 📝	
	Clinker #2	1400	Specified	0.53	1.02 📝	
Rest of the country	All other	1,001.2	Specified	5.19	1.02 📝	
					2	
÷		10 million (1997)				
e otal						

When Tier 3 Equations are applied:

For Tier 3, for each subdivision in <u>Column | Subdivision |</u>, there are three worksheets to input AD as follows:

i. CO_2 Emissions from Carbonates – Tier 3 (1/4):

- 1. <u>Column |i|</u>: select from the drop-down menu the type of carbonate used or enter in directly any user-specific carbonate.
- 2. <u>Column |Mi|</u>: for each subdivision/ carbonate type, users enter information on the mass of carbonate consumed, in tonnes.
- 3. <u>Column |Fi|</u>: enter fraction of calcination achieved for carbonate.

<u>Note that in the absence of actual data, it may be assumed that, at the temperatures and residence times achieved in cement (clinker) kilns, the degree of calcination achieved for all material incorporated in the clinker is 100 percent (i.e., Fi = 1.00) or very close to it.</u>

Example: **AD** for Tier 3 – Amount of carbonates consumed

ment Production (1/2) Cement Production (2/2) Clinker production - Tier 2 orksheet				ssions from carbonates - Tier	3 (1/4) CO2 Emissions from	rom uncalcined CKD not recycled to the kiln - Tier 3 (2/4)			
ector: ategory: ubcategory: heet:)ata	Industrial Processes and Prod Mineral Industry 2.A.1 - Cement production CO2 Emissions from carbonat								
				Equati	on 2.3 (1)				
Subdivision		Carbonate type		Mass of Carbonate consumed (tonnes)	Emission Factor (tonnes CO2/tonne carbonate)	Fraction calcination achieved for carbonate (Fraction)	CO2 Emissions from carbon (tonnes CO2)		
	Y	i.	∇	Mi	EFi	Fi 🛆	Ei = EFi * Mi * Fi		
Tokyo		CaCO3		12,200	0.44	1	5,36		
		MgCO3		2,000	0.52	1	1.04		
Rest of the country		CaCO3		5,000	0.44	1	2,19		
otal			_	10.000			0.00		
				19,200			8,60		

ii. CO_2 Emissions from uncalcined CKD not recycled to the kiln – Tier 3 (2/4):

<u>Note that</u> this worksheet will have the same subdivisions entered in the previous worksheet (1/4) available for selection from the drop-down menu. For each subdivision users enter the following:

- 1. <u>Column | Md |</u>: input weight or mass of CKD not recycled to the kiln, in tonnes.
- 2. <u>Column |Cd|:</u> input the weight fraction of original carbonate in the CKD (i.e., before calcination) not recycled to the kiln, fraction.

<u>Note that</u> because calcium carbonate is overwhelmingly the dominant carbonate in the raw materials, it may be assumed that it makes up 100 percent of the carbonate remaining in the CKD not recycled to the kiln. It is thus acceptable within good practice to set Cd as equal to the calcium carbonate ratio in the raw material feed to the kiln.

3. <u>Column |Fd|:</u> enter fraction of calcination achieved for CKD.

<u>Note that</u> for CKD, a Fd of <1.00 is more likely but the data may show high variability and relatively low reliability. In the absence of reliable data for CKD, an assumption of Fd = 1.00 will result in the correction for CKD to equal zero.

Example: AD for Tier 3 - amount of uncalcined CKD not recycled to the kiln

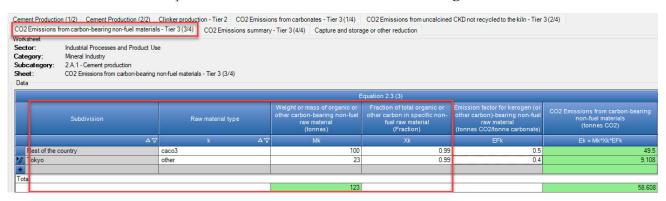
	-	aterials - Tier 3 (3/4) CO2E			_		
	ement Production (2/2) Clinker production - Tie	r 2 CO2 Emissions from ca	rbonates - Tier 3 (1/4)	CO2	2 Emissions from uncalcined C	KD not recycled to the kiln - Tier 3 (2/4)
Category: Mineral In Subcategory: 2.A.1 - Ce	ment production	uct Use nd CKD not recycled to the kiln -	Tier 3 (2/4)				
				Equation 2.3 (2))		
Subdivision		Weight or mass of CKD not recycled to the kiln (tonnes)	Weight fraction of original carbonate in the CKD not recycled to the kiln (Fraction)	Fraction calcination achieved for CKD no recycled to kiln (Fraction)		Emission factor for the uncalcined carbonate in CKD not recycled to the kiln (tonnes CO2/tonne carbon	CO2 Emissions from uncalcined CKD not recycled to the kiln (tonnes CO2)
	Δ7	Md		Fd		EFd	Ed = Md*Cd*(1-Fd)*EFd
Rest of the country		5,000	1		0.4	0.44	1,319
🖉 Tokyo		2,000	μ		0.4	0.44	527
*							
Total							
		7,000					1,846

iii. CO_2 Emissions from carbon-bearing materials – Tier 3 (3/4):

<u>Note that</u> this worksheet will have the same subdivisions entered in worksheet (1/4) available for selection from the drop-down menu. For each subdivision users enter the following:

- 1. <u>Column |k|</u>: input the type of carbon-bearing non-fuel materials.
- 2. <u>Column |Mk|</u>: input the weight or mass of organic or other carbon-bearing non-fuel raw materials, in tonnes.
- <u>Column | Xk |</u>: input the fraction of total organic or other carbon in specific non-fuel raw material, fraction. <u>Note that</u> the CO₂ emissions from non-carbonate carbon (e.g., carbon in kerogen, carbon in fly ash) in the non-fuel raw materials can be ignored (set M_k • X_k • EF_k = 0), if the heat contribution from kerogen or other carbon is < 5 percent of total heat (from fuels).

Example: AD for Tier 3 – amount of carbon-bearing materials



Emission factor input

In the category 2.A.1 Cement Production there are two main factors used across Tiers (1, 2 and 3) to define the $CO_2 EF$: i) $CO_2 EF$ for clinker in tonnes of CO_2 per tonne of clinker (Section 2.2.1.2 and Equation 2.4 in Chapter

2 Volume 3 of the 2006 IPCC Guidelines) and ii) carbon content or CO₂ content of carbonates used, tonnes of CO₂ per tonne carbonate (<u>Table 2.1</u> in Chapter 2 Volume 3 of the 2006 IPCC Guidelines).

The first one $-CO_2$ EF for clinker – is used in the following worksheets and based on country-specific or default assumptions, as further elaborated below for each tier:

- ✓ Cement Production Tier 1 (2/2)
- ✓ Clinker Production Tier 2

The second EF - CO_2 EF for carbonates – is used in the following worksheets and based on stoichiometry or formula weights and CO_2 ratios in common carbonate species (e.g. calcite - $CaCO_3$)

- ✓ Clinker Production Tier 2 (for CKD)
- \checkmark CO₂ Emissions from Carbonates Tier 3 (1/4)
- \checkmark CO₂ Emissions from uncalcined CKD not recycled to the kiln Tier 3 (2/4)
- \checkmark CO₂ Emissions from carbon-bearing materials Tier 3 (3/4)

When Tier 1 Equations are applied:

The **Cement Production (2/2)** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of unique subdivisions in worksheet **Cement Production (1/2)** and the total mass of clinker in that subdivision. Then:

1. <u>Column |D|</u>: Select either *Specified* or *Calculated* for the CO₂EF.

✓ If specified, directly enter the default CO₂ EF for clinker of 0.51 tonne CO₂ per tonne of clinker (uncorrected for CKD), or instead enter a user-specific CO₂ EF.

Note that the Tier 1 default CO₂ EF assumes a default CaO content for clinker of 65 percent and 100 percent of the CaO comes from calcium carbonate material.

ategory: Mineral Ind abcategory: 2.A.1 - Cerr	ocesses and Product Us istry ent production ons from Cement product									199
					Equation 2.1					
	Mass of Clinker for Subdivision (tonne) (tonne) Export of Clinker (tonne) (tonne) (tonne)			Emis	sion Factor for the Clinker		CO2 Emissions	CO2 Emissions		
		Clinker			nnes CO2/tonne Clinker)		(tonnes CO2)	(Gg CO2)		
Subdivision	(tonne)	Clinker				CKD correction				
	(tonne)	Clinker (tonne)	(tonne)		nes CO2/tonne Clinker)		(tonnes CO2)	(Gg CO2)	3	
74	(tonne) 7 A	Clinker (tonne)	(tonne)	(tor	nnes CO2/tonne Clinker) D	E	(tonnes CO2) F = (A - B + C) * D * E	(Gg CO2) G = F / 1000		
۵.5 Kanagawa	(tonne) 7 A 840	Clinker (tonne)	(tonne)	(tor Specified	nnes CO2/tonne Clinker) D 0.51	E	(tonnes CO2) F = (A - B + C) * D * E	(Gg CO2) G = F / 1000	3	

Example: **Tier 1 EF for clinker**

✓ If calculated, the user may calculate the CO₂ EF based on user-specific information on percentages of CaO content of clinker and non-carbonate sources of CaO. To do this, select the edit box and enter in the user-specific information.

<u>Note that</u> for the default CaO composition: 1 tonne of clinker contains 0.65 tonnes CaO from CaCO₃. This carbonate is 56.03 percent CaO and 43.97 percent CO₂ by weight. The amount of CaCO₃ needed to yield 0.65 tonnes CaO is 0.65/0.5603 = 1.1601 tonnes CaCO₃ (unrounded). The amount of CO₂ released by calcining this CaCO₃ = 1.1601 • 0.4397 = **0.5101** tonnes CO₂ (unrounded). The Tier 1 is not corrected for MgO content. Assuming no correction for CKD, the rounded default EF for clinker is 0.51 tonnes CO₂ / tonne clinker.

2. <u>Column |E|</u>: Select from the drop-down menu the default correction factor for CKD, or enter a user-specific value, dimensionless.

Example: Calculating a Tier 1 EF for clinker

gory: category:	Mineral Indus 2.A.1 - Cemer	cesses and Product Us try nt production 1s from Cement producti										199
						Equation	2.1					
Subdivisi	on	Mass of Clinker for Subdivision (tonne)	Imports for Consumption of Clinker (tonne)	Export of Clinker (tonne)		Emission Factor for t (tonnes CO2/tonne		CKD correction	CO2 Emissi (tonnes CO		CO2 Emissions (Gg CO2)	
	۵V	A	В			i i	D C	Ē	F = (A - B + C)		G = F / 1000	
Kanagawa		840			Specified		0.51	1.	02	436.968	0.43697	
Kyoto		1425	0	(Specified		0.51			0004.054	0.00105	-
Tokyo Unspecified		6270 2650	25		Specified Calculated		0.51	1.	02	3261.654 1367.22599	3.26165 1.36723	-
dispectied		2000	25		Calculated		0.51044	1.	UZ	1367.22333	1.30/23	10
		11185								5065.84799	5.06585	
	Emission Fac	ctor					t t		×			
					E	quation 2.4						
		age CaO Content of linker (CaO) (%)	Percentage Non-ca sources of Ca (%)	O from ca sou	of clinker rbonate	CaO percentage of CaCO3 (%)	Total CaCO3 needed for tonne CaO (tonne)	CO2 from calcining 1 tonne CaCO3 (tonne)	Emission Factor (uncorrected for MgO) (tonnes CO2 / tonne Clinker)			
	-	A	B	C =.					G = E * F			
	100	65		0	65	56.03	1.16009	0.44	0.51044			

When Tier 2 Equations are applied:

For each subdivision/plant in worksheet **Clinker production – Tier 2**, then:

- 1. <u>Column |B|:</u> Select either *Specified* or *Calculated* for the CO₂ EF.
 - ✓ If specified, directly enter the default CO₂ EF for clinker of **0.51 tonne CO₂ per tonne of clinker**, uncorrected for CKD, or instead enter a user-specific CO₂ EF.
 - ✓ If calculated, the user may calculate the CO₂ EF based on user-specific information on percentages of CaO content of clinker and non-carbonate sources of CaO and, optionally, the percent of MgO derived from carbonate. To do this, select the edit box and enter in the user-specific information.

ment Production (1/2) Cement Produ srksheet sctor: Industrial Processes as ategory: Mineral Industry sbcategory: 2.A.1 - Cement produc meet: CO2 Emissions from Cl ata	nd Product Use	- Tier 2 CO2 Emissio	ins in our carbonates	1000(04)	OZ Emissions nom		or recycled to the knin -	10 3(24)		1	99
ata				Equation 2.2							
Subdivision	Name of plant or type of clinker	Clinker production (tonnes)	(1	Emission Fac tonnes CO2/tonne		Cement K	tion Factor for Sin Dust (CF ckd) nensionless)	CO2 Emissions (Gg CO2)			
Δ 7	ΔV	A			в		с	D = A*B*C/10^3			
Kanagawa prefecture	Clinker #2	1,400	Calculated			3	1.02 📝		3	a 7	
	Plant #214		Specified		0.51		1.02 📝		0.52 📝		
Rest of the country	All other	1,001.2	Specified		0.51		1.02 📝		0.52		_
Emission Fact	or	3,401.2	2					×	1.04		
			Ē	Equation 2.4							
Percent Content (Ci	of Clinker carbonate source aO) CaO		CaO percentage of CaCO3 (%)	Total CaCO3 needed for tonne CaO (tonne)	CO2 from calcining 1 tonne CaCO3 (tonne)	Emission Factor (uncorrected for MgO) (tonnes CO2 / tonne Clinker)	Percent MgO derived from carbonate (optional) (%)	Emission Factor (tonnes CO2 / tonne Clinker)			
	в	C = A - B	D	E=C/D	F	G = E * F	н	l = G + (H * 0.011)			
	and the second		56.03		0.44		0				

Example: Calculating a Tier 2 EF for clinker

 \checkmark <u>Column |C|</u>: Additional information is needed to estimate the correction factor for CKD not recycled into the kiln. The factor can be entered manually (the default is **1.02** (dimensionless)) or can be estimated based

on several input data and parameters (a pop-up table). To estimate the CKD factor for each subdivision and plant or type of clinker, select the edit box and enter the following information:

- Weight of CKD not recycled to the kiln (Md), tonnes.
 <u>Note that</u> it is assumed that 100 percent of the CKD is first captured. If any CKD vents to the atmosphere, an estimate of this quantity must be made and included in the Md.
- ✓ Weight of clinker produced (Mcl), tonnes.
- ✓ Fraction of original carbonate in the CKD (i.e., before calcination) (Cd), fraction <u>Note that</u> it is acceptable to assume that the original carbonate is all CaCO₃ and that the proportion of original carbonate in the CKD is essentially the same as that in the raw mix kiln feed.
- ✓ Fraction calcination of the original carbonate in the CKD, fraction (Fd)
- ✓ Emission factor for the carbonate (Table 2.1) (EFc), tonnes CO₂/tonne carbonate may be selected from the drop-down menu or manually entered.
- ✓ Emission factor for clinker uncorrected for CKD (EFcl), tonnes CO₂/tonne clinker Note that the EF should be equal to the EF specified/calculated in <u>Column |B|</u>

For example, in illustration below, for Md/Mcl = 0.2, Cd = 0.85, Fd = 0.5, original carbonate all $CaCO_3$ (hence EFc = 0.4397 tonne CO_2 / tonne carbonate), and EFcl = user value of 0.52 tonne CO_2 / tonne clinker, the CFckd = 1.072 (unrounded) - that is, this represents about a 7 percent addition to the CO_2 calculated for the clinker alone

CO2 Emissions from carbon-bearing non-fuel materials - Tier 3(24) CO2 Emissions summary - Tier 3 (4/4) Capture and storage or other reduction Cement Production (1/2) Cement Production (2/2) Clinker production - Tier 2 CO2 Emissions from carbonates - Tier 3 (1/4) CO2 Emissions from uncalcined CKD not recycled to the kiln - Tier 3 (2/4) Worksh Sector: Category: Industrial Processes and Product Use 1990 Mineral Industry Subcate 2.A.1 - Cement production CO2 Emissions from Clinker Production - Tier 2 She Data Clinker production Emission Factor nes CO2/tonne Clink CO2 Emissions (Gg CO2) IPCC Inventory Software Kanagawa prefectur Correction Factor for Cement Kiln Dust, CF ckd Rest of the country Weight of CKD not recycled to the kiln (tonnes) Md Weight of clinker produced (tonnes), Mcl 1.000.000.00000 n of original carbonate in the CKD (i.e., before calcination) (fraction), Cd 0.85000 ? Fraction calcination of the original carbonate in the CKD (fraction), Fd 0.50000 ? on factor for the carbonate (tonnes CO2/ tonne carbonate), EFc 0.43971 ~ n factor for clinker uncorrected for CKD (tonnes CO2/tonne clinker), EFcl 0.52000 ? CE ckd 1 07188 Apply to worksheet cell Copy last Cance Time Series data entry. Uncertainties

Example: Pop-up table for CKD estimation (Tier 2 Cement Production)

When Tier 3 Equations are applied:

For each subdivision/carbonate type in worksheet CO_2 emissions from carbonates -Tier 3 (1/4):

1. <u>Column |EFi|</u>: the CO₂ EF is automatically populated in tonne of CO₂ per tonne of carbonate, based on the carbonate selected from the drop-down menu in column i. If a user-specific carbonate was entered in column i, enter the stoichiometric based EF for that carbonate in <u>Column |EFi|</u>.

Then, in worksheet CO₂ Emissions from uncalcined CKD not recycled to the kiln – Tier 3 (2/4):

 <u>Column | EFd |:</u> enter EF for the uncalcined carbonate in CKD, in tonnes CO₂/tonne carbonate. <u>Note that</u> because calcium carbonate is overwhelmingly the dominant carbonate in the raw materials, it may be assumed that it makes up 100 percent of the carbonate remaining in the CKD not recycled to the kiln. It is thus acceptable within good practice to set Cd as equal to the calcium carbonate ratio in the raw material feed to the kiln. Likewise, it is acceptable to use the emission factor for calcium carbonate for EFd.

Then, in worksheet CO₂ Emissions from carbon-bearing non-fuel materials – Tier 3 (3/4):

1. <u>Column |EFk|:</u> enter the EF for kerogen or other non-bearing non-fuel raw material, in tonnes CO₂/tonne carbonate.

Note that the CO_2 emissions from non-carbonate carbon (e.g., carbon in kerogen, carbon in fly ash) in the non-fuel raw materials can be ignored (set Mk $\cdot Xk \cdot EFk = 0$) if the heat contribution from kerogen or other carbon is < 5 percent of total heat (from fuels).

Results

CO₂ emissions from Cement Production are estimated in mass units (tonnes and Gg) by the *Software* for each row, and the total for all rows, in the following worksheets:

- ✓ For Tier 1: Cement Production Tier 1 (2/2)
- ✓ For Tier 2: Clinker Production Tier 2
- ✓ For Tier 3: CO₂ Emissions summary Tier 3 (4/4)

Total CO_2 emissions from cement production is the sum of all emissions in the above worksheets, taking into account any CO_2 capture with subsequent storage. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO_2 capture and storage.

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u> users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on other long-term reduction of CO₂ (e.g., re-conversion to carbonates),in tonnes. <u>Column |B|</u> may include short-term CO₂ capture only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.

			Ditto Cashies and	starsas as other reduction		
2 Emissions from carbon-bearing non-fuel	materials - Lier 3 (3/4) CO2 En	issions summary - Lier	r 3 (4/4) Capture and s	storage of other reduction		
rksheet ctor: Industrial Processes and Pi tegory: Mineral Industry bcategory: 2.A.1 - Cement production eet: Capture and storage or oth ata						
as CARBON DIOXIDE (CO2)	~					
as CARBON DIOXIDE (CO2) Subdivision	Source	Amou	nt CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)
Subdivision		Amoui A V	stored			
Subdivision	Source		stored (tonne)	(tonne)	(tonne)	(Gg)
Subdivision S	Source SRC		stored (tonne) A	(tonne)	(tonne) C = A + B	(Gg)
Subdivision S	Source SRC		stored (tonne) A	(tonne)	(tonne) C = A + B	(Gg)

Example: Capture and storage or other reduction

2.A.2 Lime Production

Information

Section 2.3 of the 2006 IPCC Guidelines provides three basic methodologies to estimate CO₂ emissions from Lime Production: an output-based approach using default values (Tier 1), an output-based approach that estimates emissions from CaO and CaO·MgO production and country-specific information for correction factors (Tier 2) and an input-based carbonate approach (Tier 3). Unlike the Tier 3 method which requires a plant-specific assessment, the Tier 1 and Tier 2 methods can be applied either to national, or where possible, plant statistics.

<u>GHGs</u>

The *Software* includes the following GHG for the Lime Production source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X						

IPCC Equations

- $\checkmark \quad \underline{\text{Tier 1:} Equation 2.8}$
- \checkmark <u>Tier 2: Equations 2.6</u> and <u>2.9</u>
- ✓ <u>Tier 3:Equation 2.7</u>

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The Software calculates emissions of CO2 from Lime Production using worksheets:

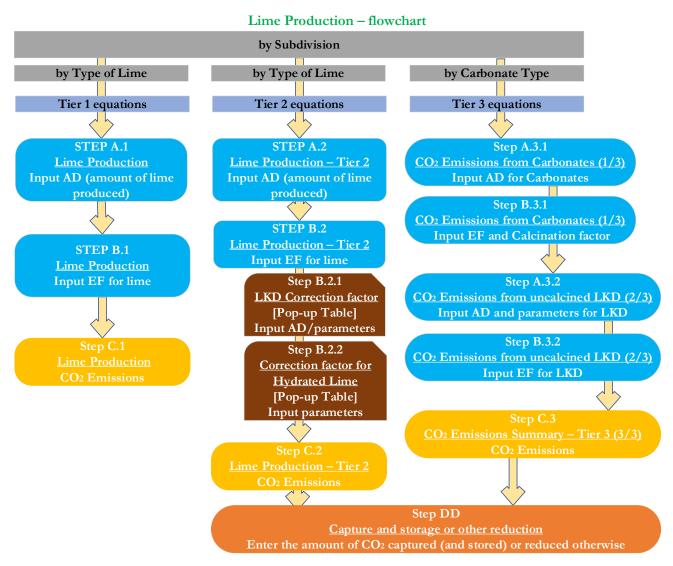
- ✓ Lime Production Tier 1: contains for each subdivision and type of lime produced: information on the amount of lime produced and the lime EF. The worksheet calculates the associated CO₂ emissions.
- ✓ Lime Production Tier 2: contains for each subdivision, name of plant and type of lime produced information on the amount of lime produced, the stoichiometric ratio of CO₂ from CaO (or CaO·MgO), CaO (or CaO·MgO) content, correction factor for lime kiln dust (LKD), and the correction factor for hydrated lime. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Carbonates Tier 3 (1/3): contains for each subdivision information on types and amounts of carbonates used, the CO₂ EF and fraction of calcination achieved. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from uncalcined LKD not recycled to the kiln Tier 3 (2/3): contains for each subdivision information on the amount of uncalcined carbonate in LKD not recycled to the kiln, the weight fraction of original carbonate in the LKD, the calcination fraction achieved and the CO₂ EF. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions summary Tier 3 (3/3): this worksheet automatically sums up total emissions from the previous two worksheets of Tier 3.
- ✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 2.2 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

To ease the use of the *Software* as well as to avoid its misuse the user follows the following flowchart for Lime Production.



Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step A.1, in the worksheet Lime Production – Tier 1, users collect and input in the *Software* information on the amount of each lime type produced.

Step B.1, in the worksheet Lime Production – Tier 1, users input an EF based on type of lime produced.

Step C.1, in the worksheet **Lime Production – Tier 1,** the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonnes and Gg). In addition, the total emissions are calculated.

When Tier 2 Equations are applied:

Step A.2, in the worksheet Lime Production – Tier 2, users collect and input in the *Software* information on the amount of each lime type produced, for each plant (if known).

Step B.2, in the worksheet **Lime Production – Tier 2,** users input EFs either based on type of lime produced. Information to estimate the correction factor for LKD not recycled to the kiln is needed (**Step B.2.0**) and for hydrated lime (**Step B.2.1**).

Step C.2, in the worksheet **Lime Production – Tier 2,** the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonnes and Gg). In addition, total emissions are calculated.

When the Tier 3 Equation is applied:

Step A.3.1, in the worksheets CO_2 Emissions from Carbonates – Tier 3 (1/3) users collect and input in the *Software* information on the types of carbonates used (amount and fraction of calcination) and in Step B.3.1, in the same worksheet, EFs based on carbonates used.

Step A.3.2, in the worksheet CO_2 Emissions from uncalcined LKD not recycled to the kiln – Tier 3 (2/3), users collect and input information on the amount of LKD not recycled to the kiln, the weight fraction of carbonates in the LKD and the calcination fraction achieved, and in Step B.3.2, in the same worksheet, information to estimate the correction factor for LKD not recycled to the kiln is entered.

Step C.3, in the worksheet CO_2 Emissions summary – Tier 3 (3/3), the *Software* calculates the associated CO_2 emissions in mass units (tonnes and Gg). In addition, the total emissions are calculated.

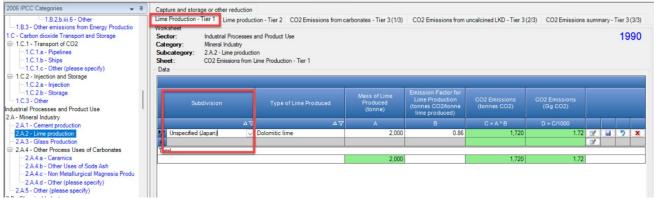
Then, for each tier, as appropriate:

Step DD, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates), not otherwise captured in the worksheets above.

Activity data input

Section 2.3.1.3, in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for lime production.

Input of AD for the Lime Production source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].



Example: single subdivision (unspecified)

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

2006 IPCC Categories 🚽 🕈	Capture and storage or other reductio	n							
1.B.2.b.iii.6 - Other	Lime Production - Tier 1 Lime produ	uction - Tier 2 CO2 Emissions from ca	rbonates - Tier 3 (1/3)	CO2 Emissions from u	uncalcined LKD - Tier 3 (2/3) CO2 Emissions	summ	ary - Tie	er 3 (3/3)
1.8.3 - Other emissions from Energy Productio 1.C - Carbon dioxide Transport and Storage 1.C.1 - Transport of CO2 1.C.1.a - Pipelines 1.C.1.b - Ships 1.C.1.c - Other (please specify) 1.C.2 - Injection and Storage	Category: Mineral Industry Subcategory: 2.A.2 - Lime product	s and Product Use ction I Lime Production - Tier 1							1990
- 1.C.2.a - Injection - 1.C.2.b - Storage - 1.C.3 - Other ndustrial Processes and Product Use 2.4 - Mineral Industry	Subdivision	Type of Lime Produced	Mass of Lime Produced (tonne)	Emission Factor for Lime Production (tonnes CO2/tonne lime produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
-2.A.1 - Cement production	Δ	√ ∆ ∇		B	C = A * B	D = C/1000			
2.A.2 - Lime production	rest of Japan	All lime production	2,000	0.75	1,500	1.5	2		7 ×
- 2.A.3 - Glass Production	Tokyo	Dolomitic lime	2,000	0.86	1,720	1.72	2		
- 2.A.4 - Other Process Uses of Carbonates		High-calcium lime	1,000	0.75	750	0.75	2		
-2.A.4.a - Ceramics							2		
 2.A.4.b - Other Uses of Soda Ash 2.A.4.c - Non Metallurgical Magnesia Produ 2.A.4.d - Other (please specify) 	Totar		5,000		3,970	3.97			

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Lime Production- Tier 1**, row by row, as follows:

1. <u>Column | Type of Lime Produced |</u>: select from the drop-down menu the type of lime produced. If the type of lime is unknown, select *All lime production*.

Note that, if type of lime is unknown, the 2006 IPCC Guidelines assume a breakdown of 85 percent high calcium lime / 15 percent dolomitic lime.

2. <u>Column |A|</u>: input the mass of each type of lime produced, in tonnes.

When Tier 2 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Lime Production- Tier 2**, row by row, as follows:

- 1. <u>Column |Name of plant|</u>: enter the name of a plant/facility. If unknown, select *Unspecified* from the drop-down menu.
- 2. <u>Column |Type of Lime Produced|</u>: select the type of lime produced from the drop-down menu or enter in a user-specific type of lime produced.
- 3. <u>Column |B|</u>: enter the amount of lime produced, in tonnes.

Example: **AD** for Tier 2 lime production for each subdivision

tegory: Mineral Indi bcategory: 2.A.2 - Lime	rocesses and Product Use ustry e production ons from Lime Production - ⁻	Tier 2							
				Equati					
Subdivision	Name of plant	Type of Lime Produced	Mass of Lime Produced (tonnes)	EF1 Stoichiometric ratio of CO2 and CaO or CaO*MgO (tonnes CO2/tonne CaO or CaO*MgO)	EF2 CaO content or CaO*MgO content (tonne CaO or CaO*MgO/tonne lime produced)	Correction Factor for Lime Kiln Dust (CF lkd) (dimensionless)	Correction Factor for Hydrated Lime (C h) (dimensionless)	CO2 Emissions (tonnes CO2)	CO2 Emissi (Gg CO2
				С	D	E		G = B*C*D*E*F	H = G/100
Δγ	Δ ₇	ΔΥ				-			
∆ ⊽ Kanagawa	∆ \7 Plant#1	△ ♥ High-calcium lime	2,000	0.79	0.95	1 🛃	0.97 🛃	1,449.74	
Kanagawa	Plant#1	High-calcium lime	2,000	0.79	0.95	1 📝	0.97 📝	1,449.74	
Kanagawa Tokyo	Plant#1 All plants	High-calcium lime High-calcium lime	2,000	0.79	0.95	1 🖉 1 🖉	0.97 📝	1,449.74 724.87	

When the Tier 3 Equation is applied:

For Tier 3, for each subdivision in Column |Subdivision|, there are two worksheets to input AD as follows:

i. CO_2 Emissions from Carbonates – Tier 3 (1/3):

1. <u>Column |i|</u>: select from the drop-down menu the type of carbonate used or enter in directly any user-specific carbonate.

2. <u>Column |Mi|:</u> for each subdivision/ carbonate type, users enter the mass of carbonate consumed, in tonnes.

Example: AD for Tier 3 – amount of carbonates consumed

ector: ategory: ubcategory: neet: ata	Industrial Processes and Prode Mineral Industry 2.A.2 - Lime production CO2 Emissions from carbonate		3)				
				Equatio	on 2.7 (1)		
	Subdivision		Carbonate type	Mass of Carbonate consumed (tonnes)	Emission Factor (tonnes CO2/tonne carbonate)	Fraction calcination achieved for carbonate (Fraction)	CO2 Emissions from carbonat (tonnes CO2)
	ΔŢ)	Mi	EFi	Fi	Ei = EFi * Mi * Fi
		CaCO3		250	0.44	1	105
Plant #1		Maco2		 200	0.52	1	104
Plant #1		MgCO3					
Plant #1 Plant#2		CaCO3	***************************************	 100	0.44	1	43
				100 120	0.44	1	43

ii. CO_2 Emissions from uncalcined LKD not recycled to the kiln – Tier 3 (2/3):

<u>Note that</u> this worksheet will have the same subdivisions entered in the previous worksheet (1/3) available for selection from the drop-down menu. For each subdivision users enter the following:

- 1. <u>Column |Md|</u>: input weight or mass of LKD not recycled to the kiln, in tonnes
- 2. <u>Column |Cd|</u>: input the weight fraction of original carbonate in the LKD (i.e., before calcination) not recycled to the kiln, fraction

<u>Note that</u> because calcium carbonate is overwhelmingly the dominant carbonate in the raw materials, it may be assumed that it makes up 100 percent of the carbonate remaining in the CKD not recycled to the kiln. It is thus acceptable within good practice to set Cd as equal to the calcium carbonate ratio in the raw material feed to the kiln.

Lime Production - Tier 1 Lime production - Tier 2 CO2 Emissions from carbonates - Tier 3 (1/3) CO2 Emissions from uncalcined LKD - Tier 3 (2/3) CO2 Emissions summary - Tier 3 (3/3) Capture and storage Worksheet Sector: Industrial Processes and Product Use Category Mineral Industry Subcategory 2.A.2 - Lime production CO2 Emissions from uncalcined LKD - Tier 3 (2/3) Sheet: Data ed carbonate i ight fraction of origin arbonate in the LKD Weight or mass of LKD (tonnes) calcinatio ed for LKD CO2 Emissions from uncald (tonnes CO2) Δ Ed = Md*Cd*(1-Fd)*El 0.95 0.44 Plant #1 1,000 0.9 0.97 0.44 Plant#2 200 b.4397 Tokyo 200 0.9 1,400 24 36

Example: AD for Tier 3 - Amount of uncalcined LKD not recycled to the kiln

Emission factor input

<u>Section 2.3.1.2</u> in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EF for Lime Production. IPCC default values for the Tier 1 and Tier 2 methods are contained in <u>Equation 2.8 and Table 2.4</u>, while the stoichiometric EF for use of each type of carbonates is found in <u>Table 2.1</u>. Then,

When the Tier 1 Equation is applied:

For each subdivision in worksheet Lime Production- Tier 1:

1. <u>Column |B|</u>: the default CO₂ EF is automatically populated, in tonnes CO₂/tonne lime produced, depending on the type of lime produced in <u>Column |Type of Lime Produced|</u>. The user may overwrite this value with user-specific information.

<u>Note that</u> the Tier 1 EF is based on stoichiometric ratios, which varies depending on the type of lime produced. The stoichiometric ratio is the amount of CO_2 released by the carbonate precursor to the lime, assuming that the degree of calcination was 100 percent and assuming no LKD. In the absence of country-specific data, the selection of All Lime Production as the type of lime produced assumes 85 percent production of high calcium lime and 15 percent production of dolomitic lime, which results in a default EF = 0.75 tonnes CO_2 / tonne lime produced.

Example: Tier 1 EF for lime – different types of limes

Category: Industr Category: Minera Subcategory: 2.A.2 -	ary: Mineral Industry tegory: 2.A.2 - Lime production : CO2 Emissions from Lime Production - Tier 1 Subdivision Type of st of Japan All lime production kyo High-calcium lime specified Dolomitic lime								
		,			_				
Subdiv		Type of Lime Pro		Mass of Lime Produce (tonne)	d	Emission Factor Productio (tonnes CO2/ton produced	n Ine lime	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
			V				۵	C = A * B	D = C/1000
rest of Japan		All lime production		2,0	000		0.75	1,500	
Tokyo		High-calcium lime		1,0	000		0.75	750	0.
Unspecified		Dolomitic lime			100		0.77	77	0
Tokyo		Dolomitic lime		2,1	000	C1	0.86	1,720	1
💥 Kanagawa				9	θ				
* Total		Lime Type		ission Factor / tonne lime produced)		Remark			
		All lime production		0.75				4,047	4
		High-calcium lime		0.75					
		Dolomitic lime		0.86	Develo	oped countries			
					and the second s	oping countries			
		Hydraulic lime		0.59					

When Tier 2 Equations are applied:

For each subdivision/name of plant/type of lime produced in worksheet Lime Production - Tier 2, then:

- 1. <u>Column |C|</u>: select from the drop-down menu the relevant stoichiometric ratio for the type of lime produced, tonnes CO₂/tonne CaO or tonnes CO₂/tonne CaO·MgO.
- 2. <u>Column |D</u>|: select from the drop-down menu the relevant CaO Content or CaO·MgO content, tonnes CaO/tonne lime or tonnes CaO·MgO/tonne lime.
- 3. <u>Column |E|</u>: Additional information is needed to estimate the correction factor for LKD not recycled into the kiln. The factor can be entered manually (the default is 1.02 (dimensionless)) or can be estimated based on several input data and parameters (a pop-up table). To estimate the LKD factor for each subdivision and plant and type of lime produced, select the edit box and enter the following information:
 - ✓ Weight of LKD not recycled to the kiln (Md), tonnes.
 - ✓ Weight of lime produced (Ml), tonnes.
 - ✓ Fraction of original carbonate in the LKD (i.e., before calcination) (Cd), fraction <u>Note that</u> it is acceptable to assume that the original carbonate is all CaCO₃ and that the proportion of original carbonate in the LKD is essentially the same as that in the raw mix kiln feed.
 - \checkmark Fraction calcination of the original carbonate in the LKD (Fd), fraction
- 4. <u>Column |F|</u>: Additional information is needed to estimate the correction factor for hydrated lime (see discussion under <u>Section 2.3.1.3</u> Chapter 2 Volume 3 of the 2006 IPCC Guidelines). The factor can be entered manually (the default is 0.97 (dimensionless)) or can be estimated based on the following input data and parameters (a pop-up table).
 - ✓ Proportion of hydrated lime (X), fraction
 - ✓ Water content (Y), fraction

Example: Tier 2 EF for lime production

19									Processes and Product Use dustry se production sions from Lime Production -	tegory: Mineral Inc bcategory: 2.A.2 - Lim
	CO2 Emissions (Gg CO2)	CO2 Emissions (tonnes CO2)	Correction Factor for Hydrated Lime (C h)	Correction Factor for Lime Kiln Dust (CF lkd)	EF2 CaO content or CaO*MgO content (tonne CaO or	EF1 Stotchiometric ratio of CO2 and CaO or CaO*MgO	Mass of Lime Produced (tonnes)	Type of Lime Produced	Name of plant	Subdivisien
			(dimensionless)	(dimensionless)	CaO*MgO/tonne lime produced)	(tonnes CO2/tonne CaO or CaO*MgO)				
	H = G/1000	G = B*C*D*E*F	F 0.97	E	D	C 0.70	8			Δ.5
		1,449.74 724.87	0.97	1 📝	0.95	0.79	2,000	High-calcium lime High-calcium lime	Plant#1 All plants	Kanagawa Tokyo
		2.562.41	0.9	1.01	0.95	0.79	3.500	Dolomitic lime	Unspecified	Unspecified
		942.33	0.9	12	0.95	0.79	1,300	High-calcium lime		
8 📝 🖬 🦻		1,478.73	þ.97. 📝	1.02 📝	0.95	0.79	2,000	High-calcium lime	1	Yokusko
			0.97 📝	2	/				1 D	
	7.16	7,158.08			-/-		9,800			otal
×			line (Ch)	or for Hydrated I	Commission To at				Kiln Dust (CF lkd)	rection Factor for Lime
	C h)	ated Lime ((tor for Hydra				F lkd)	r Lime Kiln Dust (C		
		ter since (t	in the try are			cium lime	High-cal			
ne	alcium lin	High-c				1,000.000.000	s), Md	ot recylcled to the kiln ¢onne	Weight of LKD no	
100	0.1	d lime, X	oportion of hydrate	Pri		900,000.000	es), MI	leight of lime produced (tonn	W	
280	0.2	ontent, Y	Water co			0.800	m). Cd	e. before calcination) (fraction	al carbonate in the LKD ().	Fraction of origin
972	0.0	Ch				.700	on), Fd	carbonate in the LKD (fraction	calcination of the original of	Fraction
116	0.5					1.622	Fikd	C		

When the Tier 3 Equation is applied:

For each subdivision/carbonate type in worksheet CO₂ Emissions from Carbonates – Tier 3 (1/3):

- 1. <u>Column |EFi|</u>: the EF is automatically populated in tonne of CO₂ per tonne of carbonate, based on the carbonate selected from the drop-down menu in column i. If a user-specific carbonate was entered in column i, enter the stoichiometric based EF for that carbonate in Column |EFi|.
- 2. <u>Column |Fi|:</u> enter fraction of calcination achieved for carbonate. <u>Note that</u> in the absence of actual data, it is consistent with good practice to assume that the degree of calcination achieved is 100 percent (i.e., Fi = 1.00) or very close to it.

ime Production - Tier 1 Lim	e production - Tie	2 CO2 Emiss	sions from carbonates -	Tier 3 (1/3)	CO2 Emissions fro	m uncalcined LKD - Tier 3 (2/3)) CO2 Emissions summar	y - Tier 3 (3/3)	Capture and storage
Category: Mineral Indu Subcategory: 2.A.2 - Lime									
					Equa	ion 2.7 (1)			
Subdivision		Ca	arbonate type	Ma	ss of Carbonate consumed (tonnes)	Emission Factor (tonnes CO2/tonne carbonate)	Fraction calcination achieved for carbonate (Fraction)		ons from carbonates nnes CO2)
	∆⊽		i 4	۵V	Mi	EFi	Fi	Ei =	EFi * Mi * Fi
Plant #1		CaCO3			250	0.44	1		109.9
		MgCO3			200	0.52	1		104.3
Plant#2		CaCO3			100	0.44	1		43.9
Tokyo		MgCO3			120	0.52	þ		62.6
Unspecified		CaCO3			1,000	0.44	1		439.7
*									
Total									
					1,670				760.64

Example: Tier 3 EF for lime production

Then, in worksheet CO₂ Emissions from uncalcined LKD not recycled to the kiln – Tier 3 (2/3):

- 1. <u>Column |Cd|</u>: enter the weight fraction of original carbonate in the LKD.
- 2. <u>Column |Fd|</u>: enter fraction calcination achieved for LKD. <u>Note that</u> in the absence of actual data, it is consistent with good practice to assume that the degree of calcination achieved is 100 percent (i.e., Fi = 1.00) or very close to it. For LKD, a Fd of <1.00 is more likely but the data may show high variability and relatively low reliability. In the absence of reliable
- data for LKD, an assumption of Fd = 1.00 will zero out the subtraction correction for uncalcined carbonate remaining in LKD.
 3. Column |EFd|: enter the EF for the uncalcined carbonate in LKD, tonnes CO₂/tonne carbonate <u>Note that because calcium carbonate is overwhelmingly the dominant carbonate in the raw materials</u>, in the absence of better data it may be assumed that it makes up 100 percent of the carbonate remaining in the LKD. It is thus consistent with good practice to set Cd equal to the calcium carbonate ratio in the raw material feed to the kiln. Likewise, in the absence of better data it is consistent with good practice to use the emission factor for calcium carbonate for EFd.

Example: Tier 3 EF for lime production - LKD

/orksheet						
ector:	Industrial Processes and Produ	uct Use				
ategory:	Mineral Industry					
ubcategory:	2.A.2 - Lime production					
heet:	CO2 Emissions from uncalcine	d LKD - Tier 3 (2/3)				
ata						
				Equation 2.7 (2)		
	Subdivision	Weight or mass of LKD (tonnes)	Weight fraction of original carbonate in the LKD (Fraction)	Fraction calcination achieved for LKD (Fraction)	Emission factor for the uncalcined carbonate in LKD (tonnes CO2/tonne carbonate)	CO2 Emissions from uncalcined LKD (tonnes CO2)
	$\Delta \nabla$	Md	Cd	Fd	EFd	Ed = Md*Cd*(1-Fd)*EFd
Plant #1		1,000	1	0.95	0.4	4 21
Plant#2		200	0.9	0.97	0.4	4 2
Tokyo		200	0.9	1	0.4	4
K						
otal						3
		1,400				24

Results

CO₂ emissions from Lime Production are estimated in mass units (tonnes and Gg) by the *Software* for each row, and the total for all rows, in the following worksheets:

- ✓ For Tier 1: Lime Production Tier 1
- ✓ For Tier 2: Lime Production Tier 2
- ✓ For Tier 3: CO₂ Emissions summary Tier 3 (3/3)

Total CO₂ emissions from lime production is the sum of all emissions in the above worksheets, taking into account any CO₂ capture with subsequent storage. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO₂ capture and storage.

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A| users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.</u>
- 3. <u>Column |B|</u>: users collect and input information on other long-term reduction of CO₂ (e.g., reconversion to carbonates), in tonnes. <u>Column |B|</u> may include short-term CO₂ capture only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.

							and a second s			
me Production -	- Tier 1 Lime production - Tier	2 CO2 Emissions from carbona	ates - Tier 3 (1	1/3) CO2 Emissions from un	calcined LKD - Tier 3 (2/3)	CO2 Emissions summary - Tier 3 (3	Capture and storag	e or oth	er reduct	ion
orksheet ector: ategory: abcategory: neet:	Industrial Processes and Produ Mineral Industry 2.A.2 - Lime production Capture and storage or other re									19
as CARB	BON DIOXIDE (CO2)	*								
	Subdivision	Source		Amount CO2 captured and stored	Other reduction	Total reduction	Total reduction			
				(tonne)			(Gg)			
	S AV	SRC	ΔV		(tonne) B	(tonne) C = A + B	(Gg) C / 1000			
Unspecified		SRC Unspecified	۵V	(tonne)				3		2
Unspecified		No. Contraction of the second s	ΔV	(tonne)				3	6	2
Unspecified		No. Contraction of the second s	۵V	(tonne)				-		2

Example: Capture and storage or other reduction

2.A.3 Glass Production

Information

Section 2.4 of the 2006 IPCC Guidelines provides three Tiers to estimate CO₂ emissions from Glass Production. Tier 1 method should be used where data are not available on glass manufactured by process or on the carbonates used in glass manufacturing. Tier 1 applies a default EF and cullet ratio to national-level glass production statistics.

Tier 2 is a refinement of Tier 1. Instead of collecting national statistics on total glass production, emissions are estimated based on the different glass manufacturing processes undertaken in the country (e.g., float glass, container glass, fibre glass, etc). Different manufacturing processes typically use different types and ratios of raw materials. Tier 2 method applies default EFs to each glass manufacturing process. The emission estimate must be corrected for the portion of recycled glass (cullet).

The Tier 3 methodology is based on accounting for the carbonate input to the glass melting furnace (similar to the methodology for Cement and Lime Production).

GHGs

The Software includes the following GHG for the Glass Production source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
X						

IPCC Equations

- \checkmark <u>Tier 1:Equations 2.10</u> and <u>2.13</u>
- ✓ <u>Tier 2: Equation 2.11</u>
- $\checkmark \quad \underline{\text{Tier 3: }} \underline{\text{Equation 2.12}}$

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The Software calculates emissions of CO2 from Glass Production using worksheets:

- ✓ Glass Production Tier 1/2: contains for each subdivision information on the amount of glass produced either at the national level (Tier 1, undifferentiated by type of glass) or by individual type of glass (Tier 2), the CO₂ EF and cullet ratio factor. The worksheet calculates the associated CO₂ emissions.
- ✓ Glass Production Tier 3: contains for each subdivision information on the type and amount of carbonate consumed, the CO₂ EF and the calcination fraction. The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

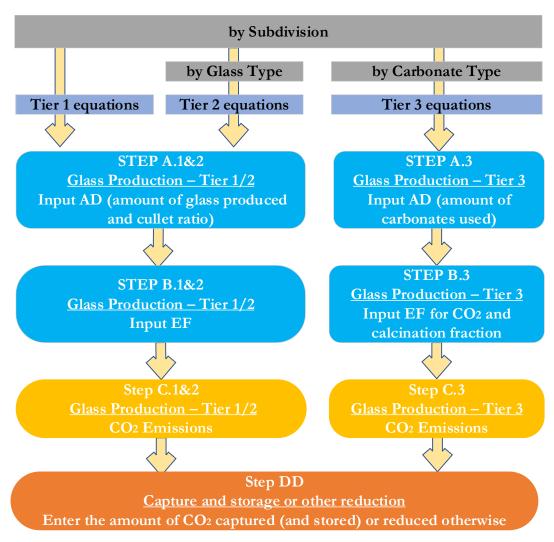
User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 2.3 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ and/or plant-specific EFs, or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Glass Production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different regionspecific EFs or applying to both regions the country-specific EF.

Glass Production - flowchart



Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When Tier 1 or Tier 2 Equations are applied:

Step A.1&2, in the worksheet Glass Production – Tier 1/2, users collect and input in the *Software* information on the total amount of glass produced and cullet ratio (Tier 1) or by each type of glass produced (Tier 2), e.g., float glass, container glass, fibre glass, etc.

Step B.1&2, in worksheet **Glass Production – Tier 1/2,** users input associated CO₂ EFs based on glass produced (either total glass production (Tier 1) or by each type of glass produced (Tier 2).

Step C.1&2, in the worksheet **Glass Production – Tier 1/2**, the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonnes and Gg) for Tier 1 and 2. In addition, total CO_2 emissions are calculated.

When the Tier 3 Equation is applied:

Step A.3, in the worksheet Glass Production – Tier 3, users collect and input in the *Software* information on the type and amount of carbonates consumed.

Step B. 3, in worksheet **Glass Production – Tier 3,** users input associated CO₂ EFs based on carbonates used and calcination fraction.

Step C.3, in the worksheet **Glass Production – Tier 3**, the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonnes and Gg) for Tier 3. In addition, total CO₂ emissions are calculated.

Then, for each tier, as appropriate:

Step DD, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates), not otherwise captured in the worksheets above.

Activity data input

Section 2.4.1.3, Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for glass production.

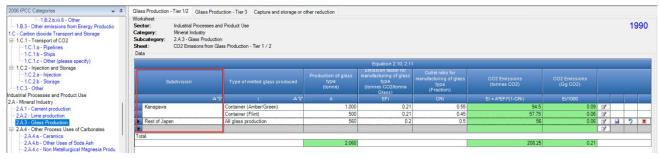
Input of AD for the Glass Production source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].



Example: single subdivision (unspecified)

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions



When Tier 1 and Tier 2 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Glass Production – Tier 1/2**, row by row, as follows:

- 1. <u>Column |i|</u>: select from the drop-down menu the type of melted glass produced, if known, or overwrite with a user-specific type of melted glass (Tier 2). If the type of melted glass is unknown, select from the drop-down menu *All glass production* (Tier 1).
- 2. <u>Column | A |</u>: input the mass of type of glass produced, in tonnes.
- 3. <u>Column |CRi|</u>: the cullet ratio for each type of glass produced will automatically be populated based on the type of glass produced, fraction. The user may overwrite with a user-specific cullet ratio.

<u>Note that</u> Tier 1 assumes a default cullet ratio of 50 percent. If country specific information is available for the average annual cullet ratio, countries are encouraged to modify the emission factor accordingly. Although the Tier 2 method provides typical default ranges for the cullet ratio (<u>Table 2.6</u> Chapter 2 Volume 3 of the 2006 IPCC Guidelines), if country-specific or plant-specific data are available countries are encouraged to collect these data. The midpoint of the range has been taken as the default.

Example: AD for Tier 1/2 – default cullet ratio ((ranges)	by type of glass
---	----------	------------------

orksheet cctor: Industrial Processes and	Product Use											1	99
tegory: Mineral Industry bcategory: 2.A.3 - Glass Production	ss Production - Tier 1 / 2												
				Equation 2.1	10, 2.11								
Subdivision	Type of melted glass pro		Production of glass type (tonne)	Emission factor manufacturing of type (tonnes CO2/to Glass)	giass	Cullet ratio for manufacturing of glass type (Fraction)		Emissions Ines CO2)	CO2 Emissions (Gg CO2)				
۵ ۷		ΔΥ		EFi		CRi			Ei/1000				
Kanagawa	Container (Amber/Green		1,000		0.21	0.55		94.5					
	Container (Flint)		500		0.21	0.45		57.75	0.06		4	<u> </u>	+
rest	Float		750	-	0.21	0.18		129.94	0.13		<u> </u>		+
Rest of Japan 7 Unspecified	All glass production All glass production	~	560 200		0.2	0.5		56 20	0.06	3		5	
Onspectned	Type of melted glass	_	ion factor for manufacturi	na of plans type		ratio for manufacturing o	Colore tupo	20		1.14	1.4	Ľ,	÷
otal	produced		(tonnes CO2/tonne C	Glass)		(Fraction)						17	-
	All glass production			0.2			0.5	Tier 1				11-	_
	Float			0.21			10% - 25%					11-	_
	Container (Flint)			0.21			30% - 60%					11	
	Container (Amber/Green)			0.21			30% - 80%						
	Fiberglass (E-glass)			0.19			0% - 15%				_	1	
	Fiberglass (Insulation)			0.25	1		10% - 50%					1	
	Specialty (TV Panel)	0		0.18			20% - 75%						
	Specialty (TV Funnel)			0.13			20% - 70%						

When the Tier 3 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Glass production – Tier 3**, row by row, as follows:

- 1. <u>Column |i|</u>: select from the drop-down menu the type of carbonate used or overwrite with user-specific carbonate.
- 2. <u>Column | Mi |:</u> for each subdivision/ carbonate type, users enter the mass of carbonate consumed, in tonnes.

Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Mineral Industry 2.A.3 - Glass Production CO2 Emissions from Glas								
						Equation 2.12			
	ubdivision		Carbonate type		Mass of Carbonate consumed (tonnes)	Emission Factor (tonnes CO2/tonne carbonate)	Fraction calcination achieved for carbonate (Fraction)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	ΔΥ		i	ΔV	Mi	EFi	Fi	Ei = EFi * Mi * Fi	Ei/1000
Plant#1		CaCO3			1,000	0.44	1	439.71	(
Plant#2		MgCO3			2,000	0.52	1	1,043.94	1
Plant#3		CaCO3			1,500	0.44	1	659.57	(
Flant#3		FeCO3			1,500	0.38	1	569.81	(
otal					6,000			2.713.02	2

Example: AD for Tier 3 – amount of carbonates consumed

Emission factor input

Section 2.4.1.2 in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EF for Glass Production.

There are two types of default EFs:

- i) CO₂ EF for glass produced in tonne CO₂ per tonne of glass produced Tier 1&2 (<u>Table 2.6</u> in Chapter 2 Volume 3 of the *2006 IPCC Guidelines*)
- ii) CO₂ EF for carbonates consumed (based on stoichiometry of carbonates) in tonnes of CO₂ per tonne of carbonate used Tier 3 (<u>Table 2.1</u> in Chapter 2 Volume 3 of the *2006 IPCC Guidelines*). Additionally, calcination fraction of carbonates is needed to make emission estimates.

When Tier 1 and Tier 2 Equations are applied:

For each combination of subdivision/type of melted glass produced in worksheet Glass Production – Tier 1/2:

1. <u>Column |EFi|</u>: the default CO₂ EF is automatically populated, in tonnes CO₂/tonne glass produced, depending on the type of melted glass produced in <u>Column |Type of melted glass produced|</u>. The user may overwrite this value with user-specific information.

orksheet ector: Industrial Processes and ategory: Mineral Industry ubcategory: 2.A.3 - Glass Production heet: CO2 Emissions from Gla									
Data				Equation 2.	10.2.11				
Subdivision	Type of melted glass produ	uced	Production of glass type (tonne)	Emission facto manufacturing of type (tonnes CO2/to Glass)	r tor I glass	Cullet ratio for nanufacturing of glass type (Fraction)		2 Emissions nnes CO2)	CO2 Emissions (Gg CO2)
Δγ	í	۵V	A	EFi		CRi	Ei = /	A*EFi*(1-CRi)	Ei/1000
Kanagawa	Container (Amber/Green		1,000		0.21	0.55		94.5	(
	Container (Flint)		500		0.21	0.45		57.75	(
rest	Float		750		0.21	0.18		129.94	¥
Rest of Japan	All glass production		560		0.2	0.5		56	
Unspecified	All glass production	V	200		0.2	0.5		20	
* Total	Type of melted glass produced		ion factor for manufactur (tonnes CO2/tonne (ng of glass type lass)		atio for manufacturing o (Fraction)	f glass type		Remark
	All glass production			0.2			0.5	Tier 1	
	Float			0.21			10% - 25%		
	Container (Flint)			0.21			30% - 60%	-	
	Container (Amber/Green)			0.21			30% - 80%		
	Fiberglass (E-glass)			0.19			0% - 15%		
	Fiberglass (Insulation)			0.25			10% - 50%		
	Specialty (TV Panel)			0.18			20% - 75%		
	Specialty (TV Funnel)			0.13			20% - 70%		

Example: Tier 1&2 EF for Glass Production

When the Tier 3 Equation is applied:

For each subdivision / carbonate type in worksheet Glass Production – Tier 3:

- <u>Column |EFi|</u>: the EF is automatically populated in tonne of CO₂ per tonne of carbonate, based on the carbonate selected from the drop-down menu in column i. If a user-specific carbonate was entered in column i, enter the stoichiometric based EF for that carbonate in <u>Column |EFi|</u>.
- <u>Column | Fi |:</u> enter fraction of calcination achieved for carbonate. <u>Note that</u> where the fraction calcination achieved for the particulate carbonate is not known, it can be assumed that the fraction calcination is equal to 1.00.

$\mathit{Example:}$ Tier 3 EF for glass production

ctor: Industrial Processes and Itegory: bcategory: 2.A.3 - Glass Production CO2 Emissions from Glas ata									
					Equation 2.12				
Subdivision	Carbonate type		Mass of Carbonat consumed (tonnes)	e	Emission Factor (tonnes CO2/tonne carbonate)		action calcination ieved for carbonate (Fraction)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
<u>۵</u> 7	Ť	۵V	Mi		EFI		Fi	Ei = EFi * Mi * Fi	Ei/1000
Plant#2	MgCO3		2.	000	0.52		1	1,043.94	
Plant#3	CaCO3		1.	500	0.44		1	659.57	
1	FeCO3			500	0.38		1	569.81	14
Unspecified	CaCO3			000	0.44		1	439.71	
<u> </u>	MgCO3	~	2.	000	0.52		1	1,043.94	
otal	Carbonate		lineral Name	(to	Emission Factor ines CO2/tonne carbona	te)		Remark	
	CaCO3	Calcite	or aragonite		0.43	971	high-magnesium or dol relatively small substit	mineral in limestone. Terms like omitic limestones refer to a ution of Mg for Ca in the general only shown for limestone.	
	MgCO3	Magnes	ite		0.52	197			
	CaMg(CO3)2	Dolomit	e		0.47	732	high-magnesium or dol relatively small substit	mineral in limestone. Terms like omitic limestones refer to a ution of Mg for Ca in the general only shown for limestone.	
	FeCO3	Siderite			0.37	987			
	Ca(Fe,Mg,Mn)(CO3)2	Ankerite	•		0.44	197	Fe. Mg. and Mn are pre	shown for ankerite assumes that sent in amounts of at least 1.0 ght range: 185.0225-215.6160. : 0.40822-0.47572	
	MnCO3	Rhodoci	hrosite		0.38	286			
	Na2CO3	Codium	carbonate or soda.		0.41	102	1		

Results

CO₂ emissions from Glass Production are estimated in mass units (tonnes and Gg) by the *Software* in the following worksheets:

- ✓ For Tier 1 and Tier 2: Glass Production Tier 1/2
- ✓ For Tier 3: Glass Production Tier 3

Total CO_2 emissions from glass production is the sum of all emissions in the above worksheets, taking into account any CO_2 capture with subsequent storage. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO_2 capture and storage.

In the worksheet **Capture and storage or other reduction** for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u> users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on other long-term reduction of CO₂ (e.g., reconversion to carbonates), in tonnes. <u>Column |B|</u> may include short-term CO₂ capture only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.

Example: Capture and storage or other reduction

tor: gory: category: et:	Industrial Processes and Produ Mineral Industry 2.A.3 - Glass Production Capture and storage or other re						
CARBO	ON DIOXIDE (CO2)	~					
	Subdivision	Source		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)
		Source	۵ <u>۲</u>	stored			Total reduction (Gg) C / 1000

2.A.4 Other Process Uses of Carbonates

Information

Section 2.5 of the 2006 IPCC Guidelines provides common methodological guidance for the following subcategories:

2.A.4.a Ceramics

2.A.4.b Other Uses of Soda Ash

2.A.4.c Non-Metallurgical Magnesia Production

2.A.4.d Other

Consistent with *good practice*, where carbonates are consumed in these industries, they are considered in the calculation worksheets of 2.A.4. Carbonates used in cement, lime and glass production have already been considered in previous sections of this Users' Guidebook. As discussed in <u>Section 2.3.1.1</u> Chapter 2 Volume 3 of the *2006 IPCC Guidelines*, all marketed and non-marketed production of lime should be reported under Lime Production. Where limestone is used for the liming of soils, the corresponding amount of carbonates should be excluded from the calculation worksheets in category 2.A.4, and rather included in the respective source category of the AFOLU sector. Where carbonates are used as fluxes or slagging agents (e.g., in iron and steel production, chemical production, or for environmental pollution control etc.), AD for that carbonate consumption should be included in those respective source categories.

The general methodological approach to estimate emissions from use of carbonates is to multiply the amount of carbonates consumed by the CO_2 EF and the fraction of calcination achieved.

GHGs

The Software includes the following GHG for the Other Process Uses of Carbonates source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
Χ						

IPCC Equations

- \checkmark <u>Tier 1</u>: <u>Equation 2.14</u>
- ✓ <u>Tier 2: Equation 2.15</u>
- \checkmark <u>Tier 3</u>: <u>Equation 2.16</u>

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

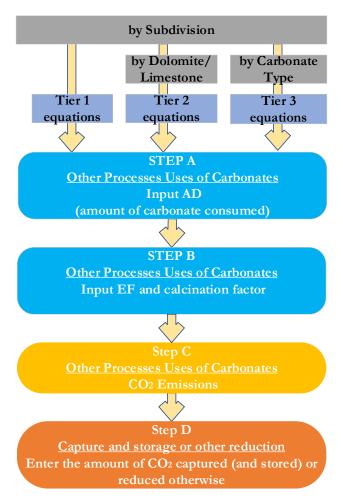
The Software calculates emissions of CO₂ from Other Process Uses of Carbonates using worksheets:

- ✓ Other Process Uses of Carbonates Tier 1/2/3: contains for each subdivision information on the amount of carbonate consumed either at the national level (Tier 1, undifferentiated by type of carbonate, total) or by specifying the amount of dolomite and limestone used (Tier 2) or by individual type of carbonate used (Tier 3), and the calcination fraction achieved. The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision tree in <u>Figure 2.4</u> of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Other Process Uses of Carbonates.



Other Process Uses of Carbonates - flowchart

Thus, for the relevant source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step A, in the worksheet **Other Process Uses of Carbonates – Tier 1/2/3,** users collect and input in the *Software* information on the amount of carbonate(s) consumed either at the national level (Tier 1, undifferentiated by type of carbonate, total) or by specifying the amount of dolomite and limestone used (Tier 2) or by individual type of carbonate used (Tier 3), as well as the calcination fraction achieved.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Step B, in the worksheet Other Process Uses of Carbonates – Tier 1/2/3, users collect and input associated CO₂ EFs based on type of carbonates used.

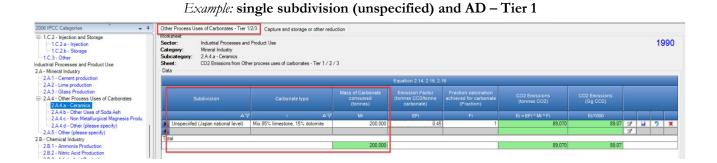
Step C, in the worksheet Other Process Uses of Carbonates – Tier 1/2/3, the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonnes and Gg). In addition, total CO₂ emissions are calculated.

Step D, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates).

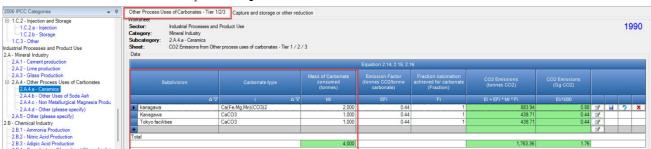
Activity data input

Section 2.5.1.3, Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Other Process Uses of Carbonates.

Input of AD for the Other Process Uses of Carbonates source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].



Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.



Example: multiple subdivisions – AD Tier 2 and Tier 3

Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Other Process Uses of Carbonates- Tier 1/2/3**, row by row, as follows:

- 1. <u>Column |i|</u>: select the type of carbonate from the drop-down menu or enter in a user-specific type.
- 2. <u>Column | Mi</u>]: input the mass of individual carbonate consumed, in tonnes. <u>Note that</u> in the Tier 1 method, the inventory compiler should collect AD for total carbonate consumption for emissive uses (see <u>Table 2.7</u> in Chapter 2 Volume 3 of the 2006 IPCC Guidelines). In the absence of better data, it is consistent with good practice for inventory compilers to assume that 85 percent carbonates consumed are limestone and 15 percent of carbonates consumed are dolomite. Tier 2 requires national level information only on total limestone and dolomite consumed.

Emission factor input

Section 2.5.1.2 in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EF for Other Process Uses of Carbonates.

Both Tier 1 and Tier 2 assume only limestone and dolomite are consumed; use of limestone results in 0.43971 tonne of CO_2 per tonne of limestone and dolomite, 0.47732 tonne of CO_2 per tonne of dolomite. For Tier 1, a ratio of 85 (limestone)/15 (dolomite) is assumed, resulting in an EF of 0.44535 tonne of CO_2 per tonne of carbonate. Tier 3 also applies stoichiometric EFs for CO_2 from carbonates which are provided in <u>Table 2.1</u> Chapter 2 Volume 3 of the 2006 IPCC Guidelines.

For each combination of subdivision/carbonate type in worksheet Other Process Uses of Carbonates – Tier 1/2/3:

- 1. <u>Column |EFi|</u>: the EF is automatically populated in tonne of CO₂ per tonne of carbonate, based on the carbonate selected from the drop-down menu in column i. If a user-specific carbonate was entered in column i, enter the stoichiometric based EF for that carbonate in <u>Column |EFi|</u>.
- 2. <u>Column |Fi|:</u> input the calcination fraction for each carbonate, fraction. <u>Note that</u> where the fraction of calcination achieved is unknown, it is consistent with good practice for the inventory compiler to assume that 100 percent calcination is achieved (i.e. enter 1.00 for <u>Column |Fi|</u>.

rksheet itegory: Industrial Processes a itegory: Mineral Industry bcategory: 2.A.4.a - Ceramics eeet: CO2 Emissions from C ata	r 1/2/3 Capture and storage or other redu and Product Use Wher process uses of carbonates - Tier 1 / 2 /						
			Equation 2.14, 2.15, 2.16				
Subdivision	Carbonate type	Mass of Carbonate consumed (tonnes)	Emission Factor (tonnes CO2/tonne carbonate)		ction calcination eved for carbonate (Fraction)	CO2 Emissions (tonnes CO2)	CO2 Emission: (Gg CO2)
	ΔV i	∆∀ Mi	EFi		Fi	Ei = EFi * Mi * Fi	Ei/1000
kanagawa	Ca(Fe,Mg,Mn)(CO3)2	2,000	0.44		1	883.94	
Kanagawa	CaCO3	1,000	0.44		1	439.71	
Tokyo facilities	CaCO3	V 1,000	0.44		1	439.71	
e otal	Carbonate	Mineral Name	Emission Factor (tonnes CO2/tonne carbo	onate)		Remark	
	Mix 85% limestone, 15% dolomite		0	.44535			
	CaCO3	Calcite or aragonite	O		high-magnesium or relatively small sub	pal mineral in limestone. Terms like dolomitic limestones refer to a stitution of Mg for Ca in the general amonly shown for limestone.	
	MgCO3	Magnesite	0	.52197			
	CaMg(CO3)2	Dolomite	a		high-magnesium or relatively small sub	pal mineral in limestone. Terms like dolomitic limestones refer to a stitution of Mg for Ca in the general amonly shown for limestone.	
	FeCO3	Siderite	0	.37987			
	Ca(Fe,Mg,Mn)(CO3)2	Ankerite	C	.44197	Fe, Mg, and Mn are percent. Formulae v	nge shown for ankerite assumes that present in amounts of at least 1.0 veight range: 185.0225-215.6160. nge: 0.40822-0.47572	
	MnCO3	Rhodochrosite	0	.38286			
	Na2CO3	Sodium carbonate or soda	0	.41492			

Example: Tier 1/2/3 EFs for other process uses of carbonates

Results

 CO_2 emissions from Other Process Uses of Carbonates are estimated in mass units (tonnes and Gg) by the *Software* in the worksheet **Other Process Uses of Carbonates – Tier 1/2/3**.

Total CO_2 emissions from other process uses of carbonates is the sum of all emissions of all subdivisions, taking into account any CO_2 capture with subsequent storage. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO_2 capture and storage.

In the worksheet **Capture and storage or other reduction** for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u> users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on other long-term reduction of CO₂ (e.g., reconversion to carbonates), in tonnes. <u>Column |B|</u> may include short-term CO₂ capture only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.

Example: Capture and storage or other reduction



2.A.5 Other

Information

There is no specific methodological guidance or worksheets for this source category in the 2006 IPCC Guidelines.

According to <u>Section 2.4.1</u> of the 2006 IPCC Guidelines, the source category 2.A.3 Glass Production includes emissions from the production of glass wool, a category of mineral wool, where the production process is similar to glass making. But, the term mineral wool may also be used to refer to natural rock- and slag-based wool. Where the production of rock wool is emissive these emissions should be reported under this source category 2.A.5.

Emissions related to slag production should be reported in the relevant metallurgical source category. The re-melting of slag to make mineral wool does not involve significant process-related emissions and does not need to be reported.

<u>GHGs</u>

The Software includes the following GHGs for the Other source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
X	Χ	Χ				

IPCC Equations

Given that there are no specific equations in the 2006 IPCC Guidelines for this category, a generic worksheet is thus provided to enable calculation of other emissions from mineral industry.

- 1. Tier 1: no IPCC Tier 1 Equation provided in the 2006 IPCC Guidelines.
- 2. <u>Tier 2</u>: IPCC basic equation with user-specific EF.
- 3. Tier 3: no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines.

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 2 basic equation.

Software Worksheets

The Software calculates emissions from Other (Mineral Industry) source category using worksheets:

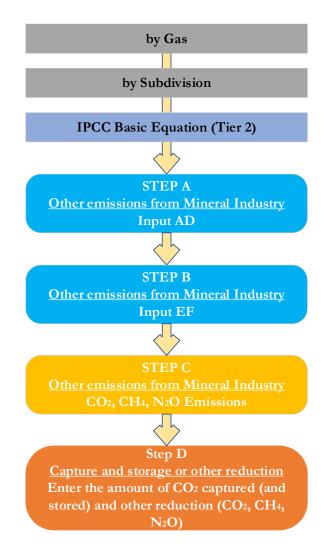
- ✓ Other: contains for each subdivision and source of emissions, information on the activity type, data and unit, and corresponding EFs. The worksheet calculates the associated CO₂, CH₄ and N₂O emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of GHG emissions, not accounted previously.

User's work Flowchart

GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Other Process Uses of Carbonates.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.



Other (Mineral industry) - flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step A, in Other worksheet, users collect and enter data on the source and AD.

Step B, in Other worksheet, users collect and enter in each row the associated EF.

Step C, in **Other** worksheet, for each row of data, the *Software* calculates the emissions in mass units (Gg). In addition, total emissions are calculated.

Step D, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input in the *Software* information on the amount of CO₂ captured (with subsequent storage) and/or other reduction of CO₂ (e.g., re-conversion to carbonates) or other GHG.

Activity data input

Input of AD for the Other source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |S| [e.g. "country name</u>" or "unspecified" as selected from the drop-down menu], or with subnational aggregations, and for each of those the univocal name/code entered in <u>Column |S|</u>.

For each subdivision in <u>Column |S|</u>, data are entered in worksheet **Other**, row by row, as follows:

- 1. <u>Column |SRC|</u>: describe the type of activity emitting GHG emissions from this category (e.g. rock wool production).
- 2. <u>Column |AT|</u>: enter the activity type corresponding to the source selected.
- 3. <u>Column | AD |</u>: enter AD (quantity).
- 4. <u>Column |U|: enter unit of the AD.</u>

Emission factor input

For each row of data entered in worksheet Other, data are entered as follows:

 <u>Column | EF |</u>: enter CH₄ or CO₂ or N₂O EF; <u>Note that</u> user shall select "Carbon dioxide (CO₂)" or "Methane (CH₄)" or "Nitrous Oxide (N₂O)" in the "Gas" bar at the top, to enter data for each GHG one by one.

$\it Example:$ multiple subdivisions, by gas

Worksheet Sector: Category: Subcatego Sheet: Data Gas	Other emissions CARBON DIOXIDE (CO2) CARBON DIOXIDE (CO2) IETHANE (CH4)	Product Use					
	IITROUS OXIDE (N2O) Subdivision	Source	Activity Type	Activity Data	Activity Data Unit	Emission Factor (Gg/U)	Emissions (Gg)
	S AV	SRC 47	7 AT AV	AD	U	EF	E = AD * EF
Kyoto		Rock wool	Unspecified	455	t	0.56	254.8
Rest of	Japan	rock wool	Unspecified	1,000	t	0.44	440
*							
Total							
				1,455			694.8

Results

Total CO₂, CH₄ and N₂O emissions from Other is the sum of all subdivisions in the above worksheet, taking into account any CO₂ capture with subsequent storage or other GHG reduction. The worksheet **Capture and storage** or other reduction is provided in the *Software* to estimate CO₂ capture and storage and other GHG reduction.

In the worksheet Capture and storage or other reduction for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on any other reduction of GHGs, in tonnes. <u>Column |B|</u> may include short-term CO₂ capture only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.

gory: Mine	strial Processes and Produc ral Industry	Use						
	5 - Other (please specify)							
	ure and storage or other red	uction						
CARBON DI	OXIDE (CO2)	~						
	DXIDE (CO2)							
METHANE (
NITROUS O	XIDE (N2O) bdivision				Amount CO2 captured and stored	Other reduction	Total reduction	Total reduction
5.			Source		(tonne)	(tonne)		(Gg)
Su	Daivision							
	s A	7	SRC	۵Ţ	A	B	C = A + B	C / 1000
		√ Unspecified	SRC	۵V		В	C = A + B	C / 1000

Example: Capture and storage or other reduction

2.B Chemical Industry

2.B.1 Ammonia Production

Information

The 2006 IPCC Guidelines provide three Tiers to estimate CO_2 emissions from Ammonia Production. Generally, all three Tiers require fuel consumption as AD: in the Tier 1 method - data are based on total ammonia production in the country multiplied by fuel requirement (gas, coal, oil) utilizing default EFs; Tier 2 – data are differentiated by process type and by fuel type (country-specific EFs) and Tier 3 – data should be obtained from producers of ammonia (plant-specific EFs).

<u>GHGs</u>

The Software includes the following GHG for the Ammonia Production source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
X	X	X				

The 2006 IPCC Guidelines do not contain methods for estimating CH₄ and N₂O emissions from ammonia production, however for interoperability with the UNFCCC ETF Reporting Tool, the *Software* allows these emissions to be calculated in category 2.B.11 Other. The source "CH₄ and N₂O emissions from ammonia production" is provided as a default dropdown in <u>Column |SRC|</u>. For further information, see description under section 2.B.11 Other.

IPCC Equations

- $\checkmark \quad \underline{\text{Tier 1}: \text{Equation 3.1}}$
- ✓ <u>Tier 2: Equations 3.2 and 3.3</u>
- ✓ <u>Tier 3</u>: <u>Equations 3.3 and 3.4</u>

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The Software calculates emissions of CO2 from Ammonia Production using worksheets:

- ✓ 1.1.1 Fuel Manager: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ Ammonia Production: contains for each subdivision (and for each process fuel type) information on the amount of ammonia produced and fuel requirement (Tier 1 and Tier 2) or only total fuel requirement (Tier 3), carbon content of fuels, oxidation factor and amount of urea produced from produced CO₂. The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheet for different Tiers.

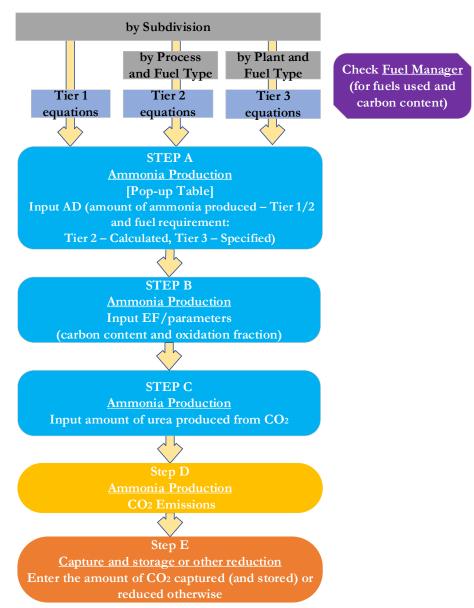
User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.1 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the Software as well as to avoid its misuse, the user follows the following flowchart.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Prior to following the flowchart below, the user shall collect and enter data in the **1.1.1 Fuel Manager** on each fuel used in ammonia production: its name, if not present among IPCC defaults, and the *calorific value* and the *carbon content* of each fuel, including for IPCC default fuels if user-specific values are available.



Ammonia Production - flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step A, in the worksheet **Ammonia Production,** users collect and input in the *Software* information on the amount of ammonia produced (Tier 1 and Tier 2 only) and fuel requirement (specified directly in Tier 3). Information is entered via a pop-up table.

Step B, in the same worksheet **Ammonia Production,** users collect and input information on the carbon content and oxidation fraction of fuels.

Step C, in the same worksheet **Ammonia Production**, users collect and input information on the amount of urea produced from the CO_2 generated from ammonia production (this will be deducted from total CO_2 emissions).

Step D, in the same worksheet **Ammonia Production**, the *Software* calculates the associated CO₂ emissions for each subdivision (and each fuel type) in mass units (kg and Gg). In addition, the total emissions are calculated.

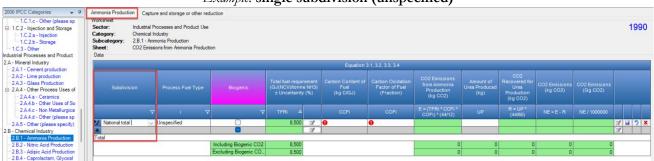
Step E, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., reconversion to carbonates) not accounted in Step C.

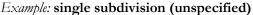
Activity data input

Section 3.2.2.3 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for ammonia production.

As a **Starting step**, users ensure that the **1.1.1 Fuel Manager** contains all fuels to be reported for ammonia production; and for each fuel listed in the Fuel Manager, the *calorific value* and the *carbon content* are entered or, for IPCC default fuels, are selected from the drop-down menu.

Second, input of AD for the Ammonia Production source category requires the user to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].





Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.



Categories - 4		pture and storage or other re	duction											
I.C.1.c - Other (please sp I.C.2 - Injection and Storage I.C.2.a - Injection I.C.2.b - Storage I.C.3 - Other strial Processes and Product	Category: Chemic Subcategory: 2.8.1-	al Processes and Product Use al Industry Ammonia Production nissions from Ammonia Produc											19	90
Industry ement production						Equation :	3.1, 3.2, 3.3, 3.4							
ent production production r Process Uses of - Ceramics - Other Uses of So	Subdivision	Process Fuel Type	Biogenic	Total fuel requ (GJ(NCV)/fonr ± Uncertaint	ne NH3)		Carbon Oxidation Factor of Fuel (Fraction)	CO2 Emissions from Ammonia Production (kg CO2)	Amount of Urea Produced (kg)	CO2 Recovered for Urea Production (kg CO2)	CO2 Emissions (kg CO2)	CO2 Emissions (Gg CO2)		
allurgica			7					E = (TFRi * CCFi * COFi) * (44/12)		R = UP * (44/60)		NE / 1000000		
pecify)	Plant#23 - Tier 3	Natural Gas (Dry)	0	4,228	1	15.3	1	237,190.8	24	17.6	237,173.2	0.24	7 8 7	×
	Ammonia - Tier 2	Natural Gas (Dry)		6,040	1	15.3	1	338,844	5	3.67	338,840.33	0.34	2	-
ion	Ammonia- Tier 1	Landfill Gas		7,550	3	14.9	1	412,481.67	15	11	412,470.67	0.41	3	-
oduction	*				3								3	
Production m, Glyoxal	Fotal													_
oduction			Including Biogenic CO					988,516.47	44			0.99		
Dioxide Prod			Excluding Biogenic CC	10,268				576,034.8	29	21.27	576,013.53	0.58		

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Ammonia Production**, row by row, as follows:

1. <u>Column |i|</u>: select each process fuel used from the drop-down menu (one row for each fuel). If unknown select Unspecified.

Note that fuels shown in the drop-down menu are those listed in the Fuel Manager.

- 2. <u>Column | Biogenic |:</u> indicate with a check if the process fuel is of biogenic origin.
- 3. <u>Column |TFRi |:</u> select the icon and input information in the pop-up table to estimate total fuel requirement.

In the pop-up table indicate if TFRj will be Calculated or Specified:

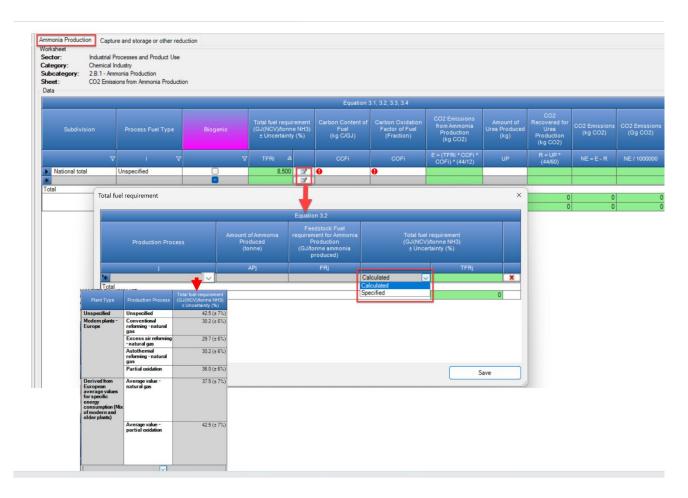
- i. If *Calculated* is selected (Tier 1 and Tier 2)
- 4. <u>Column |j|</u>: For Tier 1 select *Unspecified* or select a particular process from the default drop-down menu, for Tier 2 –specify production process type j either from the drop-down menu or manually input a user-specific process(es).
- 5. <u>Column | APj |</u>: input the mass of ammonia produced, in tonnes, either national total (Tier 1) or by process type (Tier 2).
- 6. <u>Column |FRj|</u>: the feedstock fuel requirement for ammonia production will be automatically populated based on the production process selected in <u>Column |j|</u>, in GJ/tonne NH₃ produced, or the user may overwrite.

Note that the Software automatically calculates the fuel requirement in the pop-up table and transfers the value into the main worksheet.

- ii. If *Specified* is selected (Tier 3)
- 4. <u>Column |TFRj|</u>: input the total fuel requirement for ammonia production for that subdivision (i.e. plant)/process fuel/production process.

<u>Note that</u> total fuel requirement includes fuel used for fuel plus feedstock. To avoid double counting, the amount of fuel used for ammonia production should be subtracted from fuel use included in the Energy Sector.

Example: entering AD for ammonia production -Tier 1/2/3



Emission factor input

Section 3.2.2.2 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Ammonia Production.

There are two types of EFs/parameters, with IPCC default values included in <u>Table 3.1</u> in Chapter 3 Volume 3 of the 2006 IPCC Guidelines:

- i) Carbon content of fuel, in kgC/GJ of fuel
- ii) Oxidation fraction of fuel, fraction

For each combination of subdivision/process fuel type/production process in worksheet Ammonia Production:

1. <u>Column |CCFi|</u> - the default carbon content of fuel from the **1.1.1 Fuel Manager** is automatically populated, in kgC/GJ, depending on the process fuel selected in <u>Column |i|</u>. The user may overwrite this value with user-specific information.

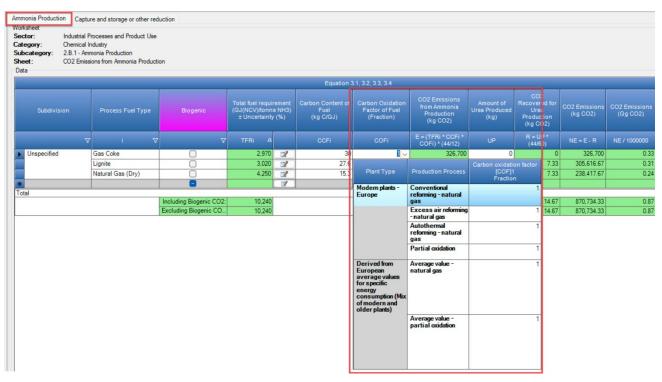
<u>Note that</u>: if Unspecified is selected in <u>Column</u> |i|, in accordance with good practice the value for <u>partial oxidation</u> shall be selected from the drop-down menu in column CCFi.

<u>Note that</u> the default carbon contents available in the drop-down menu assume either that the process fuel type is Unspecified (and thus partial oxidation is selected) or natural gas.

2. <u>Column |COFi|</u> - select from the drop-down menu the default carbon oxidation factor or enter a usercarbon oxidation factor.

Example: Tier 1 default EFs for ammonia production – carbon content

					Equation	3.1, 3.2, 3.3, 3.4						
Subdivision	Process Fuel Type	Biogenic	Total fuel requi (GJ(NCV)/tonn ± Uncertainty	e NH3)	Carbon Content of Fuel (kg C/GJ)	Carbon Oxidation Factor of Fuel (Fraction)	CO2 Emissions from Ammonia Production (kg CO2)		Mount of a Produced (kg)	CO2 Recovered for Urea Production (kg CO2)	CO2 Emissions (kg CO2)	CO2 Emissions (Gg CO2)
∆ 77	i AV	7	TFRI		CCFi	COFi	E = (TFRi * CCFi * COFi) * (44/12)		UP	R = UP * (44/60)	NE = E - R	NE / 1000000
Unspecified	Gas Coke		2,970	3	30 🗸	1	326,700		0		326,700	0.3
	Lignite	0	3,020				Carbon content fac	tor	1,000	733.33	304,890.67	0.
	Natural Gas (Dry)	0	4,250		Plant Type	Production Process	[CCF]1 (kg/GJ)		100	73.33	238,351.67	0.2
*		•		3	Modern plants -	Conventional		15.3				
Total				_	Europe	reforming - natural		10.5	1			
		Including Biogenic CO2:	10,240			gas		15.0	1,100		and the second sec	0.8
		Excluding Biogenic CO	10,240	_		Excess air reforming - natural gas		15.3	1,100	806.67	869,942.33	0.8
						Autothermal reforming - natural gas		15.3				
						Partial oxidation		21				
					Derived from European average values for specific energy consumption (Mix of modern and	Average value - natural gas	,	15.3				
					older plants)	Average value - partial oxidation		21				



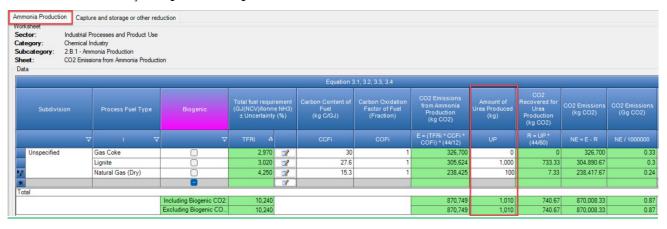
Example: Tier 1 default EFs for ammonia production - oxidation factor

Urea Production

Additionally, for reach subdivision/process fuel type, if data are available, then

 <u>Column |UP</u>|: if applicable, enter the amount of urea produced (in kg) from CO₂ generated from ammonia production. When a deduction is made for CO₂ used in urea production, it is *good practice* to ensure that emissions from urea use are included elsewhere in the inventory. If data are not available on urea production, or final end use, it is good practice to assume that CO₂ recovered is zero. <u>Note that the quantity of urea produced can be estimated from CO₂ by multiplying urea production by 44/60, which is the stoichiometric ratio of CO₂
</u>

<u>Note that the quantity of urea produced can be estimated from CO₂ by multiplying urea production by 44/60, which is the stoichiometric ratio of CO₂ to urea (CO(NH₂)₂).</u>



Example: Input of urea production – deduction of CO₂ from total emissions

Results

CO₂ emissions from Ammonia Production are estimated in mass units (kg and Gg) by the *Software* in the worksheet **Ammonia Production.**

Total CO_2 emissions from ammonia production is the sum of all subdivisions in the above worksheet, taking into account any CO_2 capture with subsequent storage. The worksheet **Capture and storage or other reduction** is

provided in the *Software* to estimate CO₂ capture and storage that is not otherwise included in the worksheet **Ammonia production** (i.e. do not include in the **Capture and storage or other reduction** worksheet a reduction for the CO₂ used for urea production as that was already accounted for in the calculation worksheet).

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on any other long-term reduction of CO₂, in tonnes. <u>Note that</u>: Column |B| may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column |Biogenic|</u>: indicate with a check if the process fuel is of biogenic origin. <u>Note that</u> consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.

egory: Chemical Industrial Proce egory: Chemical Indust category: 2.B.1 - Ammonia Capture and sto	ry Production							
ta IS CARBON DIOXIDE (CO	2)	~						
CARBON DIOXIDE (CO	-/							
Subdivision	-,	Sourc		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	Biogenie
	Δ.Υ	Sourc	Δ 🖓	stored (tonne)				Biogenie
Subdivision	ልፖ			stored (tonne)	(tonne)	(tonne)	(Gg)	Biogenii

Example: Capture and storage or other reduction

2.B.2, 2.B.3 and 2.B.4 Nitric Acid, Adipic Acid, and Caprolactam, Glyoxal and Glyoxylic Acid Production

Information

This section groups guidance for the following source categories according to their common methodological approaches applied in the *Software*:

- ✓ 2.B.2 Nitric Acid Production
- ✓ 2.B.3 Adipic Acid Production
- ✓ 2.B.4 Caprolactam, Glyoxal and Glyoxylic Acid Production

The 2006 IPCC Guidelines provide three Tiers to estimate N_2O emissions for these source categories. Tier 1 is a default method, where AD are multiplied by default EFs provided in the Guidelines. The Tier 2 method requires plant-level data and includes a correction for abatement (Tier 1 assumes no control/abatement technologies in place). Tier 3 uses plant-level data derived from direct measurements to estimate N_2O emissions.

GHGs

The *Software* includes the following GHG for the Nitric Acid Production, Adipic Acid Production and Caprolactam, Glyoxal and Glyoxylic Acid Production source categories:

CO_2	CH_4	N_2O	HFCs	PFCs	SF ₆	NF ₃
X		X				

The 2006 IPCC Guidelines do not contain methods for estimating CO₂ emissions from adipic acid production or the caprolactam, glyoxal and glyoxylic acid production source categories, however for interoperability with the UNFCCC ETF Reporting Tool, the *Software* allows these emissions to be calculated in category 2.B.11 Other. CO₂ emissions from the individual source categories are provided as a default dropdown in <u>Column |SRC|</u>. For further information, see description under section 2.B.11 Other. CO₂ emissions from nitric acid production are not included in the *Software* or the CRT.

IPCC Equations

- ✓ <u>Tier 1</u>: <u>Equation 3.5</u> (Nitric Acid), <u>Equation 3.7</u> (Adipic Acid), <u>Equation 3.9</u> (Caprolactam, Glyoxal and Glyoxylic Acid)
- ✓ <u>Tier 2: Equation 3.6</u> (Nitric Acid), <u>Equation 3.8</u> (Adipic Acid), <u>Equation 3.10</u> (Caprolactam, Glyoxal and Glyoxylic Acid)
- ✓ <u>Tier 3:</u> no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines for these source categories.

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods, including direct measurement, can be reported in the *Software* worksheets that implement IPCC Tier 1 equations.

Software Worksheets

GHG emissions from each source category are estimated using the following worksheets:

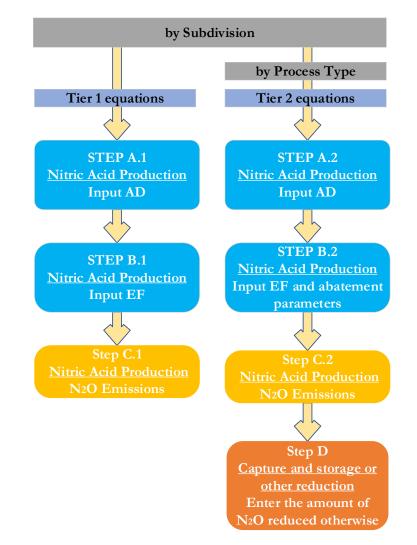
- ✓ Nitric Acid Production or Adipic Acid Production or Caprolactam, Glyoxal and Glyoxylic Acid Production: contains for each subdivision (and for each production process/technology, and in the case of caprolactam, glyoxal and glyoxylic acid production, chemical) information on the amount of product produced, EFs, and abatement parameters (destruction factor and utilization factor – Tier 2). These worksheets calculate the associated N₂O emissions for the source category.
- ✓ Capture and storage or other reduction: contains information on other reduction of N₂O, not accounted previously in the worksheet for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision trees in Figure 3.2 (Nitric Acid Production), Figure 3.3 (Adipic Acid Production) and Figure 3.4 (Caprolactam, Glyoxal and Glyoxylic Acid Production) of the 2006 IPCC

Guidelines, GHG estimates are calculated using a single methodological tier for each source category, or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements for that source category.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Nitric Acid Production.



Nitric Acid and Adipic Acid and Caprolactam, Glyoxal and Glyoxylic Acid Production - flowchart

Thus, for the relevant source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step A.1, in the worksheet Nitric Acid Production or Adipic Acid Production or Caprolactam, Glyoxal and Glyoxylic Acid Production, users collect and input in the *Software* information on the total amount of the product

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

produced. <u>Note that:</u> in worksheet **Caprolactam, Glyoxal and Glyoxylic Acid Production** information is entered separately for each chemical.

Step B.1, in the same worksheet **Nitric Acid Production** or **Adipic Acid Production** or **Caprolactam, Glyoxal** and **Glyoxylic Acid Production,** users input the associated N₂O EF (N₂O emissions/ tonne of product produced) (default or user-specific).

Note that: in worksheet Caprolactam, Glyoxal and Glyoxylic Acid Production information is entered separately for each chemical.

Step C.1, in the same worksheet **Nitric Acid Production** or **Adipic Acid Production** or **Caprolactam, Glyoxal** and **Glyoxylic Acid Production**, the *Software* calculates the associated N₂O emissions for each subdivision/process type, and in the case of caprolactam, glyoxal and glyoxylic acid production, chemical, in mass units (kg and Gg).

When the Tier 2 Equation is applied:

Step A.2, in the worksheet Nitric Acid Production or Adipic Acid Production or Caprolactam, Glyoxal and Glyoxylic Acid Production, users collect and input information at the plant level on the amount of product produced by technology/process type.

Note that: in worksheet Caprolactam, Glyoxal and Glyoxylic Acid Production information is also stratified by each chemical.

Step B.2, in the same worksheet **Nitric Acid Production** or **Adipic Acid Production** or **Caprolactam, Glyoxal** and **Glyoxylic Acid Production**, users collect and input user-specific EFs (by each technology/process), N₂O EF, destruction factor for abatement technology and abatement system utilisation factor. <u>Note that</u>: in worksheet **Caprolactam, Glyoxal and Glyoxylic Acid Production** information is also stratified by each chemical.

Step C.2, in the same worksheet **Nitric Acid Production** or **Adipic Acid Production** or **Caprolactam, Glyoxal** and **Glyoxylic Acid Production**, the *Software* calculates the associated N₂O emissions for each subdivision/process type, and in the case of caprolactam, glyoxal and glyoxylic acid production, chemical, in mass units (kg and Gg).

Step D, in the worksheet Capture and storage or other reduction, users collect and input information on the amount of other reduction of N₂O not accounted in Step C.2.

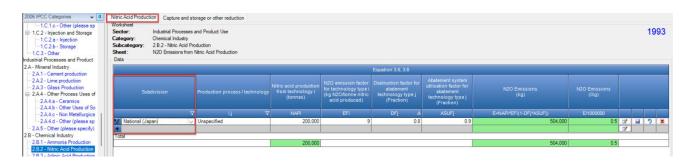
Activity data input

The following sections in Chapter 3, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of AD:

- ✓ <u>Section 3.3.2.3</u> contains information on the choice of AD for Nitric Acid Production.
- ✓ <u>Section 3.4.2.3</u> contains information on the choice of AD for Adipic Acid Production.
- ✓ <u>Section 3.5.2.1</u> contains information on the choice of AD for Caprolactam Production. <u>Note that</u>, although the 2006 IPCC Guidelines do not include a section for Choice of Activity Data for glyoxal and glyoxylic acid production the decision tree in <u>Figure 3.4</u> indicates the same type of AD as for caprolactam production is required.

Input of AD for each source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified) – nitric acid production

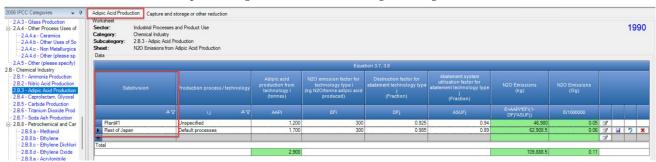


Example: single subdivision/multiple chemicals - caprolactam, glyoxal and glyoxylic acid production

ass Production her Process Uses of a - Ceramics b - Other Uses of So c - Non Metallurgica d - Other (please sp	Category: Subcategory:		s and Product Use n. Glyoxylic Acid Produ n Caprolactam, Glyoxyl and Glyoxyl									19
her (please specify) al Industry						ation 3.9, 3.10						
stry a Production cid Production cid Production ctam, Glyoxal Production	Subdi	vision	Chemical	Type of Technology	Chemical production from technology type i (tonnes)	N2O emission factor for technology type i (kg N2O/tonne chemical produced)	Destruction factor for abatement technology type j (Fraction)	Abatement system utilisation factor for abatement technology type j (Fraction)	N2O Emissions (kg)	N2O Emissions (Gg)		
Prod on I									E=CPi*EFi(1- DFj*ASUFj)			
	Unspecified		Caprolactam	Unspecified	150,000	9	0.9	0.95	195,750	0.2	3	1 2
Ш			Glyoxal	Unspecified	750	100	0		75,000			
Ш			Glyoxylic Acid	Unspecified	60,080	20	0.8	0.95	288,384	0.29	3	
lori											2	-
Dxide	Total											
					210,830				559,134	0.56	1	

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions – adipic acid production



For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Nitric Acid Production** or **Adipic Acid Production** or **Caprolactam, Glyoxal and Glyoxylic Acid Production,** row by row, as follows:

For worksheet Caprolactam, Glyoxal and Glyoxylic Acid Production only:

1. <u>Column | Chemical |:</u> select from the drop-down menu the name of the chemical produced (caprolactam, glyoxal, or glyoxylic acid).

Then, for all three worksheets:

- 2. <u>Column |i,j|</u>: select from the drop-down menu the name of production process type, i, and abatement type technology, j (if unknown select *Unspecified*), or the user may overwrite.
- 3. <u>Column |NAPi|</u>: input the mass of product produced, by subdivision/production process/technology, in tonnes.

Emission factor input

The following sections in Chapter 3, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of EFs:

- ✓ <u>Section 3.3.2.2</u> contains information on the choice of EFs for Nitric Acid Production. IPCC default EFs are included in <u>Table 3.3</u>
- ✓ <u>Section 3.4.2.2</u> contains information on the choice of EFs for Adipic Acid Production. IPCC default EFs are included in <u>Table 3.4.</u>
- ✓ <u>Sections 3.5.2.1</u> and <u>3.5.3</u> contain information on the choice of EFs for **Caprolactam, Glyoxal and Glyoxylic Acid Production**. IPCC default EFs are included in <u>Tables 3.5</u> and <u>3.6</u>

There are three types of EFs/parameters for all three source categories in the 2006 IPCC Guidelines:

- i. N_2O emissions/ tonne of product produced.
- ii. destruction factor for abatement technology, fraction.
- iii. abatement system utilisation factor for abatement technology, fraction.

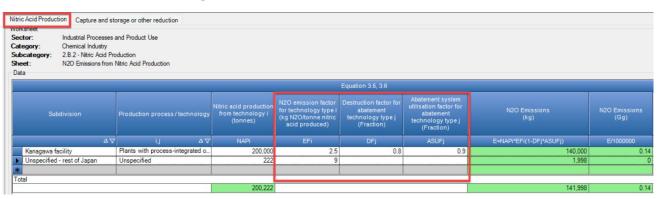
For each combination of subdivision/ production process /technology/chemical (if applicable) in worksheet Nitric Acid Production or Adipic Acid Production or Caprolactam, Glyoxal and Glyoxylic Acid Production:

1. <u>Column |EFi</u>|: select from the drop-down menu the default N₂O EF or overwrite this value with user-specific information.

<u>Note that</u> in the case of worksheets **Nitric Acid Production** and **Caprolactam**, **Glyoxal and Glyoxylic Acid Production**, the default N_2O EF for the technology type, i, and abatement technology, j, is automatically populated in <u>Column |EFi|</u>, in kg N_2O /tonne product produced, depending on the production production product of in <u>Column |ij|</u>.

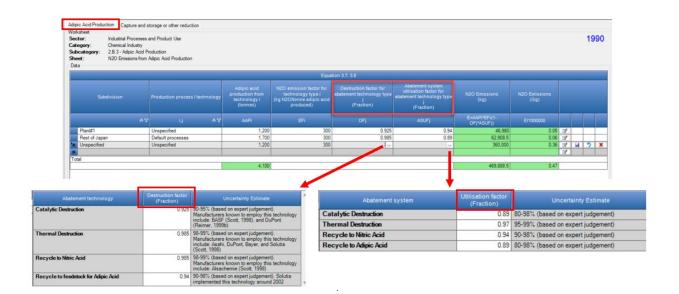
<u>Note that</u> the Tier 1 method does not disaggregate estimates by production process/ technology. Thus, where the Tier 1 method is applied, select "Unspecified" in the drop-down menu of <u>Column | i,j |</u> and leave blank cells for abatement in <u>Column | DFj |</u> and <u>Column | ASUFj |</u>.

- 2. <u>Column $|DF_j|$ </u>: enter the destruction factor for abatement technology type j, fraction. For adipic acid production, the user may instead select an appropriate destruction factor from the drop-down menu. <u>Note that. at Tier 2, destruction and/or abatement of N2O emissions are estimated in this worksheet to calculate total emissions. Double counting of those reductions in the worksheet "Capture and Storage and Other reduction" shall be avoided.</u>
- 3. <u>Column |ASUFj|</u>: enter the abatement system utilisation factor for abatement technology type j, fraction. For adipic acid production, the user may instead select an appropriate utilisation factor from the drop-down menu.



Example: Tier 1 and 2 EFs for nitric acid production

Example: destruction and abatement utilisation EF for adipic acid production



Example: IPCC default N_2O EFs for caprolactam, glyoxal and glyoxylic acid production

ategory: C ubcategory: 2	hemical Industry .B.4 - Caprolactan	s and Product Use n, Glyoxal and Glyoxyli n Caprolactam, Glyoxa			uction									
							Eq	nation	2.0, 2.10	_				
Subdivi	sion	Chemica	sl	Туре	of Technology	pro tech	Chemical oduction from hnology type i (tonnes)	for t) emission echnolog kg N2O/to mical pro	y type i nne	Destruction factor for abatement technology type j (Fraction)	Abatement system utilisation factor for abatement technology type j (Fraction)	N2O Emissions (kg)	N2O Emissions (Gg)
	۵V		۵V		ij ∆⊽							ASUFj	E=CPi*EFi(1- DFj*ASUFj)	E/1000000
Plant@2		Caprolactam		user speci	fic		1,000			9			9,000	(
Unspecified				Unspecifie	d		150,000			100	0.9	0.95	2,175,000	1
		Glyoxal		Unspecifie	d		750			100	0		75,000	(
		Glyoxylic Acid	~	Unspecifie	d		60,080			20	0.8	0.95	288,384	0
* Total		Chemical		n Process	N2O Emission Fa (kg N2O/tonne cher		Uncertaint							
		Caprolactam	Raschig			9	± 40%						2,547,384	
		Glyoxal	-			100) ± 10%							
		Glyoxylic Acid	-) ± 10%	_						

Results

N₂O emissions are estimated in mass units (kg and Gg) by the *Software* in the worksheet **Nitric Acid Production** and **Adipic Acid Production** and **Caprolactam, Glyoxal and Glyoxylic Acid Production**:

Total N_2O emissions from each source category is the sum of all subdivisions in the relevant worksheet above, taking into account any further N_2O capture, abatement or destruction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate any further N_2O reductions. But, recall, that at Tier 2 destruction and/or abatement of N_2O emissions are estimated in the relevant source category worksheet to calculate total emissions; double counting of those reductions in the worksheet **Capture and storage or other reduction** shall be avoided.

In the worksheet Capture and storage or other reduction, for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the other reduction of N₂O occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |B|</u>: users collect and input information on any other long-term reduction of N₂,O in tonnes..

Example: Capture and storage or other reduction

orksheet ector: ategory: ubcategory: heet:	Industrial Processes a Chemical Industry 2.B.2 - Nitric Acid Pro Capture and storage	duction					
iata ias NITRO	US OXIDE (N2O)		~				
	Subdivision		Source	Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)

2.B.5 Carbide Production

Information

GHG emissions are associated with production of two types of carbides – silicon carbide (SiC) and calcium carbide (CaC₂). The production of carbides can result in emissions of CO_2 and CH_4 . SiC is produced from silica sand or quartz and petroleum coke. CaC₂ is made from two carbon containing raw materials: calcium carbonate (limestone) and petroleum coke.

The 2006 IPCC Guidelines provide three Tiers to estimate CO_2 and CH_4 emissions from carbide production. Tier 1 uses national aggregate input data, national production data or production capacity data and default EFs to calculate emissions. The Tier 2 method calculates emissions using plant-level data on production of carbide and plant-specific EFs. For the plants, where plant-specific EFs are not available, Tier 2 allows use of default EFs with plant-specific AD. Tier 3 uses the plant-specific coke consumption data including C content and percent oxidised, along with a plant-specific CH₄ EF.

<u>GHGs</u>

The *Software* includes the following GHG for the Carbide Production source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X	X (silicon carbide only)					-

IPCC Equations

- \checkmark <u>Tier 1</u>: <u>Equation 3.11</u>
- ✓ <u>Tier 2</u>: Same equation as Tier 1, although with plant-specific production data, data on the use of CaC₂ for the production of acetylene used in welding applications, and user-specific or default EFs
- ✓ <u>Tier 3</u>: Same equation as Tier 1, although with plant-specific coke consumption and CH₄ EF (SiC only)

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

GHG emissions from the Carbide Production source category are estimated using the following worksheets:

- ✓ Carbide Production: contains for each subdivision (and for each type of AD used production or consumption) information on the amount of a carbide produced or raw materials used (e.g. petroleum coke) by each type of carbide (CaC₂ or SiC) and corresponding EFs (default, country-specific, plant-specific). The worksheet calculates the associated CO₂ and CH₄ emissions.
- ✓ **Carbide Use:** contains for each subdivision information on the amount of calcium carbide used for acetylene production and the EF. The worksheet calculates the associated CO₂ emissions.
- ✓ Capture and storage or other reduction: contains information on CO₂ capture (with subsequent storage) or other reductions, not accounted previously.

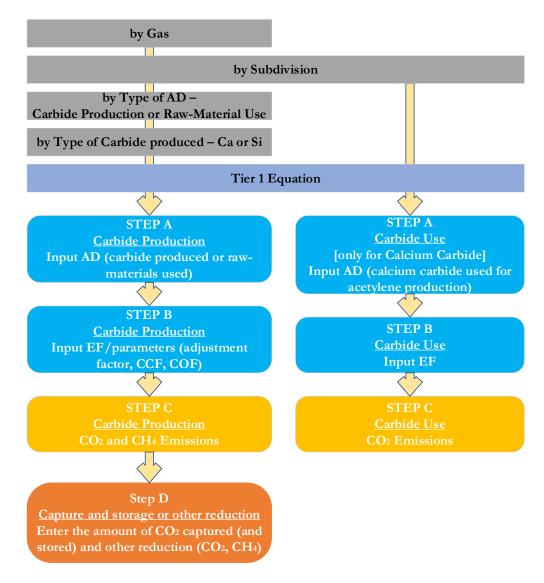
User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.5 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Carbide Production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Carbide Production – flowchart



Thus, for the source-category:

The workflow is followed first for carbide production, then carbide use.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Carbide production

Step A, in the worksheet **Carbide** Production, users collect and input in the *Software* AD for each type of carbide (CaC₂ and SiC) produced. AD can be the amount of carbide produced or the amount of the raw materials used (petroleum coke) for carbide production.

Step B, in the worksheet **Carbide** Production, for each type of AD, users collect and input the associated CO_2 and CH_4 EFs either based on carbide produced or raw materials used (default or plant-specific).

Step C, in the worksheet **Carbide Production**, the *Software* calculates the associated emissions for each subdivision and each carbide type in mass units (tonne CO₂, kg CH₄, and Gg).

Step D, in the worksheet Capture and storage or other reduction, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of GHG.

Carbide Use

Step A, in worksheet Carbide Use, users collect and input information on the amount of CaC₂ used in acetylene production.

Step B, in the worksheet Carbide Use, users input the CO₂ EF.

Step C, in the worksheet **Carbide Use**, the *Software* calculates the associated emissions for each subdivision for CaC₂ in mass units (tonne and Gg).

Activity data input

Section 3.6.2.3 in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Carbide Production.

Input of AD for the Carbide Production source category requires the user first to enter information on the subdivisions in the country. Subdivisions are entered separately for Carbide Production and Carbide Use, they may be the same or differ. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified)

006 IPCC Categories 🚽 🤻	Worksheet	Carbide Use Capture a	nd storage or other reduction							
2A3 - Glass Production 2A4 - Other Process Uses of 2A4a - Ceramics -2A4b - Other Uses of So -2A4c - Non Metallurgics -2A4d - Other (please specify) 2A5 - Other (please specify)	Subcategory: Subcategory: Sheet: Data Gas METHAN	Industrial Processes and Prod Chemical Industry - Carbide P 2.B.5 - Carbide Production CO2 and CH4 Emissions from IE (CH4)	roduction							1995
B - Chemical Industry 2.B.1 - Ammonia Production					Equation 3.11	x s				
- 2.B.2 - Mitric Acid Production - 2.B.3 - Adipic Acid Production - 2.B.4 - Caprolactam, Glyoxal				Type of Carbide Produced	Activity Data (tonne)	Emission Factor (kg CH4/tonne AD)	CH4 Emissions (kg)	CH4 Emissions (Gg CH4)		
2.B.5 - Carbide Production 2.B.6 - Titanium Dioxide Prod					AD		E = AD * EF	E / 1000000		
2.B.7 - Soda Ash Production	Unspecified		Carbide produced	Calcium Carbide (CaC2)	400	3	1,200	1	0 7	
2.B.8 - Petrochemical and Car				Silicon Carbide (SiC)	200	4	800		0 📝	
- 2.B.8.a - Methanol			Raw material used	Calcium Carbide (CaC2)	300	5	1,500		0 7	
2.B.8.b - Ethylene				Silicon Carbide (SiC)	100	6	600	1	0 📝	ッ ×
-2.B.8.c - Ethylene Dichlori									3	
2.B.8.d - Ethylene Oxide	Total									
- 2.B.8.e - Acrylonitrile					1,000		4,100		0	

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

	<i>Example:</i> multiple subdivisions	
and storage or othe	er reduction	

2006 IPCC Categories 👻 👎	Carbide Production Carbide Use Capture a	nd storage or other reductio	n							
	Worksheet Industrial Processes and Proc Category: Chemical Industry - Carbide F Subcategory: 2.8.5 - Cabide Production Sheet: Sheet: CO2 and CH4 Emissions from Data Gas	roduction								1990
2.B - Chemical Industry				Equation 3.11						
2.B.2 - Nitric Acid Production 2.B.3 - Adipic Acid Production 2.B.4 - Caprolactam, Glyoxal	Subdivision			Activity Data (tonne)	Emission Factor (kg CH4/tonne AD)	CH4 Emissions (kg)	CH4 Emissions (Gg CH4)			
2.B.5 - Carbide Production 2.B.6 - Titanium Dioxide Prod	۵V	Δ 7		AD	EF	E = AD * EF	E / 1000000			
- 2.B.7 - Soda Ash Production	north	Carbide produced	Silicon Carbide (SiC)	122	1.2	146.4	0			
2.B.8 - Petrochemical and Car	test	Raw material used	Calcium Carbide (CaC2)	50	2	100	0			
2.B.8.a - Methanol			Silicon Carbide (SiC)	40	2.5	100	0	3		
2.B.8.b - Ethylene	Unspecified	Carbide produced	Calcium Carbide (CaC2)	400	11	4,400	0	3		
2.B.8.c - Ethylene Dichlori			Silicon Carbide (SiC)	200	5.3	1,060	0	3		
2.B.8.d - Ethylene Oxide		Raw material used	Calcium Carbide (CaC2)	300	2.1	630	0	3	M	7 ×
2.B.8.e - Acrylonitrile			Silicon Carbide (SiC)	100	6	600	0			
2.B.8.f - Carbon Black	K							2		
-2.B.8.x - Other petrochem	Total									
2.8.9 - Fluorochemical Produ				1,212		7,036.4	0.01			

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Carbide Production**, row by row, as follows:

1. <u>Column |Type of Activity Data</u>]: select from the drop-down menu the type of AD to be used – carbide produced or raw materials used.

- 2. <u>Column | Type of Carbide Produced |</u>: select from the drop-down menu the type of carbide produced SiC or CaC₂. The user may enter directly another type of carbide. <u>Note that</u> users must enter a unique combination of subdivision/ type of activity data/ type of carbide produced. If the same combination is entered twice, an error will pop-up asking the user to re-enter a unique combination by changing either the subdivision or type of carbide produced.
- 3. <u>Column |AD|</u>: enter for each type of AD and for each type of carbide produced the amount of either raw materials used (e.g. petroleum coke) or carbide produced (CaC₂ or SiC), in tonnes.
- 4. <u>Column | Biogenic | :</u> indicate with a check if the process fuel is of biogenic origin.

Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Carbide Use**, row by row, as follows:

- 1. <u>Column |AD|</u>: enter information on the amount of CaC₂ used in acetylene production, in tonnes.
- 2. <u>Column | Biogenic |</u>: indicate with a check if the process fuel is of biogenic origin.

Example: AD for calcium carbide used in acetylene production

ctor: tegory: bcategory: eet: ata	Industrial Processes and Product Chemical Industry - Carbide Use 2.B.5 - Carbide Production CO2 Emissions from Use of CaC2					
				Equation 3.11		
	Subdivision	Calcium Carbide Used in Acetylene Production (tonne)	Biogenic	Emission Factor (tonnes CO2/tonne carbide used)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	V	AD	7	EF	E = AD * EF 🛛 🛆	E / 1000
test		33		1.7	56.1	
Unspecified		55		1.1	60.5	
			-			

Emission factor input

Section 3.6.2.2 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Carbide Production.

There are three types of default EFs, listed here and further described below:

- i) CO₂ and CH₄ EFs based on carbide production AD in tonnes of CO₂ and kg of CH₄ per tonne of carbide produced (<u>Tables 3.7 and 3.8</u> in Chapter 3 Volume 3 of the *2006 IPCC Guidelines*)
- ii) CO₂ and CH₄ EFs based on raw materials consumption (petroleum coke) in tonne of CO₂ and kg of CH₄ per tonne of petroleum coke (<u>Tables 3.7 and 3.8</u> in Chapter 3 Volume 3 of the 2006 IPCC Guidelines)
- iii) $CO_2 \text{ EF}$ for CaC_2 used in acetylene production in tonne of CO_2 per tonne of CaC_2 used (<u>Table 3.8</u> in Chapter 3 Volume 3 of the 2006 IPCC Guidelines).

CO2 and CH4 EFs based on carbide production

Where Carbide Produced is selected in <u>Column | Type of Activity Data</u> |, for each combination of subdivision/Type of Activity Data/ Type of Carbide Produced data are entered in worksheet **Carbide Production**, row by row, as follows:

1. <u>Column |EF</u>|: The default EF will automatically be populated based on the type of carbide produced, or the user may manually enter in user-specific EFs in tonne of CO₂ per tonne of carbide produced or kg of CH₄/tonne carbide produced.

Note that data entry for each gas is made through selection of the relevant gas in the drop-down menu for "Gas".

$\mathit{Example:}\ CO_2 \ and \ CH_4 \ EFs$ for carbide production – Tier 1

egory: Chemical Ir	rocesses and Produce ndustry - Carbide Pro												19
category: 2.8.5 - Car	oide Production												
et: CO2 and C	H4 Emissions from C	arbide Proc	duction										
S CARBON DIOXIDE (C	02) ~												
						Equation 3.11							
	Type of Activity		Type of Carbide	Activity Data			Emission Factor			CO2 Emissions	CO2 Emissions		
	Data		Produced	(tonne)			onnes CO2/tonne A	D)		(tonnes CO2)	(Gg CO2)		
							Carbon content	<u> </u>					-
						Adjustment			EF = (1-AF) *CCF*COF*				
Δ7			4 V			factor AF	(t C/tonne raw material used) CCF	factor COF	(44/12) or specified				
east	Carbide produ		Calcium Carbide (CaC2) 🗸	100) Specified				1.09	109	0.109	7.	
			Carbide		Process		Adjustment fa	ctor Remark	2.62	31.44	0.03144	2	
	Raw material u.					(tonnes CO2/tonne A	U)	CION INCOME	2.06039	251.36778	0.25137	2	T
north	Raw material u			Sil	icon carbide		.62					3	Т
north south	Haw material u	0	Silicon Carbide (SiC)	1.000									_
prost copy	Carbide produ		Calcium Carbide (SIC)	1.000	troleum coke		.09		1.09	436	0.436	2	
south				Pe	troleum coke				1.09	436 524		A COLUMN A C	+
south			Calcium Carbide (CaC2)	Per 200					and the second se		0.524	2	+
south	Carbide produ		Calcium Carbide (CaC2) Silicon Carbide (SiC)	Pe 200 300	Specified				2.62	524	0.524	2	-
south	Carbide produ		Calcium Carbide (CaC2) Silicon Carbide (SiC) Calcium Carbide (CaC2)	Pe 200 300) Specified) Specified				2.62	524 510	0.524	2	
south	Carbide produ		Calcium Carbide (CaC2) Silicon Carbide (SiC) Calcium Carbide (CaC2)	Pe 200 300	Specified Specified Specified				2.62	524 510	0.524	3	

CO2 and CH4 EFs based on raw materials consumption (petroleum coke)

Where Raw material used is selected in <u>Column | Type of Activity Data</u>|, for each combination of subdivision/Type of Activity Data/ Type of Carbide Produced data are entered in worksheet **Carbide Production**, row by row, as follows:

- 1. <u>Column | Emission Factor</u> |: Indicate in the first of five columns here if the EF will be specified or calculated.
 - i. If *Specified* (use for Tier 1 or for insertion of the results of a user-specific method (see section **1.1.3 Use** of multiple Tiers for reporting)
 - 2. <u>Column |EF|</u>: The default EF will automatically be populated based on the type of carbide produced, or the user may manually enter in user-specific EFs in tonne of CO₂ per tonne of carbide produced or kg of CH₄/tonne carbide produced. <u>Note that data entry for each gas is made through selection of the relevant gas in the drop-down menu for "Gas"</u>.

ii. If *Calculated* is selected (Tier 2 or Tier 3)

- 2. <u>Column |AF|</u>: The adjustment factor will automatically be populated based on the type of carbide produced, or the user may manually enter in a user-specific AF, dimensionless.
- 3. <u>Column |CCF|:</u> Select from the drop-down menu the CCF for the raw material used, or the user may overwrite this value with use-specific information.
- 4. <u>Column |COF|:</u> A COF of 1 will automatically populate, or the user may overwrite this value with user-specific information.

tegory: Chemical In bcategory: 2.8.5 - Carb	ocesses and Produc dustry - Carbide Pro ide Production 14 Emissions from C	duction	duction									
as CARBON DIOXIDE (CO)2) ~											
	1					Equation 3.11						-
Subdivision	Type of Activity Data		Type of Carbide Produced	Activity Data (tonne)				mission Factor nes CO2/tonne.			CO2 Emissions (tonnes CO2)	CO2 Emis (Gg CC
v	v	V	V	AD		Adjustment factor AF	(t C	bon content factor Xtonne raw terial used) CCF	Carbon oxidation factor Δ COF	EF = (1-AF) *CCF*COF* (44/12) or specified	E = AD * EF	E / 10
Unspecified	Carbide produ		Silicon Carbide (SiC)	200	Specified					2.62	524	
			Calcium Carbide (CaC2)	400	S					1.09	436	
east	1 1		Silicon Carbide (SiC)	12	S Higher	tier EF specified	d T	Ting d	TT an a sife of	2.62	31.44	0.
			Calcium Carbide (CaC2)	100	Specimea		_	Tierr	EF specified	1.09	109	
Unspecified	Raw material		Silicon Carbide (SiC)	100	Specified	6				2.6789	267.89	0.
			Calcium Carbide (CaC2)	300	Specified				6	1.7	510	
north] [Silicon Carbide (SiC)	122	Calculated	0.35		0.8645	1	2.06039	251.36778	0.
south] [Calcium Carbide (CaC2)	153	Calculated	0.67		0.8645	1	1.04605	127.61749	0.
Northeastern			Calcium Carbide (CaC2)	1000	Calculated	0.67		0.8645	1	1.04605	1046.045	1.
		8										

$Example: CO_2$ and CH_4 EFs for raw materials used – all tiers

CO2 EF for CaC2 used in acetylene production

For each subdivision, for CO₂ emissions from the use of CaC₂ in acetylene production, in worksheet Carbide Use:

1. <u>Column |EF|: input the EF for CaC₂ used for acetylene production in tonne of CO₂/tonne of CaC₂ used.</u>

$\mathit{Example:}\,\mathbf{EF}$ for calcium carbide used in acetylene production

ector: ategory: ubcategory: heet: Data	Industrial Processes and Product Chemical Industry - Carbide Use 2.8.5 - Carbide Production CO2 Emissions from Use of CaC2													
	Equation 3.11													
	Subdivision	Calcium Carbide Used in Acetylene Production (tonne)		Emission Factor (tonnes CO2/tonne carbide used)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)								
	ΔΥ	AD	V	EF	E = AD * EF	E / 1000								
Plant#22		33		1.7	56.1									
Unspecified		55		1.1	60.5									
e l			-											
* Total														
		88		Including Biogenic CO2:	116.6									
				Excluding Biogenic CO2:	116.6									

Results

CO₂ and CH₄ emissions from Carbide Production are estimated in mass units (tonnes and Gg) by the *Software* for each row, and the total for all rows, in the following worksheets:

✓ Carbide Production

✓ Carbide Use

Total CO_2 and CH_4 emissions from carbide production is the sum of all emissions in the above worksheets, taking into account any capture and storage or other reduction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions.

In the worksheet **Capture and storage or other reduction** for each subdivision, each gas and each type of carbide produced:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where CO₂ capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂ or CH₄, in tonnes.

<u>Note that</u>: Column |B| may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.

4. <u>Column |Biogenic|</u>: indicate with a check if the process fuel is of biogenic origin. <u>Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.</u>

arbide Pr lorksheet		n Carbide Us	e Captu	re and storage or other redu	ction							
ector: ategory ubcate heet: Data	y :	Industrial Proc Chemical Indu 2.B.5 - Carbide Capture and s	stry Productio	n								
Gas	CARBO	ON DIOXIDE (C	02)	~								
	Su	bdivision		Type of Carbide			Source	Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	Biogenic
			ΔV		ΔV		SRC 🛆	V A	B	C = A + B	C / 1000	
Unsp	pecified	-		Calcium Carbide (CaC2)		Unspecified		2	2	4	0	
			Ì	Silicon Carbide (SiC)		Unspecified		1	1	2	0	
unsp	pecified 1	1		Calcium Carbide (CaC2)		Unspecified		2	2	4	0	
*												8
Total									Total:	10	0.01	
Total									i otal:	10	0.01	

Example: Capture and storage or other reduction

2.B.6 Titanium Dioxide Production

Information

There are three processes that are used in the production of titanium dioxide (TiO_2) that lead to process GHG emissions: titanium slag production in electric furnaces, synthetic rutile production using the Becher process, and rutile TiO_2 production via the chloride route. The sulphate route process does not give rise to process GHG emissions that are of significance.

The 2006 IPCC Guidelines provide two Tiers to estimate CO_2 emissions from TiO₂ Production. The Tier 1 method calculates emissions using national aggregate data on production of titanium slag, synthetic rutile or rutile TiO₂ and default EFs. Tier 2 uses the plant-level AD on the quantities of reducing agent or carbothermal input and EFs (carbon content and carbon oxidation factors).

GHGs

The Software includes the following GHG for the Titanium Dioxide Production source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
Χ						

IPCC Equations

- $\checkmark \quad \underline{\text{Tier 1}: \underline{\text{Equation 3.12}}}$
- ✓ <u>Tier 2: Equation 3.13</u>
- ✓ <u>Tier 3:</u> no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The Software calculates emissions of CO₂ from Titanium Dioxide Production using worksheets:

- ✓ 1.1.1 Fuel Manager: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ **Titanium Dioxide Production:** contains for each subdivision information on the amount of TiO₂ produced by each type of production process (slag, synthetic rutile and rutile) and default CO₂ EFs. The worksheet calculates the associated CO₂ emissions.
- ✓ Titanium Dioxide production Tier 2: contains for each subdivision information on the amount of reducing agent or carbothermal input by each type of production process (slag, synthetic rutile and rutile) and plant-specific EFs (carbon content and carbon oxidation factors). The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

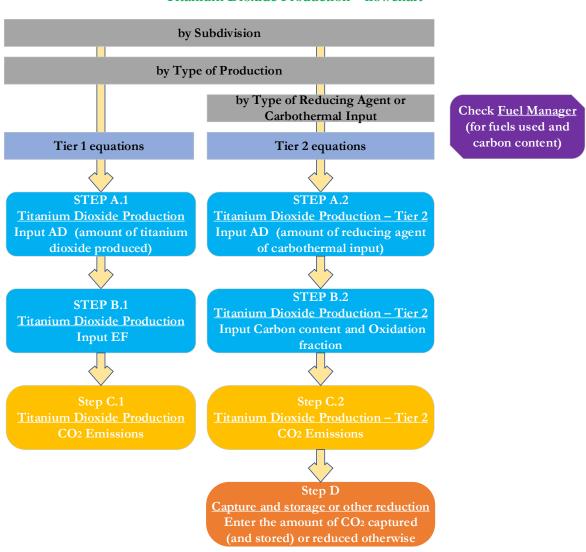
User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.6 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the Software as well as to avoid its misuse, the user follows the following flowchart.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Prior to following the flowchart below, the user shall collect and enter data in the **1.1.1 Fuel Manager** on each fuel used in TiO₂ production (necessary for Tier 2 only): its name, if not present among IPCC defaults, and the *calorific value* and the *carbon content* of each fuel, including for IPCC default fuels if user-specific values are available.



Titanium Dioxide Production – flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step A.1, in the worksheet **Titanium Dioxide Production,** users collect and input in the *Software* information on the amount of TiO₂ produced by each type (titanium slag, synthetic rutile or rutile TiO₂).

Step B.1, in worksheet **Titanium Dioxide Production,** users input CO₂ EFs per unit of production of titanium slag, synthetic rutile or rutile TiO₂.

Step C.1, in the worksheet **Titanium Dioxide Production**, for each subdivision and each production type, the *Software* calculates the associated CO₂ emissions in mass units (tonne and Gg). In addition, the total CO₂ emissions are calculated.

When the Tier 2 Equation is applied:

Step A.2, in worksheet **Titanium Dioxide Production – Tier 2,** users select the fuel type(s) or other carbothermal inputs and amounts used as reducing agents for TiO_2 production, by each type of production (titanium slag, synthetic rutile or rutile TiO_2).

Step B.2, in worksheet **Titanium Dioxide Production – Tier 2,** users collect and input the carbon content and carbon oxidation factors for the reducing agent or carbothermal input used, by each type of production (titanium slag, synthetic rutile or rutile TiO₂).

Step C.2, in the worksheets **Titanium Dioxide Production – Tier 2**, for each subdivision and each production type, the *Software* calculates the associated CO_2 emissions in mass units (kg and Gg). In addition, the total CO_2 emissions are calculated.

Step D, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 .

Activity data input

Section 3.7.2.3 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Titanium Dioxide Production.

As a **Starting step**, users ensure that the **1.1.1 Fuel Manager** contains all fuels to be reported for titanium dioxide production (Tier 2 only); and for each fuel listed in the Fuel Manager, the *calorific value* and the *carbon content* are entered or, for IPCC default fuels, are selected from the drop-down menu.

Second, input of AD for the Titanium Dioxide Production source category requires the user to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified/national)

- 2.A.4.d - Other (please s A.5 - Other (please specif Chemical Industry 3.1 - Ammonia Production 3.2 - Nitric Acid Productio	Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Produc Chemical Industry 2.B.6 - Titanium Dioxide Produc CO2 Emissions from Titanium Di	tion								1990
3.3 - Adipic Acid Producti 3.4 - Caprolactam, Glyoxa					Equation 3.12						
5 - Carbide Production 6 - Titanium Dioxide Pro 7 - Soda Ash Productio				Biogenic	Amount of Production (tonne)	Emission Factor (tonnes CO2/tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
3 - Petrochemical and C 2.B.8.a - Methanol	1	۵ 🖓	i AV	7	ADi	EFi	E = ADi * EFi	E / 1000			
B.8.b - Ethylene	A National		Titanium Slag		1,000	1.2	1.200	1.2	2	6	ウ X
B.8.c - Ethylene Dichl	National		Rutile titanium dioxide (chloride route)	0	1,500	1.34	2.010	2.01	2		
.8.d - Ethylene Oxide			Synthetic Rutile		2,000	1.43	2,860	2.86	3		
8.e - Acrylonitrile				8					3		

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

2.A.4.c - Non Metallurgi 2.A.4.d - Other (please s 5 - Other (please specif memical Industry 1 - Ammonia Production 2 - Nitric Acid Productio	Worksheet Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Produ Chemical Industry 2.B.6 - Titanium Dioxide Produc CO2 Emissions from Titanium D	tion							199
3 - Adipic Acid Producti 4 - Caprolactam, Glyoxa					Equation 3.12					
Carbide Production Titanium Dioxide Pro Soda Ash Productio		Subdivision	Type of production	Biogenic	Amount of Production (tonne)	Emission Factor (tonnes CO2/tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
- Petrochemical and C B.8.a - Methanol			1 47		ADi		E = ADi * EFi	E / 1000		
Ethylene	National		Titanium Slag		1,000	1.2	1,200	1.2		
ylene Dichl	National		Rutile titanium dioxide (chloride route)	0	1,500	1.34	2,010	2.01	1	
Oxide			Synthetic Rutile		2,000	1.43	2,860	2.86	2	
trile	Tokyo city		Synthetic Rutile		2,100	1.43	3.003	3	2	2
n Black	*								2	
Other petroche rochemical Prod	Total									
y-product emi					6,600	Including Biogenic CO2:	9.073	9.07		
gitive Emissi						Excluding Biogenic CO2:	9,073	9.07		

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Titanium Dioxide Production**, row by row, as follows:

- 1. <u>Column |i|</u>: select the type of production process for titanium dioxide from the drop-down menu- titanium slag, synthetic rutile or rutile TiO₂, or the user may overwrite
- <u>Column | Biogenic |</u>: indicate with a check if the process fuel is of biogenic origin. <u>Note that</u> as this is a Tier 1 the type of fuel is not required to be known. By default, the assumption is that the TiO₂ is using reducing agents of fossil origin, and therefore this column should remain unchecked.
- 3. <u>Column | ADi |</u>: input the mass of TiO₂ produced using each production process, in tonnes <u>Note that fuel input is not used for the Tier 1 method</u>. However, if known and to avoid double counting, the amount of reducing agent or carbothermal input used for titanium dioxide production should be subtracted from fuel use included in the Energy Sector.

When the Tier 2 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **Titanium Dioxide Production – Tier 2**, row by row, as follows:

- 1. <u>Column | Name of plant |</u>: enter the name of each plant; the Tier 2 requires plant level AD.
- 2. <u>Column |Plant-specific Type of Production |</u>: select the type of production process for titanium dioxide from the drop-down menu- titanium slag, synthetic rutile or rutile TiO₂, or the user may overwrite.
- 3. <u>Column | Reducing agent/Carbothermal input|</u>: select each reducing agent or carbothermal input used as a reducing agent from the drop-down menu (one row for each fuel type). <u>Note that</u> if a carbothermal input is used that is not included in the Fuel Manager, the user may either enter that input in the Fuel Manager, and thus make it available for selection from the drop-down menu, or alternatively, select "Unspecified" for the Fuel Type and describe in the User Notes or Remarks the carbothermal input used.
- 4. <u>Column | Biogenic |</u>: indicate with a check if the fuel is of biogenic origin.
- 5. <u>Column | ADi |:</u> enter the mass/amount of reducing agent or carbothermal input used for each plant, in GJ. <u>Note that</u> to avoid double counting, the amount of reducing agent or carbothermal input used for titanium dioxide production should be subtracted from fuel use included in the Energy Sector.

Example: AD for titanium dioxide production – Tier 2

tanium Dioxide Production	Titanium Dioxide Production - Tier 2	Capture and storage or other re	eduction					
ector: Industrial F ategory: Chemical In ubcategory: 2.B.6 - Tita	rocesses and Product Use ndustry nium Dioxide Production ions from Titanium Dioxide Production -	Tier 2						
				Equation :	3.13			
Name of plant	Plant-specific Type of Production	Fuel Type	Biogenic	Amount of reducing agent or carbothermal input i (GJ)	Carbon content factor of reducing agent or carbothermal input i	Carbon oxidation factor for reducing agent or carbothermal input i	CO2 Emissions (kg)	CO2 Emissions (Gg)
		7 AV		ADi			E=ADi*CCFi*COFi*(44/12)	E/1000000
Plant TiO2 #1	Titanium Slag	Gas/Diesel Oil		200	56	0.9	36,960	0.
Plant TiO2 #2	Rutile TiO2	Petroleum Coke		100	88	0.9	29,040	0.0
*			8					
otal								
				300		Including Biogenic	66,000	0.0
						Excluding Biogeni	66,000	0.0

Emission factor input

Section 3.7.2.2 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Titanium Dioxide Production.

There are two types of EFs:

- i) Default CO₂ EF for Tier 1 in tonne of CO₂ per tonne of product produced (<u>Table 3.9</u> in Chapter 3 Volume 3 of the 2006 IPCC Guidelines)
- ii) Plant-specific CO₂ EFs for Tier 2 collected by users the carbon content and carbon oxidation factors for reducing agent or carbothermal input (kg C/GJ and fraction, respectively).

When the Tier 1 Equation is applied:

For each combination of subdivision/type of production process in worksheet **Titanium Dioxide Production**:

1. <u>Column |EFi</u>|: the CO₂ EF is automatically populated in tonne of CO₂/tonne of product produced, when synthetic rutile or rutile titanium dioxide are selected in <u>Column |i</u>|. Users can overwrite these values with user-specific information, if available, and in the case of the TiO₂ produced via the titanium slag production process, must directly enter the CO₂ EF in this column.

Example: EFs for Titanium Dioxide Production - Tier 1

orksheet ector: ategory: ubcategory: heet: Data	Industrial Processes and Produ Chemical Industry 2.B.6 - Titanium Dioxide Produc CO2 Emissions from Titanium D	ction								
							Equation 3.12			
	Subdivision	Type of	production	Bioge	enic		of Production conne)	Emission Factor (tonnes CO2/tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	ΔΥ	i	ΔV		V		ADi	EFi	E = ADi * EFi	E / 1000
National		Titanium Slag	-)		1,000	1.2	1,200	
National		Rutile titanium dioxi	de (chloride route))		1,500	1.34	2.010	2
		Synthetic Rutile)		2,000	1.43	2,860	2
Tokyo city		Synthetic Rutile - cou	untry 🗸 🗸)		2,100	1.43	3,003	
* Fotal		Chemical	Emission Factor (tonnes CO2 / tonne		re	emark				
		Titanium Slag			Not ava	ailable	6,600	Including Biogenic CO2:	9,073	9
		Synthetic Rutile		1.43	± 10%			Excluding Biogenic CO2:	9,073	9
		Rutile titanium d			± 15%				51020/2001	

When the Tier 2 Equation is applied:

For each combination of subdivisions/individual plant/production process/fuel type, users need to input the following EFs/parameters:

- 1. <u>Column |CCFi|</u>: the carbon content factor for the corresponding fuel is automatically populated, in kgC/GJ, or the user may overwrite with user-specific information. Where a carbothermal input is used that is not in the Fuel Manager and thus Unspecified is selected in <u>Column |Reducing agent/Carbothermal input</u>, the user must insert a user-specifi cvalue for the carbothermal input.
- 2. <u>Column |COFi|</u>: input the carbon oxidation factor for the reducing agent or carbothermal input (fraction).

Example: EFs for titanium dioxide production – Tier 2

ect	tor: Industr	ial Processes and Prod	uct Use									19	99	0
te	egory: Chemic	cal Industry												
		Titanium Dioxide Produ												
		missions from Titanium	Dioxide Production -	Tie	er 2									
ata	а			_										
						Equation 3.1								
	Name of plant	Plant-specific Type of Production	Fuel Type		Biogen ic	Amount of reducing agent or carbotherma I input i (GJ)	Carbon content factor of reducing agent or carbotherma I input i	Carbon oxidation factor for reducing agent or carbotherma l input i	CO2 Emissions (kg)	CO2 Emissions (Gg)				
	V	V		V	V	ADi	CCFi	COFi 🛆	E=ADi*CCFi*COFi *(44/12)	E / 1000000				
	Plant TiO2 #1	Titanium Slag	Gas/Diesel Oil			200	20.2	0.9	13332	0.01333	2		っ	ĺ
1	Plant TiO2 #2	Rutile TiO2	Petroleum Coke			100	26.6	0.9	8778	0.00878	2			í
ł					٨						2			l
ota	al												_	Ĩ
						300		Including Bi	22110	0.02211				
								Excluding	22110	0.02211				

Results

CO₂ emissions from Titanium Dioxide Production are estimated in mass units (tonne/kg and Gg) by the *Software* for each row, and the total for all rows, in the following worksheets:

- ✓ Titanium Dioxide Production
- ✓ Titanium Dioxide Production Tier 2

Total CO_2 emissions from titanium dioxide production is the sum of all emissions in the above worksheets, taking into account any CO_2 capture with subsequent storage. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO_2 capture and storage.

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where CO₂ capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO_2 , in tonnes. <u>Note that</u>: Column |B| may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column | Biogenic |:</u> indicate with a check if the process fuel is of biogenic origin. <u>Note that</u> consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.

	Production Titanium Dioxide	Production - Tier 2	Capture and st	torage or o	other reduction				
orksheet	1010100020-00000000002000								
ector:	Industrial Processes and Produ	ict Use							
ategory:	Chemical Industry								
ubcategory:	2.B.6 - Titanium Dioxide Produ								
heet:	Capture and storage or other n	eduction							
lata									
as CARE	BON DIOXIDE (CO2)	~							
	001010102 (002)								
	Subdivision		Source		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	Biogen
			Source SRC	∆ 7	stored				Biogeni
Unspecified	Subdivision S 45				stored (tonne)	(tonne)	(tonne)	(Gg)	Biogeni
	Subdivision S 45			<u>۵</u> 7	stored (tonne)	(tonne)	(tonne)	(Gg)	Biogeni
Unspecified	Subdivision S 45			<u>م</u>	stored (tonne)	(tonne)	(tonne)	(Gg)	Biogeni 0
	Subdivision S 45			ΔŸ	stored (tonne)	(tonne)	(tonne)	(Gg)	Diogeni

Example: Capture and storage or other reduction

2.B.7 Soda Ash Production

Information

Soda ash can be produced by different processes - natural processes (monohydrate, sodium sesquicarbonate or trona and direct carbonation) and synthetic processes (Solvay process). CO₂ emitted during the natural production processes should be accounted for here in 2.B.7. CO₂ emitted during the <u>use</u> of soda ash should be accounted for under the source category of the relevant industry where the soda ash is used.

The 2006 IPCC Guidelines provide three Tiers to estimate CO_2 emissions from natural Soda Ash Production. Tier 1 is a default method, with national AD (input/trona or output/soda ash) multiplied by default EFs. To use the Tier 2 method, it is necessary to gather complete data on trona consumption or natural soda ash production for each of the plants within the country along with plant-specific EFs for the trona input or soda ash output. Tier 3 uses plant-level data derived from direct measurements to estimate CO_2 emissions. In theory, the Solvay process does not lead to CO_2 emissions because the CO_2 generated as a by-product is recovered and recycled for use in the carbonation stage (i.e. CO_2 generation equals uptake).

GHGs

The Software includes the following GHG for the Soda Ash Production source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
Х						

IPCC Equations

- \checkmark <u>Tier 1</u>: <u>Equation 3.14</u>
- ✓ <u>Tier 2:</u> IPCC Tier 1 equation, although with plant-specific AD, and if available EFs
- ✓ <u>Tier 3:</u> no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines, emissions based on direct measurement

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods, including emission from the soda ash produced via the Solvay process can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

GHG emissions from the Soda Ash Production source category are estimated using the following worksheets:

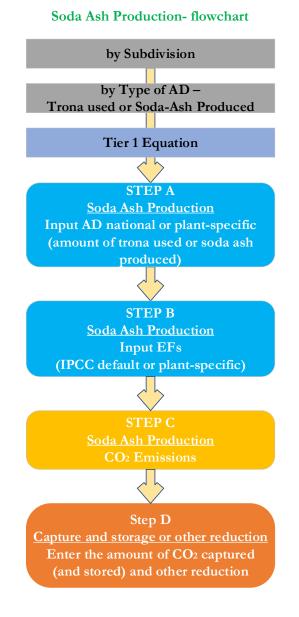
- ✓ Soda Ash Production: contains for each subdivision and each type of AD (e.g. trona used or soda ash produced) information on the amount of trona consumption or natural soda ash produced and EFs. The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.7 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Soda Ash Production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.



Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step A, in the worksheet **Soda Ash Production,** users collect and input in the *Software* information on the amount of either trona consumption or natural soda ash production (Tier 1 – national level, Tier 2 – plant-specific).

Step B, in the same worksheet **Soda Ash Production,** users either collect or directly input the CO₂ EFs for each type of AD.

Step C, in the same worksheet **Soda Ash Production,** the *Software* calculates the associated CO₂ emissions for each subdivision (and each type of AD) in mass units (tonne and Gg). In addition, total CO₂ emissions are calculated

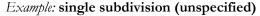
Step D, in the worksheet Capture and storage or other reduction, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 .

Activity data input

Section 3.8.2.1 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Soda Ash Production.

Input of AD for the Soda Ash Production source category requires the user to first enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |Subdivision| [e.g. "country name" or "Unspecified" as selected from the drop-down menu].





Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

her (please specif Data							1	990
dustry nia Production			Equation 3.14					
ductio sducti Subdivision Siyoxa	Type of Activity Data	Activity Data (tonne)	Emission Factor (tonnes CO2/tonne AD)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
on Pro	∆⊽ ∆⊽	AD		E = AD * EF	E / 1000			
Rest of Japan	Soda Ash produced	556	0.138	76.73	0.08	3		
C , .	Trona used	1.000	0.097	97	0.1			
10 Tokyo	Soda Ash produced	22,000	0.138	3,036	3.04	17	?	×
						2		
Dichl Total		23,556		3,209.73	3.21			

Then for each subdivision input information in worksheet **Soda Ash Production** in a single row, or in a number of rows, as follows:

- 1. <u>Column | Type of Activity Data |</u>: select from the drop-down menu the type of AD input (trona used) or output (soda ash produced).
- 2. <u>Column |AD|</u>: input the mass of either trona consumption or soda ash production, in tonnes.

Emission factor input

Section 3.8.2.1 in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Soda Ash Production.

For Tier 1, the following default CO₂ EFs are presented in the 2006 IPCC Guidelines: CO₂ EF for Trona = 0.097 tonnes CO₂/tonne of trona, CO₂ EF for soda ash = 0.138 tonnes CO₂/tonnes natural soda ash produced.

Then, for each combination of subdivision/type of AD in worksheet Soda Ash Production:

1. <u>Column |EF|:</u> input or select the down-down the default CO₂ EFs (Tier 1) or input manually plant-specific CO₂ EFs (Tier 2) in tonnes of CO₂ per tonne of soda ash produced or trona used.

Example: EFs for soda ash production – Tier 1&2

da Ash Production Capture and storage or other n	eduction				
orksheet ector: Industrial Processes and Product Us ategory: Chemical Industry ubcategory: 2.B.7 - Soda Ash Production heet: CO2 Emissions from Natural Soda As Jata					
	1		Equation 3.14		
Subdivision	Type of Activity Data	Activity Data (tonne)	Emission Factor (tonnes CO2/tonne AD)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
۵ <u>۷</u>	ΔΥ	AD	EF	E = AD * EF	E / 1000
Rest of Japan	Soda Ash produced	556	0.138	76.73	(
	Trona used	1,000	0.097	97	
Tokyo	Soda Ash produced	22,000	0.138 🗸	3,036	3
otal			Type of Activity Data	CO2 Emission Factor (tonnes CO2/tonne AD)	
		23.556	Soda Ash production	0.138	

Results

CO₂ emissions from Soda Ash Production are estimated in mass units (tonne and Gg) by the *Software* in the same worksheet **Soda Ash Production.**

Total CO₂ emissions from soda ash production is the sum of all emissions in the above worksheet, taking into account any CO₂ capture with subsequent storage. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO₂ capture and storage.

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where CO₂ capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u> users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on other long-term reduction of CO₂, in tonnes. <u>Column |B|</u> may include short-term CO₂ capture only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.

oda Ash Production	Capture and storage or other	r reduction						
ector: Ind ategory: Ch ubcategory: 2.1	dustrial Processes and Product I nemical Industry B.7 - Soda Ash Production apture and storage or other redu							
	DIOXIDE (CO2)	~						
CANDON		·						
	Subdivision		Source	-	Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)
			Source SRC	ΔV	stored (tonne)			
S	Subdivision			۵ T	stored (tonne)	(tonne) B	(tonne)	(Gg)
S Plant#2	Subdivision			^⊽	stored (tonne) A	(tonne) B	(tonne) C = A + B	(Gg) C / 1000
s	Subdivision			۵V	stored (tonne) A	(tonne) B	(tonne) C = A + B	(Gg) C / 1000

Example: Capture and storage or other reduction

2.B.8 Petrochemical and Carbon Black Production

GHG emissions from petrochemicals production include CO_2 and CH_4 emitted from fuel or process by-products combusted to provide heat or thermal energy to the production process, CO_2 and CH_4 emitted from process vents, and CO_2 and CH_4 emitted from flared waste gases. Section 3.9 in Chapter 3 Volume 3 of the *2006 IPCC Guidelines* provides common methodological guidance for estimating GHG emissions from category 2.B.8 Petrochemical and carbon black production, which specifically covers six sub-categories:

- ✓ 2.B.8.a Methanol
- ✓ 2.B.8.b Ethylene
- ✓ 2.B.8.c Ethylene Oxide
- ✓ 2.B.8.d Ethylene Dichloride (EDC) and Vinyl Chloride Monomer (VCM)
- ✓ 2.B.8.e Acrylonitrile
- ✓ 2.B.8.f Carbon Black

These petrochemicals and carbon black are addressed in detail because their global production volume and associated GHG emissions are relatively large. However, the chemicals included are not intended to represent the entire petrochemical process industry. There are a number of other petrochemical processes that emit small amounts of GHGs for which specific guidance is not provided in the 2006 IPCC Guidelines (e.g., styrene production). A seventh category, **2.B.8.x Other petrochemical production** has been added to the Software to allow for reporting of these additional petrochemicals, and to enable interoperability with the UNFCCC ETF Reporting Tool.

In addition to the common methodological guidance, additional guidance is provided to estimate GHG emissions from production of secondary products for 2.B.8.b Ethylene and 2.B.8.e Acrylonitrile.

Guidance for how to use the *Software* to estimate GHG emissions from petrochemical and carbon black production is provided, together, below due to application of common methodologies. Any distinctions for use of the *Software* for a specific petrochemical, or group of petrochemicals, is highlighted, where relevant.

Three methodological tiers are provided in the 2006 IPCC Guidelines for estimating GHG emissions from this source category. Tier 1 is a product-based EF method (default method) and applied to estimate CO_2 and CH_4 emissions. Tier 2 is a total feedstock carbon balance method (for CO_2 only). This approach is applicable in cases where AD for all carbon flows are available for both feedstock consumption and primary and secondary product production and disposition. Tier 3 requires plant-specific data and/or measurements.

<u>GHGs</u>

The *Software* includes the following GHGs for all subcategories of the petrochemical and carbon black source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
X	Χ					

IPCC Equations

The following IPCC Equations apply to all subcategories of the petrochemicals and carbon black source category, as described: '

CO₂ emissions:

- ✓ <u>Tier 1</u>: <u>Equation 3.15</u>, if information on production of each petrochemical is known. <u>Equations 3.15 and 3.16</u> if the amount of petrochemical produced is not known, but the user has information on feedstock consumption for petrochemical production.
- ✓ <u>Tier 2</u>: <u>Equation 3.17</u>. In addition, for production of **Ethylene** and **Acrylonitrile**, <u>Equations 3.18 and 3.19</u>, respectively.
- \checkmark Tier 3: Equations 3.20 and 3.21 and 3.22

CH₄ emissions:

- ✓ <u>Tier 1</u>: <u>Equations 3.23 and 3.24 and 3.25</u>
- \checkmark <u>Tier 2:</u> No Tier 2 Equations exist for CH₄ emissions in the 2006 IPCC Guidelines

<u>Tier 3: Equation 3.26</u> or <u>Equations 3.27</u> and <u>3.28 and 3.29</u> <u>Note that</u> a plant would use either i) Equation 3.26 (atmospheric measurements) or ii) Equations 3.27, 3.28, and 3.29 (combustion, flaring and venting) to estimate CH₄ emissions following the Tier 3 method

As explained in section **1.1.3 Use of multiple Tiers for reporting**, for both CO₂ and CH₄, estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

GHG emissions from the Petrochemical and Carbon Black source category are estimated using the following worksheets. The set of worksheets available to the user for all subcategories have a common naming convention, except for the first worksheet for collection of AD, which has a unique name for each chemical, as follows:

- ✓ 1.1.1 Fuel Manager: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ [Methanol][Ethylene][Ethylene Dichloride and Vinyl Chloride Monomer][Ethylene Oxide][Acrylonitrile][Carbon Black][Other petrochemical] Production Tier 1/2 worksheet is an AD input worksheet for Tier 1 and Tier 2 for CO₂ and CH₄ emissions. It contains for each subdivision the choice of data input based on the chemical produced or feedstock consumed for each type of production process. In the worksheets for Ethylene and Acrylonitrile there is also a sub-table for inputting the AD associated with the carbon content of secondary products.
- ✓ CO₂ Emissions Tier 1: contains for each subdivision/production process the amount of the specific chemical produced and the CO₂ EFs. The worksheet calculates the associated CO₂ emissions.
- ✓ CH₄ Emissions Tier 1: contains for each subdivision/production process the amount of the specific chemical produced and the CH₄ EFs, by source (total, fugitive and venting). The worksheet calculates the associated CH₄ emissions through use of a sub-table.
- ✓ CO₂ Emissions Tier 2: contains for each subdivision information on the carbon content of the chemical produced. The data on total carbon content of feedstock and chemical production (both primary product, and in the case of ethylene and acrylonitrile, secondary product) are automatically transferred from the relevant AD worksheet. The worksheet calculates the associated CO₂ emissions for Tier 2 (based on carbon/mass-balance).
- ✓ CO₂ and CH₄ Emissions from Combustion Tier 3 (1/3): contains for each subdivision (plant-level) information on the type and amount of fuel used, conversion factor and EFs for CO₂ and CH₄. The worksheet calculates the associated plant-specific CO₂ and CH₄ emissions from combustion.
- ✓ CO₂ and CH₄ Emissions from Flared Gas Tier 3 (2/3): contains for each subdivision (plant-level) information on the type and amount of flared gas (including whether the flared gas is of biogenic origin), conversion factor and EFs for CO₂ and CH₄. The worksheet calculates the associated plant-specific CO₂ and CH₄ emissions from flaring.
- ✓ CO₂ and CH₄ Emissions Summary Tier 3 (3/3): contains for each subdivision (plant-level) information on the amount of emissions from venting (including whether the vented emissions are of biogenic origin). The combustion and flaring emissions are transferred automatically from the two previous worksheets. The worksheet calculates the total plant-specific CO₂ and CH₄ emissions from combustion, flaring and venting.
- ✓ Atmospheric measurement data CH₄ Emissions Tier 3: contains for each subdivision/plant (and each measurement campaign) the measured atmospheric concentrations of VOC/CH₄ and other parameters (fraction of CH₄ in VOC, background/reference concentrations, wind speed and plume area). The results of CH₄ emissions from measurements campaigns are summed over time to present annual CH₄ emissions.
- ✓ **Capture and storage or other reduction:** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂ and CH₄, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision trees in Figure 3.8 (for CO_2 emissions) and Figure 3.9 (for CH_4 emissions) of the 2006 IPCC Guidelines, as well as Figure 3.10 (illustrating the Tier 2 carbon balance flow diagram), GHG estimates are calculated using a single methodological tier for each chemical in the petrochemical and carbon black production source category, or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements for that source category.

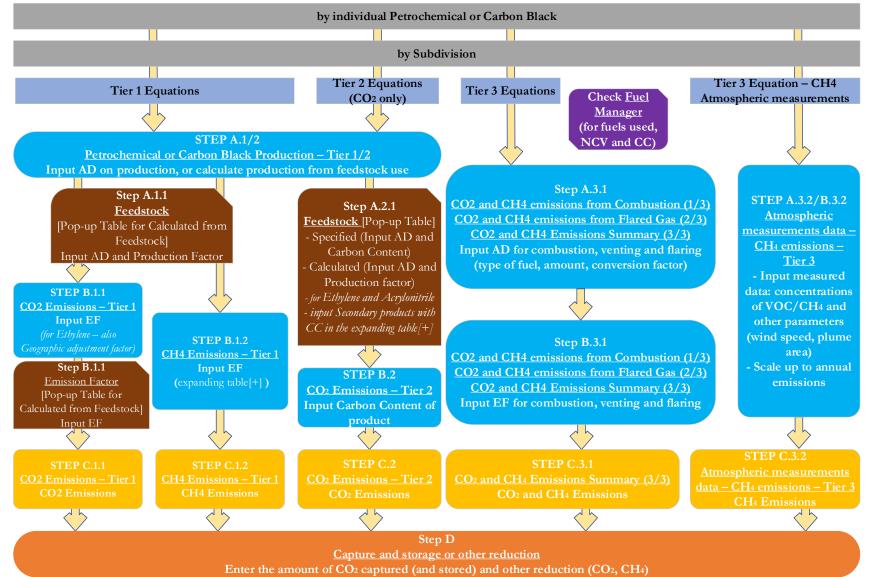
To ease the use of the *Software* as well as to avoid its misuse, for the Petrochemical and Carbon Black Production source category, users follow the following two flowcharts for CO₂ and CH₄ emissions. As the emissions from petrochemical and carbon black production vary both with the process used and the feedstock used, the choice of method shall be repeated for each product, process and feedstock used.

Prior to following the flowchart below, for users applying the Tier 3 method for CO₂ (Equations 3.27, 3.28 and 3.29) shall collect and enter data in the **1.1.1 Fuel Manager** on each fuel used for the petrochemical and carbon black production source category: its name, if not present among IPCC defaults, and the *calorific value* and the *carbon content* of each fuel, including for IPCC default fuels if user-specific values are available.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Petrochemical and Carbon Black Production – CO2 and CH4– flowchart

Note that this flowchart shall be followed for subcategories 2.B.8.a – 2.B.8.f and 2.B.8.x, as applicable



Thus, for the relevant petrochemical or carbon black subcategory:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 or Tier 2 Equations are applied:

Step A.1/A.2, in the worksheet [Methanol][Ethylene][Ethylene Dichloride and Vinyl Chloride Monomer][Ethylene Oxide][Acrylonitrile][Carbon Black][Other petrochemical] Production – Tier 1/2, users collect and input in the *Software* information either the amount of the respective chemical produced (specified input by users) or the amount of feedstock used (from which the amount of chemical produced is calculated) for each type of production process. Information on feedstock is entered in pop-up table (Step A.1.1 and Step A.2.1)

For the **Ethylene and Acrylonitrile** subcategories (Tier 2), users specify or calculate (by applying a production factor from feedstock) the amount of each secondary product produced from feedstock (**Step A.2.1**).

Then, for Tier 1:

Step B.1.1, in the worksheet **CO**₂ **Emissions – Tier 1,** users input CO₂ EFs for each type of production process, per tonne of chemical produced. For the **Ethylene Production** subcategory, users also enter in the geographic adjustment factor, if applicable. Where the CO₂ EF is based on feedstock consumption, the CO₂ EF is calculated in a pop-up table (Step B.1.1).

Step B.1.2, in the worksheet **CH**₄ **Emissions – Tier 1,** users input CH₄ EFs for each type of production process/source (total/fugitive/venting), per tonne of chemical produced.

Step C.1.1, in the worksheet **CO**₂ **Emissions – Tier 1,** the *Software* calculates the associated CO₂ emissions for each type of production process in mass units (tonne and Gg). In addition, total CO₂ emissions are calculated.

Step C.1.2, in the worksheet **CH**₄ **Emissions – Tier 1,** the *Software* calculates the associated CH₄ emissions for each type of production process/ source (total/fugitive/venting in mass units (tonne and Gg). In addition, total CH₄ emissions are calculated.

Then, for Tier 2:

Step B.2, in the worksheet CO_2 Emissions – Tier 2, users input the carbon content of the chemical produced for each type of production process, per tonne of chemical produced.

For the **Ethylene Production** and **Acrylonitrile Production** subcategories, in the sub-tables of the worksheets **Ethylene Production-Tier 1/2** and **Acrylonitrile Production-Tier 1/2**, users input the carbon content of each secondary product produced (**Step A.2.1**).

Step C.2, in the worksheet CO_2 **Emissions – Tier 2,** the *Software* calculates the associated CO_2 emissions for each type of production process in mass units (tonne and Gg). In addition, total CO_2 emissions are calculated.

When the Tier 3 Equations are applied:

For the Plant-specific Data Approach

Step A.3.1, in the worksheets CO_2 and CH_4 Emissions from Combustion – Tier 3 (1/3), CO_2 and CH_4 Emissions from Flared Gas – Tier 3 (2/3) and CO_2 and CH_4 Emissions Summary – Tier 3 (3/3), users collect and input in the *Software* information on the amount of fuel used, gas flared and gas vented, and their units.

Step B.3.1, in the worksheets CO_2 and CH_4 Emissions from Combustion – Tier 3 (1/3) and CO_2 and CH_4 Emissions from Flared Gas – Tier 3 (2/3), users input the conversion factors and CO_2 and CH_4 EFs for the fuels combusted and gases flared.

Step C.3.1 in the worksheet CO_2 and CH_4 Emissions Summary – Tier 3 (3/3), the *Software* calculates the associated GHG emissions in mass units (tonne and Gg). In addition, total GHG emissions are calculated.

For the Atmospheric Measurement Approach

Step A.3.2, /B.3.2 in the worksheet Atmospheric measurement data – CH₄ Emissions – Tier 3, users collect and input in the *Software* for each plant and each measurement campaign, the atmospheric concentrations of VOC/CH₄ and other parameters (fraction of CH₄ in VOC, background/reference concentrations, wind speed and plume area, summing up measurement campaigns to cover the entire year.

Step C.3.2 in the worksheet **Atmospheric measurement data – CH₄ Emissions – Tier 3**, the *Software* calculates the associated CH₄ emissions for each plant in mass units (kg and Gg).

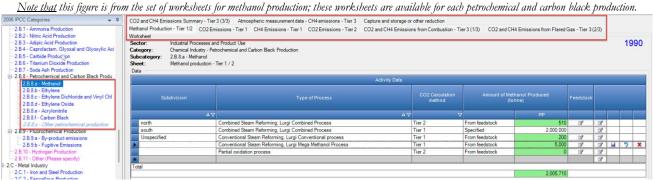
Then, for each tier, as appropriate:

Step D, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of GHG, not otherwise captured in the worksheets above.

Activity data input

Section 3.9.2.3 Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for each chemical in the Petrochemical and carbon black production source category.

Input of AD for Petrochemical and carbon black production source category requires the user first to navigate to the relevant chemical in the navigation tree on the left-hand side of the screen, and then select the worksheet for AD entry. The AD entry worksheet is labelled as **[Name of chemical] Production-Tier 1/2**.



Input of AD for the subcategories of the Petrochemical and Carbon Black Production source category requires the user to first enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column | Subdivision |</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified)

Note that this figure is from the set of worksheets for carbon black production; a unique subdivision could be identified for each chemical.

	Carbon Black production - Fier 1/2 Worksheet	CO2 Emissions - Tier 1 CH4 Emissions - Tier 1 CO2 Emissions - Tier 2 CO2 and CH	4 Emissions from Combustio	n - Tier 3 (1/3) CO2 an	IC CH4 Emissions from Pil	aleu Gas - II	s 3(2/3)	
-2.8.3 - Adipic Acid Production -2.8.4 - Caprolactam, Glyoxal and Glyoxylic Aci -2.8.5 - Carbide Production -2.8.6 - Titanium Dioxide Production -2.8.7 - Soda Ash Production	Sector: Industrial Process Category: Chemical Industry Subcategory: 2.B.8f - Carbon I	ses and Product Use - Petrochemical and Carbon Black Production Black duction - Tier 1 / 2						19
2.8.8 - Petrochemical and Carbon Black Produ 2.8.8 a - Methanol		Activity Da	ta					
2.B.8.b - Ethylene			CO2 Calculation	Amount of Carbo	on Black produced			
- 2.B.8.c - Ethylene Dichloride and Vinyl Chl - 2.B.8.d - Ethylene Oxide	Subdivision		method		onne)			
- 2.B.8.d - Ethylene Oxide - 2.B.8.e - Acrylonitrile		Type of Process এ স				Feedstock		
2.8.8.d - Ethylene Oxide 2.8.8.e - Acrylonitrile 2.8.8.f - Carbon Black			method		onne)			
2.8.8.d - Ethylene Oxide 2.8.8.e - Acrylonitrile		47	method 쇼·고	(to	pnne) PP			•

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: common set of worksheets for each chemical

Example: multiple subdivisions

Note that this figure is from the set of worksheets for ethylene oxide production; separate subdivisions could be identified for each chemical

2006 IPCC Categories 👻 👎	CO2 and CH4 Emissions Summary - Tier	3 (3/3) Atmospheric measurement data - CH4 emissions - Tier 3 Capture and storage o	r other reduction						
2.8.1 - Ammonia Production 2.8.2 - Nitric Acid Production 2.8.3 - Adipic Acid Production 2.8.4 - Caprolactam, Glyoxal and Glyoxylic Aci 2.8.5 - Carbide Production	Ethylene Oxide production - Tier 1/2 CC Worksheet Sector: Industrial Processes and	2 Emissions - Tier 1 CH4 Emissions - Tier 1 CO2 Emissions - Tier 2 CO2 and CH4 Er 4 Product Use ochemical and Carbon Black Production		n - Tier 3 (1/3) CO2 a	nd CH4 Emissions from FI	lared Gas - T	ier 3 (2/3)		990
2.B.6 - Titanium Dioxide Production	Sheet: Ethylene Oxide producti	on - Tier 1 / 2							
2.B.7 - Soda Ash Production 2.B.8 - Petrochemical and Carbon Black Produ 2.B.8 - Methanol	Data	Activity Data	15. T			_			
2.B.8.b - Ethylene 2.B.8.c - Ethylene Dichloride and Vinyl Chl 2.B.8.d - Ethylene Oxide	Subdivision		CO2 Calculation method		ne Oxide produced nne)				
- 2.B.8.e - Acrylonitrile - 2.B.8.f - Carbon Black	∆ \	Δ \	v v		PP				
2.8.8.x - Other petrochemical production	10 Northern region	Air Process [default]	Tier 2	From feedstock	900	1	3 6	1 2	X
2.8.9 - Fluorochemical Production	Unspecified	Air Process (default)	Tier 1	Specified	200		3		
- 2.B.9.a - By-product emissions		Oxygen Process	Tier 2	Specified	150	3	2		
2.B.9.b - Fugitive Emissions	*						2		
2.B.10 - Hydrogen Production	Total								
					1,250				
1-2 C - Matal Industry									

When the Tier 1 and Tier 2 Equations are applied:

For each chemical, and each subdivision for that chemical in worksheet [Methanol][Ethylene][Ethylene Dichloride and Vinyl Chloride Monomer][Ethylene Oxide][Acrylonitrile][Carbon Black][Other petrochemical] Production – Tier 1/2, the user will in <u>Column |Subdivision|</u> input information in a single row, or in a number of rows, as follows:

 <u>Column |Product Type|</u> (applicable to subcategory 2.B.8.c Ethylene Dichloride and Vinyl Chloride Monomer Production subcategory only): select from the drop-down menu whether information in that row is for the production of ethylene dichloride or vinyl chloride monomer.

<u>Note that:</u> Users should use either EDC production or VCM production (not both) as AD.

2. <u>Column |Type of Process |</u>: select the name of the type of production process for each chemical from the drop-down menu, or the user may overwrite.

Note that, in the absence of country-specific information, the 2006 IPCC Guidelines provide a default process (and type of feedstock) in Table 3.11.

- 3. <u>Column | CO₂ Calculation method</u>: select from the drop-down whether Tier 1 or Tier 2 is applied.
- 4. <u>Column |Amount of [Chemical] Produced, PP|</u>: select whether the AD for the amount of chemical produced is specified (i.e. entered) directly or calculated from the feedstock used (Tier 1 and Tier 2). For entry of AD, the following column headers are applicable when either Tier 1 or Tier 2 methods are implemented:

Note that:

Specified: when selected, the user inputs manually the amount of the chemical produced in <u>Column | PP |</u>.

From feedstock – when selected, the user inputs in a sub-table (accessed by clicking on the icon in <u>Column | Feedstock |</u> the following: <u>Column | Type of Feedstock |</u> Select the type of feedstock from the drop-down menu or enter a user-specific feedstock. In the absence of country-specific information, the 2006 IPCC Guidelines provide a default type of feedstock) in <u>Table 3.11</u>.

<u>Column |Biogenic|</u> indicate with a check if the process fuel is of biogenic origin. <u>Note that</u> CO₂ emissions from flared gas of biogenic origin will not be included in national totals.

<u>Column |FA|</u> enter the amount of feedstock consumed.

<u>Column |SPP|:</u> slect the IPCC default for the tonnes of chemical produced per tonne of feedstock used, or overwrite with user-specific value. Once calculated, the amount of the chemical produced automatically appears in the main worksheet.

<u>Note that</u>: for Tier 2, if the amount of chemical was specified in <u>Column |PP|</u>, <u>Column |SPP|</u> should not be filled, and in fact, any amount of petrochemical produced calculated in <u>Column |PP|</u> of the subtable, whill not transfer back to the main table.

- 5. <u>Column | Feedstock |</u>: user shall select the icon in this column to enter information on feedstock consumed in two cases:
 - ✓ The user is calculating the amount of the chemical produced based on feedstock consumed (Tier 1 and Tier 2), as described in step 3 above.
 - ✓ The user has selected use of a Tier 2 method in <u>Column |CO₂ Calculation method|</u>, which requires information on the amount and carbon content of feedstock(s) consumed.

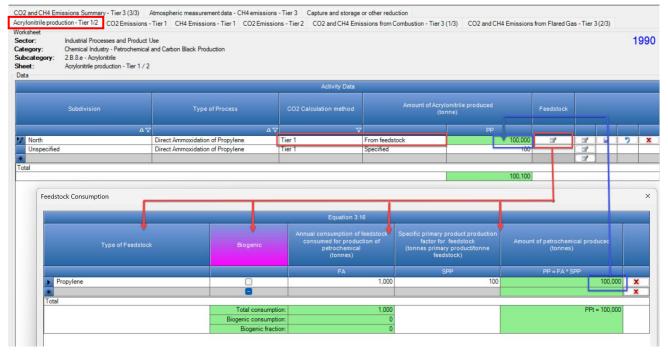
Example: AD input Tier 1 and Tier 2-chemical produced is specified directly in |Column PP|

Note that this figure is from the set of worksheets for EDC/VCM Production; this worksheet is available for each petrochemical and carbon black production.

tegory: Chemical Indust bcategory: 2.B.8.c - Ethyler	ises and Product Use y - Petrochemical and Carbon Black le Dichloride and Vinyl Chloride Mon ide and Vinyl Chloride Monomer pro	nomer						1	99
		Activity Data							
Subdivision	Product type		CO2 Calculation method		duct produced nne)	Feedsto ck			
Δ	7 47	۵۵	V		PP				
Unspecified	Ethylene Dichloride	Balanced Process [default]	Tier 1	Specified	100				
	and the second	Integrated EDC/VCM Production Plant	Tier 2	Specified	300	3			
		Integrated EDC/VCM Froduction Franc							
	Vinyl Chloride Monomer	Balanced Process [default]	Tier 1	Specified	200				
	Vinyl Chloride Monomer			Specified From feedstock	200 1,952.7	3	the second		2

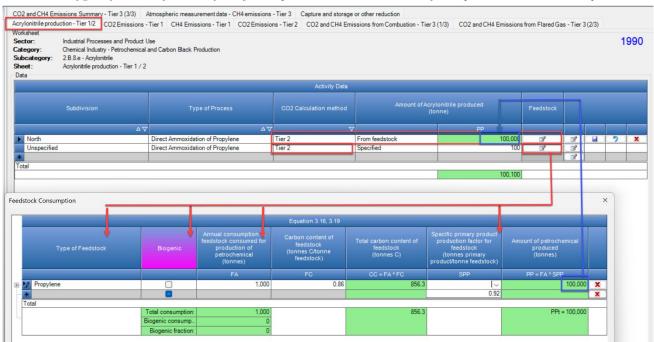
Example: AD input Tier 1-chemical produced calculated from feedstock

Note that this figure is from the set of worksheets for Acrylonitrile Production; this sub-table is available for each petrochemical and carbon black production.



Example: AD input Tier 2 -entering AD from feedstock use

Note that this figure is from the set of worksheets for Acrylonitrile production; this sub-table is available for each petrochemical and carbon black production.



For the subcategories Ethylene Production (2.B.8.b) and Acrylonitrile Production (2.B.8.e) only:

In addition to entering information on the primary products above, when estimating GHG emissions for Ethylene Production and Acrylonitrile Production following a Tier 2 method (i.e. Tier 2 is selected in <u>Column | CO₂</u> <u>Calculation method |</u>, AD on secondary products must also be entered in the feedstock sub-table by:

- 1. For each type of feedstock in the feedstock sub-table, click the symbol "⊞" on the left of the row to open a drop-down table where information on the secondary products are to be compiled. Then:
- <u>Column |Secondary Product|</u>: select from the drop-down menu each secondary produced from the primary product for each type of feedstock, one row for each secondary product, or enter in user-specific secondary products.

<u>Note that</u>: In the absence of country specific information, the user shall enter one row for each and every secondary product available in the drop-down menu to ensure that the carbon content of these secondary products is considered in the mass balance at Tier 2.

- 3. <u>Column |SP|:</u> the user by default can *calculate* the amount of each secondary product produced, or may specify this information directly in <u>Column |SP|</u> by selecting "Specified"
 - ✓ If *Calculated:* by default, the *Software* automatically calculates the amount of secondary product produced in <u>Column |SP|</u>, in tonnes, for each type of secondary product selected from the dropdown menu in <u>Column |Secondary Product</u>|, based on default specific secondary product production factors automatically populated in <u>Column |SSP|</u> for the relevant feedstocks (in kg secondary product /tonne ethylene or acrylonitrile produced) taken from <u>Table 3.25</u> (for ethylene) and <u>Table 3.26</u> (for acrylonitrile) of the *2006 IPCC Guidelines*.
 - ✓ If *Specified*: <u>Column |SSP|</u> is greyed out and the user enters the amount of each secondary product directly in <u>Column |SP|</u>.

					nent data - CH4 emissions - Ti - Tier 1 CO2 Emissions - Ti				- Tier 3 (1/3) C	O2 and CH	4 Emissions from	n Flared Ga	is - Tier 3 (2/3)	
roxylic Aci Category:			roduct Use nemical and Carbon I	Black Prod	uction									19
Istock Consumption		ale dana										×		
					Equation 3.16, 3.18	1			~			P		
Type of	Feedstock		Biogenic		Annual consumption of fee consumed for productio petrochemical (tonnes)		Carbon conten (tonnes C/tonr		Total carbon c (to	ontent of f nnes C)	eedstock			
1.					FA		FC		CC	= FA * FC			3	
Ethane						100		0.86			85.6	×		a 🤊
1000					Secondary produ	icts							3	
Secondary pr	oduct	production fail (kg secondar	ondary product ctor for feedstock ry product/tonne dstock)		Amount of secondary p (tonnes)			ent of secondary p nne secondary pr		Total carbon content of secondary product (tonnes C)		F	
	···		SSP				FA* SSP / 1000 ir specified		SC		TSC = SP * SC			
Tot			uct	Calculate	ed secondary product productio	on factor fo	r feedstock Carb	on content of seco	ondary product			×		
Type of Feedstock		Secondary prod	luct		(kg secondary product/tonn			nes C/tonne secor				0		
Ethane	High Value Ch	emicals					842							
	Ethylene						803		0.856					
	Propylene						16		0.8563	stant of f	eedstock			
	Butadiene						23		0.888	nes C)				
	Aromatics	1					157							
_	Hydrogen	ducts and backfl	ows				60			FA*FC				
*	Methane						61		0.749			×		
l otal		opane after recyc	la				0		0.745	-		-		
k the b	Other C4	opanie andi Tecyc	no.				6				05.0			
at the t	C5/C6						26			-				
ancel	C7+ non-arom	atics					0				Save			
	<430C						0			-			2 Date	Series data entry
	>4300						0						rime	Jones uata entry
	Losses						5			-				
n, for th	Total						1.000							

Example: AD on secondary products input – Tier 2 – ethylene and acrylonitrile production only

For the subcategory Other Petrochemical Production (2.B.9.x) only:

Guidance for inputting AD for other petrochemical production follows the guidance provided above for subcategories 2.B.8.a-2.B.8.f, except an additional column is available to specify the other type of petrochemical that is produced. For other petrochemical production, AD entry for Tier 1 and Tier 2 is as follows:

1. <u>Column | Petrochemical type |</u>: select from the drop-down menu the type of petrochemical produced (i.e. styrene) or if another petrochemical, manually enter the chemical name.

It is assumed that secondary products are not applicable for other petrochemicals.

When the Tier 3 Equations are applied:

As illustrated in the flowchart for the petrochemical and carbon black production source category, there are two Tier 3 approaches for estimating GHG emissions, one applying plant-specific data, and one relying on atmospheric measurements. AD for these two Tier 3 approaches are discussed, separately, below.

Tier 3 using plant-specific data (CO₂ and CH₄ emissions)

For each chemical, and each subdivision for that chemical in worksheet CO_2 and CH_4 Emissions from Combustion – Tier 3 (1/3), the user will input information in a single row, or in a number of rows, plant-specific information as follows:

- 1. <u>Column |Fuel</u>]: select each fuel used from the drop-down menu (one row for each fuel). <u>Note that fuels shown in the drop-down menu are those listed in the Fuel Manager.</u> <u>Note that</u> user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.
- 2. <u>Column |U|</u>: select the unit of fuel consumption data (e.g. tonne, TJ, m³) from the drop-down menu or overwrite with a user-specific unit.
- 3. <u>Column |FA|</u>: enter amount of fuel consumed.
- 4. <u>Column |CV|:</u> enter the conversion factor to convert the consumption unit to an energy unit (TJ). <u>Note that</u> if Tonnes is selected, the NCV/GCV is sourced from the Fuel Manager and compiled by the Software as the conversion factor; while if the

consumption unit is TJ the Software compiles the conversion factor cell with the value 1. Where other units are applied (e.g. m3) this cell becomes blank and the user shall enter the relevant conversion factor here the user shall enter the relevant conversion factor here.

Example: AD for Tier 3 – amount of fuels combusted

Note that this figure is for methanol production; this worksheet is available for each petrochemical and carbon black production.

	ary - Tier 3 (3/3) Atmospheric n				particular in the local division of the loca		rage or other reduction						
	CO2 Emissions - Tier 1 CH4 E	missio	ons - Tier 1 CO2 Emissio	ns - Tie	r 2 CO2 and CH	14 E	missions from Combus	stion - Tier 3 (1/3)	CO2 and CH4 Emissions from	Flared Gas - Tier 3 (2/3	5)		
tegory: Chemical Indu bcategory: 2.B.8.a - Meth	Emissions from Combustion - Tier 3	3 (1/3)											199
					Equation 3	3.21	3.28						
Subdivision	Fuel		Consumption Unit (Mass, Volume or Energy	Unit)	Amount of fuel consumed for Methanol production (U)		Conversion Factor (TJ/Unit)	CO2 Emission Factor (tonnes CO2 / TJ)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
	V	∇	U		FA	V	CV 🛆	EF	E = FA * CV * EF	E / 1000			
Unspecified	Gas/Diesel Oil		TJ		2,00	00	1	74.0	7 148,133.33	148.13			
	Natural Gas Liquids		TJ			25	1	64.1	7 1,604.17	1.6			
	Other Kerosene		m3		1.00		1,000	71.8	7 71,866,666.67	71,866.67		_	
Unspecified		\sim	Tonne		12	20		7	0		2		2
btal	Fuel Type	Т			alorific Value C (TJ / Gg)		on content (NCV) (kg C / GJ)				2		
9555	Liquid Fuels	Avi	iation Gasoline		44.3		19.1	Including Biogenic	72,016,404.17	72,016.4			
		Bit	umen		40.2		22	Excluding Biogenic	72,016,404.17	72,016.4			
		Cru	ude Oil		42.3		20						
		Eth	ane		46.4		16.8						
		Ga	s/Diesel Oil	-	43		20.2						
		Jet	Gasoline		44.3		19.1						
			Kerosene		44.1		19.5						

Then, for each chemical, and each subdivision for that chemical in worksheet CO_2 and CH_4 Emissions from Flared Gas – Tier 3 (2/3), the user will input information in a single row, or in a number of rows, plant-specific information as follows:

- 1. <u>Column | Flared Gas |</u>: enter a name for, or description of, the flared gas (e.g. the type of gas).
- 2. <u>Column | Biogenic |</u> indicate with a check if the flared gas is of biogenic origin. <u>Note that</u> CO₂ emissions from flared gas of biogenic origin will not be included in national totals.
- 3. <u>Column |U|</u>: select the unit of the amount of flared gas (e.g. GJ, TJ, m³) from the drop-down menu or overwrite with a user-specific unit.
- 5. <u>Column |FG|</u>: enter the amount of gas flared during production of the chemical.
- 6. <u>Column |CV|:</u> enter the conversion factor to convert the consumption unit to an energy unit (TJ). <u>Note that</u> if the consumption unit is GJ or TJ the Software compiles the conversion factor cell with the value 0.001 or 1, respectively. Where other units are applied (e.g. tonne or m3) this cell becomes blank and the user shall enter the relevant conversion factor here.

Example: AD for Tier 3 – amount of flared gas

<u>Note that</u> this figure is for ethylene oxide production; this worksheet is available for each petrochemical and carbon black production.

O2 and CH4 Emissions Summary thylene Oxide production - Tier 1/						bustion - Tier 3 (1/3)	CO2 and CH4 Emissions fi	rom Flared Gas - Tier	3 (2/3)	
forksheet ector: Industrial Proces ategory: Chemical Industri ubcategory: 2.8.8.d - Ethylen	ses and Product Use y - Petrochemical and Carbor	n Black Produ				boston - no s (no)				199
				Equation 3.22, 3	.29				100	
Subdivision	Flared gas	Biogenic	Consumption Unit (Mass, Volume or Energy Unit)	Amount of gas flared during Ethylene Oxide production (U)	Conversion Factor (TJ/Unit)	CO2 Emission Factor (tonnes CO2 / TJ)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
Δ 7	7 47	V	U	FG 🖓	CV	EF	E = FG * CV * EF	E / 1000		
Ø Unspecified	natural gas		TJ 🗸	200	1	56	11,200	11.2		2
									2	
*										
* Total				200		Including Biogenic	11.200	11.2	-	

Tier 3 using atmospheric measurements (CH4 emissions)

The Tier 3 method using atmospheric measurements does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

For the subcategory Other Petrochemical Production (2.B.9.x) only:

Guidance for inputting AD for other petrochemical production follows the guidance provided above for subcategories 2.B.8.a-2.B.8.f, except an additional column is available to specify the other type of petrochemical that is produced. For other petrochemical production, AD entry for Tier 3 is as follows:

1. <u>Column | Petrochemical type |</u>: select from the drop-down the type of petrochemical produced (i.e. styrene) or if another petrochemical, manually enter the chemical name.

Emission factor input

<u>Section 3.9.2.2</u> in Chapter 3 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for each subcategory of the petrochemical and carbon black production source category. The source for the IPCC default EFs for each chemical are presented in Table 2.

<u>Table 3.11</u> provides the default feedstocks and processes assumed for each chemical for the Tier 1 method. IPCC default EFs are available for at least each default process/feedstock.

Table 2. Source of EFs	for the petrochemical	and carbon black	production source category

Chemical	CO ₂ EFs	CH ₄ EFs
2.B.8.a Methanol	Table 3.12 and Table 3.10 (carbon content)	2.3 kg CH ₄ emissions per tonne of methanol produced.
2.B.8.b Ethylene	<u>Table 3.14</u> , <u>Table 3.15</u> (geographic adjustment factor), <u>Table 3.10</u> (carbon content)	<u>Table 3.16</u>
2.B.8.c Ethylene dichloride and vinyl chloride monomer	Table 3.17, Table 3.10 (carbon content)	<u>Table 3.19</u>
2.B.8.d Ethylene oxide	Table 3.20, Table 3.10 (carbon content)	<u>Table 3.21</u>
2.B.8.e Acrylonitrile	<u>Table 3.22</u> , <u>Table 3.10</u> (carbon content)	0.18 kg CH ₄ /tonne acrylonitrile produced
2.B.8.f Carbon black	Table 3.23, Table 3.10 (carbon content)	<u>Table 3.24</u>
2.B.8.x Other petrochemical production	User -specified	User -specified

For the input of CO₂ and CH₄ EFs the following worksheets are used for different Tiers:

- ✓ CO₂ Emissions Tier 1
- ✓ CH₄ Emissions Tier 1
- \checkmark CO₂ Emissions Tier 2
- \checkmark CO₂ and CH₄ Emissions from Combustion Tier 3 (1/3)
- \checkmark CO₂ and CH₄ Emissions from Flared Gas Tier 3 (2/3)

When the Tier 1 Equations are applied (CO₂ and CH₄):

i.CO2 emissions

The CO_2 Emissions – Tier 1 worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of subdivision/type of process combinations that applied the Tier 1 CO₂ calculation method, as

entered in worksheet [Methanol] [Ethylene] [Ethylene Dichloride and Vinyl Chloride Monomer] [Ethylene Oxide] [Acrylonitrile] [Carbon Black] [Other petrochemical] Production – Tier 1/2.

<u>Note that:</u> for the subcategory Ethylene Dichloride and Vinyl Chloride Monomer, the rows are further stratified by product type (either EDC or VCM). For the subcategory Other petrochemical production, rows are further stratified by petrochemical type entered by the user.

Then enter EF information for 2.B.8.a Methanol and 2.B.8.b Ethylene as follows:

1. <u>Column | EF |:</u> select whether the CO₂ EF is specified or calculated from feedstock. <u>*Note that:*</u>

Specified: -when selected the user enters the CO₂ EF directly

From feedstock: – to calculate the $CO_2 EF$ from the feedstock, select the icon for the drop-down table. Any feedstock entered in the AD worksheet will be automatically populated in the drop-down table, and accordingly the corresponding $CO_2 EF$ available in the drop-down in <u>Column EFk(CO_2)</u>

2. <u>Column |GAF|</u> (applicable for Ethylene production only): select from the drop-down the geographic adjustment factor corresponding to the relevant region. The geographic adjustment factor takes into account that the default CO₂ EF for ethylene production.

<u>Note that</u> Tier 1 CO2 EFs for ethylene production have been developed based on data for ethylene steam crackers operating in Western Europe. Geographic Adjustment Factors are applied to the Tier 1 EF to account for regional variability in steam cracker operating efficiency.

Example: Tier 1 CO₂ EFs for 2.B.8.a methanol and 2.B.8.b ethylene production

Note that this figure is for methanol production; this worksheet is available for each ethylene production.

ubcategory: 2.8.8	tal Processes and Product Use cal Industry - Petrochemical and Carbon Black. Production a - Methanol missions from Methanol Production - Tier 1			ibustion - Tier 3 (1/3)	CO2 and CH4 Em	issions from Flared Gi	as - Her 3(2/3)	ł	199
Subdivision	Type of Process	Equation Amount of Methanol Produced (tonne)		Emission Factor CO2/tonne methano	l produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
	<u>م</u>			EF		E = PP * EF	E / 1000		
north	Combined Steam Reforming, Lurgi Combined Process		Specified	25		12,750		2	
south	Combined Steam Reforming, Lurgi Combined Process	2,000,000		25		50,000,000	50,000		+
Unspecified	Conventional Steam Reforming, Lurgi Conventional process		From feedstock	5.29	2	1,057	1.06		
	Conventional Steam Reforming, Lurgi Mega Methanol Process		From feedstock	0.27	3	1,335	1.34		
-		2,005,710			Including Biogenic	50,015,142	50,015.14	_	
	CO2 Emission Factor	2,005,710			Including Biogenic	50,015,142	50,015.14		
	CO2 Emission Factor		t of petrochemical p (tonnes)	produced	C	. 50,015,142 02 Emission Factor onne petrochemical	>		
(t of petrochemical p	roduced	C	02 Emission Factor	>		
	Type of Feedstock		t of petrochemical p (tonnes)	produced	C	D2 Emission Factor onne petrochemical	>		
	Type of Feedstock		t of petrochemical p (tonnes)		C	D2 Emission Factor onne petrochemical	> produced)		

Example: Tier 1 geographic adjustment factor for 2.B.8.b ethylene production

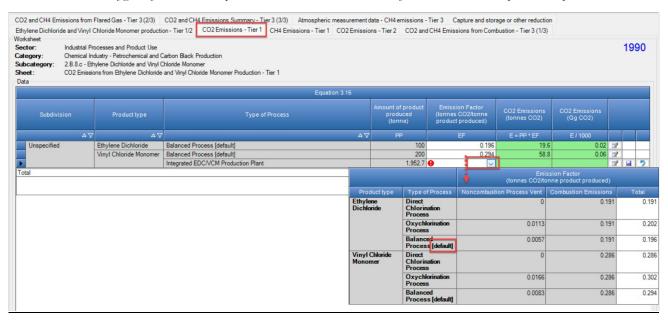
	Immary - Tier 3 (3/3) Atmospheric measurement data - CH4 emissions /2 CO2 Emissions - Tier 1 CO2 Emissions CH4 Emissions - Tier 1 CO2 Emissions			and the state of the second state		er 3 (1/3) CO2 and CH4 Emissi	ions fro	m Flared Gas	- Tier 3 (2/3)	
ategory: Industrial abcategory: 2.8.8.b -	I Processes and Product Use I Industry - Petrochemical and Carbon Black Production Ethylene ssions from Ethylene Production - Tier 1										1990
			Eq	uation 3.15							
Subdivision	Type of Process	Amount Ethyler Produce (tonne	te ed		ssion Factor nne ethylene prod	luced)	Geographic Adjustment Factor (%)		Emissions ines CO2)	CO2 Emissions (Gg CO2)	
∆ ⊽	Δ 🕁								PP * EF * SAF/100)		
North	Steam cracking		0	From feedstock		2	110 🗸				3 9 1
otal				Geograp	iic region		Geographic Ad <mark>justment F</mark> (%)	actor		Remark	
			Wes	tern Europe				100		able 3.14 are based ropean steam crack	
			East	tern Europe				110	Not includin	g Russia	
			Japa	an and Korea				90			
			Asia	a, Africa, Russia				130	Including As	sia other than Japan	and Korea
			Nort	th America and So	uth America and			110			

Then enter EF information for 2.B.8.c Ethylene Dichloride and Vinyl Chloride Monomer, 2.B.8.f Carbon Black and 2.B.8.x Other petrochemical production as follows:

 <u>Column |EF|</u>: select from the drop-down the IPCC default value for the relevant type of process, if available, or enter a user-specific value, in tonnes CO₂/tonne product produced. <u>Note that:</u> the drop-down identifies the "default process" in accordance with Table 3.11 for EDC/VCM.

Example: Tier 1 CO₂ EFs for 2.B.8.c EDC/VCM, 2.B.8.f carbon black, and other 2.B.8.x petrochemical production

Note that this figure is for EDC/VCM production; a similar worksheet is available for carbon black and other petrochemical production.



Then enter EF information for 2.B.8.d Ethylene Oxide as follows:

- 1. For each row, users click the symbol "⊞" on the left of the row to open a drop-down table where EF values are to be compiled based on the catalyst specificity.
- 2. <u>Column | Catalyst selectivity |:</u> in the sub-table, select from the drop-down the catalyst selectivity (see <u>Table</u> <u>3.20</u> of the *2006 IPCC Guidelines*, and accompanying guidance), otherwise enter in user-specific information.
- <u>Column | Fpp |:</u> enter in the fraction (0-1) of the production produced using the catalyst selectivity identified in <u>Column | Catalyst selectivity |</u> <u>Note that:</u> The total in <u>Column | Fpp |</u> for each subdivision should equal 1.

4. <u>Column |EF|</u>: the *Software* automatically populates the IPCC default CO₂ EF, in tonnes CO₂/tonne ethylene oxide produced, based on the selection in <u>Column |Catalyst selectivity|</u>. The user may overwrite this value.

ector: tego bcat bcat eet: ata	ry: Chemical Indust egory: 2.B.8.d - Ethyler	ry - Pe ne Oxio	trochemical and Carbon		ction									199
							Equation 3.15							
	Subdivision				Туре с	f Process		Amount of Ethylene Oxide produced (tonne)		Emissions nes CO2)			CO2 Emi: (Gg C	
		۵V			_		ΔV	PP			E		E/10	00
	Unspecified		Air Process [default]					200			1	45.34		C
-	Catalyst Selectivity		Fraction of productior per specified Catalyst			Emission Factor CO2/tonne Ethylene Oxide produced)		2 Emissions nnes CO2)	CO2 Emis (Gg Cl					
			Fpp			EF	E=F	P * Fpp * EF	E / 10	00				
-	▶ 75	~		0.5		0.66		66		0.0			2	
1	Туре		ocess	Catalyst Se	electivity	Emission F (tonnes CO2/tonne Ethyle		69.	10	0.0		-	-	-
	* Air Process [default	1			70		0.863	A COMPANY AND A CO		0.0	3			
	Tot				75		0.663							_
					80		0.5	145.	34	0.1	5			

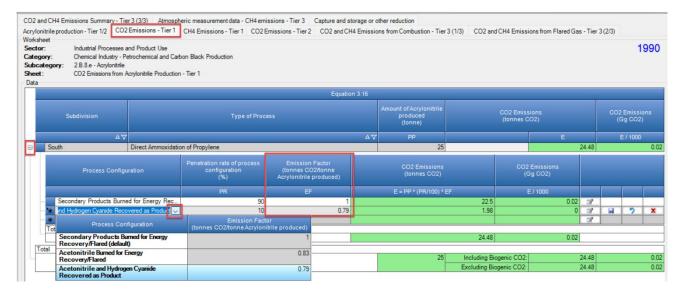
Example: Tier 1 CO₂ EFs for 2.B.8.d ethylene oxide production

Then enter EF information for 2.B.8.e Acrylonitrile as follows:

- 1. For each row, users click the symbol "⊞" on the left of the row to open a drop-down table where EF values are to be compiled based on the process configuration.
- 2. <u>Column |Process Configuration|</u>: in the sub-table, select from the drop-down the process configuration (see <u>Table 3.22</u> of the 2006 IPCC Guidelines, and accompanying guidance), otherwise enter in user-specific information.
- 3. <u>Column |PR|:</u> enter in the penetration rate (%) of the process configuration identified in <u>Column |Process</u> <u>Configuration|</u>

<u>Note that:</u> The total in <u>Column | PR |</u> for each subdivision should equal 1.

4. <u>Column |EF|</u>: the *Software* automatically populates the IPCC default CO₂ EF, in tonnes CO₂/tonne acrylonitrile produced, based on the selection in <u>Column |Process Configuration|</u>. The user may overwrite this value.



Example: Tier 1 CO₂ EFs for 2.B.8.e acrylonitrile production

ii. CH₄ emissions

The CH₄ Emissions – Tier 1 worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/type of process combinations entered in worksheet [Methanol] [Ethylene] [Ethylene Dichloride and Vinyl Chloride Monomer] [Ethylene Oxide] [Acrylonitrile] [Carbon Black][Other petrochemical] Production – Tier 1/2.

Note that: for the subcategory Ethylene Dichloride and Vinyl Chloride Monomer, the rows are further stratified by product type (either EDC or VCM). For the subcategory Other petrochemical production, rows are further stratified by petrochemical type entered by the user.

Then enter EF information for 2.B.8.a Methanol, 2.B.8.c Ethylene Oxide, 2.B.8.d Acrylonitrile and 2.B.8.x Other petrochemical production as follows:

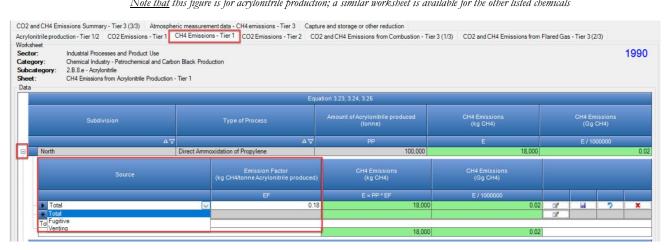
- 1. For each row, users click the symbol " \boxplus " on the left of the row to open a drop-down table where EF values are to be compiled based on the amount of chemical produced, separated between fugitive, venting and total CH₄ emissions.
- 2. <u>Column |Source|</u>: select from the drop-down whether the $CH_4 EF_5$ to be entered are based on fugitive, vented or total emissions.

Note that: the IPCC default CH4 EFs are for total CH4 emissions; if user has specific information separate CH4 EFs could be entered for fugitive and vented emissions.

3. <u>Column |EF|</u>: select IPCC default CH₄ EFs from the drop-down, if available, otherwise enter in userspecific information, in kg CH₄/tonne product produced.

Example: Tier 1 CH₄ EFs .for 2.B.8.a methanol, 2.B.8.d ethylene oxide, 2.B.8.e acrylonitrile and 2.B.8.x other petrochemical production

<u>Note that</u> this figure is for acrylonitrile production; a similar worksheet is available for the other listed chemicals



Then enter EF information for **2.B.8.b Ethylene Production** as follows:

- 1. For each row, users click the symbol "" on the left of the row to open a drop-down table where EF values are to be compiled based on the type of feedstock used and amount of chemical produced.
- 2. <u>Column |Source|</u>: select from the drop-down menu whether the CH₄ EFs to be entered are based on fugitive, vented or total emissions.
- 3. <u>Column |EF|</u>: select whether the CH₄ EF is specified or based on feedstock. Note that:

Specified: -when selected the user enters the CH₄ EF directly

From feedstock: - IPCC default CH4 EFs for ethylene production are available based on feedstock used (EFs are available for ethane, naphtha and all other feedstocks). Information on the feedstocks are entered by selecting the icon for the drop-down table in Column [EF]: Note that: the option to enter an EF based on the feedstock consumed is only active in the case where the Tier 1 method was selected in worksheet Ethylene Production – Tier 1/2 and the amount of ethylene produced in that worksheet was calculated from feedstock in Column |PP|.

- 4. <u>Column | Type of Feedstock |:</u> The feedstocks are automatically populated based on information entered in Ethylene Production – Tier 1/2.
- Column | EFk(CH₄) |: select the IPCC default CH₄ EF, otherwise enter in the user-specific value. 5.

Example: Tier 1 CH₄ EFs for 2.B.8.b ethylene production

hylene Production - Ti orksheet	er 1/2 CO2 Emissions - Tier 1 CH	H4 Emissions - Tier 1 CO2 Emi	ssions - Tier 2 CO2	and CH4 Emissions	from Combustion	- Tier 3 (1/3) CO2	and CH4 Emissions from FI	ared Gas - Tier 3 (2/3)	
ategory: Cher ubcategory: 2.8.8	strial Processes and Product Use nical Industry - Petrochemical and Carb 3.b - Ethylene Emissions from Ethylene Production - T								199
		<i></i>	Equ	uation 3.23, 3.24, 3.2	5				
	Subdivision		ess		ylene Produced nne)		4 Emissions (kg CH4)	CH4 Emissior (Gg CH4)	
	۵⊽		۵ ۷	· · · · · · · · · · · · · · · · · · ·	PP		E	E / 1000000	
North		Steam cracking			2	2,244	0		
		(kg CH4	Emission Factor Itonne ethylene produ			CH4 Emissions (kg CH4)	CH4 Emission: (Gg CH4)		
			EF			E = PP * EF	E / 1000000		
Total		From feedstock			8			3 3	" ×
Total									
mission Factor								×	
									s
	Type of Feedstock			etrochemical produ (tonnes)			CH4 Emission Factor 14/tonne petrochemical pro	oduced)	
				PPk			EFk (CH4)		
Ethane					2,000 244				
Naphtha I					244	Type of Feed		ssion Factor trochemical produced)	
					2,244	Ethane		6	

Then enter EF information for 2.B.8.d Ethylene Oxide and 2.B.8.f Carbon Black as follows:

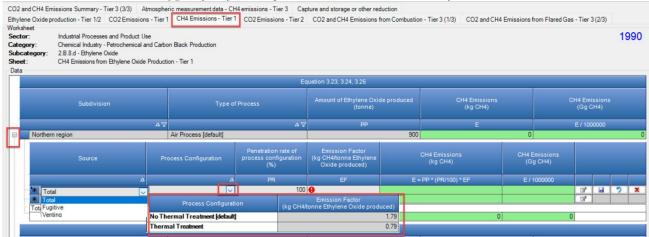
- 1. For each row, users click the symbol "⊞" on the left of the row to open a drop-down table where EF values are to be compiled based on the source, process configuration (type and penetration rate).
- 2. <u>Column |Source|</u>: select from the drop-down whether the CH₄ EFs to be entered are based on fugitive, vented or total emissions.
- 3. <u>Column |Process Configuration|</u>: in the sub-table, select from the drop-down the appropriate process configuration. The default configurations as contained in <u>Table 3.21</u> (ethylene oxide) and <u>Table 3.24</u> (carbon black) of the 2006 IPCC Guidelines are identified.
- 4. <u>Column |PR|</u>: enter in the penetration rate (%) of the process configuration identified in <u>Column |Process</u> <u>Configuration |</u>

Note that: The total in Column |PR| for each subdivision should equal 1.

5. <u>Column |EF|</u>: the *Software* automatically populates the IPCC default CH₄ EF, in kg CH₄/tonne chemical produced, based on the selection in <u>Column |Process Configuration|</u>, otherwise enter in the user-specific value.

Example: Tier 1 CH₄ EFs for 2.B.8.d ethylene oxide and 2.B.8.f carbon black production

Note that this figure is for ethylene oxide production; a similar worksheet is available for carbon black



When the Tier 2 Equations are applied (CO₂ only):

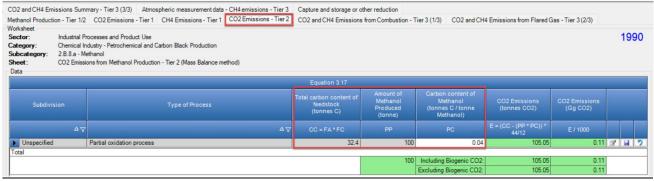
The CO₂ Emissions – Tier 2 worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of subdivision/type of process combinations that applied the Tier 2 CO₂ calculation method, as entered in worksheet [Methanol] [Ethylene] [Ethylene Dichloride and Vinyl Chloride Monomer] [Ethylene Oxide] [Acrylonitrile] [Carbon Black] [Other petrochemical] Production – Tier 1/2. <u>Note that</u>: for the subcategory Ethylene Dichloride and Vinyl Chloride Monomer, the rows are further stratified by product type (either EDC or VCM). For the subcategory Other petrochemical production, rows are further stratified by petrochemical type entered by the user.

Then,

- 1. <u>Column |CC|</u>: the total carbon content of the feedstock is automatically populated, in tonnes C, based on information entered in the AD worksheet.
- 2. <u>Column |PP|:</u> the total amount of chemical produced is automatically populated, in tonnes, based on information entered in the AD worksheet.
- 3. <u>Column |PC|</u>: select from the drop-down menu the IPCC default carbon content for each petrochemical and carbon black from <u>Table 3.10</u>; otherwise enter in the user-specific value

Example: Tier 2 CO₂ carbon content of primary products

Note that this figure is for methanol production; but columns applicable to all petrochemicals and carbon black production

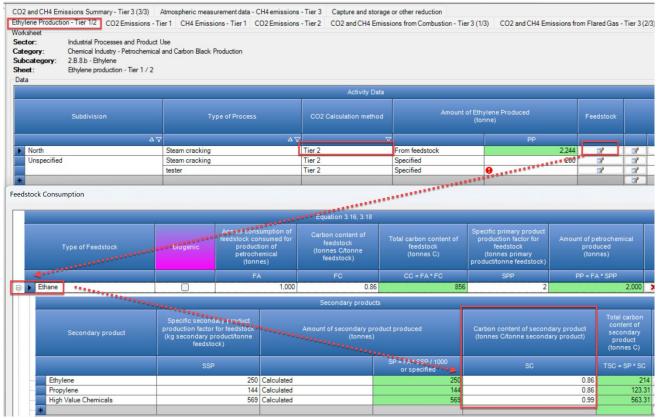


For 2.B.8.b Ethylene Production and 2.B.8.e Acrylonitrile Production, the carbon content of secondary products shall also be considered in the mass balance equation. To incorporate the carbon content of these secondary products:

- 1. <u>Column |SPC|</u>: the total carbon content of the secondary product, in tonnes C, is automatically transferred to this table from the AD worksheet. To enter in the carbon content for these secondary products:
 - a. In worksheets **[Ethylene Production Tier 1/2]** and **[Acrylonitrile Production- Tier 1/2]** select the feedstock sub-table for those rows for which the Tier 2 Calculation Method was selected.
 - b. For each row, users click the symbol """ on the left of the row to open a drop-down table where secondar products are to be entered.
 - c. <u>Column |SC|</u>: the *Software* automatically populates the carbon content of secondary products, in tonnes C/tonne secondary product where IPCC defaults exist; otherwise the user may enter user-specific carbon contents.

Example: Tier 2 CO₂ carbon content of secondary products (2.B.8.b ethylene and 2.B.8.e acrylonitrile production)

Note that this figure is for ethylene production; a similar worksheet is available for acrylonitrile production



Example: Tier 2 CO_2 carbon content of products for 2.B.8.b ethylene and 2.B.8.e acrylonitrile production

Note that this figure is for ethylene production; a similar worksheet is available for acrylonitrile production

		mmary - Tier 3 (3/3) Atmospheric measurement data - CH4 emissions 2 CO2 Emissions - Tier 1 CH4 Emissions - Tier 1 CO2 Emissions	and the second se	nd storage or other CH4 Emissions from		1/3) CO2 and CH4	Emissions from Flared Gas	- Tier 3 (2/3)		
Worksheet Sector: Category: Subcategory: Sheet: Data	Chemical 2.B.8.b -	Processes and Product Use Industry - Petrochemical and Carbon Black Production Ethylene sions from Ethylene Production - Tier 2 (Mass Balance method)							19	990
			Equa	ition 3.17						
Subdivis			Total carbon content of feedstock (tonnes C)	Amount of Ethylene Produced (tonne)	Carbon content of Ethylene produced (tonnes C / tonne Ethylene)		CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
	۵V	ΔŢ				SPC	E = (CC - (PP * PC + SPC)) * 44/12			
Morth		Steam cracking	975.56	2,244	0.856	965.93	-7,007.85	-7.01	2	12
Total				2,244		Carbon content of pe (tonnes C / tonne pet				

When the Tier 3 Equations are applied:

Tier 3 CO2 and CH4 EFs using plant-specific data

For each chemical/subdivision/fuel in worksheet **CO**₂ and **CH**₄ Emissions from Combustion – Tier 3 (1/3), the user will input information in a single row, or in a number of rows, plant-specific information as follows:

1. <u>Column |EF|</u>: select from the drop-down menu the IPCC default value for the given GHG or enter a userspecific value, in tonnes CO₂/TJ or kg CH₄/TJ.

Note that user shall select "Carbon dioxide (CO2)" or "Methane (CH4)" in the "Gas" bar at the top, to enter data for each GHG one by one.

Example: Tier 3 CO_2 and CH_4 EF for combustion

Note that this figure is for ethylene production; but the same worksheet is available for all petrochemicals

ategory::::::::::::::::::::::::::::::::::::		tion - Tier 1/2 CO2	Emissions - Tier 1	CH4 Emissi	ons - Tier 1 CO2 Emissions -	Tier 2 CO2 and CH4 E	Emissions from Combus	stion - Tier 3 (1/3)	CO2 and CH4 Emissions from I	Flared Gas - Tier 3 (2/3)		
Luel Type (Al fuels) Gas CARBON DIOXIDE (CO2) CARBON DIOXIDE (CO2) METHANE (CH4) Equation 3.21, 3.28 CO2 Emission Factor (TJ/Unit) CO2 Emission Conversion Factor (TJ/Unit) CO2 Emission Factor (TJ/Unit) CO2 Emission Conversion Factor (TJ/Unit) CO2 Emission Factor (TJ/Unit) CO2 Emission (TJ/Unit)	ector: ategory: abcategory: neet:	Chemical Industry 2.B.8.b - Ethylene	Petrochemical and Ca									19	9
METHANE (CH4) Equation 321, 328 Conversion 521, 328		All fuels)	✓ Gas	CARBON D	DIOXIDE (CO2)								
Subdivision Fuel Consumption Unit (Mass, Volume or Energy Unit) consumed for Ethylene production (U) Conversion Factor (TJ/Unit) CO2 Emission Factor (TJ/Unit) CO2 Emissions (for nes CO2 / TJ) CO2 Emission						Equation 3.2	1, 3.28						
Biodiesels TJ 233 1 70.77 16,488.63 16.49 27 Crude Oil Tonne 4,000 0.04 73.33 12,408 12,41 27 2 Gas/Diesel Oil m3 100 6 74.07 44,440 44.44 27 2 1 tal 73.33.653 73.34 1		bdivision				consumed for Ethylene production		Factor					
Crude Oil Tonne 4.000 0.04 73.33 12.408 12.41 27 4 Gas/Diesel Oil m3 100 6 74.07 44.440 47 4		۵ . ۲		۵V	U	FA 🛛	CV	EF	E = FA * CV * EF	E / 1000			ſ
Gas/Diesel Oil m3 100 6 74.07 44.440 44.44 27 24 val 4,333 Including Biogenic 73,336.63 73.34	Unspecifie	ed	Biodiesels		TJ	233	1	70.7	7 16,488.63	16.49	2		Г
Image: Contract of the second secon			Crude Oil		Tonne	4,000	0.04	73.3	3 12,408	12.41	2		Γ
4,333 Including Biogenic 73,336.63 73.34			Gas/Diesel Oil		m3	100	6	74.0	7 44,440	44.44		2	ſ
4,333 Including Biogenic 73,336.63 73.34											2		l
	tal					1 000			70.000.00	70.04	_		_
Excluding Biogenic. 56,848 56,85						4,333		Excluding Biogenic					

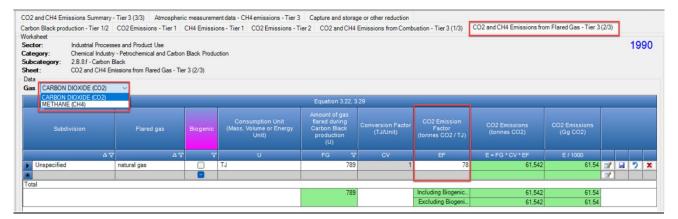
Then, for each chemical, and each subdivision for that chemical in worksheet CO_2 and CH_4 Emissions from Flared Gas – Tier 3 (2/3), the user will input information in a single row, or in a number of rows, plant-specific information as follows:

1. <u>Column |EF|</u>: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in tonnes CO₂/TJ or kg CH₄/TJ.

Note that user shall select "Carbon dioxide (CO2)" or "Methane (CH4)" in the "Gas" bar at the top, to enter data for each GHG one by one.

Example: Tier 3 CO₂ and CH₄ EF for flared gas

Note that this figure is for carbon black production; but the same worksheet is available for all petrochemicals and carbon black



Then, for each chemical, the *Software* automatically transfers total CO_2 (fossil and biogenic) and CH_4 emissions from combustion and flared gas following the Tier 3 method into worksheet CO_2 and CH_4 Emissions Summary – Tier 3 (3/3). For each chemical/subdivision/gas the user will input information in a single row, or in a number of rows, plant-specific information on emissions from process vents as follows:

When "Carbon dioxide (CO₂)" is selected in the "Gas" bar at the top:

- 1. <u>Column |Ev Fossil</u>]: enter a user-specific value for CO₂ emissions from process vents that are of fossil origin, in tonnes CO₂.
- 2. <u>Column |Ev Biogenicl|</u>: enter a user-specific value for CO₂ emissions from process vents that are of biogenic origin, in tonnes CO₂.

When "Methane (CH₄)" is selected in the "Gas" bar at the top:

1. <u>Column | Ev |</u>: enter a user-specific value for total CH₄ emissions from process vents, in kg CH₄.

Example: Tier 3 –gas vented

Note that this figure is for ethyelen production; but the same worksheet is available for all petrochemicals and carbon black

CO2 and CH4 Emissions Su	ummary - Tier 3 (3/3)	Atmospheric m	easurement data - C	H4 emissions - Tie	r 3 Capture and s	storage or other redu	iction				
Category: Chemica Chemica Chemica	I Processes and Prod I Industry - Petrocherr Ethylene I CH4 Emissions Sum	nical and Carbon Bla	ck Production								1990
CARBON DIOXIDE METHANE (CH4)					Equation 3.	20, 3.27					
Subdivision	CO2 Emissio Combi (tonnes		CO2 Emissions (tonne:		CO2 Emissions fr (tonne:	om Process Vents s CO2)	Total CO2 (tonnes		Total CO2 E (Gg C		
۵Ţ	Ec Fossil	Ec Biogenic	Ef Fossil	Ef Biogenic	Ev Fossil	Ev Biogenic	E = Ec + Ef + Ev Fossil	E = Ec + Ef + Ev Biogenic	E / 1000 Fossil	E / 1000 Biogenic	
Unspecified	56,848	16,488.63	168,000		25	55	224,873	16,543.63	224.87	16.54	2 6 7
Total											

Tier 3 using atmospheric measurements (CH₄ emissions)

The Tier 3 method using atmospheric measurements does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

Direct measurement

For each subdivision in worksheet Atmospheric measurement data - CH₄ Emissions– Tier 3, the user will input information in a single row, or in a number of rows, plant-specific information as follows:

- 1. <u>Column | Measurement Campaign |</u>: enter name or dates of measurements campaigns. <u>Note that</u>: the dates of the measurement campaigns, when summed, must cover the entire reporting year.
- 2. <u>Column |CtotalVOCs|</u>: for each measurement campaign input concentration of total measured VOCs, in μg/m³.
- 3. <u>Column | CH_{4frac} |:</u> enter the CH₄ fraction in total VOC concentration, fraction.
- 4. <u>Column | CH₄bglevel</u>: enter the ambient CH₄ concentration at the background location, in μ g/m³.
- 5. <u>Column | Wind Speed |:</u> enter the wind speed at the plant in, m/s.
- 6. <u>Column | Plume Area |:</u> enter the plume area in m².

Then the *Software* calculates CH_4 emissions in $\mu g/s$. To convert it to kg per year, the factor 0.03154 is used, which is the conversion from μg to kg and from second to year.

7. <u>Column |AEF|:</u> individual measurement campaigns may only be a fraction of time during the year, the emissions must be summed over time to cover emissions from the entire year. In this column, enter the fraction of the year the measurement campaign was operational: (e.g. if <u>Column |Measurement Campaign|</u> indicates "January – June" <u>Column |AEF|</u>=0.5 to reflect half the year. <u>Note that</u> the sum of the fractions in column AEF for a given subdivision should =1.

Example: CH₄ atmospheric measurements – Tier 3

Note that this figure is for ethylene oxide production; this worksheet is available for each petrochemical and carbon black production.

tegory: Chemical bcategory: 2.B.8.d - I	Processes and Prodi Industry - Petrochem Sthylene Oxide ric measurement dat	uct	Use and Carbon Black			Capture a	and storage or oth	er reduction						19	990
						Equa	ation 3.26								
Subdivision (facility)	Measurement campaign (e.g. date)		VOC concentration at the facility (µg / m²)	Fraction of total VOC concentration that is CH4 (Fraction)	Ambient CH4 concentration at background location (µg / m³)	Wind speed at the facility (m / s)	Plume area (m²)	CH4 Emissions (µg / s)	Scaling factor to kg/yr ((kg/yr) / (µg/s))	Fraction of the annual emissions represented by the measurement	CH4 Emissions (kg CH4)	CH4 Emissions (Gg CH4)			
		v			CH4bglevel			Em = (CtotalVOCs * CH4frac - CH4bglevel) * WS * PA			E=Em*SF* AEF				
Petrochemical#1	Jan-June		500	0.8	2	56	44	980,672	0.03	0.5	15,463.24	0.02	3		23
	July-Dec		1,000	0.6	5	66	42	1,649,340	0.03	0.5	26,006.79	0.03			
													2		
al															

Results

 CO_2 and CH_4 emissions from the production of methanol, ethylene, ethylene oxide, ethylene dichloride and vinyl chloride monomer, acrylonitrile, carbon black and other petrochemicals are estimated for each chemical individually in mass units (tonnes of CO_2 and kg CH_4 and Gg) by the *Software*, for different Tiers in the following worksheets:

- \checkmark CO₂ Emissions Tier 1
- \checkmark CH₄ Emissions Tier 1
- \checkmark CO₂ Emissions Tier 2
- \checkmark CO₂ and CH₄ Emissions Summary Tier 3 (3/3)
- ✓ Atmospheric measurement data CH₄ Emissions Tier 3

Where the user has indicated use of biogenic feedstock in the production of a petrochemical or carbon black in the *Software*, CO₂ emissions are totalled including and excluding biogenic CO₂.

Total CO_2 and CH_4 emissions from the production of each chemical, is the sum of all emissions in the above worksheet for that chemical, taking into account any capture and storage or other reduction. The worksheet **Capture** and storage or other reduction is provided in the *Software* to estimate these reductions.

In the worksheet **Capture and storage or other reduction** for each subdivision and each gas:

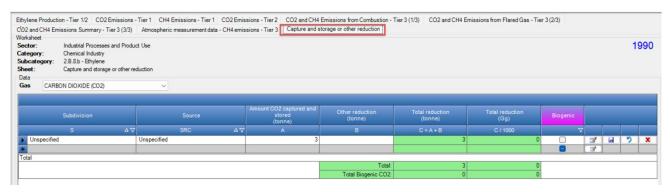
- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where CO₂ capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂ or CH₄, in tonnes.

<u>Note that</u>: Column |B| may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.

 <u>Column | Biogenic |:</u> indicate with a check if the process fuel is of biogenic origin. <u>Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.
</u>

Example: Capture and storage or other reduction – for each chemical produced

Note that this figure is from the set of worksheets for ethylene production; this worksheet is available for each petrochemical and carbon black production.



2.B.9 Fluorochemical Production

Fluorochemical Production includes two subcategories:

✓ 2.B.9.a By-product Emissions

✓ 2.B.9.b Fugitive Emissions

Emissions of a chemical occur during its production and distribution or as a by-product during the production of a related chemical (HFC-23 from HCFC-22 production is specifically identified as a category). There may also be emissions of the material that is being produced; the so-called 'fugitive emissions.' Both by-product and fugitive emissions are calculated in the same way and for sources that are not key categories, fugitive and by-product emissions are considered the same.

For the purposes of data entry in the *Software*, and for interoperability with the UNFCCC ETF Reporting Tool, HFC-23 emissions from HCFC-22 emissions are always calculated under source category 2.B.9.a By-product Emissions. Fugitive emissions from production of HFC-134a, SF₆ and NF₃ should be calculated and reported pursuant to the corresponding worksheets under category 2.B.9.b Fugitive Emissions.

For other emissions from fluorinated gas production, it is assumed that if category 2.B.9 is a key category, and emissions of a particular gas are considered significant, then the release of that gas should be considered a byproduct emission and calculated and reported under category 2.B.9.a. If category 2.B.9 is key, but release of a particular gas is not considered significant, or if category 2.B.9 is non-key, other emissions from fluorinated gas production should be considered a fugitive emissions and reported under source category 2.B.9.b Fugitive emissions. This is consistent with <u>footnote 2</u> in IPCC worksheet 3 of 3 for this category.

Given the guidance above, and review of the corresponding decision trees in Figures 3.16 and 3.17 of Volume 3, Chapter 3 of the 2006 IPCC Guidelines the user shall consider whether emissions from fluorochemical production should be should be calculated and reported following worksheets for:

- ✓ 2.B.9.a By-product Emissions HFC-23 emissions from HCFC-22 production
- ✓ 2.B.9.a By-product Emissions Other fluorinated compounds
- ✓ 2.B.9.b Fugitive Emissions Other fluorinated compounds

Once the user identifies where emissions should be reported, the corresponding guidance below can be consulted to support data entry. The IPPU Users' Guidebook separates the guidance for these three sets of activities to ease data entry and enhance comparability in reporting across users.

2.B.9.a By-product Emissions – HFC-23 emissions from HCFC-22 production

Information

HFC-23 is generated as a by-product during the manufacture of HCFC-22.

The 2006 IPCC Guidelines provide three Tiers to estimate HFC-23 emissions from HCFC-22 production. The Tier 1 method is relatively simple, involving the application of a default EF to the quantity of HCFC-22 produced at individual plants or, if there is no abatement by destruction, to the total national output of HCFC-22. The Tier 2 method involves application of a Tier 2 EF based on knowledge of process efficiencies, and if known, abatement. Tier 3 has three approaches based on direct measurement: Tier 3a (direct measurements of vent streams), Tier 3b (proxy method – when emissions are correlated with a proxy parameter) and Tier 3c (in-process measurements in a reactor when HFC-23 emissions related to HCFC-22 production).

<u>GHGs</u>

The *Software* includes the following GHGs for HFC-23 emissions from HCFC-22 production under the By-product Emissions (2.B.9.a) source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
			Χ	Χ	Χ	X

IPCC Equations

- $\checkmark \quad \underline{\text{Tier 1}: \text{Equations 3.30}}$
- ✓ <u>Tier 2</u>: <u>Equations 3.31, 3.32</u> and <u>3.33</u>
- ✓ <u>Tier 3</u>: Tier 3a (Direct measurement of vent streams): <u>Equations 3.34</u> and <u>3.37</u>, Tier 3.b (Proxy method): <u>Equations 3.35</u>, <u>3.38</u>, and <u>3.39</u>, and Tier 3c (Monitoring reactor product): <u>Equations 3.36</u> and <u>3.40</u>

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Tier 1 equations.

Software Worksheets

By-product Emissions – HFC-23 emissions from HCFC-22 production are estimated using the following worksheets:

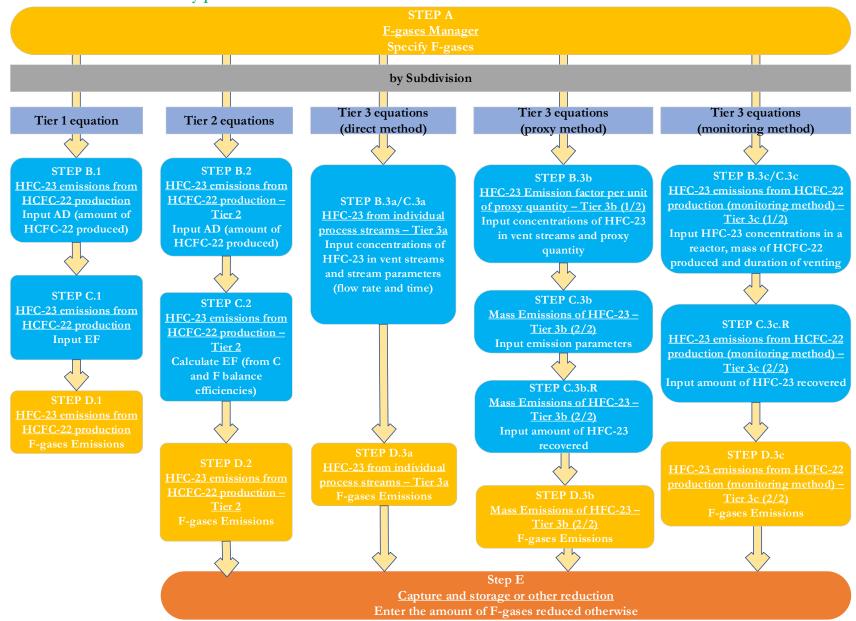
- ✓ 1.1.2 F-gases Manager: contains data on F-gases used (including imported) and/or produced and exported in country.
- ✓ HFC-23 emissions from HCFC-22 production: this worksheet contains for each subdivision the amount of HCFC-22 produced and HFC-23 default EFs. The users may input country-specific EFs. The worksheet calculates the associated HFC-23 emissions.
- ✓ HFC-23 emissions from HCFC-22 production Tier 2: contains for each subdivision the amount of HCFC-22 produced and EF based on carbon-balance and fluorine-balance efficiencies. The worksheet calculates the associated HFC-23 emissions.
- ✓ HFC-23 emissions from individual process streams (Direct Method) Tier 3a: contains for each stream and measurement campaign the concentrations of HFC-23 in the vented gas stream(s), the flow rate and time parameters needed to produce annual emissions. The worksheet calculates the associated HFC-23 emissions.
- ✓ HFC-23 Emission Factor per unit of proxy quantity Tier 3b (1/2): contains for each stream and trial campaign the concentrations of HFC-23, the flow rate and the proxy quantity. The worksheet calculates a HFC-23 EF per unit of proxy.
- ✓ Mass emissions of HFC-23 Tier 3b (2/2): contains for each subdivision and each stream the correlation parameter (emission rate to operation rate) and duration of venting. It also contains information on recovery (destruction) of HFC-23. The worksheet calculates the associated by-product HFC-23 emissions.
- ✓ HFC-23 emissions from HCFC-22 (Monitoring Method) Tier 3c (1/2): contains for each subdivision and release period the concentrations of HFC-23 in the reactor, amount of HCFC-22 produced during the release and duration when HFC-23 was vented, rather than destroyed. The worksheet calculates HFC-23 emissions during individual release periods and for the year.
- ✓ HFC-23 emissions from HCFC-22 (Monitoring Method) Tier 3c (2/2): contains for each subdivision and each stream the amount of recovery (destruction) of HFC-23. The worksheet calculates the annual HFC-23 emissions.
- ✓ Capture and storage or other reduction: contains information on any other amount of recovered (reduced) fluorinated compounds, which are not accounted for in the Tier 1, 2 and 3 worksheets.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.16 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse users follow the following flowchart for By-product Emissions – HFC-23 emissions from HCFC-22 production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.



By-product emissions-HFC-23 emissions from HCFC-22 Production - flowchart

Thus, for the source-category:

Step A, 1.1.2 F-gases Manager, users ensure that all F-gases emitted for this source category (in this case, HFC-23) have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step B.1, in the worksheet HFC-23 emissions from HCFC-22 production, users collect and input in the *Software* information on the amount of HCFC-22 produced.

Step C.1, in the worksheet **HFC-23 emissions from HCFC-22 production,** users collect and input an EF for HFC-23 emissions from HCFC-22 production.

Step D.1, in the worksheet **HFC-23 emissions from HCFC-22 production,** the *Software* calculates the associated HFC-23 emissions in mass units (kg and Gg of HFC-23).

When the Tier 2 Equations are applied:

Step B.2, in the worksheet HFC-23 emissions from HCFC-22 production – Tier 2, users collect and input in the Software information on the amount of HCFC-22 produced.

Step C.2, in the worksheet **HFC-23 emissions from HCFC-22 production – Tier 2,** users input the carbonbalance and fluorine-balance efficiencies to calculate an average EF.

Step D.2, in the worksheet HFC-23 emissions from HCFC-22 production – Tier 2, the *Software* calculates the associated HFC-23 emissions in mass units (kg and Gg of HFC-23).

When the Tier 3 Equations are applied:

Tier 3.a Direct method

Step B.3a/C.3.a, in the worksheet **HFC-23 emissions from individual process streams (Direct Method) – Tier 3a,** users collect and input in the *Software* for each stream and measurement campaign the concentrations of HFC-23 in the gas streams which are vented, as well as the flow rate and time parameters needed to produce annual emissions.

Step D.3a, in the worksheet **HFC-23 emissions from individual process streams (Direct Method) – Tier 3a,** the *Software* calculates the associated HFC-23 emissions for each vent stream in mass units (kg and Gg of HFC-23).

Tier 3.b Proxy method

Step B.3b, in the worksheet **HFC-23 Emission Factor per unit of proxy quantity – Tier 3b (1/2),** users collect and input in the *Software*, for each stream and trial campaign, information on the concentrations of HFC-23, as well as the flow rate and the proxy quantity.

Step C.3b, in the worksheet Mass emissions of HFC-23 – Tier 3b (2/2), users input process parameters on the measured standard emission rate to the actual rate at the facility, the current process operating rate for the proxy quantity, and the duration of venting.

Step C.3b.R, in the worksheet Mass emissions of HFC-23 – Tier 3b (2/2), for each vent stream users input in the *Software* the amount of recovered (destroyed) HFC-23.

Step D.3b, in the worksheet **Mass emissions of HFC-23 – Tier 3b (2/2),** the *Software* calculates the associated HFC-23 emissions for each vent stream and total emissions in mass units (kg and Gg of HFC-23).

Tier 3.c Monitoring method

Step B.3c /C.3c, in the worksheet HFC-23 emissions from HCFC-22 (Monitoring method) – Tier 3c (1/2), users collect and input in the *Software* information for each release period on the concentrations of HFC-23 in the reactor, the amount of HCFC-22 produced during the release and duration when HFC-23 was vented, rather than destroyed.

Step C.3c.R, in the worksheet HFC-23 emissions from HCFC-22 (Monitoring method) – Tier 3c (2/2), users input the amount of recovered (destroyed) HFC-23.

<u>Note that</u>: where there is abatement then it must be shown that the abatement actually treats all streams that may be released into the atmosphere, including direct gas vents and the outgassing of aqueous streams. The latter, especially, may not be passed to the destruction facility. If all potential vent streams are not treated, the method cannot be used.

Step D.3c, in the worksheet HFC-23 emissions from HCFC-22 (Monitoring Method) – Tier 3c (2/2), the *Software* calculates the associated HFC-23 emissions in mass units (kg and Gg of HFC-23).

Then, for each tier, as appropriate:

Step E, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of recovered/reduced fluorinated compounds, not accounted for elsewhere in calculation worksheets.

Activity data input

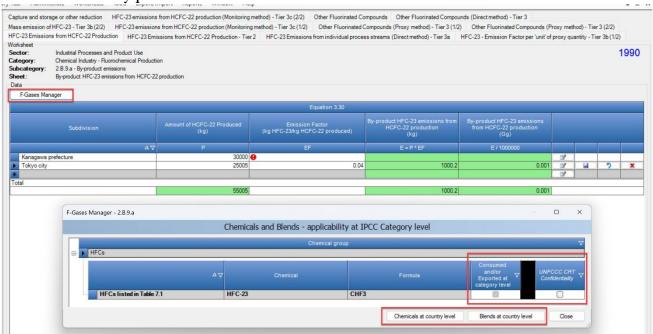
Section 3.10.1.2 in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for By-product emissions of HFC-23 from HCFC-22 production.

As a **Starting step**, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases (or, if applicable, blends) to be reported for the source category By-product emissions of HFC-23 from HCFC-22 production. In this case, the only relevant F-gas is HFC-23.

<u>Note that</u> if HFC-23 is not checked in the F-gases Manager, then it will not be possible to enter any data. If data entry is not possible, select the **F-Gases Manager** from any tab. This will open the F-gases Manager – applicability at IPCC Category Level. Navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level-F-gases Manager to check HFC-23. Save and close the dialogue box for the country level F-gases Manager and the user returns to the Category level F-gases Manager.

The user is not required to further select relevant F-gases for this category (HFC-23 will be automatically checked). For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool: If AD and/or emissions for this category are considered confidential, the user may check the box UNFCCC CRT Confidentiality. If checked, "C" will be reported for AD and "IE" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT, as unspecified mix of HFCs and PFCs, in tonnes CO₂ equivalents.

Example: Populating the F-gases manager and designating confidentiality for category: By-product emissions-HFC-23 emissions from HCFC-22 Production



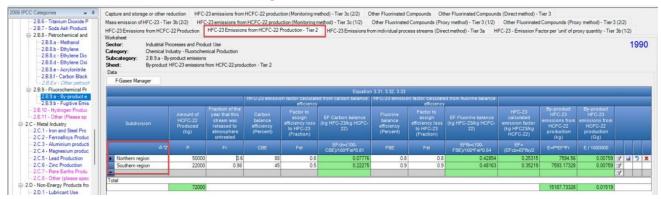
Second, input of AD for the By-product emissions of HFC-23 from HCFC-22 production requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified)

2.8.6 - Titanium Dioxide P 2.8.7 - Soda Ash Producti 2.8.8 - Petrochemical and	Mass emission of HFC-23 - Tier 3b (2/2) HFC-23 emission HFC-23 Emissions from HCFC-22 Production HFC-23 Em	ins from HCFC-22 production (Monitorin	g method) - Tier 3c (1/2) Other Fluorinated C	Compounds (Proxy method) - Tier 3 (1/2	Other Fluorinated Compounds (Pr			A CONTRACTOR OF
2.6.8.a - Methanol 2.6.8.b - Ethylene 2.6.8.c - Ethylene Dic 2.6.8.c - Ethylene Dic 2.6.8.c - Ethylene Dxi 2.6.8.c - Acrylonitrile 2.6.8.f - Carbon Black 2.6.8.k - Other petroch	Sector: Industrial Processes and Product Use Category: Chemical Industry - Fluorochemical Product Subcategory: 2.8.9.a - By-product emissions							200
	Sods Ale Producti HFC-23 Emissions from HCFC-22 Production HFC-23 Emissions from individual process streams (Direct method) - Tier 3 HFC-23 Emission Factor per Unit of proxy que 38 - Ethylene Cit. 38 - Ethylene Cit. 39 - Ethylene Cit. 39 - Ethylene Cit. 30 - Ethylene Cit. 3							
2.8.9 - Fluorochemical Pr			Equation 3.30					
2.B.9 - Fluorochemical Pr 2.B.9.a - By-product e 2.B.9.b - Fugitive Emis - 2.B.10 - Hydrogen Produc - 2.B.11 - Other (Please sp	Subdivision		Emission Factor				-	
2.8.9.a - By-product e 2.8.9.b - Fugitive Emis - 2.8.10 - Hydrogen Produc - 2.8.11 - Other (Please sp C - Metal Industry		(kg)	Emission Factor					_
2.8.9.a - By-product e 2.8.9.b - Fugitive Emis - 2.8.10 - Hydrogen Produc - 2.8.11 - Other (Please sp		(kg)	Emission Factor (kg HFC-23/kg HCFC-22 produced)	HCFC-22 production (kg) E = P * EF	from HCFC-22 production (Gg)	3		7 ×
2.B.9.a - By-product e 2.B.9.b - Fugitive Emis - 2.B.10 - Hydrogen Produc - 2.B.11 - Other (Please sp 2.C. Metal Industry - 2.C.1 - Iron and Steel Pro	Δ7	(kg) P	Emission Factor (kg HFC-23kg HCFC-22 produced) EF	HCFC-22 production (kg) E = P * EF	from HCFC-22 production (Gg) E / 1000000	3	3	? ×

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions



When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in HFC-23 emissions from HCFC-22 production worksheet, row by row, as follows:

1. <u>Column | P |</u>: input the amount of HCFC-22 produced, in kg.

When Tier 2 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in HFC-23 emissions from HCFC-22 production – Tier 2 worksheet, row by row, as follows:

1. <u>Column | P|</u>: input the amount of HCFC-22 produced, in kg.

Example: AD input - Tier 2

	r 3b (2/2) HFC-	23 emissions non	THCFC-22 produ	cuon (Monitoring r	nethod) - Tier 3c (1/2)	Uther Fluorinated	Compounds (Pro:	xy method) - Tier 3 (1/2)	Other Fluorinated	a Compounds (Pro	(xy method) - Tier 3	(212)	
-23 Emissions from HCFC	-22 Production	HFC-23 Emission	s from HCFC-22 F	Production - Tier 2	HFC-23 Emissions fro	om individual proc	ess streams (Dire	ct method) - Tier 3a H	FC-23 - Emission Fa	actor per 'unit' of p	roxy quantity - Tier	3b (1/2	0
egory: Chemical In iccategory: 2.B.9.a - By set: By-product I a	ocesses and Produ dustry - Ruorochem product emissions HFC-23 emissions fr	nical Production	uction - Tier 2										199
F-Gases Manager													
					Equation								
			HFC-23 emissio	in factor calculate efficiency	d from carbon balance	HFC-23 emissio	n tactor calculate efficiency	d from fluorine balance					
Subdivision	Amount of HCFC-22 Produced (kg)	Fraction of the year that this stream was released to atmosphere untreated	Carbon balance efficiency (Percent)	Factor to assign efficiency loss to HFC-23 (Fraction)	EF Carbon balance (kg HFC-23/kg HCFC- 22)	Fluorine balance efficiency (Percent)	Factor to assign efficiency loss to HFC-23 (Fraction)	EF Fluorine balance (kg HFC-23/kg HCFC- 22)	HFC-23 calculated emission factor (kg HFC23/kg HCFC-22)	By-product HFC-23 emissions from HCFC-22 production (kg)	By-product HFC-23 emissions from HCFC-22 production (Gg)		
					EFcb=(100- CBE)/100*Fel*0.81			EFfb=(100- FBE)/100*Fel*0.54	EF= (EFcb+EFfb)/2	E=P'EF'Fr			
Northern region	50000	0.6	88	0.8	0.07776	0.8	0.8	0.42854	0.25315	7594.56	0.00759	3 6	2
Southern region	22000	0.98	45	0.5	0.22275	0.9	0.9	0.48163	0.35219	7593.17328	0.00759	3	
												2	

When Tier 3 Equations are applied:

Tier 3.a Direct method

The Tier 3.a Direct method does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

Tier 3.b Proxy method

The Tier 3.b Proxy method does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

Tier 3.c Monitoring method

The Tier 3.c Monitoring method does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

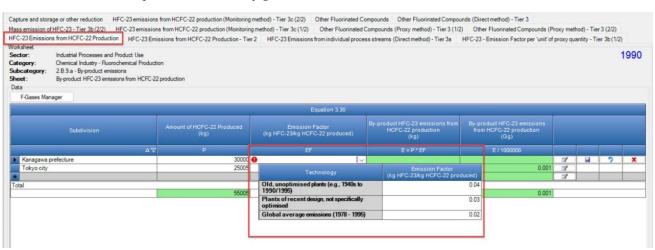
Emission factors input

Section 3.10.1.2 in Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for By-product emissions of HFC-23 from HCFC-22. Higher-tier methods rely on plant-specific measurements or sampling. Tier 1 default EFs are provided in Table 3.28

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, in worksheet **HFC-23 emissions from HCFC-22 production** row by row, as follows:

1. <u>Column |EFi</u>|: select from the drop-down menu the IPCC default EF, otherwise input a user-specific value, in kg of HFC-23/kg of HCFC-22 produced.



Example: Tier 1 EFs - By-product emissions of HFC-23 from HCFC-22

When Tier 2 Equations are applied:

In the Tier 2 methodology, the HFC-23 EF is derived from records of process efficiencies. The EF is generally calculated as the average of the carbon efficiency (Equation 3.32) and the fluorine efficiency (Equation 3.33), unless there are overriding considerations (such as a much lower uncertainty of one of the efficiency measures) that can be adequately documented.

Annual average carbon and fluorine balance efficiencies are features of a well-managed HCFC-22 plant and are normally available to the plant operator or may be obtained by examination of process accounting records. Similarly, if there is a vent treatment system, the length of time that this stream was in operation, and treatment of that vent stream should also be available from plant records.

To calculate the EF, for each subdivision in <u>Column |Subdivision|</u>, data are entered in **By-product emissions of HFC-23 from HCFC-22. Tier 2:** worksheet, row by row, as follows:

- 1. <u>Column |Fr|:</u> enter the fraction of the year when the vent stream was released to the atmosphere without treatment.
- 2. <u>Column |CBE|</u>: enter the carbon balance efficiency taken from the plant operator, in percent.
- 3. <u>Column | Fel |:</u> enter the efficiency loss factor, fraction. <u>Note that</u> the factor to assign the efficiency loss to HFC-23 is specific to each plant and, if this method of calculation is used, the factor should have been established by the process operator. By default, the value is 1; that is all of the loss in efficiency is due to co-production of HFC-23. In practice, this is commonly the most significant efficiency loss, being much larger than losses of raw materials or products.
- 4. <u>Column |FBE|</u>: enter the fluorine balance efficiency taken from the plant operator, in percent.
- 5. <u>Column | Fel|:</u> enter in the efficiency loss factor, fraction. <u>Note that</u> the factor to assign the efficiency loss to HFC-23 is specific to each plant and, if this method of calculation is used, the factor should have been established by the process operator. By default, the value is 1; that is all of the loss in efficiency is due to co-production of HFC-23. In practice, this is commonly the most significant efficiency loss, being much larger than losses of raw materials or products.

Equations 3.32 and 3.33 also include variables for carbon content and fluorine content. The factors for carbon and fluorine contents are calculated from the molecular compositions of HFC-23 and HCFC-22 and are common to all HCFC-22 plants at 0.81 for carbon and 0.54 for fluorine. These contents are directly incorporated into the EF calculations in the *Software*.

Example: Tier 2 EFs - By-product emissions of HFC-23 from HCFC-22

pture and storage or other	reduction HFC-	23 emissions from	HCFC-22 product	tion (Monitoring m	ethod) - Tier 3c (2/2) O	ther Fluorinated (Compounds Oth	er Fluorinated Compound	ds (Direct method) -	Tier 3			
ss emission of HFC-23 - T	ier 3b (2/2) HFC	-23 emissions from	nHCFC-22 produ	ction (Monitorina r	nethod) - Tier 3c (1/2)	Other Fluorinated	Compounds (Pro	xy method) - Tier 3 (1/2)	Other Fluorinated	d Compounds (Pro	xy method) - Tier 3	(2/2)	
C-23 Emissions from HCF	C-22 Production	HFC-23 Emission	s from HCFC-22 F	Production - Tier 2	HFC-23 Emissions fro	m individual proc	ess streams (Dire	ct method) - Tier 3a H	FC-23 - Emission F	actor per 'unit' of pr	oxy quantity - Tier	3b (1/2)
tegory: Chemical bcategory: 2.B.9.a - E	Processes and Produ ndustry - Fluorocher ly-product emissions t HFC-23 emissions f	nical Production	uction - Tier 2										199
F-Gases Manager					-							_	_
						3.31, 3.32, 3.33		d from fluorine balance					
				efficiency			efficiency						
Subdivision	Amount of HCFC-22 Produced (kg)	Fraction of the year that this stream was released to atmosphere untreated	Carbon balance efficiency (Percent)	Factor to assign efficiency loss to HFC-23 (Fraction)	EF Carbon balance (kg HFC-23/kg HCFC- 22)	Fluorine balance efficiency (Percent)	Factor to assign efficiency loss to HFC-23 (Fraction)	EF Fluorine balance (kg HFC-23/kg HCFC- 22)	HFC-23 calculated emission factor (kg HFC23/kg HCFC-22)	By-product HFC-23 emissions from HCFC-22 production (kg)	By-product HFC-23 emissions from HCFC-22 production (Gg)		
Δ7					EFcb=(100- CBE)/100"Fel*0.81			EFfb=(100- FBE)/100*Fel*0.54	EF= (EFcb+EFfb)/2	E=P"EF"Fr			
Northern region	50000	0.6	88	0.8	0.07776	0.8	0.8	0.42854	0.25315		0.00759		2
Southern region	22000	0.98	45	0.5	0.22275	0.9	0.9	0.48163	0.35219	7593.17328	0.00759	Summer of the second	
-												2	
tal													

Direct measurement

Tier 3.a Direct method

For each subdivision in <u>Column |i|</u>, data are entered in worksheet **HFC-23 emissions from individual process** streams (Direct Method) – Tier 3a, row by row, as follows:

- 1. <u>Column |i|</u>. enter a name for individual process stream.
- 2. <u>Column |Measurement campaign|:</u> for each subdivision/process stream input the name or dates of the measurement campaigns.
- 3. <u>Column |Cij|</u>: For each subdivision/process stream/measurement campaign, input the concentration of HFC-23 in the gas stream which is actually vented, in kg HFC-23/ kg of gas stream.
- 4. <u>Column |f_{ii}|:</u> For each subdivision/process stream/measurement campaign input the flow rate of the gas, in kg of gas stream per hour.
- 5. Column <u>|t|</u>: For each subdivision/process stream/measurement campaign enter the length of time in hours, these parameters are measured.

Note that the sum of hours input in column "t" shall correspond to the total time, in hours, of activity of the facility (i) in the reporting year, for which individual jet streams (j) are input in the worksheet.

Example: Tier 3a – direct method

CUER DO TO D		1150 00 1 1 1 1 105					mpounds (Direct method) - T		-		
as emission of HFC-23 - Tier 3			C-22 production (Monitoring me					Compounds (Proxy method)			
C-23 Emissions from HCFC-22 ksheet	2 Product	ion HFC-23 Emissions from	HCFC-22 Production - Tier 2	HFC-23 Emissions from	individual process stream	ms (Direct method) - Tier 3	HFC-23 - Emission Fac	ctor per 'unit' of proxy quantit	ty - Tie	r 3b (1/2	2)
bcategory: 2.B.9.a - By-pri eet: HFC-23 Emissi ata	ustry - Fluc roduct em	rochemical Production	rt method) - Tier 3a								199
F-Gases Manager											
				Equation	n 3 34, 3 37						
					n 3.34, 3.37				_		_
Subdivision (facility)			Measurement campaign (e.g. date)	Equation IHFC-23 concentration in the gas stream actually vented from process stream j at facility i (kg HFC-23 / kg gas stream)	n 3.34, 3.37 Mass flow of the gas stream from process stream j at facility (kg gas stream / hour)	Length of time in the year over which these parameters are measured and remain constant (hours)	'Instantaneous' HFC-23 emissions (kg)	'Instantaneous' HFC-23 emissions (Gg)			
	•∆	individual process stream j ∆⊽		HFC-23 concentration in the gas stream actually vented from process stream j at facility i (kg HFC-23 / kg gas	Mass flow of the gas stream from process stream j at facility i	year over which these parameters are measured and remain constant	emissions				
	<u>۵</u> ۳		(e.g. date)	HFC-23 concentration in the gas stream actually vented from process stream j at facility i (kg HFC-23 / kg gas stream)	Mass flow of the gas stream from process stream j at facility i (kg gas stream / hour)	year over which these parameters are measured and remain constant	emissions (kg)	emissions (Gg)	3	u	2
(facility) i	۵Ţ	j AV	(e.g. date) ́ 	HFC-23 concentration in the gas stream actually vented from process stream j at facility i (kg HFC-23 / kg gas stream) Cij	Mass flow of the gas stream from process stream j at facility i (kg gas stream / hour) fij 3100	year over which these parameters are measured and remain constant (hours) t	emissions (kg) Eijt = Cij * fij * t	emissions (Gg) Eijt / 1000000			2

Tier 3.b Proxy method

For each subdivision in <u>Column |i| (Tier 3 requires plant- or facility- specific input)</u>, data are entered in worksheet **HFC-23 Emission Factor per unit of proxy quantity – Tier 3b (1/2)**, row by row, as follows:

1. <u>Column |j|</u> enter a name for the individual vent stream.

- 2. <u>Column |T|:</u> for each subdivision (plant)/vent stream, input the name or date of the trial campaigns.
- 3. <u>Column |CT_{ij}|</u>: for each subdivision/vent stream/trial campaign input the concentration of HFC-23 in the vent stream, in kg HFC-23/kg of gas stream.
- 4. <u>Column $|fT_{ij}|$:</u> for each subdivision/vent stream/trial campaign, input the average mass flow rate of the vent stream, in kg of vent stream/hour.
- 5. Column <u>|PORT_{ij}|</u>:for each subdivision/vent stream/trial campaign, input the proxy quantity (e.g. operating rate) in units per hour.

<u>Note that</u> the 'unit' depends on the proxy quantity adopted for plant i vent stream j (for example, kg/hour or m^3 /hour of feedstock). In almost all cases, the rate of plant operation is considered a suitable proxy and the quantity of HFC-23 emitted depends on the current plant operating rate and the length of time the vent flow was released.

The worksheet calculates an **average** HFC-23 EF per unit of proxy. Then, the subdivisions/vent streams and the calculated EF entered in worksheet **HFC-23 Emission Factor per unit of proxy quantity – Tier 3b (1/2)** are transferred automatically to worksheet **Mass emissions of HFC-23 – Tier 3b (2/2)**.

Then, for each subdivision/individual vent stream,

6. <u>Column $|F_{ij}|$ </u> the users enter a dimensionless factor relating the measured standard mass emission rate to the emission rate at the actual plant operating rate.

<u>Note that</u> in many cases, the fraction produced is not sensitive to operating rate and Fi is unity (i.e., the emission rate is proportional to operating rate). In other cases the emission rate is a more complex function of the operating rate. In all cases Fi should be derived during the plant trial by measuring HFC-23 production at different operating rates. For situations where a simple function relating the emissions to the operating rate cannot be determined from testing, the proxy method is not considered appropriate and continuous measurement is desirable.

7. <u>Column |POR_{ij}|</u>: Users enter the current process operating rate applicable to that vent stream, j, averaged over the time period, t, in 'unit/hour'.

<u>Note that</u> the units of this parameter must be consistent between the plant trial establishing the standard emission rate and the estimate of ongoing, operational emissions

8. <u>Column |t|</u>: enter the time, in hours, of actual venting for the year, or the period if the process is not operated continuously.

<u>Note</u> that annual emissions become the sum of all the periods during the year. The periods during which the vent stream is processed in a destruction system should not be counted here.

9. Column <u>|Rij|</u>: enter in the quantity of HFC-23 recovered from each vent stream for use as chemical feedstock, and hence destroyed, in kg/year.

-				-		and a second	Fluorinated Compounds (Direct method) - Ti			a T.	2 (2
	3 - Emissions from HCFC-22 Pro 3 - Emission Factor per 'unit' of							orinated Compounds (Proxy ssions from HCFC-22 Produc		3) - Tie	r 3 (2)
orksh ecto ateg ubca heet)ata	reet r: Industrial Processe pory: Chemical Industry - ategory: 2.8.9.a - By-produce	s and Product Use Fluorochemical Production									199
-	aace manager				Equation 3.39						
	Subdivision (facility)	Individual vent stream	Trial campaign (e.g. date)	ine average mass fractional concentration of HFC-23 in vent stream j at facility i during the trial T (kg HFC-23 / kg gas stream)	The average mass flowrate of vent stream j at facility i during the trial T (kg / hour)	The proxy quantity (such as process operating rate) at facility i during the trial T (Unit / hour)	The standard mass emission factor of HFC-23 in vent stream j at facility i during the trial T per 'unit' of proxy quantity (kg / Unit)	The standard mass emission factor of HFC- 23 in vert stream j at facility i per 'unit' of proxy quantity (kg / Unit)			
	i 🛆 🖓	j Av	T AV	CT,ij	fT,ij	PORT,ij 🥠	ST,ij = CT,ij * fT,ij / PORT,ij	Sij = AVG(ST,ij)			
L	Inspecified	Jan-June	4	0.6	5222	2	1566.6		2		2
	Inspecified		5	0.5	5	4	0.625		3	_	
		tester									

Example: **AD** for Tier 3b – proxy method (1/2)

Example: AD for Tier 3b – proxy method (2/2)

tal		and the second sec				1			-							land in	<u> </u>
Unapecilieu		tester	-		0.75		0.9		4	2115.75375	5000	13500	0	13500			-
Unspecified	_	Jan-June		-	183.6125	-	0.9		3	2115 75375	8000	16926030	0	16926030	16.92603	12	
			۵v		?		?		?	MEMij = Sij * Fij * PORij		TVSij = MEMij * t			Eij / 1000000		
Subdivisi (facility		Individual vent s		I ne sta mass en factor of in vent s at facilit 'unit' of quan (kg /	HFC-23 tream j ty i per proxy tity	Dimensioni factor relating measured standard mi emission rat the emission at the actu facility operat	g the ass e to rate al	i ne curren process operating ra applicable to stream j at fac i averaged o time (Unit / hou	ate vent cility over	Mass emission of HFC- 23 in vent stream jat facility i (kg / hour)	I ne actual total duration of venting for the year, or the period if the process is not operated continuously	Total vent stream jat facility i (kg / Year)	HEC-23 recovered for vent stream j at facility i for use as chemical feedstock, and hence destroved	Annual emission of HFC-23 in vent stream j at facility i (kg)	Annual emission of HFC-23 in vent stream j at facility i (Gg)		
F-Gases Man	sger									Equation 3.38							
stor: egory: scategory: set: a	Chemical 2.B.9.a - Mass emi	Processes and Pro Industry - Ruoroche By-product emission ission of HFC-23 - T	emical F s	Production													199
ksheet		er 'unit' of proxy qu			/2) M	ass emission o	THEC	-23 - 11er 30 (2	(2)	HFC-23 emissions from	HCFC-22 production	n (Monitoring method) - 1	er 3c (1/2) HFC-3	23 Emissions from HCF	C-22 Production		
										rect method) - Tier 3a 0		and a second		her Fluorinated Compo		- Tie	и 3 (л
			-					-	-				-			-	

Tier 3.c Monitoring method

For each subdivision in <u>Column |i|</u>, plant-specific data are entered in worksheet **HFC-23 emissions from HCFC-22 (Monitoring Method) – Tier 3c (1/2),** row by row, as follows:

- 1. <u>Column |M|</u> users input the name or time for individual release period(s).
- 2. <u>Column $|C_i|$ </u>: For each subdivision/individual release period input the concentration of HFC-23 in the reactor product, in kg HFC-23 per kg HCFC-22 produced.
- 3. <u>Column |P_i|:</u> input the mass of HCFC-22 produced during individual release period M, in kg.
- 4. <u>Column |tF|:</u> enter the fraction of the period during which this HFC-23 is actually vented to the atmosphere rather than destroyed.

Worksheet HFC-23 emissions from HCFC-22 (Monitoring Method) – Tier 3c (1/2) then sums the vented HFC-23 from each facility during the year, in kg. Then, in worksheet HFC-23 emissions from HCFC-22 (Monitoring Method) – Tier 3c (2/2):

5. <u>Column $|R_i|$: enter the amount of HFC-23 recovered from the facility for use as chemical feedstock and hence destroyed.</u>

<u>Note that</u>: where there is abatement then it must be shown that the abatement actually treats all streams that may be released into the atmosphere, including direct gas vents and the outgassing of aqueous streams. The latter, especially, may not be passed to the destruction facility. If all potential vent streams are not treated, the method cannot be used.

C-23 Emissions from HCFC-22 Production	ion - Tier 2 HFC-23 Emissions fro	om individual process streams	s (Direct method) - Tier 3a	Other Fluorinated Compou	inds (Proxy method) - Tier 3 (1/2)			
C-23 emissions from HCFC-22 product	ion (Monitoring method) - Tier 3c (2/2	2) Other Fluorinated Comp	ounds Other Fluorinated	Compounds (Direct method)	- Tier 3 HFC-23 Emissions from H	CFC-22 Production		
C-23 - Emission Factor per 'unit' of prox	y quantity - Tier 3b (1/2) Mass en	hission of HFC-23 - Tier 3b (2)	 HFC-23 emissions from the second s	om HCFC-22 production (Mo	nitoring method) - Tier 3c (1/2)			
kikhet ctor: Industrial Processes and tegory: Chemical Industry - Ruor bcategory: 2.8.9.a - By-product emit eet: HFC-23 emissions from H ta F-Gases Manager	ochemical Production	od) - Tier 3c (1/2)						19
· www.rinitager			Equation 3	40				
Subdivision (facility)	Individual release period	Concentration of HFC-23 in the reactor product at facility i during individual release period M (kg HFC-23 / kg HCFC- 22)	Mass of HCFC-22 produced at facility i	Fractional duration during which this HFC-23 is actually vented to the	HFC-23 vented from an individual facility i during individual release period M (kg)	Annual HFC-23 vented from an individual facility i (kg / Year)		
Subdivision		in the reactor product at facility i during individual release period M (kg HFC-23 / kg HCFC- 22)	Mass of HCFC-22 produced at facility i while Ci applies during individual release period M	Fractional duration during which this HFC-23 is actually vented to the atmosphere, rather than destroyed	facility i during individual release period M	an individual facility i		
Subdivision (facility)		in the reactor product at facility i during individual release period M (kg HFC-23 / kg HCFC- 22)	Mass of HCFC-22 produced at facility i while Ci applies during individual release period M (kg) Pi 1200000	Fractional duration during which this HFC-23 is actually vented to the atmosphere, rather than destroyed (Fraction)	facility i during individual release period M (kg)	an individual facility i (kg / Year)	3	2

Example: Tier 3.c – monitoring method (1/2)

Example: Tier 3.c – monitoring method (2/2)

ni e-zo chiabiona non murrosal process areania (birec	t method) - Tier 3a Other Fluorinated 0	Compounds (Proxy method) - Tier 3 (1/2)	Other Fluorinated Compounds (Proxy meth	od) - Tier 3 (2/2) Capture and storage or	other reduction
HFC-23 - Emission Factor per 'unit' of proxy quantity - Tier					2 Production - Tier 2
IFC-23 emissions from HCFC-22 production (Monitoring r	nethod) - Tier 3c (2/2) Other Fluorinate	d Compounds Other Fluorinated Compounds	inds (Direct method) - Tier 3 HFC-23 Em	issions from HCFC-22 Production	
forksheet industrial Processes and Product Use adegory: Chemical Industry - Fluorochemical Product adegory: 2.8.9.a By-product emissions from HCFC-22 product Data F-Gases Manager F-Gases Manager	iction				199
Poases Manager		Equation 3.40			
		Equation 3.40			
	Annual HFC-23 vented from an	Annual quantity of HFC-23 recovered	Annual HFC-23 emissions from an	Annual HFC-23 emissions from an	
Subdivision (facility)	individual facility i (kg)	from facility i for use as chemical feedstock, and hence destroyed (kg)	individual facility i (kg)	individual facility i (Gg)	
		feedstock, and hence destroyed	individual facility i	individual facility i	
(facility) I △▽ Facility UniCHEM		feedstock, and hence destroyed (kg) Ri	individual facility i (kg)	individual facility i (Gg)	∵ ⊌ ୨
(facility) i ∆⊽	(kg) Vi	feedstock, and hence destroyed (kg) Ri 3	individual facility i (kg) Ei = VI - Ri	individual facility i (Gg) Ei / 1000000	2° 14 ?

Results

By-product Emissions- HFC-23 emissions from HCFC-22 production are estimated in mass units (kg and Gg) by the *Software* for each row, and the total for all rows, in the following worksheets.

- ✓ HFC-23 emissions from HCFC-22 production
- ✓ HFC-23 emissions from HCFC-22 production Tier 2
- ✓ HFC-23 emissions from individual process streams (Direct Method) Tier 3a
- ✓ Mass emissions of HFC-23 Tier 3b (2/2)
- ✓ HFC-23 emissions from HCFC-22 (Monitoring Method) Tier 3c (2/2)

Total HFC-23 emissions from HFC-23 emissions from HCFC-22 production is the sum of all emissions in the above worksheets, taking into account any capture or destruction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions. As described above, recovery and destruction are already accounted for in the Tier 2 and Tier 3 worksheets above. Users shall ensure that recovery /destruction reported in the worksheet **Capture and storage or other reduction** does not double count that already reported.

In the worksheet **Capture and storage or other reduction**, for each subdivision and each F-gas:

- 1. <u>Column |CH|</u>: select from the drop-down menu HCFC-22
- 2. <u>Column |SRC|</u>: enter any identifying information for the source, if applicable.
- 3. Column |B|: collect and input information on any other long-term reduction of HFC-23, in tonnes.

Example: Capture and storage or other reduction

	ssions from HCFC-2	2 productio	(Monitoring method)	- Tier 3c (2/2) 0	ther Fluorinated Compounds	Other F	luorinated Compounds (Dired	t method) - Tier 3 HFC	-23 Emissions from HCFC	-22 Production		
FC-23 Em	issions from individua	al process s	treams (Direct metho	d) - Tier 3a Othe	er Fluorinated Compounds (Pro	oxy method	d) - Tier 3 (1/2) Other Flux	prinated Compounds (Prox	ty method) - Tier 3 (2/2)	Capture and storage or othe	er reductio	on
orksheet												
ector: ategory:	Industrial Proc Chemical Indu		roduct Use									199
bcatego eet:		oduct emiss										
ata	Capture and st	orage or our	er reduction									
as	HFC-23 (CHF3)		~	F-Gases Manage	r							
ias	HFC-23 (CHF3)		× [F-Gases Manage	r							
ias I	HFC-23 (CHF3)				r		Amount CO2 captured		-		T	
ias I	Subdivision		Type of Fluorina produ	led Compound	Source		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)		
as (۵V	Type of Fluorina	led Compound	Source	^∀	and stored (tonne)					
Unspe	Subdivision S		Type of Fluorina produ	ted Compound iced	Source	۵⊽	and stored (tonne)	(tonne)	(tonne)	(Gg)	3	a 2

2.B.9.a By-product Emissions - other fluorinated compounds

Information

A large number of fluorine containing GHGs can be produced as by-product emissions during fluorochemical manufacture and emitted into the atmosphere.

For the purposes of data entry in the *Software*, and for interoperability with the UNFCCC ETF Reporting Tool, HFC-23 emissions from HCFC-22 emissions are always calculated under source category 2.B.9.a By-product Emissions. Fugitive emissions from production of HFC-134a, SF₆ and NF₃ should be calculated and reported pursuant to the corresponding worksheets under category 2.B.9.b Fugitive Emissions.

For other emissions from fluorinated gas production, it is assumed that if category 2.B.9 is a key category, and emissions of a particular gas are considered significant, then the release of that gas should be considered a byproduct emission and calculated and reported under category 2.B.9.a. If category 2.B.9 is key, but release of a particular gas is not considered significant, or if category 2.B.9 is non-key, other emissions from fluorinated gas production should be considered a fugitive emissions and reported under source category 2.B.9.b Fugitive emissions. This is consistent with <u>footnote 2</u> in IPCC worksheet 3 of 3 for this category.

The 2006 IPCC Guidelines provide two Tiers to estimate by-product emissions from other fluorinated compounds (other than HFC-23 emissions from HCFC-22 production). The Tier 1 methodology relies on information on total production of the fluorinated gas (individual species of HFCs, PFCs, SF₆ and other fluorinated GHGs) and a default EF. There are two Tier 3 approaches: Tier 3a and Tier 3b. In the Tier 3a methodology, total emissions equal the sum of factory-specific emissions of each by-product fluorinated gas determined using standard methods to estimate the composition and flowrate of gas streams vented to the atmosphere after any abatement technology. In the Tier 3b proxy methodology, the emission rate of the by-product is normalised to a more easily (or accurately) measurable parameter, such as feedstock flow rate.

The Tier 2 method based on process efficiencies, which works for HFC-23 emissions from HCFC-22 plants, is considered of less value for other types of fluorinated gas production plants, and thus not included in the *Software*. In accordance with the 2006 IPCC Guidelines, in the absence of country-specific information, the quantity of emissions estimated from process inefficiencies may be used in a qualitative decision as to whether or not these emissions are a significant subcategory under a key category, in which case, a Tier 3 methodology in the *Software* should be used.

<u>GHGs</u>

The *Software* includes the following GHGs for production of other fluorinated compounds under the By-product Emissions (2.B.9.a) source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
			Χ	X	Χ	Χ

IPCC Equations

- ✓ <u>Tier 1</u>: <u>Equation 3.41</u>
- ✓ <u>Tier 2</u>: no IPCC Tier 2 Equation provided in the 2006 IPCC Guidelines
- ✓ <u>Tier 3</u>: <u>Equation 3.42</u> (Direct method) and <u>Equation 3.43</u>, <u>3.38 and 3.39</u> (Proxy method)

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Tier 1 equations.

Software Worksheets

GHG emissions from By-product emissions- from production of other fluorinated compounds are estimated using the following worksheets:

✓ 1.1.2 F-gases Manager: contains data on F-gases used (including imported) and/or produced and exported in country.

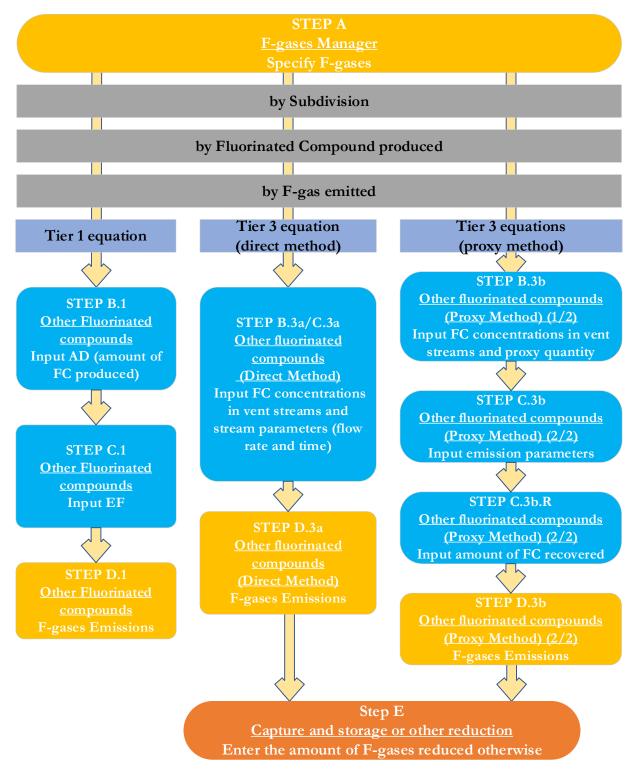
- ✓ Other Fluorinated Compounds: this worksheet contains for each subdivision and each principal fluorinated compound produced the amount of production of principal compound and a default EF. The worksheet calculates the by-product emissions of other fluorinated compounds.
- ✓ Other Fluorinated Compounds (Direct Method) Tier 3 contains for each stream and measurement campaign the concentrations of fluorinated compounds in the gas streams which are vented, the flow rate and the time parameters needed to produce annual emissions. The worksheet calculates the by-product emissions of other fluorinated compounds.
- ✓ Other Fluorinated Compounds (Proxy Method) Tier 3 (1/2): contains for each stream and trial campaign the concentrations of fluorinated compounds, the flow rate and the proxy quantity. The worksheet calculates EF of fluorinated compounds per unit of proxy.
- ✓ Other Fluorinated Compounds (Proxy Method) Tier 3 (2/2): contains for each subdivision and each stream the correlation parameter (emission rate to operation rate) and duration of venting. It also contains information on recovery (destruction) of fluorinated compounds. The worksheet calculates the by-product emissions of other fluorinated compounds.
- ✓ Capture and storage or other reduction: contains information on any other amount of recovered (reduced) fluorinated compounds, which are not accounted for in the Tier 1, 2 and 3 worksheets.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.17 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for By-product Emissions-from production of other fluorinated compounds.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.



By-product emissions from production of other fluorinated compounds - flowchart

Thus, for the source-category:

Step A, 1.1.2 F-gases Manager, users ensure that all F-gases emitted for this source category have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step B.1, in the worksheet **Other Fluorinated Compounds,** users collect and input in the *Software* information on the amount of a principal fluorochemical compound produced, and the gase(es) emitted.

Step C.1, in the worksheet Other Fluorinated Compounds, users input an EF for by-product fluorinated compounds emitted.

Step D.1, in the worksheet **Other Fluorinated Compounds,** the *Software* calculates the associated fluorochemical compounds emissions in mass units (kg and Gg).

When Tier 3 Equations are applied:

Tier 3.a Direct method

Step B.3a/C.3.a in the worksheet **Other Fluorinated Compounds (Direct Method) – Tier 3,** users collect and input in the *Software,* for each stream and measurement campaign, the concentrations of fluorochemical compounds in the gas streams which are vented, the flow rate and time parameters needed to produce annual emissions.

Step D.3a, in the worksheet **Other Fluorinated Compounds (Direct Method) – Tier 3,** the *Software* calculates the associated fluorochemical compounds emissions for each vent stream in mass units (kg and Gg).

Tier 3.b Proxy method

Step B.3b, in the worksheet Other Fluorinated Compounds (Proxy Method) – Tier 3 (1/2), users collect and input in the *Software* information for each stream and trial campaign the concentrations of fluorochemical compounds, as well as the flow rate and the proxy quantity.

Step C.3b, in the worksheet Other Fluorinated Compounds (Proxy Method) – Tier 3 (2/2), for each vent stream users input in the *Software* the measured standard emission rate to the actual rate at the facility, the current process operating rate for the proxy quantity, and the duration of venting

Step C.3b.R, in the worksheet Other Fluorinated Compounds (Proxy Method) – Tier 3 (2/2), for each vent stream, users input the amount of recovered (destroyed) fluorochemical compound.

Step D.3b, in the worksheet Other Fluorinated Compounds (Proxy Method) – Tier 3 (2/2), the *Software* calculates the associated fluorochemical compounds emissions for each vent stream and total emissions in mass units (kg and Gg).

Then, for each tier, as appropriate:

Step E, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of recovered/reduced fluorinated compounds, which are not accounted for elsewhere in calculation worksheets.

Activity data input

Section 3.10.2.2 Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for By-product emissions from production of other fluorinated compounds.

As a **Starting step**, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases (or, if applicable, blends) to be reported for the source category By-product emissions from production of other fluorinated compounds.

<u>Note that</u> if no F-gases are checked in the F-gases Manager, it will not be possible to enter any data in this worksheet. If data entry is not possible, select the **F**-Gases Manager from any tab. This will open the F-gases Manager – applicability at IPCC Category Level. Navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level- F-gases Manager to check all F-gases consumed (including imported) and produced and exported. Save and close the dialogue box for the country level F-gases Manager and the user returns to the IPCC Category level F-gases Manager. In the IPCC Category level F-gases Manager, the user selects which of the relevant F-gases are applicable for this category.

For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool: If AD and/or emissions for a particular F-gas in this category is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. If checked, "C" will be reported for AD and "IE" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate.

Example: Populating the F-gases manager and designating confidentiality for category: By-product emissions from production of other fluorinated compounds

gory: Chemical Industry - F ategory: 2.B.9.a - By-product	and Product Use Nuorochemical Production emissions ive Emissions from Production of C	Nther Fluorinated Compounds								19
-Gases Manager										
			Equation 3.41							
Subdivision	Principal Fluorinated Compound Produced	Gas emitted	Amount of Principal Fluorinated Compound Produced (kg)	Emission Factor (kg by-product gas emitted/kg F-compound produced)	Emissions (kg)	Emissions (Gg)				
	Δ Δ 7	7	V Pk	EFk	Ek = Pk * EFk	Ek / 1000000				
Unspecified	any gas	PFC-14 (CF4)	10000000	0.005	500000		3		2	×
		HFC-23 (CHF3)	1000	0.005	5	0.00001				
	test	HFC-32 (CH2F2)	1000	0.005	5	0.00001				_
		HFC-41 (CH3F)	1000	0.005	5	0.00001		-		-
F-Gases Mana	iger - 2.B.9.a	HFC-43-10mee (CF3CHFCHFCF2CF3) Chemicals and Blends	s - applicability at I	0.005	500	0.0005	×			
	5	Chemicals and Blend:	s - applicability at I Chemical group	PCC Category level	000					
	5		s - applicability at I Chemical group Gases select		Consumed and/or Exported at category level					
B HFC	5	Chemicals and Blends	s - applicability at I Chemical group Gases select ca	PCC Category level	Consumed analor Exported at category level	UNFCCC CRT Confidentiality				
B HFC	8	Chemicals and Blends	s - applicability at I Chemical group Gases select ca CF4 CF4	PCC Category level	Consumed and/or Exported at category tevel	UNFCCC CRT Confidentiality				
B HFC	8	Chemicals and Blends △ ▼ Chemical PFC-14 PFC-116 PFC-218	s - applicability at I Chemical group Gases select ca CF4 C2F6 C3F8	PCC Category level that may be ted for this ttegory	Consumed and/or Exported at category level C	UNFCCC CRT Confidentiality				
B HFC	8	Chemicals and Blends	s - applicability at I Chemical group Gases select CF4 CF4 CF4 C3F8 C4F10	PCC Category level that may be ted for this ttegory	Consumed and/or Exported at category tevel	UNFCCC CRT Confidentiality				
	s 3 PFCs listed in Table 7.1	Chemicals and Blends	s - applicability at I Chemical group Gases select CF4 CF4 C2F6 C3F8 C4F10 n-C6F	PCC Category level that may be ted for this tegory	Consumed andior Exported at category tevel					
	8	Chemicals and Blends Chemical PFC-14 PFC-116 PFC-218 PFC-31-10 PFC-5-1-14 PFC-216	s - applicability at I Chemical group Gases select ca CF4 C3F8 C4F10 n-C6F c-C3F6	PCC Category level that may be ted for this tegory	Consumed and/or Exported at category level C	UNFCCC CRT Confidentiality				
	s 3 PFCs listed in Table 7.1	Chemicals and Blends	s - applicability at I Chemical group Gases select CF4 CF4 C2F6 C3F8 C4F10 n-C6F	PCC Category level that may be ted for this tegory	Consumed andior Exported at category tevel					

Second, input of AD for By-product emissions from production of other fluorinated compounds requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified)

 2.8.6 - Titanium Dioxide P 2.8.7 - Soda Ash Producti 2.8.8 - Petrochemical and 	HFC-23 Emissions from individual pr HFC-23 emissions from HCFC-22 pr Worksheet		Internet of the second se					er redu	ction	
28.8.a - Methanol 28.8.b - Ethylene 28.8.c - Ethylene Dic 28.8.d - Ethylene Oxi 28.8.e - Acrylonitrile 28.8.f - Carbon Black 28.8.r - Other petroch	Sector: Industrial Processe Category: Chemical Industry Subcategory: 2.8.9.a - By-produc	is and Product Use - Fluorochemical Production ct emissions gitive Emissions from Production of C	ther Ruorinated Compounds							199
E 2.B.9 - Fluorochemical Pr				A CALCULATION OF COMPANY						
				Equation 3.41						
2.8.9.a - By-product e 2.8.9.b - Fugitive Emis - 2.8.10 - Hydrogen Produc - 2.8.11 - Other (Please sp	Subdivision	Principal Fluorinated Compound Produced	Gas emitted	Equation 3.41 Amount of Principal Fluorinated Compound Produced (kg)	Emission Factor (kg by-product gas emitted/kg F-compound produced)	Emissions (kg)	Emissions (Gg)			
2.8.9.a - By-product e 2.8.9.b - Fugitive Emis - 2.8.10 - Hydrogen Produc - 2.8.11 - Other (Please sp C - Metal Industry				Amount of Principal Fluorinated Compound Produced	(kg by-product gas emitted/kg F-compound					-
2.8.9.a - By-product e -2.8.9.b - Fugitive Emis -2.8.10 - Hydrogen Produc -2.8.11 - Other (Please sp C - Metal Industry -2.C.1 - Iron and Steel Pro		Compound Produced		Amount of Principal Fluorinated Compound Produced (kg) V Pk 10000000	(kg by-product gas emitted/kg F-compound produced) EFk 0.005	(kg)	(Gg) Ek / 1000000 0.5	3		*
2.8.9.a - By-product e 2.8.9.b - Fugitive Emis -2.8.10 - Hydrogen Produc -2.8.11 - Other (Please sp C - Metal Industry		Compound Produced	7	Amount of Principal Fluorinated Compound Produced (kg)	(kg by-product gas emitted/kg F-compound produced) EFk	(kg) Ek = Pk * EFk	(Gg) Ek / 1000000	3	u .	> ×

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

2.B.6 - Titanium Dioxide P	HFC-23 Emissions from individual									ction	
2.B.7 - Soda Ash Producti 2.B.8 - Petrochemical and 2.B.8 - Methanol	HFC-23 emissions from HCFC-22 (Worksheet		od) • Tier 3c (2/2) Other	Fluorinated Compound	Other Fluorinated	Compounds (Direct m	ethod) - Tier 3 HFC-23	Emissions from HCFC-22 Product	ion		
2 B.8.b - Ethylene 2 B.8.c - Ethylene Dic 2 B.8.d - Ethylene Oxi 2 B.8.e - Acrylonitrile 2 B.8.f - Carbon Black	Category: Chemical Industr Subcategory: 2.8.9.a · By-prod	ses and Product Use y - Ruorochemical Production luct emissions ins from individual process str		3							19
- 2.8.9 - Fluorochemical Pr					Equation 3.34, 3	37, 3.42					
28.9.0 - Reyroduct e 28.9.0 - Fugitive Emis 28.9.0 - Fugitive Emis 2.8.10 - Hydrogen Produc 2.8.11 - Other (Please sp 2.0 - Metal Industry 2.C.1 - Iron and Steel Pro 2.C.2 - Ferroalloys Produc	Subdivision (facility)	Individual process stream	Measurement campaign (e.g. date)	FC concentration in the gas stream actually vented from process stream j at facility i (kg FC / kg gas stream)	Mass flow of the gas stream from process stream j at facility i (kg gas stream / hour)	Length of time in the year over which these parameters are measured and remain constant (hours)	Instantan	eous: FC emissions (kg)	Instantaneous' FC emissions (Gg)		
-2.C.3 - Aluminium producti -2.C.4 - Magnesium produc	i 5								Eijaverage / 1000000		
- 2.C.5 - Lead Production	North	Northern	Jan - December	0.7	25	5000	87500	17.5	0.00002	3	
2.C.6 - Zinc Production	2 East	#456	Jan-December	0.9	34	5000	153000	30.6	0.00003	3	?
-2.C.7 - Rare Earths Produ -2.C.8 - Other (please spec	Total	<u> </u>							1	8	-
								48.1	0.00005		

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in **Other fluorinated compounds** worksheet, row by row, as follows:

- 1. <u>Column | Principal compound produced |:</u> enter the principal compound produced.
- 2. <u>Column | Gas emitted |:</u> select from the drop-down menu, the gas emitted.
- 3. <u>Column | Pk |</u>: enter the amount of principal fluorinated compound produced, in kg.

Example: AD for other fluorinated compounds - Tier 1

IFC-23 - Emission Factor per 'un	nit of prox	y quantity - Tier 3b (1/2) Ma	ss emission of HFC-23 - Tier 3b (2/2) HFC-2	23 emissions from HCFC-22	2 production (Monitoring method	- Tier 3c (1/2) HFC-23 E	Emissions from HCFC-22 F	Produc	tion - Tie	r2
FC-23 Emissions from individua	al process	streams (Direct method) - Tier	3a Other Fluorinated Compounds (Proxy m	nethod) - Tier 3 (1/2) Oth	er Fluorinated Compounds (Pro	xy method) - Tier 3 (2/2)	Capture and storage or othe	er red	uction	
IFC-23 emissions from HCFC-2 lorksheet	22 product	ion (Monitoring method) - Tier 3	8c (2/2) Other Fluorinated Compounds Oth	her Fluorinated Compounds	(Direct method) - Tier 3 HF(C-23 Emissions from HCFC-	22 Production			
Subcategory: 2.8.9.a - By-pr	ustry - Fluor roduct emi	ochemical Production	her Fluorinated Compounds							19
F-Gases Manager										
				Equation 3.41						
		Principal Fluorinated Compound Produced	Gas emitted	Equation 3.41 Amount of Principal Fluorinated Compound Produced (kg)	Emission Factor (kg by-product gas emitted/kg F-compound produced)	Emissions (kg)	Emissions (Gg)			
F-Gases Manager	20		Gas emitted	Amount of Principal Fluorinated Compound Produced	(kg by-product gas emitted/kg F-compound					
F-Gases Manager	Δ.ζ.	Compound Produced	Gas emitted ▼ PFC-14 (CF4)	Amount of Principal Fluorinated Compound Produced (kg)	(kg by-product gas emitted/kg F-compound produced)	(kg)	(Gg)) x

When Tier 3 Equations are applied:

Tier 3.a Direct method

The Tier 3.a Direct method does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

Tier 3.b Proxy method

The Tier 3.b Proxy method does not rely on AD*EF. Refer to section Direct measurement below to learn how to enter data in the *Software* for this method.

Emission factors input

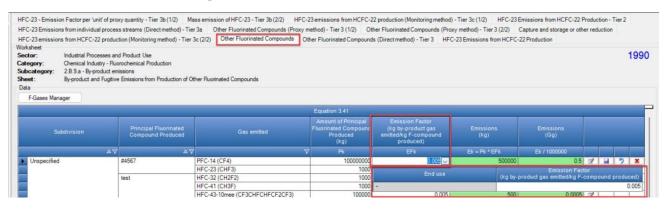
Section 3.10.2.2 Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for By-product emissions from production of other fluorinated compounds.

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, in worksheet **Other fluorinated compounds** row by row, as follows:

1. <u>Column |EFk</u>|: select from the drop-down menu the IPCC default EF, otherwise input a user-specific value, in kg of by-product gas emitted per kg of principal gas produced.

Example: Tier 1 EFs – other fluorinated compounds



Direct measurement

Tier 3.a Direct method

For each subdivision in <u>Column |i|</u>, data are entered in worksheet **Other Fluorinated Compounds (Direct Method) – Tier 3,** row by row, as follows:

- 1. <u>Column |j|:</u> enter a name for individual process stream.
- 2. <u>Column |Measurement campaign|:</u> for each subdivision/process stream input the name or dates of the measurement campaigns.
- 3. <u>Column |Cij|</u>: For each subdivision/process stream/measurement campaign, input the concentration of HFC-23 in the gas stream which is actually vented, in kg fluorinated compound/kg of gas stream.
- 4. <u>Column |f_{ij}|:</u> For each subdivision/process stream/measurement campaign input the flow rate of the gas, in kg of gas stream/ hour.
- 5. <u>Column |t|</u>: For each subdivision/process stream/measurement campaign enter the length of time in hours, these parameters are measured.

<u>Note that</u> the sum of hours input in column "t" shall correspond to the total time, in hours, of activity of the facility (i) in the reporting year, for which individual jet streams (j) are input in the worksheet.

Example: **Tier 3 – direct method**

ategory: 2.8.9.a - By-product emissions at: Other PC Emissions from individual process streams (Direct method) - Ter 3 HFC-23 (CHF3) FGases Manager Subdivision (nclility) Individual process stream FG concentration in the gas stream i at stream Measurement campaign (e.g. date) FC concentration in the gas stream i at stream Measurement campaign (e.g. date) The facility i (e.g. date) The facility i (fig Gas stream i at neumin constant hour) The facility i (fig Gas stream i at remain constant hour) The facility i (fig	Over which arameters ured and constant Instantaneous' FC emissions (kg) Instantaneous' FC emissions (Gg) t Eij = Cij * fij * t Eijaverage = AVG(Eijt) Eijaverage / 1000000 Image: Cij * fij * t	East
et: Other FC Emissions from individual process streams (Direct method) - Tier 3 HFC-23 (CHF3) FGases Manager Subdivision (facility) Individual process FG. concentration the gas stream (e.g. date) FC concentration from process stream j at facility i (e.g. date) FC concentration the gas stream j (e.g. date) Equation 3.34, 3.37, 3.42	of time in over which rureders Instantaneous' FC emissions emissions (kg) (Gg)	
category: 2.8.9.a - By-product emissions et: Other FC Emissions from individual process streams (Direct method) - Tier 3 HFC-23 (CHF3) V F-Gases Manager	199	
category: 2.8.9.a - By-product emissions et: Other FC Emissions from individual process streams (Direct method) - Tier 3	19	
	199	wbcategory: 2.8.9.a - By-pr heet: Other FC Emis Data
	1.000	
-23 emissions from HCFC-22 production (Monitoring method) - Tier 3 c (2/2) Other Fluorinated Compounds [Other Fluorinated Compounds (Direct method) - Tier 3 HFC-23 Emissions from HCFC-22 Production	ds (Direct method) - Tier 3 HFC-23 Emissions from HCFC-22 Production	

Tier 3.b Proxy method

For each subdivision in <u>Column |i| (Tier 3 requires plant- or facility- specific input)</u>, data are entered in worksheet **Other Fluorinated Compounds (Proxy method) – Tier 3 (1/2)**, row by row, as follows:

- 1. <u>Column |j|</u> enter a name for the individual vent stream.
- 2. <u>Column |T|:</u> for each subdivision (plant)/vent stream, input the name or date of the trial campaigns.
- 3. <u>Column |CT_{ij}|</u>: for each subdivision/vent stream/trial campaign input the concentration of fluorinated compound in the vent stream, in kg fluorinated compound/kg of gas stream.
- 4. <u>Column $|fT_{ij}|$:</u> for each subdivision/vent stream/trial campaign, input the average mass flow rate of the vent stream, in kg of vent stream/hour.
- 5. <u>Column | PORT_{ij}|</u>: for each subdivision/vent stream/trial campaign, input the proxy quantity (e.g. operating rate) in units per hour.

<u>Note that</u> the 'unit' depends on the proxy quantity adopted for plant i vent stream j (for example, kg/ hour or m³/ hour of feedstock). In almost all cases, the rate of plant operation is considered a suitable proxy and the quantity of fluorinated compound emitted depends on the current plant operating rate and the length of time the vent flow was released.

The worksheet calculates an **average** Fluorinated compound EF per unit of proxy. Then, the subdivisions/vent streams and the calculated EF entered in worksheet **Other Fluorinated Compounds (Proxy method) – Tier 3** (1/2), are transferred automatically to worksheet **Other Fluorinated Compounds (Proxy method) – Tier 3** (2/2).

Then, for each subdivision/individual vent stream,

6. <u>Column $|F_{ij}|$ </u> the users enter a dimensionless factor relating the measured standard mass emission rate to the emission rate at the actual plant operating rate.

<u>Note that</u> in many cases, the fraction produced is not sensitive to operating rate and Fi is unity (i.e., the emission rate is proportional to operating rate). In other cases the emission rate is a more complex function of the operating rate. In all cases Fi should be derived during the plant trial by measuring HFC-23 production at different operating rates. For situations where a simple function relating the emissions to the operating rate cannot be determined from testing, the proxy method is not considered appropriate and continuous measurement is desirable.

7. <u>Column |POR_{ij}|</u>: Users enter the current process operating rate applicable to that vent stream, j, averaged over the time period, t, in 'unit/hour'.

<u>Note that</u> the units of this parameter must be consistent between the plant trial establishing the standard emission rate and the estimate of ongoing, operational emissions

8. <u>Column |t|.</u>: enter the time, in hours, of actual venting for the year, or the period if the process is not operated continuously.

<u>Note</u> that annual emissions become the sum of all the periods during the year. The periods during which the vent stream is processed in a destruction system should not be counted here.

9. <u>Column |Rij|</u>: enter in the quantity of fluorinated compound recovered from each vent stream for use as chemical feedstock, and hence destroyed.

Results

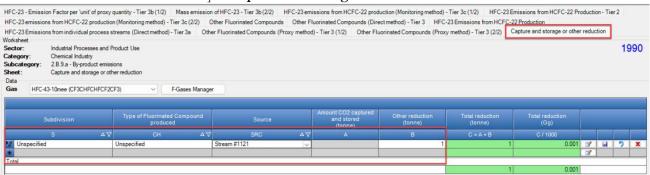
By-product emissions from production of other fluorinated compounds are estimated in mass units (kg and Gg) by the *Software* in the following worksheets for different Tiers.

- ✓ Other Fluorinated Compounds:
- ✓ Other Fluorinated Compounds (Direct Method) Tier 3
- ✓ Other Fluorinated Compounds (Proxy Method) Tier 3 (2/2)

Total emissions from production of other fluorinated compounds is the sum of all emissions in the above worksheets, taking into account any capture or destruction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions. As described above, recovery and destruction are already accounted for in the Tier 3 worksheets above. Users shall ensure that recovery /destruction reported in the worksheet **Capture and storage or other reduction** does not double count that already reported.

In the worksheet **Capture and storage or other reduction**, for each subdivision and each F-gas:

- 1. <u>Column |CH|</u>: enter in the drop-down menu the type of fluorinated compound produced, for which the destruction / reduction activity is taking place.
- 2. <u>Column |SRC|</u>: enter any identifying information for the source, if applicable.
- 3. <u>Column |B|:</u> collect and input information on any other long-term reduction of fluorinated GHGs emitted, in tonnes.



Example: Capture and storage or other reduction

2.B.9.b Fugitive Emissions - from production of other fluorinated compounds

Information

Emissions of a chemical occur during its production and distribution or as a by-product during the production of a related chemical (HFC-23 from HCFC-22 production is covered specifically and described above). There may also be emissions of the material that is being produced; the so-called **'fugitive emissions'**.

For the purposes of data entry in the *Software*, and for interoperability with the UNFCCC ETF Reporting Tool, HFC-23 emissions from HCFC-22 emissions are always calculated under source category 2.B.9.a By-product Emissions. Fugitive emissions from production of HFC-134a, SF₆ and NF₃ should be calculated and reported pursuant to the corresponding worksheets under category 2.B.9.b Fugitive Emissions.

For other emissions from fluorinated gas production, it is assumed that if category 2.B.9 is a key category, and emissions of a particular gas are considered significant, then the release of that gas should be considered a byproduct emission and calculated and reported under category 2.B.9.a. If category 2.B.9 is key, but release of a particular gas is not considered significant, or if category 2.B.9 is non-key, other emissions from fluorinated gas production should be considered a fugitive emissions and reported under source category 2.B.9.b Fugitive emissions. This is consistent with <u>footnote 2</u> in IPCC worksheet 3 of 3 for this category.

The Software provides only a Tier 1 method for fugitive emissions from fluorochemical production, based on the production of the fluorinated compound and a default EF.

<u>GHGs</u>

The *Software* includes the following GHGs for production of other fluorinated compounds under the Fugitive Emissions (2.B.9.b) source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
			Χ	X	Χ	X

IPCC Equations

- \checkmark <u>Tier 1</u>: <u>Equation 3.41</u>
- ✓ <u>Tier 2</u>: no IPCC Tier 2 Equation provided in the 2006 IPCC Guidelines
- ✓ <u>Tier 3</u>: no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Tier 1 equations.

Software Worksheets

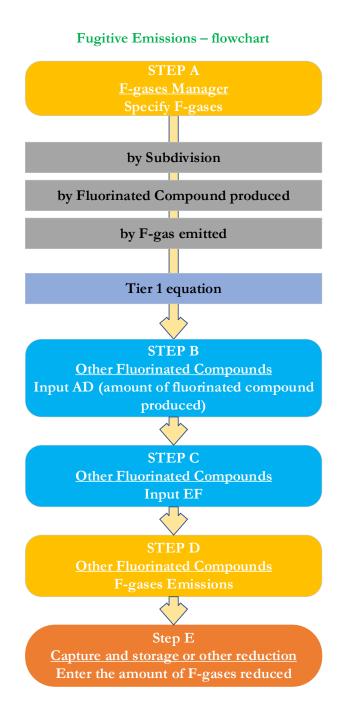
GHG emissions from the Fugitive emissions source category are estimated using the following two worksheets:

- ✓ 1.1.2 F-gases Manager: contains data on F-gases used (including imported) and/or produced and exported in country.
- ✓ **Other Fluorinated Compounds:** contains for each subdivision information on the amount of fluorinated gas produced and the fugitive EF. The worksheet calculates the associated F-gases emissions.
- ✓ Capture and storage or other reduction: contains information on reduction of F-gases.

User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.17 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Fugitive Emissions-from production of other fluorinated compounds.



Thus, for the source-category:

Step A, 1.1.2 F-gases Manager, users ensure that all F-gases emitted for this source category have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step B, in the worksheet **Other fluorinated compounds,** users collect and input in the *Software* information on the amount of fluorinated principal compound produced and the gas(es) emitted.

Step C, in worksheet Other fluorinated compounds, users input an EF for fluorinated compounds.

Step D, in the worksheet **Other fluorinated compounds**, the *Software* calculates the associated fluorochemical compounds emissions in mass units (kg and Gg).

Step E, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of recovered/reduced fluorinated compounds, which are not accounted for elsewhere in calculation worksheets.

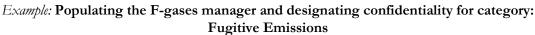
Activity data input

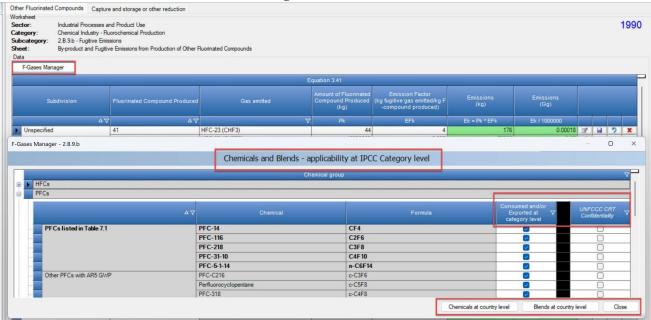
Section 3.10.2.2 Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for fugitive emissions from production of other fluorinated compounds.

As a **Starting step**, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases (or, if applicable, blends) to be reported for the source category Fugitive Emissions.

<u>Note that</u> if no F-gases are checked in the F-gases Manager, it will not be possible to enter any data in this worksheet. If data entry is not possible, select the **F**-Gases Manager from any tab. This will open the F-gases Manager – applicability at IPCC Category Level. Navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level- F-gases Manager to check all F-gases consumed (including imported) and produced and exported. Save and close the dialogue box for the country level F-gases Manager and the user returns to the IPCC Category level F-gases Manager. In the IPCC Category level F-gases Manager, the user selects which of the relevant F-gases are applicable for this category.

For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool: If AD and/or emissions for a particular F-gas in this category is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. If checked, "C" will be reported for AD and emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate.





Second, input of AD for Fugitive Emissions requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified)

2006 IPCC Categories + 4	Other Fluorinated Compounds	Capture and storage or other reduction								
28.5 - Carbide Production -28.6 - Titanium Dioxide Productio 28.8 - Stoda Ash Production ⇒ 28.8 - Petrochemical and Carbon -28.8 a - Methanol -2.8.8 b - Ethylene	Category: Chemical Ind Subcategory: 2.8.9.b - Fug	cesses and Product Use ustry - Ruorochemical Production titve Emissions nd Fugitive Emissions from Production of Other	Ruomated Compounds							1990
-2.B.8.c - Ethylene Dichloride a -2.B.8.d - Ethylene Oxide	F-Gases Manager									
-2.B.8.e - Acrylonitrile	Equation 3.41									
-2.8.8.f - Carbon Black -2.8.8.x - Other petrochemical 2.8.9 - Fluorochemical Production -2.8.9.a - By-product emissions	Subdivision	Fluorinated Compound Produced	Gas emitted	Amount of Fluorinated Compound Produced (kg)		Emissions (kg)	Emissions (Gg)			
2.B.9.b - Fugitive Emissions		2 24	7	7 Pk	EFk	Ek = Pk * EFk	Ek / 1000000			
- 2.B.10 - Hydrogen Production	Unspecified	SF6	HFC-23 (CHF3)	44	4	176	0.00018	3		
2.B.11 - Other (Please specify)		HFC-152a	HFC-134a (CH2FCF3)	1000000	0.005	50000	0.05	3		
.C - Metal Industry		HFC-134a	HFC-32 (CH2F2)	1000000	0.005	50000	0.05	3		
- 2.C.1 - Iron and Steel Production			HFC-41 (CH3F)	10000000	0.005	50000	0.05	3		
- 2.C.2 - Ferroalloys Production	B		HFC-43-10mee (CF3CHFCHFCF2CF3)	10000000	0.005	50000	0.05		1 2	×
- 2.C.3 - Aluminium production			HFC-134 (CHF2CHF2)	10000000	0.005	50000	0.05	3		

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions



Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in **Other fluorinated compounds** worksheet, row by row, as follows:

- 1. <u>Column | Principal compound produced |:</u> enter the principal compound produced.
- 2. <u>Column | Gas emitted |:</u> select from the drop-down menu, the gas emitted.
- 3. <u>Column | Pk |</u>: enter the amount of principal fluorinated compound produced, in kg.

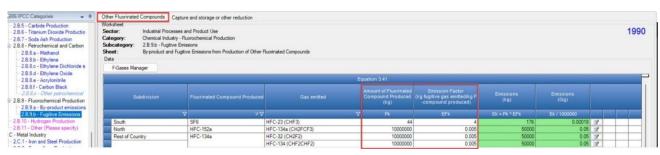
Emission factors input

Section 3.10.2.2 Chapter 2 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Fugitive emissions from production of other fluorinated compounds.

For each subdivision in <u>Column |Subdivision|</u>, in worksheet **Other fluorinated compounds** row by row, as follows:

1. <u>Column |EFk</u>|: select from the drop-down menu the IPCC default EF, otherwise input a user-specific value, in kg of fugitive gas emitted/kg of principal gas produced.

Example: AD and EFs for fugitive emissions – Tier 1



Results

Fugitive emissions from production of other fluorinated compounds are estimated in mass units (kg and Gg) by the *Software* in the worksheet **Other Fluorinated Compounds**.

Total emissions from production of other fluorinated compounds is the sum of emissions in the above worksheet, taking into account any capture or destruction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions.

In the worksheet **Capture and storage or other reduction**, for each subdivision and each F-gas:

- 1. <u>Column |SRC|</u>: enter any identifying information for the source, if applicable.
- 2. <u>Column |B|</u>: collect and input information on any other long-term reduction of fluorinated GHGs emitted, in tonnes.

Example: Capture and storage or other reduction

her Fluorinated Compounds Capture	and storage or other reduction						
srksheet ector: Industrial Processes an stegory: Chemical Industry sbcategory: 2.8.9.b - Fugtive Emiss capture and storage or	d Product Use						199
ata has HFC-245ca (CH2FCF2CHF2)	 ✓ F-Gases Mar 	ager					
	FGases Mar Type of Fluorinated Compound produced		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	
Subdivision	Type of Fluorinated Compound produced	Source	and stored				
Subdivision	Type of Fluorinated Compound produced	Source	and stored (tonne)	(tonne)	(tonne)	(Gg)	2 4 7 3

2.B.10 Hydrogen Production

Information

Section 3.11 Chapter 3, Volume 3 of the 2019 IPCC Guidelines provides three Tiers to estimate CO_2 emissions from Hydrogen Production. The Tier 1 methods use national or regional level AD on hydrogen production or feedstock consumption together with default factors and data on recovered CO_2 to derive emissions. The Tier 2 method allows the use of the same AD, but with and country-specific factors along with data on recovered CO_2 . Tier 3 requires plant-specific AD and factors. Tier 1a is the default method based on national total of hydrogen production, where Tier 1b assumes feedstock requirements for hydrogen production and Tier 1c is based on the amount of feedstock consumption. Tier 2b and Tier 2c requires information on feedstock requirements for hydrogen production, and hydrogen production, respectively and country specific carbon content factors. Tier 3b and Tier 3c require plant-specific data.

The 2019 Refinement guidance provides estimation methods for CO₂ only.

As for CH₄ and N₂O emissions, steam reforming and gasification produce very minor emissions of CH₄ and N₂O, in addition to CO₂ emissions. The available literature indicates that emissions of CH₄ and N₂O are very low, activity data for the process combustion source are likely to be hard to obtain, and the literature evidence is insufficient to establish an estimation method. Hence, no reporting of CH₄ and N₂O is required per the *2019 Refinement*.¹ For the purposes of interoperability with the UNFCCC ETF Reporting Tool, the *Software* provides an option to estimate and report these emissions through use of a generic worksheet.

<u>GHGs</u>

The Software includes the following GHG for the Hydrogen Production source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
X	Χ	Χ				

IPCC Equations

$\underline{CO_2}$

- ✓ <u>Tier 1</u>: <u>Equations 3.44 (New), 3.45 (New) and 3.46 (New)</u>
- ✓ Tier 2: Equations 3.47 (New) and 3.48 (New)
- ✓ <u>Tier 3</u>: <u>Equations 3.49 (New)</u> and <u>3.50 (New)</u>

<u>CH₄ and N₂O</u>

Given that there are no specific equations in the 2006 IPCC Guidelines for this category, a generic worksheet is thus provided to enable calculation of CH_4 and N_2O emissions from hydrogen production.

- ✓ <u>Tier 1</u>: no IPCC Tier 1 Equation provided in the 2006 IPCC Guidelines
- ✓ <u>Tier 2</u>: IPCC basic equation with user-specific EF
- ✓ <u>Tier 3</u>: no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines

Software Worksheets

The *Software* calculates GHG emissions from Hydrogen Production using 7 worksheets:

- ✓ 1.1.1 Fuel Manager: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b): contains for each subdivision, individual type of process and feedstock, information on the <u>amount of hydrogen produced</u> and feedstock requirement (with carbon content) and amount of CO₂ recovered. The worksheet calculates the associated CO₂ emissions.

¹ See page. 3.35 of Chapter 3 Volume 3 of the 2019 Refinement.

- ✓ CO₂ Emissions from Hydrogen Production (Tier 1c/2c): contains for each subdivision, individual type of process (if known) and type of feedstock information on the <u>amount of feedstock</u> used (with carbon content) and amount of CO₂ recovered. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Hydrogen Production (Tier 3b): contains for each subdivision, individual type of process and feedstock, information on the amount of hydrogen produced and feedstock requirement (with plant-specific carbon content) and amount of CO₂ recovered, and solid C stored. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Hydrogen Production (Tier 3c): contains for each subdivision, individual type of process and type of feedstock information on the <u>amount of feedstock</u> used (with plant-specific carbon content) and amount of CO₂ recovered and solid C stored. The worksheet calculates the associated CO₂ emissions.
- ✓ CH₄ and N₂O Emissions from Hydrogen Production: a generic worksheet that contains for each subdivision and production process information on AD (type and amount) and EF for CH₄ and N₂O. The worksheet calculates the associated CH₄ and N₂O emissions.
- ✓ Capture and storage or other reduction: contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, N₂O and CH₄, not accounted previously in the worksheets for different Tiers.

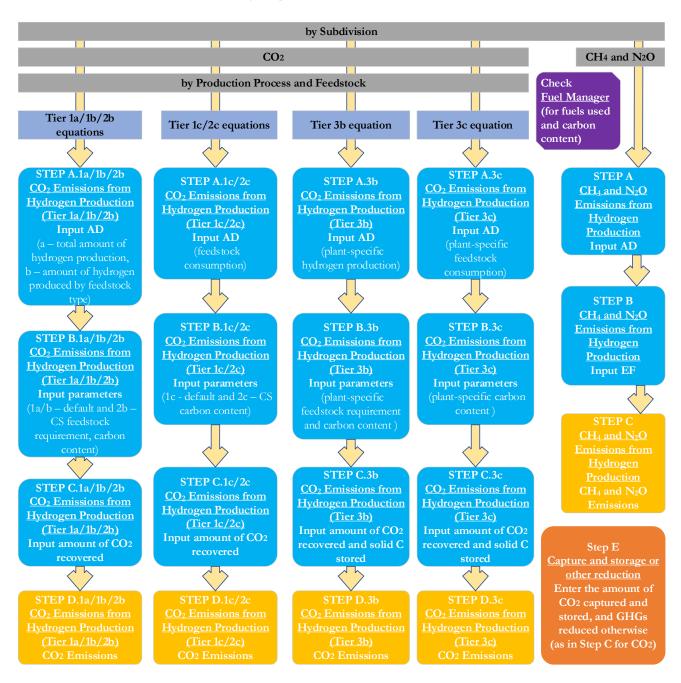
User's work Flowchart

Consistent with the key category analysis and the decision tree in Figure 3.20 of the 2019 Refinement, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of country- or plant-specific¹ EFs.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Hydrogen Production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Hydrogen Production - flowchart



Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or plants).

Then, for each subdivision, if any:

When Tier 1 Equations are applied:

Step A.1a, A.1b and A.1c, in the worksheets CO_2 Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO_2 Emissions from Hydrogen Production (Tier 1c/2c), users collect and input in the *Software* information on the amount of hydrogen produced or the amount of feedstock.

Step B.1a, B.1b and B.1c, in the worksheet CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO₂ Emissions from Hydrogen Production (Tier 1c/2c), users input in the *Software* default feedstock requirement (Tier 1a/1b only) and default carbon content.

Step C.1a, C.1b and C.1c, in the worksheet CO_2 Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO_2 Emissions from Hydrogen Production (Tier 1c/2c), users input in the *Software* information on CO_2 recovered (if no information available it is good practice to assume 0 recovery).

Step D.1a, D.1b and D.1c, in the worksheet CO_2 Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO_2 Emissions from Hydrogen Production (Tier 1c/2c), for each subdivision, CO_2 emissions are calculated in mass units (tonnes and Gg). In addition, total CO_2 emissions are calculated.

When Tier 2 Equations are applied:

Step A.2b and A.2c, in the worksheets CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO₂ Emissions from Hydrogen Production (Tier 1c/2c), users collect and input in the *Software* information on the amount of hydrogen produced or the amount of feedstock.

Step B.2b and B.2c, in the worksheet CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO₂ Emissions from Hydrogen Production (Tier 1c/2c), users input in the *Software* country-specific and process-specific feedstock requirement and country-specific carbon content.

Step C.2b and C.2c, in the worksheet CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO₂ Emissions from Hydrogen Production (Tier 1c/2c), users input in the *Software* information on CO₂ recovered.

Step D.2b and D.2c, in the worksheet CO_2 Emissions from Hydrogen Production (Tier 1a/1b/2b) and/or CO_2 Emissions from Hydrogen Production (Tier 1c/2c), for each subdivision, type of production process and type of feedstock, CO_2 emissions are calculated in mass units (tonnes and Gg). In addition, total CO_2 emissions are calculated.

When the Tier 3 Equation is applied:

Step A.3b and A.3c, in the worksheets CO₂ Emissions from Hydrogen Production (Tier 3b) and CO₂ Emissions from Hydrogen Production (Tier 3), users collect and input in the *Software* plant-specific information on the amount of hydrogen produced or the amount of feedstock consumed.

Step B.3b and B.3c, in the worksheet CO₂ Emissions from Hydrogen Production (Tier 3b) and/or CO₂ Emissions from Hydrogen Production (Tier 3c), users input in the *Software* plant-specific and process-specific feedstock requirement and plant-specific carbon content.

Step C.3b and C.3c, in the worksheet CO₂ Emissions from Hydrogen Production (Tier 3) and/or CO₂ Emissions from Hydrogen Production (Tier 3c), users input in the *Software* information on CO₂ recovered and the amount of solid carbon stored.

Step D.3b and D.3c, in the worksheet CO_2 Emissions from Hydrogen Production (Tier 3b) and/or CO_2 Emissions from Hydrogen Production (Tier 3c), for each subdivision, type of production process and type of feedstock, CO_2 emissions are calculated in mass units (tonnes and Gg). In addition, total CO_2 emissions are calculated.

Then as appropriate:

i) if emissions of CH4 and N2O are estimated

Step A, in the worksheet CH_4 and N_2O Emissions from Hydrogen Production, users collect and input in the *Software* information on AD relevant for CH_4 and N_2O emissions.

Step B, in the worksheet CH_4 and N_2O Emissions from Hydrogen Production, users collect and input in the *Software* information on EFs relevant for CH₄ and N₂O emissions.

Step C, in the worksheet **CH**₄ and **N**₂**O Emissions from Hydrogen Production,** for each subdivision, CH₄ and N₂O emissions are calculated in Gg.

ii) if there is capture <u>additional to</u> that in Step C for CO₂

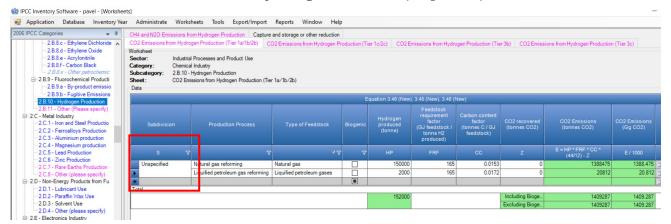
Step E, in the worksheet Capture and storage or other reduction, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates) and reduction of CH_4 and N_2O .

Activity data input

Section 3.11.2.3 in Chapter 3 Volume 3 of the 2019 Refinement contains information on the choice of AD for hydrogen production.

As a **Starting step**, users ensure that the **1.1.1 Fuel Manager** contains all fuels to be reported for hydrogen production (if the Tier 1c, Tier 2.c, or Tier 3 methods are applied); and for each fuel listed in the Fuel Manager, the *calorific value* and the *carbon content* are entered or, for IPCC default fuels, are selected from the drop-down menu.

Second, input of AD for the Hydrogen Production source category requires the user to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |S| [e.g. "country name" or "Unspecified" as selected from the drop-down menu].</u>



Example: single subdivision (unspecified)

Where subnational aggregations are input, provide the univocal name/code into Column |S| for each subdivision.

6 IPCC Categories 🗸 🗸	CH4 and N2O Emissions from	m Hydrogen Production Capture	and storage or other reduction									
	Worksheet Sector: Industrial Category: Chemical Subcategory: 2.8.10 - H	Processes and Product Use	D2 Emissions from Hydrogen P r 1a/1b/2b)	roduction (Ti	er 1c/2c) CO2 E	missions from Hydro	sgen Production (Tie	(3b) CO2 Emiss	iions from Hydrogen Productio	n (Tier 3c)		
2.8.9.b - Production Data -2.8.9.b - Fugitive Emissions Equation 3.45 (New), 3.45 (New) 2.8.10 - Hydrogen Production Equation 3.45 (New), 3.45 (New)												
-2.B.11 - Other (Please specify) -2.C - Metal Industry -2.C.1 - Iron and Steel Productio -2.C.2 - Ferroalloys Production -2.C.3 - Aluminium production	Subdivision						CO2 recovered (tonnes CO2)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
2.C.4 - Magnesium production 2.C.5 - Lead Production 2.C.6 - Zinc Production	s v	V		7					E = HP * FRF * CC * (44/12) - Z			
- 2.C.5 - Zinc Production - 2.C.7 - Rare Earths Production	East Region	Default	Unspecified		1000	175	0.0183	0	11742.5	11.742		
2.C.8 - Other (please specify)	West Region	Natural gas reforming	Natural gas		150000	165	0.0153	0	1388475	1388.47		
2.D - Non-Energy Products from Fu		L quified petroleum gas reforming	Liquified petroleum gases		2000	165	0.0172	0	20812	20.8		
- 2.D.1 - Lubricant Use	*											
- 2.D.2 - Paraffin Wax Use 2.D.3 - Solvent Use	Tetel				153000			Including Bioge	1421029.5	1421.02		

Example: multiple subdivisions

Then,

When Tier 1 and Tier 2 Equations are applied:

Following a Tier1 or Tier 2 approach, the following AD are entered, depending on the method chosen:

- ✓ <u>Tier 1a:</u> requires total national production of hydrogen.
- \checkmark <u>Tier 1b/2b</u>: requires total national production, by type of feedstock.
- \checkmark <u>Tier 1c/2c</u>: requires total national feedstock consumption for hydrogen production, by type of feedstock.

For the Tier 1a, Tier 1b and Tier 2b methods: for each subdivision in Column |S|, data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b), row by row, as follows:

- 1. <u>Column | Production process |</u>: select the type of production process, or, if unknown, select Unspecified (one row for each type of production process). A country-specific production process may also be entered. The Tier 1a method assumes a default production process and that the feedstock type is unspecified.
- 2. <u>Column |Type of feedstock</u>|: if a particular production process is selected, the type of feedstock will appear automatically (depending on the process). The user may overwrite the type of feedstock. If the user applies a Tier 1a method and assumes a default production process, the feedstock type is automatically listed as unspecified.
- 3. <u>Column | Biogenic |</u>: indicate with a check if the process feedstock is of biogenic origin.
- 4. <u>Column |HP|</u>: input the amount of hydrogen produced, in tonnes.

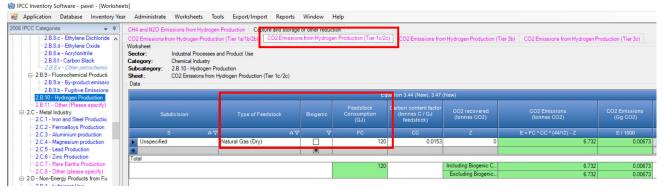
Example: AD input for Tier 1a/1b /2b Hydrogen Production

tegory: C bcategory: 2	hemical li .B.10 - Hy	rocesses and Product Use ndustry rdrogen Production ions from Hydrogen Produ										1	99
				Equ	ation 3.46 (New)), 3.45 (New), 3.4	8 (New)						
Subdivision	,	Production Process	Type of Feedstock	Biogeni c	Hydrogen produced (tonne)	requirement factor (GJ feedstock / tonne H2 prod	Carbon content factor (tonnes C / GJ feedstock)	CO2 recovered (tonnes CO2)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
	۵Ţ	۵V	۵V	V		FRF		z	E = HP * FRF * CC * (44/12) - Z	E / 1000			
		Default	Unspecified		2000	175	0.0183	0	23485	23.485	2		
Unspecified		Materia Continue	Natural gas		1000	165	0.0153	0	9256.5	9.2565	2		2
Unspecified		Natural gas reforming	Ivatural gas					***********************************		******************************		ARTIGATIA	STREET,

For the Tier 1c and Tier 2c methods: for each subdivision in Column |S|, data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 1c/2c), row by row, as follows:

- 1. <u>Column |Type of feedstock|</u>: select the relevant fuel used as feedstock (one row for each feedstock) from the drop-down menu.
- <u>Note that fuels shown in the drop-down menu are those listed in the Fuel Manager.</u>
- 2. <u>Column |Biogenic|</u>: indicate with a check if the process feedstock is of biogenic origin.
- 3. <u>Column |FC|</u>: input the amount of feedstock consumed, in GJ.

Example: AD input for Tier 1c/2c Hydrogen Production (AD – feedstock consumption)



When Tier 3 Equations are applied:

The Tier 3b and Tier 3c methods require the same type of AD as described above on hydrogen production (Tier 3b) or feedstock consumption (Tier 3c), but the AD must be plant-specific. Tier 3b data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 3b), while for Tier 3c data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 3c).

Emission factor input

Section 3.11.2.2 Chapter 3 Volume 3 of the 2019 Refinement contains information on the choice of EFs for Hydrogen Production.

There are two types of EFs: i) feedstock requirement and ii) carbon content of feedstock. Default parameters for Tier 1 and Tier 2 are provided in <u>Table 3.30 (New)</u> Chapter 3 Volume 3 of the *2019 Refinement*.

The Tier 1 assumes default parameters and no capture of CO_2 . For Tier 2, users need to collect country-specific parameters and for Tier 3 – plant-specific feedstock requirement and carbon content by process and feedstock types.

When Tier 1 and Tier 2 Equations are applied:

For the Tier 1a, Tier 1b and Tier 2b methods: for each combination of subdivision/production process/type of feedstock, data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b), row by row, as follows.

- 1. <u>Column |FRF|</u>: input feedstock requirement in GJ per tonne of hydrogen produced.
- 2. <u>Column |CC|</u>: input carbon content of feedstock in tonnes of C per GJ of feedstock.

In Tier 1 and Tier 2 the values below are automatically populated based on the selection made in <u>Column</u> <u>Production Process</u>. The user may overwrite these values. The default values are provided in a drop-down table. See the example below.

Example: Tier 1a/b and Tier 2b parameters for Hydrogen Production (AD – hydrogen production)

IPCC Categories 👻 🕈			Capture and storage	or other reduc	tion									
2.8.8.c - Ethylene Dichloride 2.8.8.d - Ethylene Oxide 2.8.8.e - Acrylonitrile 2.8.8.f - Carbon Black	Worksheet Sector: Industr	rogen Production (Tier 1a/1b/) ial Processes and Product Use		s from Hydroge	en Production (Tier 1c	:/2c) CO2	Emissions	s from Hydrogen Pro	duction (Tier 3b)	O2 Emissions from Hydrogen Production	n (Tier 3c)			
2.8.8.1 - Carbon Black		cal Industry - Hydrogen Production												
2.B.9 - Fluorochemical Producti		missions from Hydrogen Produ	tion (Tier 1a/1b/2b)											
- 2.B.9.a - By-product emissio	Data													
2.B.9.b - Fugitive Emissions														
 2.B.10 - Hydrogen Production 2.B.11 - Other (Please specify) 						-								
2.C - Metal Industry 2.C.1 - Iron and Steel Productio	Subdivision				Hydrogen produced (tonne)	Feedsto requirement (GJ feedst tinne H2 pro	factor ock /	Carbon content factor (tonnes C / GJ feedstock)	O2 recovered tonnes CO2)	CO2 Emissions (tonnes CO2)	CO2 Emission (Gg CO2)			
- 2.C.2 - Ferroalloys Production - 2.C.3 - Aluminium production	S AV		Δ	v v	нр									
- 2.C.4 - Magnesium production		 Default	Unspecified		HP 1000	FRF	175	CC 0.0183	Z 0	E = HP * FRF * CC * (44/12) - Z 11742.5	E / 1000			
- 2.C.5 - Lead Production	East Region		Unspecified Naphtha		2000		1/5		0					
- 2.C.6 - Zinc Production	West Region				150000		170	0.022	0	25813.33333	25.81			
- 2.C.7 - Rare Earths Production - 2.C.8 - Other (please specify)		Natural gas reforming	Natural gas		150000		170			1402500	14			
= 2.D - Non-Energy Products from Fu	Total	Produc on P	ess		Type of Feedstock		Biogenio	GJ feedstock /	quirement factor conne H2 produced)	Carbon content factor (tonnes C / GJ feedstock)				
- 2.D.1 - Lubricant Use	Total	Default		Unspecified					175 (± 30%	0.0183 (0.0148 - 0.0276) 5.83	1440.05			
- 2.D.2 - Paraffin Wax Use		Natural gas reformin		Natural gas					165 (± 10%	0.0153 (0.0148 - 0.0159) 142 2.5	1414.3			
- 2.D.3 - Solvent Use		Liquified petroleum gas refo	rmina	-	roleum gases				165 (± 15%					
2.D.4 - Other (please specify) 2.E - Electronics Industry		Naphtha reforming		Naphtha					165 (± 15%)	0.0200 (0.0189 - 0.0208)				
- 2.E.1 - Integrated Circuit or Sem		Methanol reforming		Methanol					165 (± 20%					
- 2.E.2 - TFT Flat Panel Display		Biosteam reforming, other I	auid	Bioethanol					175 (± 20%	0.0217 (0.0183 - 0.0260)				
- 2.E.3 - Photovoltaics		Coal gasification		Coking Coal					215 (± 20%	0.0258 (0.0238 - 0.0276)				
2.E.4 - Heat Transfer Fluid		Plastic gasification		Other Petrol	eum Products				185 (± 10%)	0.0200 (0.0160 - 0.0240)				
>		Mixed waste gasification (n	on-biomass fraction)	Municipal W	astes (non-biomass	fraction)			275 (± 15%	0.0250 (0.0200 - 0.0330)				
heet notes 🗸 🗸		Wood waste gasification		Wood / Woo	d Waste				260 (± 10%	0.0305 (0.0259 - 0.0360)				
• •		Wood sludge gasification		Wood sludg	8				195 (± 15%					
		Black liquor gasification		C.L.U.L.	s (black liquor)				150 (± 10%		ies Ti			

For the Tier 1c/2c methods: for each combination of subdivision/production process/type of feedstock, data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 1c/2c), row by row, as follows.

1. <u>Column |CC|</u>: input carbon content of feedstock in tonnes of C per GJ of feedstock. This value is automatically populated based on the selection made in <u>Column |Type of Feedstock|</u> (Tier 1c) and may be overwritten by the user (Tier 2c).

When Tier 3 Equations are applied:

For the Tier 3b method: for each combination of subdivision/production process/type of feedstock, data are entered in worksheet CO_2 Emissions from Hydrogen Production (Tier 3b), row by row, as follows.

- 1. <u>Column |FRF|</u>: input plant-specific feedstock requirement in GJ per tonne of hydrogen produced.
- <u>Column |CC|</u>: input carbon content of feedstock in tonnes of C per GJ of feedstock. The value may be selected from the drop-down, or the user may overwrite the value.
 <u>Note that</u> the Tier 3 method requires plant-specific information on carbon content, so if the value available from the Fuel Manager is not specific for this plant, the user must overwrite the value.

For the Tier 3c method: for each combination of subdivision/production process/type of feedstock, data are entered in worksheet CO₂ Emissions from Hydrogen Production (Tier 3c), row by row, as follows.

 <u>Column |CC|</u>: input carbon content of feedstock in tonnes of C per GJ of feedstock. This value is automatically populated based on the selection made in <u>Column |Type of Feedstock|</u>. <u>Note that</u> the Tier 3 method requires plant-specific information on carbon content, so if the value available from the Fuel Manager is not specific for this plant, the user must overwrite the value.

Example: Tier 3c EF parameters for Hydrogen Production

Application Database Inventory Yea	r Administrate Worksheets	s Tools Export/Imp	oort Reports Window	Help									
IPCC Categories 🚽 🤻	CH4 and N2O Emissions from H	vdrogen Production Ca	apture and storage or other red	uction									
2.B.8.c - Ethylene Dichloride	CO2 Emissions from Hydrogen P	Production (Tier 1a/1b/2b)	CO2 Emissions from Hydro	gen Produc	tion (Tier 1c/2c) Cl	02 Emissions from I	Hydrod	en Productio	n (Tier 3b) CO2	Emissions from Hydrogen Productio	n (Tier 3c)		
2.B.8.d - Ethylene Oxide	Worksheet												
2.B.8.e - Acrylonitrile		cesses and Product Use											
2.B.8.f - Carbon Black	Category: Chemical Indu												
- 2.B.8.x - Other petrochemic - 2.B.9 - Eluorochemical Producti		ogen Production											
2.B.9.a - By-product emissio	Data CO2 Emission	s from Hydrogen Productio	n (Tier 3c)										
2.B.9.b - Fugitive Emissions	Data												
- 2.B.10 - Hydrogen Production	Equation 3.49 (New)												
2.B.11 - Other (Please specify)													
2.B.11 - Other (Please specify) - 2.C - Metal Industry					Feedstock	arbon content		recovered	Stored solid	CO2 Emissions	CO2 Emissio		
2.B.11 - Other (Please specify) 2.C - Metal Industry 2.C.1 - Iron and Steel Productio	Subdivision	Production Process	Type of Feedstock	Biogenic	Consumption			recovered nes CO2)	carbon	CO2 Emissions (tonnes CO2)			
2.8.11 - Other (Please specify) 2.C - Metal Industry 2.C.1 - Iron and Steel Productio 2.C.2 - Ferroalloys Production	Subdivision	Production Process	Type of Feedstock	Biogenic		factor							
2.B.11 - Other (Please specify) -2.C - Metal Industry -2.C.1 - Iron and Steel Productio -2.C.2 - Ferroalloys Production -2.C.3 - Aluminium production	Subdivision	Production Process	Type of Feedstock	Biogenic	Consumption	factor tonnes C / GJ			carbon	(tonnes CO2)	CO2 Emissio (Gg CO2)		
2.B.11 - Other (Please specify) 2.C - Metal Industry - 2.C.1 - Iron and Steel Production - 2.C.2 - Ferroalloys Production - 2.C.3 - Aluminium production - 2.C.4 - Magnesium production	Subdivision S 47				Consumption	factor tonnes C / GJ			carbon	(tonnes CO2) E = (FC * CC * (44/12)) - (Z + Sc			
2.B.11 - Other (Please specify) -2.C - Metal Industry -2.C.1 - Iron and Steel Productio -2.C.2 - Ferroalloys Production -2.C.3 - Aluminium production	s Av	7 Δ7	- Δ _V		Consumption (GJ) FC	factor tonnes C / GJ feedstock)			carbon (tonnes)	(tonnes CO2) E = (FC * CC * (44/12)) - (Z + Sc * (44/12))	(Gg CO2) E / 1000		
2.2.11 - Other (Please specify) 2.2. Netal Industry 2.2.1 - Iron and Steel Productio 2.2.2.4 Auminium production 2.2.3.4 Auminium production 2.2.3.4 Auminium production 2.2.5.1 ead Production 2.2.6.7 Ead Production 2.2.6.7 Eads Production 2.2.7.7 Rars Earths Production				▼	Consumption (GJ)	factor tonnes C / GJ feedstock) CC		nes CO2) Z	carbon (tonnes) Sc	(tonnes CO2) E = (FC * CC * (44/12)) - (Z + Sc * (44/12))	(Gg CO2)		
-2.B.11-Other (Please specify) -2.C - Metal Industry -2.C.1- Iron and Steel Productio -2.C.2 - Ferroalloys Production -2.C.3 - Auminium production -2.C.4 - Magnesium production -2.C.6 - Lasd Production -2.C.6 - Zinc Production -2.C.7 - Rare Earths Production -2.C.7 - Rare Earths Production -2.C.8 - Direr (please specify)	S ∆⊽ ▶ Unspecified ★	7 Δ7	- Δ _V		Consumption (GJ) FC	factor tonnes C / GJ feedstock) CC		nes CO2) Z	carbon (tonnes) Sc	(tonnes CO2) E = (FC * CC * (44/12)) - (Z + Sc * (44/12))	(Gg CO2) E / 1000		
-2.B.11-Other (Please specify) -2.C. Meal Industry -2.C.1 - Iron and Steel Production -2.C.2 - Ferroalloys Production -2.C.3 - Aluminism production -2.C.4 - Magnesium production -2.C.5 - Lace Production -2.C.7 - Rare Earths Production	s Av	7 Δ7	- Δ _V	▼	Consumption (GJ) FC	factor tonnes C / GJ feedstock) CC		nes CO2) Z	carbon (tonnes) Sc	(tonnes CO2) E = (FC * CC * (44/12)) - (Z + Sc * (44/12))	(Gg CO2) E / 1000 0.50		

CH4 and N2O Emissions from Hydrogen Production

A generic worksheet contains for each subdivision and production process information on AD (type and amount) and EF for CH_4 and N_2O . The worksheet calculates the associated CH_4 and N_2O emissions.

Activity data input

Input of AD for CH_4 and N_2O Emissions from Hydrogen Production requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |S|</u> [e.g. "*country name*" or "*unspecified*" as selected from the drop-down menu], or with subnational aggregations, and for each of those the univocal name/code entered in <u>Column |S|</u>.

For each subdivision in <u>Column |S|</u>, data are entered in worksheet CH₄ and N₂O Emissions from Hydrogen Production, row by row, as follows:

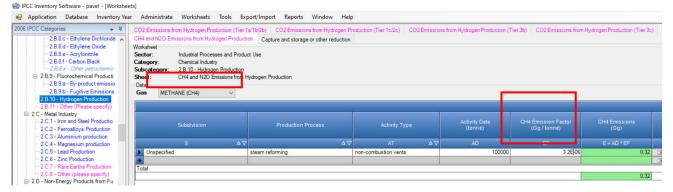
- 1. <u>Column |Production Process |</u>: describe the type of production process emitting GHG emissions from this category (e.g. consider those identified for estimating CO₂ emissions).
- 2. <u>Column |AT|:</u> enter the activity type corresponding to the production process identified.
- 3. <u>Column | AD |</u>: enter AD (quantity), in tonnes.

Emission factor input

For each row of data entered in worksheet CH_4 and N_2O Emissions from Hydrogen Production, data are entered as follows:

 <u>Column | EF |</u>: enter CH₄ or N₂O EF; <u>Note that</u> user shall select "Methane (CH₄)" or "Nitrous Oxide (N₂O)" in the "Gas" bar at the top, to enter data for each GHG one by one.

Example: CH₄ emissions from Hydrogen Production



Results

The Tier 1/2 and Tier 3 worksheets all include the possibility to account for CO_2 recovered, and for the Tier 3 methods only, stored solid carbon (i.e. solid carbon or coke formed unintentionally during the production process and disposed of as waste (i.e., not combusted at the production facility)).

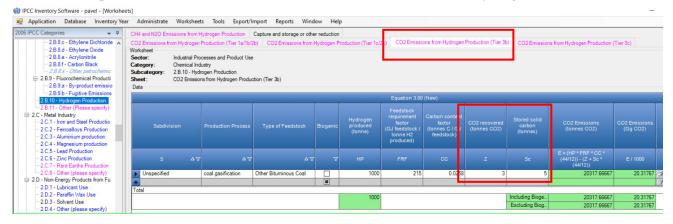
To estimate the total CO₂ emitted into the atmosphere, the amount of CO₂ released from that subdivision that has been instead recovered is to be entered in Gg CO₂ in <u>Column |Z|</u> of the following worksheets:

- ✓ CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b)
- ✓ CO₂ Emissions from Hydrogen Production (Tier 1c/2c)
- ✓ CO₂ Emissions from Hydrogen Production (Tier 3b)
- ✓ CO₂ Emissions from Hydrogen Production (Tier 3c)

In addition, the amount of solid carbon or coke formed unintentionally during the production process and disposed of as waste is to be entered in tonnes in <u>Column |Sc|</u> of the following worksheets:

- ✓ CO₂ Emissions from Hydrogen Production (Tier 3b)
- ✓ CO₂ Emissions from Hydrogen Production (Tier 3c)

Example: Carbon recovered and solid carbon stored for Tier 3 for Hydrogen Production



<u>Then,</u> CO₂ emissions from Hydrogen Production are estimated in mass units (tonnes and Gg) by the *Software* for each row, and the total for all rows, in the following worksheets:

- ✓ For Tier 1: CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b) and CO₂ Emissions from Hydrogen Production (Tier 1c/2c)
- ✓ For Tier 2: CO₂ Emissions from Hydrogen Production (Tier 1a/1b/2b) and CO₂ Emissions from Hydrogen Production (Tier 1c/2c)
- ✓ For Tier 3: CO₂ Emissions from Hydrogen Production (Tier 3b) and CO₂ Emissions from Hydrogen Production (Tier 3c).

CH₄ and N₂O Emissions from Hydrogen Production are estimated in Gg by the *Software* in the following worksheet CH₄ and N₂O Emissions from Hydrogen Production.

Total emissions from hydrogen production is the sum of all emissions in the above worksheets, taking into account any CO₂ capture with subsequent storage and any other reduction of CO₂, CH₄ and N₂O.

Please note that CO_2 recovery and the amount of Carbon stored may be already accounted in the worksheets for different Tiers, so only the additional amount of captured or reduced CO_2 shall be entered into the worksheet **Capture and storage or other reduction**.

In the worksheet **Capture and storage or other reduction** for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u> users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on other long-term reduction of CO_2 (e.g., re-conversion to carbonates), in tonnes. <u>Column |B|</u> may include short-term CO_2 capture only in cases where the subsequent CO_2 emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column |Biogenic</u>|: indicate with a check if the reductant is of biogenic origin. Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.

CO2 Emis	ssions from Hydrogen F	roduction (Tier 1c/2	2c) CO2 Emissions from Hydro	gen Production (Tier	r 3b)				
CO2 Emis	ssions from Hydrogen F	roduction (Tier 3c)	CH4 and N2O Emissions from	Hydrogen Productio	Capture and storage or	other reduction	CO2 Emissio	ns from Hydrogen Production (Fier 1a/1b/2b)
Vorkshee	t								
Sector:	Industrial Proc	esses and Product	Use						
ategon	: Chemical Indu	stry							
Subcate	gory: 2.B.10 - Hydro	gen Production							
heet:	Capture and s	orage or other redu	iction						
Data									
Gas	METHANE (CH4)		~						
	CARBON DIOXIDE (C	22)							
	METHANE (CH4)								
	NITROUS OXIDE (N2			Am	ount CO2 captured and	Other redu	intion	Total reduction	Total reduction
	Subdivision				stored (tonne)	(tonne		(tonne)	(Gg)
		۵ 🏹	SRC	ΔV					C / 1000
Uns	pecified		Unspecified				1	1	0.0
*									
Total			1						
									0.00

Example: Capture and storage or other reduction

2.B.11 Other

Information

This section describes calculation of other sources of emissions in the chemical industry not included in source categories 2.B.1-2.B.10.

This category also allows for estimating of GHG emissions from categories for which specific methods are not provided in the 2006 IPCC Guidelines or the 2019 Refinement, but for which information is contained in the common reporting tables of the MPGs, specifically:

- ✓ CH_4 and N_2O emissions from Ammonia Production
- ✓ CO₂ emissions from Adipic Acid, Caprolactam, Glyoxal and Glyoxylic Acid Production

<u>GHGs</u>

Other emissions from the chemical industry include the following GHGs:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
Χ	Χ	Χ	X	X	X	X

IPCC Equations

Given that there are no specific equations in the 2006 IPCC Guidelines or the 2019 Refinement for this category, a generic worksheet is thus provided to enable calculation of other sources of emissions from the chemical industry.

- ✓ Tier 1: no IPCC Tier 1 Equation provided in the 2006 IPCC Guidelines or the 2019 Refinement
- ✓ Tier 2: IPCC basic equation with user-specific EF
- ✓ Tier 3: no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines or the 2019 Refinement

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement IPCC Tier 2 basic equation.

Software Worksheets

The Software calculates emissions from Other (Chemical industry) using worksheets:

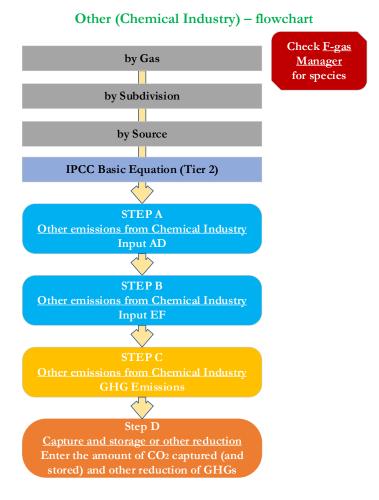
- ✓ Other: contains source, AD (type, amount and unit), and EF for each GHG, and calculates associated emissions.
- ✓ **Capture and storage or other reduction**: Capture and storage or other reduction: contains information on CO₂ capture (with subsequent storage) and other reduction of GHGs, not accounted previously.

User's work Flowchart

GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Other (Chemical industry).

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.



Thus, for the source-category:

If applicable, users ensure that all F-gases emitted for this source category have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step A, in Other worksheet, users collect and enter data on the source of emissions and activity data.

Step B, in Other worksheet, users collect and enter in each row the associated EF.

Step C, in Other worksheet, for each row of data, the *Software* calculates the emissions in mass units (Gg). In addition, total emissions are calculated.

Step D, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input information on the amount of CO₂ captured (with subsequent storage) and/or other reduction of GHG.

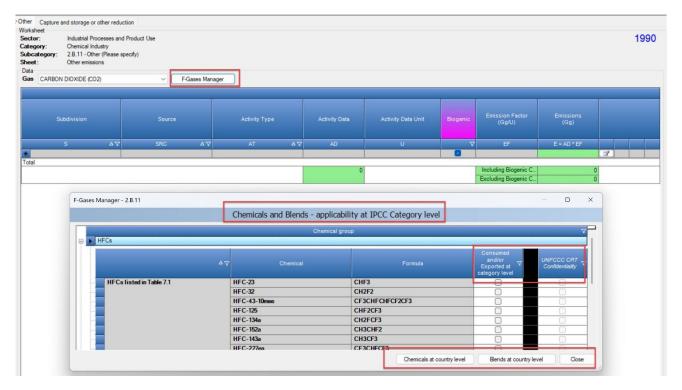
Activity data input

As a **Starting step**, if the source to be entered results in emission of F-gases, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases (or, if applicable, blends) to be reported.

<u>Note that</u> if no F-gases are checked in the F-gases Manager, it will not be possible to select an F-gas from the **Gas** drop-down menu. If F-gas selection is not possible, select the **F-Gases Manager** from any tab. This will open the F-gases Manager – applicability at IPCC Category Level. Navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level-F-gases Manager to check all F-gases consumed (including imported) and produced and exported. Save and close the dialogue box for the country level F-gases Manager and the user returns to the IPCC Category level F-gases Manager. In the IPCC Category level F-gases Manager, the user selects which of the relevant F-gases are applicable for this category.

For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool: If AD and/or emissions for a particular F-gas in this category is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. If checked, "C" will be reported for AD and "IE" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate.

Example: Populating the F-gases manager and designating confidentiality for category: Other (Chemical Industry)



Second, input of AD for the Other source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |S| [e.g. "country name</u>" or "unspecified" as selected from the drop-down menu], or with subnational aggregations, and for each of those the univocal name/code entered in <u>Column |S|</u>.

For each subdivision in <u>Column |S|</u>, data are entered in worksheet **Other**, row by row, as follows:

- 4. <u>Column |SRC|</u>: describe the type of activity emitting GHG emissions from this category. The user may select from the drop-down (which includes pre-defined categories that are included in the UNFCCC ETF Reporting Tool (see Annex I), or enter user-specific categories. <u>Note that</u> once a category and amount of AD are entered for a particular gas, the category name automatically appears for each gas. If the category is not relevant for another gas, the user should leave the EF column blank. Do not change the AD again, as this will result in the updating of AD for all worksheets in this tab.
- 5. <u>Column |AT|</u>: enter the activity type corresponding to the source selected.
- 6. <u>Column | AD |</u>: enter AD (quantity).
- 7. <u>Column |U|</u>: enter Unit of the AD.

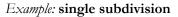
8. <u>Column | Biogenic |</u> (CO₂ only): indicate with a check, and if applicable, if the process feedstock is of biogenic origin.

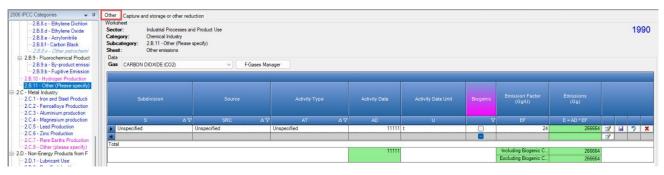
Emission factor input

For each row of data entered in worksheet **Other**, data are entered as follows:

1. <u>Column |EF|</u>: enter EF for each GHG;

Note that user shall select the relevant gas in the "Gas" bar at the top, to enter data for each GHG one by one. As noted above, if the category is not relevant for a particular gas, the user should leave the EF column blank.





Results

Total GHG emissions from Other is the sum of all subdivisions in the above worksheet, taking into account any CO_2 capture with subsequent storage or other GHG reduction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate CO_2 capture and storage and other GHG reduction.

In the worksheet **Capture and storage or other reduction** for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on any other reduction of GHGs, in tonnes. <u>Column |B|</u> may include short-term CO₂ capture or reduction of other GHGs only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column | Biogenic</u> |: indicate with a check if the reductant is of biogenic origin. Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.

Example:	Capture and	storage or	other reduction
----------	-------------	------------	-----------------

Other Works Sector Catego Subc	heet or: gory: ategory:	Industrial Processes Chemical Industry 2.B.11 - Other (Pleas Capture and storage	and Produ se specify)								
Data Gas	-	DIOXIDE (CO2)			F-Gases Manager						
	CARBON METHAN	DIOXIDE (CO2)									
	NITROUS	Subdivision					Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	Biogenic
			AV		SRC	ΔV	A		C = A + B	C / 1000	7
	Inspecified			Unspecified			1		1	0.001	
*											8
Total											
								Total:	1	0.001	
								Total Biogenic CO2:	1	0.001	

2.C Metal Industry

2.C.1 Iron and Steel Production

Information

The 2006 IPCC Guidelines provide guidance for estimation of CO_2 and CH_4 emissions from Iron and Steel Production and from Coke Production (emissions from Coke Production should be reported in the Energy sector). Estimation methodologies from the 2019 Refinement have also been incorporated in the Software to estimate CO_2 emissions for Coke production.

There are three Tiers for both Iron and Steel Production and for Coke Production: Tier 1 - EF method, Tier 2 - mass-balance method based on national / country-specific data and Tier 3 - mass-balance method based on plant-specific data (if plant-specific CO₂ emissions data are not available, CO₂ emissions can be calculated from plant-specific AD applying the Tier 2 method). The Tier 2/3 (mass-balance) method is used only for estimation of CO₂ emissions. In addition, a simplified carbon balance method (Tier 1b) from the 2019 Refinement is available for Coke Production.

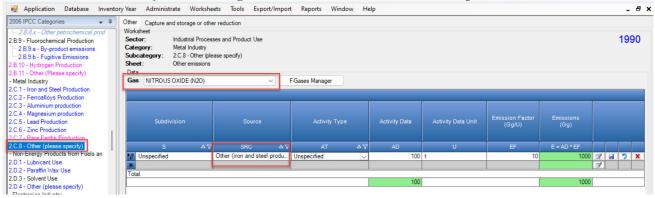
<u>GHGs</u>

The Software includes the following GHGs for the Iron and Steel Production source category:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
X	Χ					

According to the 2006 *IPCC Guidelines*, N_2O may be emitted from iron and steel production. However, these emissions are likely to be small and no methodologies are provided for N_2O emissions. Users can calculate estimates of N_2O for this category, provided they develop country-specific methods based on researched data. These emissions can be reported in the IPCC inventory worksheet for category **2.C.8 Other**.

Example: Estimating N₂O emissions from iron and steel production



IPCC Equations

<u>Coke Production</u> Emissions estimated here and reported in the Energy sector. References are from the 2006 IPCC *Guidelines* and the 2019 Refinement:

- ✓ Tier 1 (CO₂, CH₄): Equation 4.1 or, for CO₂ only, 4.1B (New)
- ✓ Tier 2 (CO₂): Equation 4.2 (Updated)
- ✓ Tier 3 (CO₂, CH₄): Either measure emissions or, for CO₂ only, apply the Tier 2 equations, using plantspecific carbon contents of all materials used and produced

Iron and Steel Production (2006 IPCC Guidelines):

- ✓ <u>Tier 1 (CO₂): Equations 4.4, 4.5, 4.6, 4.7 and 4.8</u>
- ✓ <u>Tier 1 (CH₄)</u>: <u>Equations 4.12, 4.13 and 4.14</u>

- \checkmark Tier 2 (CO₂): Equations 4.9, 4.10 and 4.11
- \checkmark <u>Tier 3 (CO₂)</u>: Either measure emissions or apply the Tier 2 equations, using plant-specific AD

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The *Software* calculates emissions of CO₂ and CH₄ from Coke Production (to be reported in Energy Sector) using the following worksheets:

- ✓ 1.1.1 Fuel Manager: contains data on carbon content and calorific value of each fuel used in the NGHGI.
- ✓ CO₂ and CH₄ emissions from Coke Production: contains for each subdivision information on the coke production process, the amount of coke produced and CO₂ and CH₄ EFs. The worksheet calculates the associated CO₂ and CH₄ emissions for Tier 1.
- ✓ CO₂ Emissions from metallurgical coke production (mass balance): contains for each subdivision the mass balance of the carbon in the input and output materials (amount of the materials and their carbon content). The worksheet calculates the associated CO₂ emissions.

The Software calculates emissions of CO2 and CH4 from Iron and Steel Production using the following worksheets:

- ✓ 1.1.1 Fuel Manager: contains data on carbon content and calorific value of each fuel used in the NGHGI.
- ✓ CO₂ and CH₄ emissions from Iron and Steel Production: contains for each subdivision information on the amount of iron, steel, pellet, sinter, and/or direct reduced iron (DRI) produced and CO₂ and CH₄ EFs. The worksheet calculates the associated CO₂ and CH₄ emissions for Tier 1.
- ✓ CO₂ emissions from Iron and Steel Production Tier 2/3: contains for each subdivision the mass balance of the carbon in the input and output materials (amount of the materials and their carbon content). The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ emissions from Sinter Production Tier 2/3: contains for each subdivision the mass balance of the carbon in the input and output materials (amount of the materials and their carbon content). The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ emissions from Pellet Production Tier 2/3: contains for each subdivision information on fuel consumption and fuel carbon content. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ emissions from Direct Reduced Iron Production Tier 2/3: contains for each subdivision information on fuel consumption and fuel carbon content. The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂ and CH₄, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

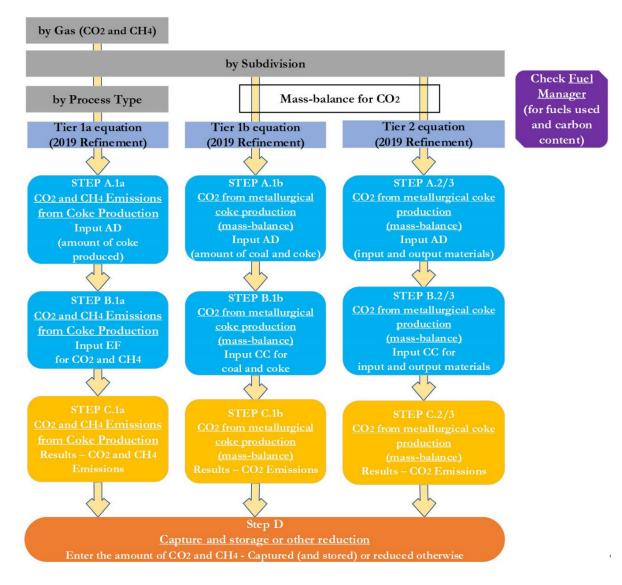
Consistent with the key category analysis and the decision tree in Figure 4.6 of the 2006 IPCC Guidelines or Figure 4.6 (Updated) of the 2019 Refinement, GHG estimates are calculated for Coke Production using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

Similarly, consistent with the key category analysis and the decision trees in <u>Figure 4.7</u> for CO_2 and <u>Figure 4.8</u> for CH_4 of the 2006 IPCC Guidelines, GHG estimates are calculated for Iron and Steel Production.

To ease the use of the *Software* as well as to avoid its misuse, users follow the following two flowcharts to estimate GHG emissions for Coke Production and Iron and Steel Production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Coke Production



Coke Production - flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step A.1a, in the worksheet CO_2 and CH_4 emissions from Coke Production, users collect and input in the *Software* information on the amount coke produced.

Step B.1a, in the worksheet CO₂ and CH₄ emissions from Coke Production users input CO₂ and CH₄ EFs.

Step C.1a in the worksheet CO_2 and CH_4 emissions from Coke Production, the *Software* calculates the associated emissions for each subdivision in mass units (tonne for CO_2 and kg for CH_4 , and Gg). In addition, the total emissions of all subdivisions are shown.

When the Tier 1b Equation is applied:

Step A.1b, in the worksheet CO₂ Emissions from metallurgical coke production (mass balance), users collect and input in the *Software* information on the quantity of coking coal consumed and coke produced.

Step B.1b in the worksheet CO₂ Emissions from metallurgical coke production (mass balance), users collect and input in the *Software* information on the carbon content of coking coal consumed and coke produced.

Step C.1b in the worksheet CO_2 Emissions from metallurgical coke production (mass balance), the *Software* calculates the associated emissions for each subdivision in mass units (tonne for CO_2 and Gg). In addition, the total emissions of all subdivisions are shown.

When the Tier 2 Equation is applied:

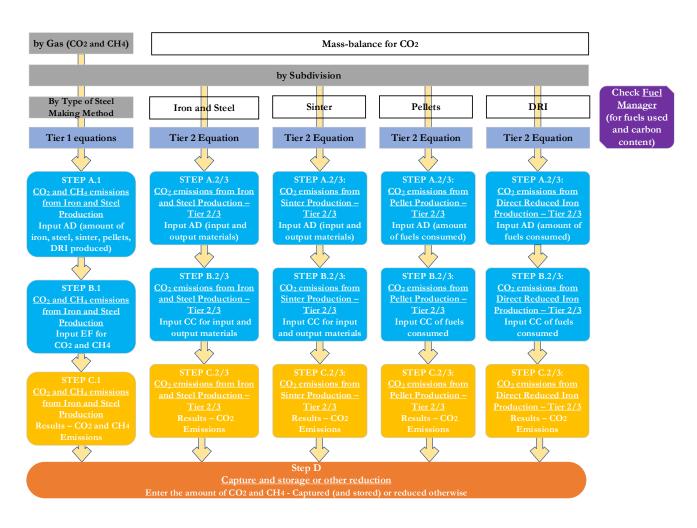
Step A.2/3, in the worksheet **CO₂ Emissions from metallurgical coke production (mass balance)**, users collect and input in the *Software* information on the amount of each input and output. National statistics are appropriate for the Tier 2 method; for Tier 3 plant-level data are required.

Step B.2/3, in the worksheet CO₂ Emissions from metallurgical coke production (mass balance), users input carbon content of each input and output material. National statistics are appropriate for the Tier 2 method; for Tier 3 plant-level carbon content information is required.

Step C.2/3, in the worksheet CO_2 Emissions from metallurgical coke production (mass balance), the *Software* calculates the associated emissions for each subdivision in mass units (tonne for CO_2 and Gg). In addition, the total emissions of all subdivisions are shown.

Then, for each tier, as appropriate:

Step D, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of GHG, not otherwise captured in the worksheets above.



Iron and Steel Production -flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When Tier 1 Equations are applied

Step A.1, in the worksheet CO_2 and CH_4 emissions from Iron and Steel Production, users collect and input in the *Software* information on the amount of iron, sinter, pellet and DRI produced and for each steel making method – the amount of steel produced.

Step B.1, in the worksheet CO_2 and CH_4 emissions from Iron and Steel Production, for each subdivision and steel making method/product users input respective CO_2 and CH_4 EFs.

Step C.1, in the worksheet **CO**₂ and **CH**₄ emissions from Iron and Steel Production, the *Software* calculates the associated emissions for each subdivision in mass units (tonne for CO_2 and kg for CH_4 , and Gg). In addition, the total emissions of all subdivisions are shown.

When Tier 2 Equations are applied

Step A.2/3, in the worksheets CO_2 emissions from Iron and Steel Production – Tier 2/3 and CO_2 emissions from Sinter Production – Tier 2/3, users collect and input in the *Software* information on the amount of each

input and output material used and in the worksheets CO_2 emissions from Pellet Production – Tier 2/3 and CO_2 emissions from Direct Reduced Iron Production – Tier 2/3, users collect and input in the *Software* information on the amount of fuel consumption. National statistics are appropriate for the Tier 2 method; for Tier 3 plant-level data are required.

Step B.2/3, in the worksheets CO_2 emissions from Iron and Steel Production – Tier 2/3 and CO_2 emissions from Sinter Production – Tier 2/3, users input carbon content of each input and output material and in the worksheets CO_2 emissions from Pellet Production – Tier 2/3 and CO_2 emissions from Direct Reduced Iron Production – Tier 2/3, users input fuel carbon content. National statistics are appropriate for the Tier 2 method; for Tier 3 plant-level carbon content information is required.

Step C.2/3, in the worksheets CO_2 emissions from Iron and Steel Production – Tier 2/3, CO_2 emissions from Sinter Production – Tier 2/3, CO_2 emissions from Pellet Production – Tier 2/3, and CO_2 emissions from Direct Reduced Iron Production – Tier 2/3, the *Software* calculates the associated emissions for each subdivision in mass units (tonne for CO_2 and Gg). In addition, the total emissions of all subdivisions are shown in each worksheet.

Then, for each tier, as appropriate:

Step D, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) or other reduction of CO_2 and reduction of CH_4 , not otherwise captured in the worksheets above.

Activity data input

Section 4.2.2.4 in Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Coke Production and Iron and Steel Production. The collection of the AD for this source category is challenging, particularly the overlap between emissions to be reported in the Energy Sector and the IPPU sector. As such, the user may also wish to consult the introduction to section 4.2, Volume 3 of the 2006 IPCC Guidelines, as well as Box 1.1 in Chapter 1, Volume 3.

As a **Starting step**, users ensure that the **1.1.1 Fuel Manager** contains all fuels to be reported for coke production and iron and steel production (Tier 1b (coke production only), Tier 2 and Tier 3); and for each fuel listed in the Fuel Manager, the *calorific value* and the *carbon content* are entered or, for IPCC default fuels, are selected from the dropdown menu.

Second, input of AD for the Iron and Steel Production source category requires the user first to enter information on the subdivisions in the country for both Coke Production and Iron and Steel Production. Users compile the calculation worksheets either with a single row of data for the entire category (in the case of Iron and Steel Production, for each steelmaking method), with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the dropdown menu].

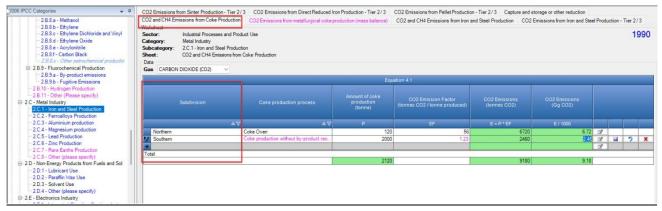
When identifying subdivisions for worksheet CO_2 Emissions from metallurgical coke production (mass balance), the user must ensure consistency between the naming of subdivisions in this worksheet, and worksheet Emissions from Coke Oven Gas flaring in category 1.B.1.c.ii Coke Production. This is because an automatic subtraction takes place for CO_2 emissions from coke oven gas flaring, in cases where a Tier 2/3 method is applied. For this subtraction to take place, the subdivision names must be the same.

Example: single subdivision (unspecified) -iron and steel production

PCC Categories		- Tier 2/3 CO2 Emissions from Direct Reduced		CO2 Emissions from Pellet Production CO2 and CH4 Emissions from Iron a	Construction of the second sec				
2.8.8.9 - Ethylene Dichloride and Vinyl 2.8.8.0 - Ethylene Dichloride and Vinyl 2.8.8.0 - Ethylene Dixide 2.8.8.0 - Acrylonitrile 2.8.8.0 - Acrylonitrile 2.8.8.0 - Acrylonitrile 2.8.8.2.0 - Cerbon Black 2.8.8.2.0 - Cerbon Black 2.8.8.2.0 - Cerbon Black	Worksheet Sector: Industrial Processes Category: Metal Industry Subcategory: 2.C.1 - Iron and Stee Sheet: CO2 and CH4 Emiss Data		roduction (mass balance)	CO2 and CH4 Emissions nonmon a		:02 Emissions from Iron and Ste	el Produ	ction -	199
2.B.9.a - By-product emissions	Gas CARBON DIOXIDE (CO2)	•	Emul	ion 4.4 - 4.8					_
-2.B.9.b - Fugitive Emissions	-		Equan	1011 4.4 - 4.8		-			
- 2.B.10 - Hydrogen Production 2.B.11 - Other (Please specify)				CO2 Emission Factor	CO2 Emissions	CO2 Emissions			
2.C - Metal Industry 2.C.1 - Iron and Steel Production 2.C.2 - Ferroalloys Production	Subdivision		Production (tonne)	(tonnes CO2 / tonne produced)	(tonnes CO2)	(Gg CO2)			
2.C.2 - Ferroalloys Production 2.C.3 - Aluminium production		47	p	er er	E=P*EF	E / 1000			
2.C.4 - Magnesium production	Unspecified	Basic Oxygen Furnace (BOF)	2000	1.35	27	2.7	2		
- 2.C.5 - Lead Production		Direct Reduced Iron production	4563		319			-	
- 2.C.6 - Zinc Production		Electric Arc Furnace (EAF)	1000	0.08		80 0.08	1	-	
- 2.C.7 - Rare Earths Production		Global Average Factor (65% BOF, 30%	1000	1.06	10	1.06	2		
2.C.8 - Other (please specify)		Iron Production	2050	1.35	276	7.5 2.7675	1		
2.D - Non-Energy Products from Fuels and Sol 2.D.1 - Lubricant Use		Sinter Production	7855	0.2	15	571 1.571	3		2 1
2.D.1 - Lubricant Use	1						2		
2.D.2 - Paranti Wax Ose 2.D.3 - Solvent Use	Total			l'and the second se			and the second second		
- 2.D.4 - Other (please specify)			18468		1137.	2.6 11.3726			
2.E - Electronics Industry				die State State					
2.E.1 - Integrated Circuit or Semiconductor									

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions – coke production



Then, for Coke Production

When Tier 1 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 and CH_4 emissions from Coke Production and/or CO_2 Emissions from metallurgical coke production (mass balance), row by row, as follows (to be reported in the Energy Sector):

In worksheet CO2 and CH4 emissions from Coke Production

- 1. <u>Column | Coke production process |</u>: input from the drop-down menu the default process <Coke oven>, select additional processes included in the *2019 Refinement*, or input manually country-specific process.
- 2. <u>Column | P |</u>: input the amount/mass of coke produced, in tonnes.

Example: coke production- Tier 1: AD input for CO_2 - multiple subdivision

2.B.8.e - Acrylonitrile	CO2 and CH4 Emissions from Coke Production	CO2 Emissions from metallurgical coker	production (mass balance)	CO2 and CH4 Emissions from Iron a	nd Steel Production CO2 E	Emissions from Iron and Ste	el Produc	ion - Tier	2/3
28.81 - Carbon Black 28.84 - Char perdochemical productio 28.95 - Fluorechemical Production 28.95 a - Spurroduct emissions 28.95 - Fugitive Emissions 28.95 - Fugitive Emissions 28.10 - Hydrogen Production -28.11 - Other (Please specify)	Viorkenneet Sector: Industrial Processes and Pro Category: Metal Industry Subcategory: 2.C.1 - Iron and Steel Produc Sheet: CO2 and CH4 Emissions from Data Gas CARBON DIOXIDE (CO2)	tion						:	2022
2.C - Metal Industry 2.C.1 - Iron and Steel Production			Equ	ation 4.1					
2.C.2 - Ferroalloys Production 2.C.3 - Aluminium production 2.C.4 - Magnesium production 2.C.5 - Lead Production 2.C.6 - Zine Production	Subdivision		Amount of coke production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
- 2.C.7 - Rare Earths Production	ΔV		P	EF	E = P * EF	E / 1000			
2.C.8 - Other (please specify)	Kanagawa prefecture	Coke production using by-product reco.	15000	0.51	7650	7.65	2		
2.D - Non-Energy Products from Fuels and Sol	National (all the rest)	Coke Oven	100000	0.56	56000	56	3	G 7	
- 2.D.1 - Lubricant Use - 2.D.2 - Paraffin Wax Use	M						3		
2.D.3 - Solvent Use 2.D.4 - Other (please specify)	Total		115000		63650	63.65			
20 - Our clease specify 22 - Electronic Industry 22.1 - Integrated Circuit or Semiconductor 22.2 - TFT Flat Panel Display 22.3 - Photovoltaics 22.4 - Heat Transfer Fluid									

In worksheet CO₂ Emissions from metallurgical coke production (mass balance)

- 1. <u>Column |CC|</u>: input the amount/mass of coking coal consumed for coke production, in tonnes.
- 2. <u>Column |CO|</u>: input the amount/mass of coke produced, in tonnes.

Note that the Tier 1b method requires information only on the quantity of coking coal consumed and coke produced. There is an opportunity for users to include information on additional inputs and outputs in this worksheet; the additional inputs are required under a Tier 2 method.

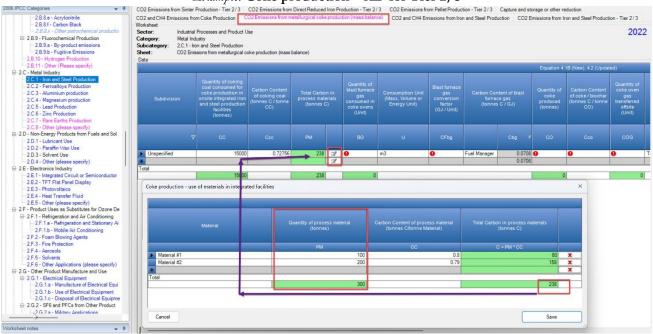
When the Tier 2 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **CO₂ Emissions from metallurgical** coke production (mass balance), row by row, as follows, recalling that national statistics are appropriate for a Tier 2 method, while plant-specific data are required for Tier 3.

The mass balance method requires information on input and output materials

Input materials

- 1. <u>Column |CC|</u>: input the amount/mass of coking coal consumed for coke production, in tonnes.
- 2. <u>Column |PM|</u>: input the amount of process materials used for coke production, in tonnes. This information is entered in the sub-table associated with <u>Column |PM|</u>.
- 3. <u>Column |Bg|</u>: input the amount/mass blast furnace gas consumed in coke ovens
- 4. <u>Column |U|</u>: enter the unit of the blast furnace gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 5. <u>Column |CFbg|</u>: enter the conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ, TJ or tonnes of fuel are selected in <u>Column |U|</u>, CFbg is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³ or a user defined unit) the user shall enter the relevant conversion unit here.



Example: Coke production – AD for Tier 2/3

Output materials

- 6. <u>Column |CO|</u>: input the amount/mass of coke produced, in tonnes.
- 7. <u>Column |COG|</u>: input the amount/mass of coke oven gas transferred offsite.
- 8. <u>Column |U|</u>: enter the unit of the coke oven gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 9. <u>Column |CFcog|</u>: enter conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ, TJ or tonnes of fuel are selected in <u>Column |U|</u>, CFcog is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³ or a user defined unit) the user shall enter the relevant conversion unit here.
- 10. <u>Column |BPC|</u>: input the amount of coke oven by-product transferred offsite, in tonnes. This information is entered in <u>Column |COB|</u> of the sub-table associated with <u>Column |BPC|</u>, in the same manner as is shown for <u>Column |PM|</u> above.

Then, for Iron and Steel Production

When Tier 1 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 and CH_4 emissions from Iron and Steel Production, row by row:

- 1. <u>Column | Type of Steel Making Method, etc/</u>]: input from the drop-down menu the type of steelmaking method, if known (e.g. basic oxygen furnace (BOF), pellet, sinter, iron and DRI Production. If unknown, select the Global Average Factor or input manually country-specific method.
- 2. <u>Column |P|</u>: input the amount/mass of individual type of product produced (steel BOF, electric arc furnace (EAF), open hearth furnace (OHF) or total production, as well as iron, pellet, sinter and DRI) in tonnes.

When Tier 2 Equations are applied:

AD required to implement the Tier 2/Tier 3 methods differ for the different processes. For each process, and for each subdivision in <u>Column |Subdivision|</u>, data are entered row by row, recalling that national statistics are appropriate for a Tier 2 method, while plant-specific data are required for Tier 3.

i. CO₂ emissions from Iron and Steel Production – Tier 2/3 worksheet:

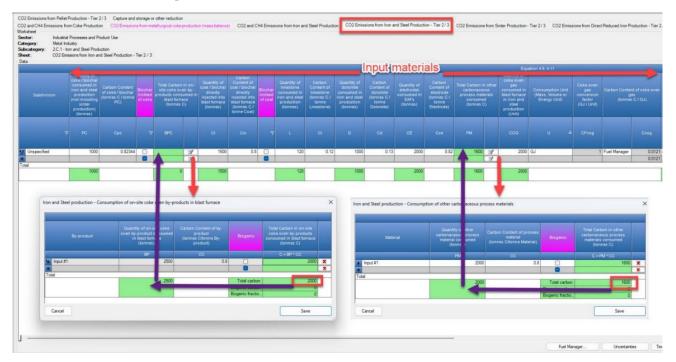
The mass balance method requires information on input and output materials, as applicable. Data are entered row by row, as follows:

Input materials

- 1. <u>Column |PC|</u>: input the quantity of coke or biochar consumed in iron and steel production in tonnes.
- 2. <u>Column |Biochar instead of coke|</u>: check if biochar is used instead of coke for iron and steel production. By default this column is unchecked.
- 3. <u>Column |BPC|</u>: input the quantity of onsite coke oven by-products consumed in the blast furnace, in tonnes. This information is entered the sub-table associated with <u>Column |BPC|</u> (see image below).
- 4. <u>Column |CI|</u>: input the quantity of coal directly injected into the blast furnace, in tonnes.
- 5. <u>Column |L|</u>: input the quantity of limestone consumed in iron and steel production, in tonnes.
- 6. <u>Column |D|</u>: input the quantity of dolomite consumed in iron and steel production, in tonnes.
- 7. <u>Column |CE|</u>: input the quantity of carbon electrodes consumed in EAFs, in tonnes.
- 8. <u>Column |PM|</u>: input the quantity of other carbonaceous and process materials consumed in iron and steel production, such as sinter or waste plastic, in tonnes. This information is entered the sub-table associated with <u>Column |PM|</u> (see image below).
- 9. <u>Column |COG|</u>: input the quantity of coke oven gas consumed in the blast furnace.
- 10. <u>Column |U|</u>: enter the unit of the coke oven gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 11. <u>Column |CFcog|</u>: enter the conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ, TJ or tonnes of fuel are selected in <u>Column |U|</u>, CFcog is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³ or a user defined unit) the user shall enter the relevant conversion unit here.

Output Materials

- 12. <u>Column |S|:</u> quantity of steel produced, in tonnes.
- 13. <u>Column |IP|</u>: quantity of iron production not converted to steel, in tonnes.
- 14. <u>Column |BG|</u>: quantity of blast furnace gas transferred offsite.
- 15. <u>Column |U|</u>: enter the unit of the blast furnace gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 16. <u>Column | CFbg|</u>: enter the conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ, TJ or tonnes of fuel are selected in <u>Column |U|</u>, CFbg is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³ or a user defined unit) the user shall enter the relevant conversion unit here.



Example: Iron and Steel Production – AD for input materials for Tier 2/3

Example: Iron and steel production – AD for output materials for Tier 2/3

Carbon Content of coke over gas (tonnes) Annual non-Energy CO2 emissions (Gg CO2) Annual non-Energy CO2 emissions (Gg CO2) gas (tonnes) Carbon converted to tonne Steel) Carbon converted to tonne Steel) Carbon Content of tonne Steel) Carbon Converted to tonne Steel) Annual non-Energy CO2 emissions (Gg CO2) Annual non-Energy CO2 (tonnes C/GJ) A														-	202
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$					0	utput	mater	ials							
Ccog S Cs IP Cip BG U Δ CFbg Cbg Ccog + L * Ci + D * Cd + OE * Ccog + S * CS + IP * Cip + BG * CFbg * Cbg] * 44/12 E / 1000		gas	steel produced	Carbon Quantity of iron Content of iron Content of iron Content of iron Content of iron Biast furnace gas Biast furnace gas Biast furnace gas Convertent of conversion Ann produced (tonnes) produced tonne Steel) converted to steel converted to steel converted to steel converted to offsite converted to Energy Uniti (GJ / Unit) conversion furnace gas (tonnes C / GJ) Ann			Energy CO2 emissions								
7 Fuel Manager 0.012 10 200 0 0 1000 GJ 1 Fuel Manager 0.0708 23003.12667 23.00313 🖉 🖬 🦉		Ccog	s	Cs	IP	Cip	BG	U A	CFbg		Cbg	Cci + L * Cl + D * Cd + CE * Cce + PM + COG * CFcog * Ccog - S * Cs - IP * Cip - BG *	E / 1000		
0.012	Fuel Manage		10	200	0	0	1000	GJ	1	Fuel Manager		23003.12667			2
			10		0		1000				Including Bio	23003.12667	23.00313		

ii. CO₂ emissions from Sinter Production – Tier 2/3 worksheet:

For Sinter production, the Tier 2/3 method is similar to Iron and Steel production, and the illustrations are broadly applicable to sinter production, although with input and output materials unique to sinter production. Data are entered row by row, as follows and as applicable.

Input Materials

- 1. <u>Column |CBR|</u>: input the quantity of coke breeze/biochar purchased and produced onsite for sinter production, in tonnes.
- 2. <u>Column |Biochar instead of coke breeze|</u>: check if biochar is used instead of coke breeze for sinter production. By default this column is unchecked.
- 3. <u>Column |COG|</u>: input the quantity of coke oven gas consumed in the blast furnace for sinter production.

- 4. <u>Column |U|</u>: enter the unit of the coke oven gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 5. <u>Column | CFcog</u>|: enter the conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ, TJ or tonnes of fuel are selected in <u>Column |U|</u>, CFcog is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³ or a user defined unit) the user shall enter the relevant conversion unit here.
- 6. <u>Column |BG|:</u> quantity of blast furnace gas consumed in sinter production.
- 7. <u>Column |U|</u>: enter the unit of the blast furnace gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 8. <u>Column | CFbg|</u>: enter the conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ, TJ or tonnes of fuel are selected in <u>Column |U|</u>, CFbg is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³ or a user defined unit) the user shall enter the relevant conversion unit here.
- 9. <u>Column |OPM|</u>: input the quantity of other process materials, such as natural gas and fuel oil, consumed, in tonnes. This information is entered the sub-table associated with <u>Column |OPM|</u>

Output Materials

- 10. <u>Column |SOG|</u>: input the quantity of sinter off gas transferred offsite either to iron and steel production facilities or other facilities.
- 11. <u>Column |U|</u>: enter the unit of the sinter off gas entered (e.g. Gg, TJ, m³, tonne). The user may enter a user-specific unit (e.g. BTUs).
- 12. <u>Column |CFsog|</u>: enter the conversion factor to convert the consumption unit to GJ. <u>Note that</u>, where GJ or TJ of fuel is selected in <u>Column |U|</u>, CFsog is sourced from the Fuel Manager and compiled by the Software as a conversion factor. Where other units are applied (e.g. m³, tonnes, or a user defined unit) the user shall enter the relevant conversion unit here.

iii. CO₂ emissions from Direct Reduced Iron Production – Tier 2/3 and CO₂ emissions from Pellet Production – Tier 2/3

The worksheets for DRI production and Pellet Production are the same. The Tier 2/3 method is based on fuel consumption and fuel carbon content. Emissions are derived from combusting fuel, coke breeze, metallurgical coke and/or biochar. Data are entered row by row, as follows, and as applicable:

- 1. <u>Column |NG|</u>: input the amount of natural gas used in DRI/pellet production, in GJ.
- 2. <u>Column |CBR|</u>: input the amount of coke breeze/biochar used in DRI/pellet production, in GJ.
- 3. <u>Column |Biochar instead of coke breeze |</u>: check if biochar is used instead of coke breeze for DRI/pellet production. By default this column is unchecked.
- 4. <u>Column |CM|</u>: input the amount of metallurgical coke /biochar used in DRI/pellet production, in GJ.
- 5. <u>Column |Biochar instead of metallurgical coke|</u>: check if biochar is used instead of metallurgical for DRI/pellet production. By default, this column is unchecked.

Example: DRI Production – AD for Tier 2/3

Illustration also applies to Pellet Production

tegory: Metal Industry bcategory: 2.C.1 - Iron ar	esses and Product Use ad Steel Production s from Direct Reduced		2/3									20:
			-			Equa	tion 4.11					_
	Amount of natural gas used (GJ)	Carbon Conte (tonne	nt of natural gas s C / GJ)	Amount of coke breeze / biochar used (GJ)	Carbon Content of coke breeze / biochar (tonnes C / GJ)	Biochar instead of coke breeze	Amount of metallurgical coke / biochar (GJ)	Carbon Content of metallurgical coke / biochar (tonnes C / GJ)	Biochar instead of metallurgical coke	Annual non-Energy CO2 emissions (tonnes CO2)	Annual non- Energy CO2 emissions (Gg CO2)	
۵	7 NG		Cng	CBR	Cobr	V	СМ	Ccm		E = [NG * Cng + CBR * Ccbr + CM * Ccm] * 44/12	E / 1000	
National	15000	Fuel Manager	0.0153	1200	0.0292	0	120000	0.029		13729.98	13.72998	389
tal			0.0153			8			8			3
	15000			1200			120000		Including Biogenic CO	13729.98	13.72998	
									Excluding Biogenic C	13729.98	13,72998	

Emission factor input

Section 4.2.2.3 in Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for the Iron and Steel Production source category and coke production. For coke production, section 4.2.2.3 of the 2019 Refinement is also relevant. There are three sets of default EFs:

- i) Tier 1 EFs for CO₂ (<u>Table 4.1</u> in Chapter 4, Volume 3 of the 2006 IPCC Guidelines), and, additionally for coke production, <u>Table 4.1 (Updated</u>) in Chapter 4, Volume 3 of the 2019 Refinement
- ii) Tier 1 EFs for CH₄ (<u>Table 4.2</u> in Chapter 4, Volume 3 of the 2006 IPCC Guidelines)
- iii) Tier 2/3 EFs for CO₂ carbon content of materials/fuels (<u>Table 4.3</u> Chapter 4, Volume 3 of the 2006 *IPCC Guidelines*)

Then, for Coke Production

When Tier 1 Equations are applied:

For each combination of subdivision/coke production process in worksheet CO₂ and CH₄ Emissions from Coke Production:

 <u>Column |EF|</u>: select from the drop-down menu the IPCC default value for the given GHG or enter a userspecific value, in tonnes CO₂/tonne coke produced or kg CH₄/tonne coke produced. <u>Note that</u> user shall select "Carbon dioxide (CO₂)" or "Methane (CH₄)" in the "Gas" bar at the top, to enter data for each GHG one by one.

Example: Tier 1 EF for coke production

CO2 Emissions from Direct Reduced Iron Production - Tie	er 2/3 CO2 Emissions from Pellet Production - Tier	2/3 Capture and storage or othe	r reduction					
	missions from metallurgical coke production (mass ball	ance) CO2 and CH4 Emissions f	rom Iron and Steel Production CO2 Emiss	isions from Iron and Steel Production - Tier	2/3 CO2 Emissions from Si	nter Productio	n - Tier 2/3	1
Watchated Sector: Industrial Processes and Product Use Category: Metal Industry Subcategory: 2.C.1. Iron and Steel Production Sheet: CO2 and CH4 Emissions from Coke Prod Data Gas CARBON DIOXIDE (CO2)	luction						:	2022
CARBON DIOXIDE (CO2) METHANE (CH4)		Equ	ation 4.1					
Subdivision	Coke production process	Amount of coke production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
Δ \	∆ ⊽	Р	EF	E = P * EF	E / 1000			
Kanagawa prefecture	Coke production using by-product recovery techn	15000	0.51		7.65	3	2	X
National (all the rest)	Coke Oven	100000	0.56	6 56000	56	3	-	
* Total						2		
1008		115000		63650	63.65			

For each subdivision in worksheet CO₂ Emissions from metallurgical coke production (mass balance):

- 1. <u>Column |Ccc|</u>: select from the drop-down menu the carbon content for coking coal taken from the **1.1.1 Fuel Manager** or enter a user-specific value, in tonnes C/tonne coking coal.
- 2. <u>Column |Cco|</u>: select from the drop-down menu the carbon content for coke taken from the **1.1.1 Fuel Manager** or enter a user-specific value, in tonnes C/tonne coke.

Note that the Tier 1b method requires information only on the quantity of coking coal consumed and coke produced. There is an opportunity for users to include EF information for additional inputs and outputs in this worksheet; the additional inputs are required under a Tier 2 method. For information on the entry of these additional factors, see instruction for the Tier 2 equation below.

When the Tier 2 Equation is applied:

For each subdivision in worksheet CO₂ Emissions from metallurgical coke production (mass balance):

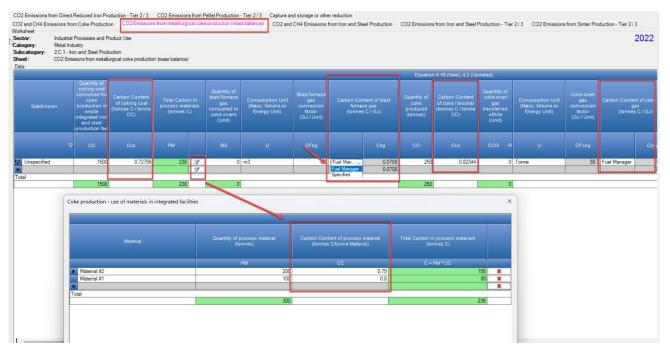
- 1. <u>Column |Ccc|</u>: select from the drop-down menu the carbon content for coking coal taken from the **1.1.1 Fuel Manager** or enter a user-specific value, in tonnes C/tonne coking coal.
- 2. <u>Column |PM|</u>: input the carbon content of process materials used for coke production, in tonnes C/tonne material. This information is entered in <u>Column |CC|</u> in the sub-table associated with <u>Column |PM|</u>.

3. <u>Column | Cbg|</u>: indicate whether the carbon content for blast furnace gas shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of blast furnace gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.

- 4. <u>Column |Cco|</u>: select from the drop-down menu the carbon content for coke taken from the 1.1.1 Fuel Manager or enter a user-specific value, in tonnes C/tonne coke.
- 5. <u>Column | Ccog|</u>: indicate whether the carbon content for coke oven gas shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of coke oven gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.



Example: Tier 2 EF for coke production

Then, for Iron and Steel Production

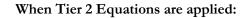
When Tier 1 Equations are applied:

For each combination of subdivision/ type of steelmaking method, etc in worksheet CO_2 and CH_4 Emissions from Iron and Steel Production:

 <u>Column | EF |</u>: select from the drop-down menu the IPCC default value for the given GHG or enter a userspecific value, in tonnes CO₂/tonne produced or kg CH₄/tonne produced. <u>Note that user shall select "Carbon dioxide (CO₂)" or "Methane (CH₄)" in the "Gas" bar at the top, to enter data for each GHG one by one.
</u>

Example: Tier 1 EF for iron and steel production

O2 Emissions from Sinter Production - Tier 2	3 CO2 Emissions from Direct Reduced I	Iron Production - Tier 2/3	_				and storage or other reduction			
O2 and CH4 Emissions from Coke Production	CO2 Emissions from metallurgical coke	production (mass balance))	CO2 and CH4 Emissions	from Iron	and Steel Production (CO2 Emissions from Iron and	Steel Prod	uction - T	ier 2/3
forksheet iector: Industrial Processes and Proc ategory: Metal Industry ubcategory: 2.C.1 - Iron and Steel Produc heet: CO2 and CH4 Emissions from Data Data	tion									202
		Equ	uatio	on 4.4 - 4.8						
Subdivision	Type of Steelmaking Method, etc	Amount of Steel or Iror Production (tonne)	n	CO2 Emission Fac (tonnes CO2 / tonne pro		CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
۵ <i>\</i>	ΔV	Р		EF		E = P * EF	E / 1000			
Unspecified	Electric Arc Furnace (EAF)	200	000		~ 80.0	16	600	1.6 📝		2
* Fotal						02 Emission Factor CO2 / tonne produced)		emark		
		200	Ele	ectric Arc Furnace (EAF)		0.08	Steel Production: Consensu Environmental Performance (International Iron and Steel	e Indicator	s 2003 ST	EEL



For each subdivision in worksheet CO_2 emissions from Iron and Steel Production – Tier 2/3, as applicable. <u>Note that</u> the default carbon contents should be used only if an inventory compiler does not have information on conditions in iron and steel-making facilities but has detailed activity data for the process materials and offsite transfers.

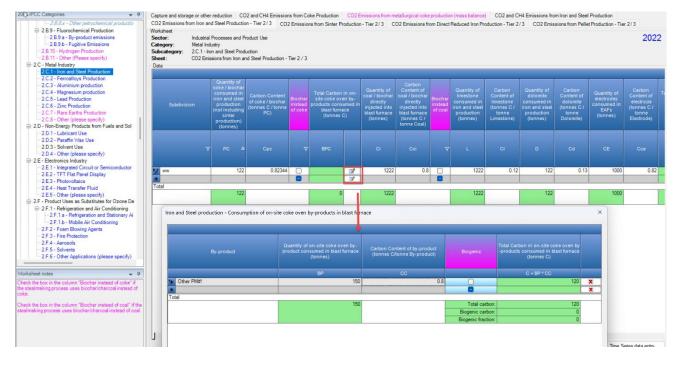
- 1. <u>Column |Cpc|</u>: select from the drop-down menu the IPCC default value for coke or enter a user-specific value, including for biochar, in tonnes C/tonne coking coal/biochar.
- 2. <u>Column |BPC|</u>: input the carbon content of by-products, in tonnes C/tonne by-product. This information is entered in <u>Column |CC|</u> in the sub-table associated with <u>Column |BPC|</u>.
- 3. <u>Column |Ci|</u>: select from the drop-down menu the IPCC default value for the carbon content of coal directly injected into the blast furnace, or enter a user-specific value, in tonnes C/tonne coal/biochar.
- 4. <u>Column |Cl|</u>: select from the drop-down menu the IPCC default value for the carbon content of limestone, or enter a user-specific value, in tonnes C/tonne limestone.
- 5. <u>Column |Cd|</u>: select from the drop-down menu the IPCC default value for the carbon content of dolomite, or enter a user-specific value, in tonnes C/tonne dolomite.
- 6. <u>Column |Cce</u>]: select from the drop-down menu the IPCC default value for the carbon content of electrodes, or enter a user-specific value, in tonnes C/tonne electrode.
- 7. <u>Column |PM|</u>: input the carbon content of other carbonaceous process materials used for iron and steel production, in tonnes C/tonne material. This information is entered in <u>Column |CC|</u> in the sub-table associated with <u>Column |PM|</u>.
- 8. <u>Column | Ccog</u>|: indicate whether the carbon content for coke oven gas shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of coke oven gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.

- 9. <u>Column |Cs|</u>: select from the drop-down menu the IPCC default value for the carbon content of steel, or enter a user-specific value, in tonnes C/tonne steel.
- 10. <u>Column |Cip</u>|: select from the drop-down menu the IPCC default value for the carbon content of iron production not converted to steel, or enter a user-specific value, in tonnes C/tonne iron.
- 11. <u>Column | Cbg|</u>: indicate whether the carbon content for blast furnace gas transferred offsite shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of blast furnace gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.

Example: Tier 2 EF for iron and steel production



Then, for each subdivision in worksheet CO₂ emissions from Sinter Production – Tier 2/3, as applicable:

- 1. <u>Column | Ccbr |</u>: enter a user-specific value, in tonnes C/tonne coke breeze or biochar.
- 2. <u>Column | Ccog</u>|: indicate whether the carbon content for coke oven gas shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of coke oven gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.

12. <u>Column |Cbg|</u>: indicate whether the carbon content for blast furnace gas consumed in sinter production shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of blast furnace gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.

- 3. <u>Column |OPM|</u>: input the carbon content of other process materials used for sinter production, in tonnes C/tonne material. This information is entered in <u>Column |CC|</u> in the sub-table associated with <u>Column |OPM|</u>.
- 4. <u>Column | Csog |</u>: enter a user-specific value, in tonnes C/tonne sinter off-gas transferred offsite.

Then, for each subdivision in worksheet CO_2 emissions from Direct Reduced Iron Production – Tier 2/3 and worksheet CO_2 emissions from Pellet Production – Tier 2/3, as applicable:

1. <u>Column |Cng|</u>: indicate whether the carbon content for natural gas shall be taken from the Fuel Manager or specified. Where the carbon content is taken from the *Fuel Manager*, the value will automatically appear in the gray-colored cell. Where *Specified*, the cell becomes white and the user shall input the carbon content of natural gas, in tonnes C/GJ.

Note that: section 1.1.1 Fuel Manager provides further information on populating the Fuel Manager.

- 2. <u>Column | Ccbr |</u>: enter a user-specific value, in tonnes C/tonne coke breeze or biochar.
- 3. <u>Column | Ccm |</u>: enter a user-specific value, in tonnes C/tonne metallurgical coke or biochar.

Results

Coke Production

 CO_2 and CH_4 emissions from Coke Production (to be reported in the Energy sector) are estimated in mass units (tonnes and Gg for CO_2 and kg and Gg for CH_4) by the *Software* in the following worksheets:

- ✓ CO₂ and CH₄ emissions from Coke Production
- ✓ CO₂ Emissions from metallurgical coke production (mass balance)

It is important to note that total emissions from coke production estimated in worksheet CO_2 Emissions from metallurgical coke production (mass balance) automatically subtract in <u>Column |Eflaring|</u>. CO₂ emissions from flaring of coke oven gas, estimated in worksheet Emissions from Coke Oven Gas flaring in category 1.B.1.c.ii Coke Production. This subtraction should only take place where the Tier 2/3 method is applied in worksheet CO_2 Emissions from metallurgical coke production (mass balance); the Tier 1b method assumes that coke oven gas produced is burned on site for energy recovery, and therefore CO_2 emissions from flaring are equal to zero. To ensure that the proper CO_2 is deducted, separate subdivisions should be entered for Tier1b and Tier 2/3, and these subdivisions should be consistent with those entered in the worksheet Emissions from Coke Oven Gas flaring in category 1.B.1.c.ii Coke Production.

All emissions from coke production will be reported under the Energy sector, under category 1.A.1.c.i Manufacture of Solid Fuels.

Iron and Steel Production

CO₂ and CH₄ emissions from Iron and Steel Production are estimated in mass units (tonnes and Gg for CO₂ and kg and Gg for CH₄) by the *Software* in the following worksheets:

- ✓ CO₂ and CH₄ emissions from Iron and Steel Production Tier 1
- ✓ CO₂ emissions from Iron and Steel Production Tier 2/3
- \checkmark CO₂ emissions from Sinter Production Tier 2/3
- \checkmark CO₂ emissions from Pellet Production Tier 2/3
- ✓ CO₂ emissions from Direct Reduced Iron Production Tier 2/3

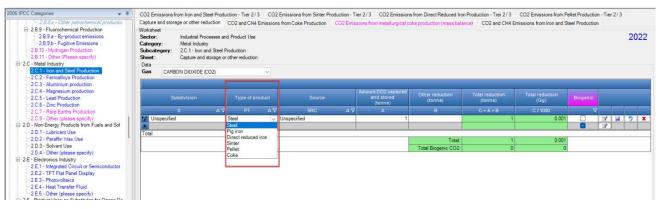
For both coke production and iron and steel production, where the user has indicated use of biochar in production in the *Software*, CO_2 emissions are totalled including and excluding biogenic CO_2 .

Total CO_2 and CH_4 emissions from coke and iron and steel production, is the sum of all emissions in the above worksheets, taking into account any capture and storage or other reduction. The worksheet **Capture and storage** or other reduction is provided in the *Software* to estimate these reductions.

In the worksheet **Capture and storage or other reduction** for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂ or CH₄, in tonnes. <u>Note that:</u> <u>Column |B|</u> may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column |Biogenic|</u>: indicate with a check if the reducing agent/fuel is of biogenic origin. <u>Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.</u>

Example: Capture and storage or other reduction



2.C.2 Ferroalloys Production

Information

The 2006 IPCC Guidelines provide guidance for estimation of CO2 and CH4 emissions from Ferroalloy Production.

There are three methodological Tiers: Tier 1 - EF method for CO₂ and CH₄, Tier 2 - mass-balance method using national / country-specific data for carbon content and EF for reducing agents and Tier 3 - mass-balance method based on plant-specific data and carbon content of input and output materials, including reducing agents. Tiers 2 and 3 (mass-balance) are used only for estimation of CO₂ emissions.

<u>GHGs</u>

The Software includes the following GHGs for the Ferroalloy Production source category:

CO_2	CH_4	N_2O	HFCs	PFCs	SF ₆	NF ₃
X	X					

According to the 2006 *IPCC Guidelines*, N_2O emissions are possible, but the errors associated with estimates or measurements of N_2O emissions from the ferroalloys industry are very large and thus, a methodology is not provided. Users can calculate estimates of N_2O for this category, provided they develop country-specific methods based on researched data. These emissions can be reported in the IPCC inventory worksheet for category **2.C.8 Other**.

IPCC Equations

- ✓ Tier 1: Equations 4.15 (CO₂) and 4.18 (CH₄ from ferrosilicon and silicon metal production)
- ✓ Tier 2<u>: Equation 4.16</u>
- \checkmark Tier 3: <u>Equations 4.17</u> and <u>4.19</u>

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The Software calculates emissions of CO₂ and CH₄ from Ferroalloys Production using the following worksheets:

- ✓ CO₂ and CH₄ Emissions from Ferroalloy Production: contains for each subdivision, each type of ferroalloy and furnace type (if known), information on the amount of ferroalloy produced and CO₂ and CH₄ EFs. The worksheet calculates the associated CO₂ and CH₄ emissions.
- ✓ CO₂ Emissions in Reducing Agents Tier 2: contains for each subdivision, each type of ferroalloy and each type of reducing agent, information on the amount of reducing agents consumed and CO₂ EFs. The worksheet calculates the associated CO₂ emissions from reducing agents.
- ✓ CO₂ Emissions in Reducing Agents Tier 3: contains for each subdivision, each type of ferroalloy and each type of reducing agent, information on the amount and carbon content of reducing agents (carbon content can be calculated in the pop-up table based on plant-specific data). The worksheet calculates the associated CO₂ emissions from reducing agents.
- ✓ CO₂ Emissions in Ore Tier 2/3: contains for each subdivision, each type of ferroalloy and each type of ore, information on the amount and carbon content of ore consumed. The worksheet calculates the associated CO₂ emissions from ore.
- ✓ CO₂ Emissions in Slag forming material Tier 2/3: contains for each subdivision, each type of ferroalloy and each type of slag forming material, information on the amount and carbon content of slag forming material consumed. The worksheet calculates the associated CO₂ emissions from slag forming material.
- ✓ CO₂ Emissions in Products Tier 2/3: contains for each subdivision and each type of ferroalloy produced, information on the amount and carbon content of ferroalloys produced. The worksheet calculates the associated CO_2 "contained" in ferroalloys produced.

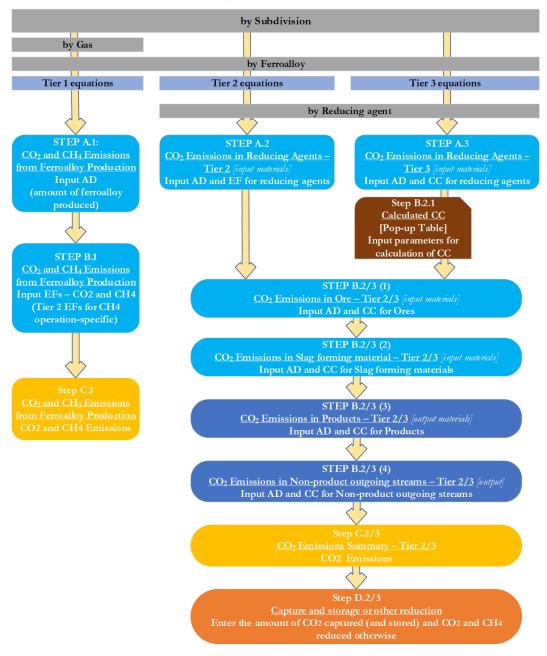
- ✓ CO₂ Emissions in Non-product outgoing streams Tier 2/3: contains for each subdivision, each type of ferroalloy produced and each non-product outgoing stream, information on the amount and carbon content of non-product outgoing streams. The worksheet calculates the associated CO₂ "contained" in non-product outgoing streams.
- ✓ CO₂ Emissions Summary Tier 2/3: (non-editable table) contains for each subdivision and each type of ferroalloy produced, the results of the estimation of CO₂ emissions from input and output materials for Tier 2 and Tier 3.
- ✓ Capture and storage or other reduction contains for each subdivision and each type of ferroalloy produced, information on CO₂ capture (with subsequent storage) and other reduction of CO₂ and CH₄, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and decision trees in <u>Figure 4.9</u> of the 2006 IPCC Guidelines (for CO₂) and <u>Figure 4.10</u> GHG estimates are calculated using three methodological Tiers: Tier 1 or Tier 2 or Tier 3 or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, users follow the following flowchart for the Ferroalloy Production source category.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.



Ferroalloy Production - flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When Tier 1 Equations are applied

Step A.1, in the worksheet CO_2 and CH_4 Emissions from Ferroalloy Production, for each subdivision, each type of ferroalloy produced and each type of furnace, if known, users collect and input in the *Software* information on the amount of each type of ferroalloy produced.

Step B.1, in the worksheet **CO**₂ and **CH**₄ **Emissions from Ferroalloy Production**, for each subdivision, each type of ferroalloy produced and each type of furnace, if known, users input respective CO₂ and CH₄ EFs.

Step C.1, in the worksheet CO_2 and CH_4 Emissions from Ferroalloy Production, the *Software* calculates the associated emissions for each subdivision in mass units (tonne for CO_2 and kg for CH_4 and Gg). In addition, the total emissions of all subdivisions are shown.

When Tier 2 / Tier 3 Equations are applied

Step A.2, in the worksheet CO_2 Emissions in Reducing Agents – Tier 2, for each subdivision and each type of ferroalloy produced, users collect and input information on the type (name of reducing agent and whether biogenic or fossil in origin) and amount of reducing agent used and CO_2 EFs based on the reducing agent used.

Step A.3, in the worksheet CO_2 Emissions in Reducing Agents – Tier 3, for each subdivision and each type of ferroalloy produced, users collect and input information on the type (name of reducing agent and whether biogenic or fossil in origin) and amount of reducing agent used and the carbon content of the reducing agent. Carbon content can either be specified or calculated in a pop-up table (Step B.2.1). When applying Tier 3, plant-specific data are required.

Then for both Tier 2 and Tier 3 (applying plant-specific data for Tier 3):

Step B.2/3, in the worksheets CO_2 Emissions in Ore – Tier 2/3, CO_2 Emissions in Slag forming material – Tier 2/3, CO_2 Emissions in Products – Tier 2/3, and CO_2 Emissions in Non-product outgoing streams – Tier 2/3 for each subdivision and each type of ferroalloy produced, users collect and input information on additional input materials (ore, slag forming materials) and output materials (products/ferroalloys and non-product streams), as well as the carbon content of those materials.

Step C.2/3, in the worksheet **CO**₂ **Emissions Summary – Tier 2/3**, for each subdivision and type of ferroalloy, the *Software* calculates the total emissions from each input and output material in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown in each worksheet. CO₂ emissions from reducing agents of biogenic origin are estimated separately from those of fossil origin.

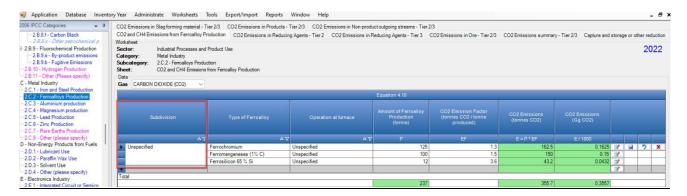
Then, for each tier, as appropriate:

Step D, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates) and reduction of CH_4 , not otherwise captured in the worksheets above.

Activity data input

Section 4.3.2.3 Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Ferroalloy Production.

Input of AD for the Ferroalloy Production source category requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].



Example: single subdivision (unspecified)

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

A- Magnesium production Amount of Ferroalloy CO2 Emission Factor CO2 Emission Factor CO2 Emission Factor				20)22
C2-Ferrolloys Production C3-Aluminum production C4-Magnetium production Amount of Ferroalloy CO2 Emission Factor C02 Emission		12			
C.SLead Production Subdivision Type of Ferroalloy Operation at furnace Production (fonne) Out 2 ministring (fonnes CO2) Out 2 ministring (fonnes CO2) C.S Zinc Production	CO2 Emissions (Gg CO2)				
C.8 - Other (please specify) $\Delta \nabla$ $\Delta \nabla$ P EF E = P * EF	E/1000				
Energy Products from Fuels Northern Ferrochromium Unspecified 125 1.3 162.5 Lubricant Use Ferromanganeses (1% C) Unspecified 100 1.5 150	0.162		-		_
Parafin Visa Use Southern J Ferrosilicon 65 % Sr Unspecified 12 3.6 432	0.043	32		2	×
- Other (please specify) troinics floating Total 237 3557	0.355	Lunite	 		-

Example: multiple subdivisions

When Tier 1 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 and CH_4 emissions from Ferroalloy Production, row by row, as follows:

- 1. <u>Column |Type of Ferroalloy|</u>: select from the drop-down menu the default type of ferroalloy produced or input manually a country-specific type of ferroalloy.
- 2. <u>Column |Operation of furnace|</u>: select from the drop-down menu the default type of furnace or input manually a country-specific type of furnace, if known. For Tier 1, the user may select Unspecified.
- 3. <u>Column | P |</u>: input the amount/mass of the individual type of ferroalloy produced, in tonnes.

When Tier 2/Tier 3 Equations are applied:

The types of AD are the same for Tier 2 and Tier 3; the only difference being that Tier 3 requires plant-specific data. Thus, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheets CO_2 emissions in Reducing Agents – Tier 2 and CO_2 emissions in Reducing agents – Tier 3, row by row, as follows:

<u>Note that</u> there is not an automatic link of subdivisions among the Tier 2/Tier 3 worksheets. In particular, where Tier 3 is used, the user should ensure that all relevant worksheets for each plant are filled in. Further, note that not all worksheets may necessarily be relevant, they are to be used, as applicable.

- 1. <u>Column |Type of Ferroalloy|</u>: select from the drop-down menu the default type of ferroalloy produced or input manually a country-specific type of ferroalloy produced.
- 2. <u>Column |Reducing agent type|</u>: select from the drop-down menu the default type of reducing agent (fossil or select from options of biogenic origin). Manual input is not allowed, what is critical is the distinction between reducing agents of fossil and biogenic origin since emissions from bio-reducing agents will not be counted to the national total.
- 3. <u>Column |i|:</u> select from the drop-down menu the default reducing agent (e.g. coke) or input manually country-specific reducing agent.
- 4. <u>Column | Mi</u> : input the amount/mass of reducing agent, in tonnes.

Example: AD input for reducing agents - Tier 2 and Tier 3

2 and CH4 Emissions from Ferroalloy	Production CO2 Emissions in Redu	icing Agents - Tier 2 (CO2 Emissions in Reducing Age	nts - Tier 3 CO2 Emiss	ions in Ore - Tier 2/3	CO2 Emissions in Non-pro	duct outgoing streams - 1	fier?
rksheet ctor: Industrial Processes an tegory: Metal Industry bcategory: 2.C.2 - Ferroalloys Prod eet: CO2 Emissions in Redu sta	uction							
			Equation 4.	16				
Subdivision	Type of Ferroalloy	Reducing agent type	Reducing agent	Mass of reducing agent (tonnes)	Emission Factor (tonnes CO2 / tonne i)	CO2 Emissions in Reducing Agents (tonnes CO2)	CO2 Emissions in Reducing Agents (Gg CO2)	
۵ 7	V	V	i AV	Mi	EFI	Ei = Mi * EFi	Ei / 1000	
Unspecified	Ferrosilicon 45% Si	Other Biogenic	biochar	100	2.3	230	0.23	
	Ferrosilicon 65 % Si	Fossil	Coal (for FeSi and Si-metal)	255	3.1	790.5	0.7905	1
	Ferrosilicon 90% Si	Fossil	Coke (for FeMn and Si	100	3.2	320	0.32	
otal						II		_
				455	Including Biogenic CO	1340.5	1.3405	Г
					Excluding Biogenic C	1110.5	1,1105	4

Then, for both Tier 2 and Tier 3

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions in Ore – Tier 2/3, row by row, as follows:

- 1. <u>Column |Type of Ferroalloy|</u>: select from the drop-down menu the default type of ferroalloy produced or input manually a country-specific type of ferroalloy produced.
- 2. <u>Column |h|</u>: input manually the name of the ore used for ferroalloy production.
- 3. <u>Column | Mh |</u>: input the amount/mass of ore used, in tonnes.

D2 and CH4 Emissions from Ferroall orksheet	oy Production CO2 Emissions in Red	ucing Agents - Tier 2	CO2 Emissio	ons in Reducing Agents	- Tier 3 CO2 Emissions in	Ore - Tier 2/3 CO2 Emissions in Non-p	roduct outgoing streams
actor: Industrial Processes stegory: Metal Industry sbcategory: 2.C.2 - Ferroalloys P neet: CO2 Emissions in O ata	roduction						
				Equation 4.16, 4	.17		
Subdivision	Type of Ferroalloy			Mass of Ore (tonnes)	Carbon Content of Ore (tonnes C / tonne Ore)	CO2 Emissions in Ore (tonnes CO2)	CO2 Emissions in C (Gg CO2)
	۵7 ۲	∀ h	۵V	Mh	CCh	Eh = Mh * CCh * 44/12	Eh / 1000
Kanagawa prefecture	Ferrochromium	Ore for Ferrochron	nium	200	0.05	366.66667	0.36
Plant Ferroal	Ferrosilicon 45% Si	Ore for FeSi45		100	0 0.03	110	0

Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions in Slag forming materials – Tier 2/3, row by row, as follows:

- 1. <u>Column |Type of Ferroalloy|</u>: select from the drop-down menu the default type of ferroalloy produced or input manually a country-specific type of ferroalloy produced.
- 2. <u>Column |j|</u>: input manually the name of the slag forming material used for ferroalloy production.
- 3. <u>Column |Mj|</u>: input the amount/mass of slag forming material used, in tonnes.

$\mathit{Example:}$ AD input for slag forming materials – Tier 2/3

CO2 Emissions summary - Tier 2/3 Vorksheet	Capture and storage or other reduction	CO2 Emissions in Slag forming ma	terial - Tier 2/3 CO2 Em	issions in Products - Tier 2/3	CO2 and CH4 Emissions from Ferro	oalloy Production
Sector: Industrial Processe Category: Metal Industry Subcategory: 2.C.2 - Ferroalloys	is and Product Use Production Slag forming material - Tier 2/3					
			Equation 4.16, 4.17			
Subdivision	Type of Ferroalloy	Slag forming material	Mass of Slag forming material (tonnes)	Carbon Content of Slag forming material (tonnes C / tonne j)	CO2 Emissions in Slag forming material (tonnes CO2)	CO2 Emissions in SI forming material (Gg CO2)
	47	7 j Δ7	Mj	CCj	Ej = Mj * CCj * 44/12	Ej / 1000
Kanagawa prefecture	Ferrochromium	Slag forming for Kanagawa	1000	0.07	256.66667	0.256
Plant ferroal	Ferrosilicon 75% Si	Slag forming for plant	200	0.05	36.66667	0.036
Total						

Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 emissions in Products – Tier 2/3, row by row, as follows:

- 1. <u>Column |Type of Ferroalloy|</u>: select from the drop-down menu the default type of ferroalloy produced or input manually a country-specific type of ferroalloy produced.
- 2. <u>Column |k|</u>: input manually the name of the type of ferroalloy produced.
- 3. <u>Column |Mk|</u>: input the amount/mass of ferroalloy produced, in tonnes.

Example: AD input for products (ferroalloys) – Tier 2/3

O2 Emissions s	ummary - Tier 2/3 Capture a	nd storage or other reduction Cl	D2 Emissi	ons in Slag forming material -	Tier 2/3 CO2 Emissions in P	roducts - Tier 2/3 CO2 Emissions in Ore - Tier 2	/3
/orksheet iector: Category: iubcategory: iheet: Data	Industrial Processes and Production Metal Industry 2.C.2 - Ferroalloys Production CO2 Emissions in Products - T	uct Use					
					Equation 4.16, 4.17		
	Subdivision	Type of Ferroalloy		Mass of Product (tonnes)	Carbon Content of Product (tonnes C / tonne k)	CO2 Emissions in Products (tonnes CO2)	CO2 Emissions in Products (Gg CO2)
	Δγ	k	Δγ	Mk	CCk	Ek = Mk * CCk * 44/12	Ek / 1000
Kanagawa p	refecture	Ferromanganeses (1% dfdfd		122	0.7	313.13333	0.313
Plant Ferroa	d.	Ferrosilicon 45% Si		100	0.05	18.33333	0.018
*							
Total							
				222		331.46667	0.33

Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions in Nonproduct outgoing streams – Tier 2/3, row by row, as follows:

- 1. <u>Column |Type of Ferroalloy|</u>: select from the drop-down menu the default type of ferroalloy produced or input manually a country-specific type of ferroalloy produced.
- 2. <u>Column |1|</u>: input manually the name of the non-product outgoing stream from ferroalloy production.
- 3. <u>Column |M|</u>: input the amount/mass of non-product outgoing stream, in tonnes.

Example: AD input for non-product outgoing streams – Tier 2/3

202 Emissions in Non-product outgoing	streams - Tier 2/3 CO2 and CH4 Emis	sions from Ferroalloy Production	CO2 Emissions in Redu	cing Agents - Tier 2 CC	2 Emissions in Reducing Agents - Tier 3	CO2 Emissions summ
Vorksheet Sector: Industrial Processes a Category: Metal Industry Subcategory: 2.C.2 - Ferroalloys Pro Sheet: CO2 Emissions in Non Data						
			Equation 4.16, 4.17			
Subdivision	Type of Ferroalloy	Non-product outgoing stream	Mass of Non-product outgoing stream (tonnes)	Carbon Content of Non- product outgoing stream (tonnes C / tonne I)	CO2 Emissions in Non-product outgoing streams (tonnes CO2)	CO2 Emissions in No product outgoing streams (Gg CO2)
Δ	ম শ		М	CCI	EI = MI * CCI * 44/12	EI / 1000
Kanagawa prefecture	Ferrochromium	Stream A	25	0.04	3.66667	0.0036
Plant Ferroal	Ferrosilicon 45% Si	Stream B	30	0.09	9.9	0.00
otal						
			55		13.56667	0.013

Emission factor input

Section 4.3.2.2 in Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Ferroalloy Production. There are four sets of default EFs:

- 1. Tier 1 EFs for CO₂ (Table 4.5 Chapter 4 Volume 3 of the 2006 IPCC Guidelines)
- 2. Tier 2 EFs for CO₂ (<u>Table 4.6</u> Chapter 4 Volume 3 of the 2006 IPCC Guidelines)
- 3. Tier 1 EFs for CH₄ (<u>Table 4.7</u> Chapter 4 Volume 3 of the 2006 IPCC Guidelines)
- 4. Tier 2 EFs for CH₄ (Table 4.8 Chapter 4 Volume 3 of the 2006 IPCC Guidelines)

The first, third and fourth sets of default EFs are entered in <u>Column |EF|</u> of the worksheet CO_2 and CH_4 Emissions from Ferroalloy Production. The second set is entered in <u>Column |EFi|</u> in the worksheet CO_2 Emissions in Reducing Agents – Tier 2 (Tier 2 for Reducing Agents is a EF approach). The default EFs are embedded in the *Software*. Users may manually over-write EFs with country-specific values.

Note that the user shall select "Carbon dioxide (CO₂)" or "Methane (CH₄)" in the "Gas" bar at the top, to enter data for each GHG one by one.

Example: Ferroalloy Production – Tier 1 EFs for CO₂

CO2 and CH4 Emissions from Ferror	CO2 Emissions in Non-product outgoing streams alloy Production CO2 Emissions in Reducing Agent				2 Emissions in Slag forming	g material - Tier	2/3
Category: Metal Industry Subcategory: 2.C.2 - Ferroalloys	es and Product Use Production secon from Fengaloy Production						199
		Equat	on 4.15, 4.18	,			
Subdivision		Amount of Ferroalio Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
	47 47	V P	EF	E = P * EF	E/1000		
National	Ferrochromium	34500	1.3	44850	44.85	3	
	Ferromanganeses (1% C)	12000 🥜	1.5	18000	18	3	
	Ferromanganeses (7% C)	25000	1.3	32500	32.5	3	
	Ferrosilicon 45% Si	150000	2.5		375	3	
	Perrosilicon 45% Si					3	
	Ferrosilicon 45% Si Ferrosilicon 65 % Si	250000 🥜	3.6	900000	900		
			36	000000 800008	800	3	
	Ferrosilicon 65 % Si	250000 d 200000 d 300000 d	4.8	800000 1440000	800 1440		
	Ferrosilicon 65 % Si Ferrosilicon 75% Si	250000 2 200000 2 300000 2 2000	4.8	800000 1440000 2800	800 1440 2.8	3	
	Ferrosilicon 65 % Si Ferrosilicon 75% Si Ferrosilicon 90% Si	250000 d 200000 d 300000 d	4.8	800000 1440000 2800	800 1440	3	2
Total	Ferrosilicon 65 % Si Ferrosilicon 75% Si Ferrosilicon 90% Si Silicomanganese	250000 2 200000 2 300000 2 2000	4	800000 1440000 2800	800 1440 2.8 50	3	2

Example: Ferroalloy Production – Tier 2 EFs for CO₂

CO2 Emissions in Products - Tier 2/3						nd storage or other reduc			
	and Product Use	Reducing Agents - Tier	CO2 Emissions in	Reduci	ng Agents - Tier 3 C	O2 Emissions in Ore - T	er 2/3 CO2 Emission	is in Slag forming m	
Data	0	93	Equ	ation 4.	16		5 .		
Subdivision	Subdivision Type of Ferroalloy Reducing agent typ		Reducing agen		Mass of reducing agent (tonnes)	Emission Factor (tonnes CO2 / tonne i)	CO2 Emissions in Reducing Agents (tonnes CO2)	CO2 Emissions Reducing Ageni (Gg CO2)	
ΔΥ	2	V	i .		Mi	EFi	Ei = Mi * EFi	Ei / 1000	
Kanagawa prefecture	Ferrosilicon 90% Si	Charcoal	Charcoal		2000	2.5	5000	5	
	Ferrosilicon 90% Si	Fossil	Coal (for FeSi and S	·met.	12000	3.1	37200	37.2	
	Silicon metal	Fossil	Electrode paste	~	4000	3.4	13600	13.6	
Total			Reducing age	it	(tonnes CO2 / tonn		Remark		
- Coldi			Coal (for FeSi and S	-metal)		3.1			
			Coal (for other ferroa	loys)			s are encouraged to use sed on average blend of balloy producer.		
			Coke (for FeMn and	SiMn)		3.2 3.2 - 3.3			
			Coke (for other ferro	lloys)		Inventory compiler specific values ba coke for each ferro	s are encouraged to use sed on average blend of alloy producer.	e producer- coal and/or	
			Coke (for Si and FeS	i)		3.3 3.3 - 3.4			

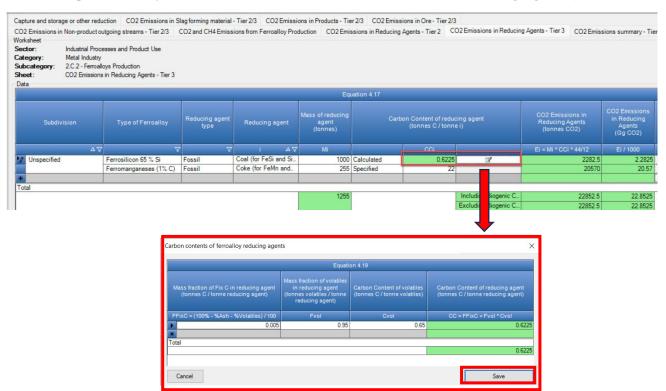
The Tier 3 method for Ferroalloy Production requires plant-specific data on carbon content of the input and output materials. These carbon contents must be input by users manually in the following worksheets CO_2 Emissions in Ore – Tier 2/3 (in <u>Column |CCh|</u>), CO_2 Emissions in Slag forming material – Tier 2/3 (in <u>Column |CCh|</u>), CO_2 Emissions in Products – Tier 2/3 (in <u>Column |CCk|</u>), and CO_2 Emissions in Non-product outgoing streams – Tier 2/3 (in <u>Column |CCl|</u>).

In worksheet CO_2 Emissions in Reducing Agents – Tier 3, users may either input the carbon content manually (i.e. specify the value in <u>Column |CCi|</u>) or calculate the carbon content in reducing agents (Tier 3) based on the mass fraction of fixed carbon, mass fraction of volatiles and carbon content of volatiles in the reducing agent (Equation 4.19).

Thus for each subdivision in <u>Column |Subdivision|</u>, when <u>Column |CCi|</u> is calculated, users must collect and input in the pop-up table plant-specific data, row by row, as follows:

- 1. <u>Column |FFixC|</u>: users collect and input the mass fraction of fixed C in the reducing agent, in tonnes of carbon/ tonne of reducing agent.
- 2. <u>Column | Fvol</u>]: users collect and input the mass fraction of volatiles in reducing agent, in tonnes volatiles/ tonne reducing agent.
- 3. <u>Column |Cvol|</u>: users collect and input carbon content in volatiles, tonnes C/tonne volatiles. Note that unless other information is available, Cvol = 0.65 for coal and 0.80 for coke.

Example: Ferroalloy Production - Calculation of Carbon Content in Reducing Agents (Tier 3)



Results

CO₂ and CH₄ emissions from Ferroalloy Production are estimated in mass units (tonnes and Gg for CO₂ and kg and Gg for CH₄) by the *Software* in the following worksheets:

✓ CO₂ and CH₄ emissions from Ferroalloy Production

✓ CO₂ Emissions Summary – Tier 2/3.

Total CO_2 and CH_4 emissions from ferroalloy production is the sum of all emissions in the above worksheets, taking into account any CO_2 capture with subsequent storage or other GHG reduction. For Tier 2/3, note that the CO_2 emissions include both CO_2 of biogenic and fossil origin, and totals are provided both including and excluding biogenic CO_2 .

Example: Results of CO ₂ emiss	ions – Tier $2/3$.
---	---------------------

02 Emissions in Non-pro 02 Emissions summary -												
sksheet sctor: Industri stegory: Metal Ir ubcategory: 2.C.2.+	al Processes and Produ	ct Use	reduction CO21	Emissions in Siag	forming material -	Ther2/3 CO2E	missions in Produc	ts - Her 23 CO	2 Emissions in Or	e - 11er 2/3		202
						Equation 4.16, 4.17						
Subdivision	Type of Ferroalloy	CO2 Emission Agents (tonnes	- Tier 2	CO2 Emission Agents (tonnes		CO2 Emissions in Ore (tonnes CO2)	CO2 Emissions in Slag forming material (tonnes CO2)	CO2 Emissions in Products (tonnes CO2)	in Non-product outgoing streams (tonnes CO2)		Annual non-Energy CO2 emissions (tonnes CO2)	Annual non Energy CO emissions (Gg CO2)
۵ ₇	7	Fossil Ei(T2)	Biogenic Ei(T2)	Fossil Ei(T3)	Biogenic Ei(T3)						E = Ei(T2) + Ei(T3) + Eh + Ej - Ek - El	
Kanagawa prefect	Ferrochromium					366.66667	256.66667		3.66667		619.66667	0.619
	Ferromanganeses							313.13333			-313.13333	-0.313
Plant Ferroal	Ferrosilicon 45% Si					110		18.33333	9.9		81.76667	0.081
	Ferrosilicon 75% Si						36.66667				36.66667	0.036
Unspecified	Ferrosilicon 65 % Si	790.5		2282.5							3073	3.0
	Ferrosilicon 45% Si		230								230	0.
	Ferrosilicon 90% Si	354									354	0.3
	Ferromanganeses			20570							20570	20.
otal												
		1144.5	230	22852.5	0	476.66667	293.33333	331,46667	13.56667	Including Biogenic	24651,96667	24.651

In the worksheet **Capture and storage or other reduction**, for each subdivision and each gas (CO₂ and CH₄):

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|</u>: users collect and input information on any other long-term reduction of CO₂, in tonnes. Note that: Column |B| may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column | Biogenic</u> | : indicate with a check if the reductant is of biogenic origin. Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.

Example: Capture and storage or other reduction

		CO2 Emissions in Reducing Agents -						
Vivorksheet	rage or other reduction CO2 Emi	ssions in Slag forming material - Tier 2/3	CO2	Emissions in Products - Tier 2/3	CO2 Emissions in Non-produ	ct outgoing streams - Tier 2/3	CO2 Emissions summary - Tier 2/3	3
Sector: Category:	Industrial Processes and Product Metal Industry	Use						
Subcategory: Sheet:	2.C.2 - Ferroalloys Production Capture and storage or other redu	iction						
Data 📻	HANE (CH4)	~						
	BON DIOXIDE (CO2) HANE (CH4)							
	Subdivision			Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	
	S AV	SRC	ΔV	A	B	C = A + B	C / 1000	
Plant Ferro	al	Stream3			1		0.001	C
*								C
Total							0.001	-

2.C.3 Aluminium Production

Information

The 2006 IPCC Guidelines provide guidance for estimation of CO_2 and PFCs (CF₄ and C_2F_6) emissions from Aluminium Production.

For CO₂, the Tier 1 method for calculating CO₂ emissions uses only broad cell technology characterizations (Prebake or Søderberg); Tier 2/3 are calculated using a mass balance approach The choice of method between the Tier 2 and Tier 3 method will depend on whether anode or paste composition data are available at the individual plant level.

For PFCs, the Tier 1 method uses technology-based default emission factors for the four main production technology types (Centre-Worked Prebake (CWPB), Side-Worked Prebake (SWPB), Horizontal Stud Søderberg (HSS) and Vertical Stud Søderberg (VSS). The Tier 2/3 methods utilizes equations for estimating CF₄ emissions based on the relationship between anode effect and performance: the slope and the overvoltage coefficient equations. Tier 3 requires measurements at the individual facility (plant-specific data). In Tier 2/3, because the process mechanisms that produce PFC emissions are similar for CF₄ and C₂F₆, the two gases should be considered together (C₂F₆ emissions are calculated as a fraction of CF₄ emissions).

<u>Note that</u>, for users using the Software for reporting to the UNFCCC ETF Reporting Tool, the MPGs include a category under Aluminium Production, **2.C.3.b F-gases used in foundries**. The CRT contains a footnote for this category that reads "According to the 2006 IPCC Guidelines, possible SF₆ from casting are to be included under Mg production. However, in the current CRT a separate subcategory exists and is reported by Parties.". For users wishing to report under CRT 2.C.3.b, F-gases used in foundries, this information can be entered in category 2.C.8 Other of the Software, and will map to the appropriate category in the CRT.

GHGs

The Software includes the following GHGs for the Aluminium Production source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X				X		

IPCC Equations

GHG emissions from the Aluminium Production source category are estimated by applying the following IPCC equations (Chapter 4 Volume 3 of the *2006 IPCC Guidelines*):

For CO₂

- ✓ Tier 1: Equation 4.20
- ✓ Tier 2/3: Equations 4.21, 4.22, 4.23 (Prebake) and 4.24 (Søderberg)

For PFCs

- ✓ Tier 1: Equations 4.25
- ✓ Tier 2/3: Equations 4.26 (Prebake) and 4.27 (Søderberg)

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The Software calculates CO₂ and PFC emissions from Aluminium Production using the following ten worksheets:

CO₂ emissions:

✓ CO₂ Emissions from Aluminium Production: contains for each subdivision and each type of technology (Prebake and Soderberg) information on the amount of aluminium produced and default CO₂ EFs. The worksheet calculates the associated CO₂ emissions.

- ✓ CO₂ Emissions from Prebake Anode Consumption– Tier 2/3: contains for each subdivision information on the amount of aluminium produced by Prebake technology, net Prebake anode consumption, and the sulphur and ash content in baked anodes. The worksheet calculates the associated CO_2 emissions.
- ✓ CO₂ Emissions from Pitch Volatiles Combustion (Prebake) Tier 2/3: contains for each subdivision information on the initial weight and hydrogen content of green anodes, baked anode production and waste tar collected. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Bake Furnace Packing Materials (Prebake) Tier 2/3: contains for each subdivision information on packing coke consumption, baked anode production, and the sulphur and ash content in packing coke. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Paste Consumption (Søderberg) Tier 2/3: contains for each subdivision information on the amount of aluminium produced by Søderberg technology, paste consumption, emissions of cyclohexane soluble matter, binder content in paste, sulphur, hydrogen and ash content in pitch, sulphur and ash content in calcined coke, and carbon in skimmed dust from Søderberg cells. The worksheet calculates the associated CO₂ emissions.

PFCs emissions:

- ✓ 1.1.2 F-gases Manager: contains data on F-gases used (including imported) and/or produced and exported in the country.
- ✓ PFC Emissions from Aluminium Production: contains for each subdivision and each production technology type information on the amount of aluminium produced and corresponding default CF₄ and C₂F₆ EFs. The worksheet calculates the associated PFCs emissions for Tier 1.
- ✓ PFC Emissions from Aluminium Production Slope Method Tier 2/3: contains for each subdivision and each production technology type information on the amount of aluminium produced, anode effect in minutes per cell-day, slope coefficient for CF_4 and weight fraction of C_2F_6 per CF_4 . The worksheet calculates the associated PFCs emissions.
- ✓ PFC Emissions from Aluminium Production Overvoltage Method Tier 2/3: contains for each subdivision and each production technology type information on the amount of aluminium produced, anode effect overvoltage, overvoltage coefficient for CF₄, process current efficiency and weight fraction of C₂F₆ per CF₄. The worksheet calculates the associated PFCs emissions.

Capture and storage or other reduction (CO₂ and PFCs):

✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂ and PFCs, not accounted previously in the worksheets for different Tiers.

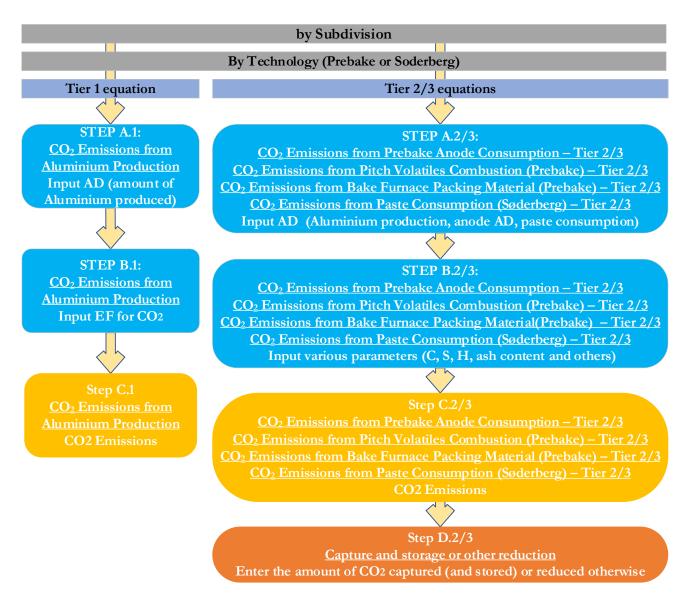
User's work Flowchart

Consistent with the key category analysis and the decision trees in Figure 4.11 (for CO₂) and Figure 4.12 (for PFCs) of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following two flowcharts for the estimation of CO_2 and PFC emissions from aluminium production

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Aluminium Production – CO₂ – flowchart



Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step A.1, in the worksheet CO₂ Emissions from Aluminium Production, users collect and input in the *Software* information on the amount of aluminium produced by each type of technology (Prebake or Søderberg).

Step B.1, in the worksheet CO_2 Emissions from Aluminium Production, users collect and input CO_2 EFs for each type of technology (Prebake or Søderberg).

Step C.1, in the worksheet CO_2 Emissions from Aluminium Production, the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

When the Tier 2/Tier 3 Equations are applied:

For Prebake technology

Step A.2/3, in the worksheet CO₂ Emissions from Prebake Anode Consumption – Tier 2/3, users collect and input in the *Software* information on the amount of aluminium produced by Prebake technology and net Prebake anode consumption; in the worksheet CO₂ Emissions from Pitch Volatiles Combustion (Prebake) – Tier 2/3, users collect and input information on the initial weight of green anodes and baked anode production; and in the worksheet CO₂ Emissions from Bake Furnace Packing Material (Prebake) – Tier 2/3, users collect and input information on baked anode production and packing coke consumption. For Tier 3, plant-specific AD should be input by users manually.

Step B.2/3, in the worksheet CO_2 Emissions from Prebake Anode Consumption – Tier 2/3, users collect and input sulphur and ash content in baked anodes; in the worksheet CO_2 Emissions from Pitch Volatiles Combustion (Prebake) – Tier 2/3, users collect and input hydrogen content in green anodes and waste tar collected, and in the worksheet CO_2 Emissions from Bake Furnace Packing Material (Prebake) – Tier 2/3, users collect and input sulphur and ash content in packing coke.

Step C.2/3, in the worksheets CO_2 emissions from Prebake Anode Consumption – Tier 2/3, CO_2 Emissions from Pitch Volatiles Combustion (Prebake) – Tier 2/3, and CO_2 emissions from Bake Furnace Packing Material (Prebake) – Tier 2/3, the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown in each worksheet.

For Søderberg technology

Step A.2/3, in the worksheet CO_2 Emissions from Paste Consumption (Søderberg) – Tier 2/3, users collect and input in the *Software* information on the amount of aluminium produced by Soderberg technology and paste consumption. For Tier 3 plant-specific AD should be input by users manually.

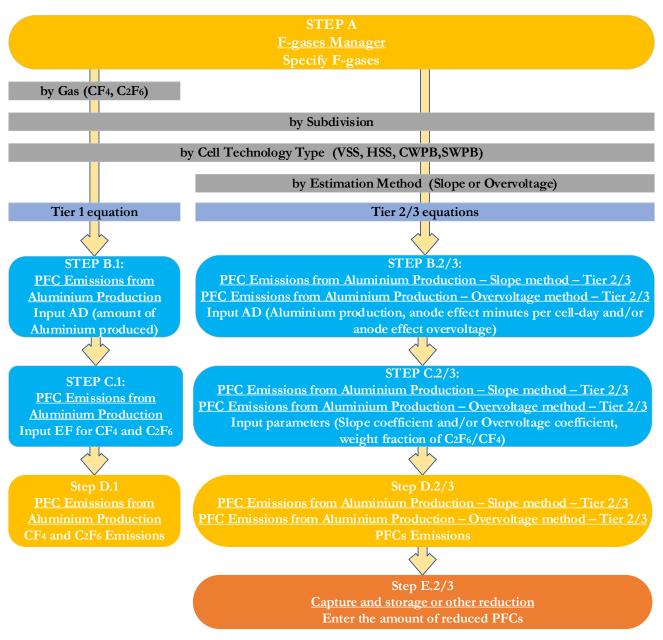
Step B.2/3, in the worksheet CO_2 Emissions from Paste Consumption (Søderberg) – Tier 2/3, users collect and input emissions of cyclohexane soluble matter, binder content in paste, sulphur, hydrogen and ash content in pitch, sulphur and ash content in calcined coke, and carbon in skimmed dust from Soderberg cells.

Step C.2/3, in the worksheet CO₂ Emissions from Paste Consumption (Søderberg) – Tier 2/3, the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

Then, for each tier, as appropriate:

Step D.2/3, in the worksheet Capture and storage or other reduction, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates) or other GHG, not otherwise captured in the worksheets above.

Aluminium Production – PFCs – flowchart



Thus, for the source-category:

Step A, **1.1.2 F-gases Manager**, users ensure that all F-gases emitted for this source category (in this case, PFCs) have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step B.1, in the worksheet **PFC Emissions from Aluminium Production**, users collect and input in the *Software* information on the amount of aluminium produced by each type of technology (CWPB, SWPB, VSS and HSS).

Step C.1, in the worksheet **PFC Emissions from Aluminium Production**, for each type of technology (CWPB, SWPB, VSS and HSS) users input respective CF_4 and C_2F_6 EFs.

Step D.1, in the worksheet **PFC Emissions from Aluminium Production**, the *Software* calculates the associated PFCs emissions (C_2F_6 and CF_4) for each subdivision in mass units (kg and Gg). In addition, the total emissions of all subdivisions are shown.

When Tier 2/Tier 3 Equations are applied:

For Slope method

Step B.2/3, in the worksheet **PFC Emissions from Aluminium Production – Slope method – Tier 2/3**, users collect and input in the *Software* information on the amount of aluminium produced by each production technology type (CWPB, SWPB, VSS and HSS) and anode effect in minutes per cell-day.

Step C.2/3, in the worksheet PFC Emissions from Aluminium Production – Slope method – Tier 2/3, for each production technology type (CWPB, SWPB, VSS and HSS) users input slope coefficient for CF₄ and weight fraction of C_2F_6 per CF₄.

Step D.2/3, in the worksheet **PFC Emissions from Aluminium Production – Slope method – Tier 2/3**, the *Software* calculates the associated PFC emissions (C_2F_6 and CF_4) for each subdivision in mass units (kg and Gg). In addition, the total emissions of all subdivisions are shown in each worksheet.

For Overvoltage method

Step B.2/3, in the worksheet **PFC Emissions from Aluminium Production – Overvoltage method – Tier 2/3,** users collect and input in the *Software* information on the amount of aluminium produced by each production technology type (CWPB and SWPB) and the corresponding anode effect overvoltage.

Step C.2/3, in the worksheet PFC Emissions from Aluminium Production – Overvoltage method – Tier 2/3, for each production technology type (CWPB and SWPB) users input the overvoltage coefficient for CF₄, process current efficiency and weight fraction of C_2F_6 per CF₄.

Step D.2/3, in the worksheet **PFC Emissions from Aluminium Production – Overvoltage method – Tier 2/3,** the *Software* calculates the associated PFC emissions (C_2F_6 and CF_4) for each subdivision in mass units (kg and Gg). In addition, the total emissions of all subdivisions are shown in each worksheet.

Then, for each tier, as appropriate:

Step E.2/3, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of reduced PFCs (C_2F_6 and CF_4), not otherwise captured in the worksheets above.

Activity data input

Section 4.4.2.5 in Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Aluminium Production.

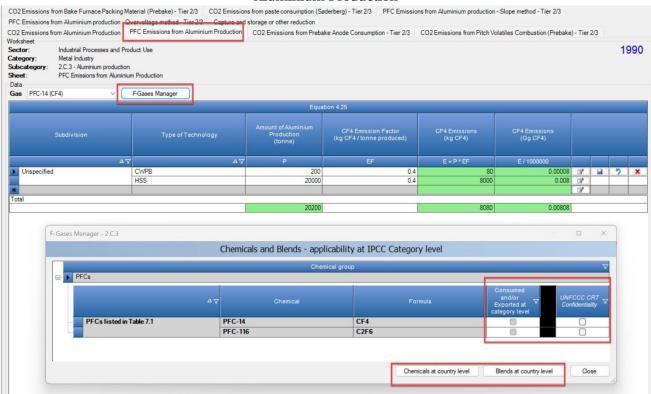
As a **Starting step**, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases to be reported for the source category Aluminium Production. In this case, the only relevant F-gases are CF_4 and C_2F_6 .

<u>Note that</u> if either of these gases is not checked in the F-gases Manager, then it will not be possible to enter any data. If data entry is not possible, select the **F-Gases Manager** from any tab for PFC emissions. This will open the F-gases Manager – applicability at IPCC Category Level. Navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level- F-gases Manager to check CF_4 and C_2F_6 . Save and close the dialogue box for the country level F-gases Manager and the user returns to the Category level F-gases Manager.

The user is not required to further select relevant F-gases for this category (CF_4 and C_2F_6 will be automatically checked).

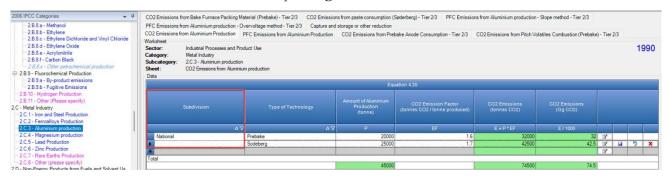
For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool: If emissions for this category are considered confidential, the user may check the box UNFCCC CRT Confidentiality. If checked, "IE" will be reported for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT, as unspecified mix of HFCs and PFCs, in tonnes CO₂ equivalents.

Example: Populating the F-gases manager and designating confidentiality for category: Aluminium Production



Second, input of AD for the Aluminium Production source category requires the user to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision



Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

2006 IPCC Categories 🗸 🗸	CO2 Emissions from Bake Furnace P	acking Material (Prebake) - Tier 2/3	CO2 Emission	s from paste consumption (Søderberg) - Tier 2/3 PFC Emissio	ons from Aluminium production	- Slope method - Tier 2/3			
2.8.8.a - Methanol 2.8.8.b - Ethylene 2.8.8.c - Ethylene Dichloride and Vinyl Chloride		uction - Overvoltage method - Tier 2/3 uction PFC Emissions from Aluminiu			bake Anode Consumption - Tier 2/3	CO2 Emissions from Pitch Vo	platiles Combustion (Prebake) - Tier 2/3		
28.8.4 - Ethylene Oxide 28.8.e - Acrylonithile 28.8.4 - Carbon Black 28.8.4 - Carbon Black 28.8.4 - Carbon Ethechemical production 29.2.8.9.4 Fluorochemical Production	Sector: Industrial Processe Category: Metal Industry Subcategory: 2.C.3 - Aluminium p	s and Product Use roduction n Aluminium production							4	1990
2.B.9.a - By-product emissions 2.B.9.b - Fugitive Emissions			Equation 4.20							
- 2.B.10 - Hydrogen Production - 2.B.11 - Other (Please specify)					CO2 Emission Factor	CO2 Emissions	CO2 Emissions			
C - Metal Industry - 2.C.1 - Iron and Steel Production - 2.C.2 - Ferroalloys Production	Subdivision			Production (tonne)	(tonnes CO2 / tonne produced)	(tonnes CO2)	(Gg CO2)			
2.C.2 - Ferroalloys Production		۵V	ΔV	ρ	EF	E=P*EF	E / 1000			
- 2.C.4 - Magnesium production	National	Sodeberg		25000	1.7	42500	42.5	3		
2.C.5 - Lead Production	Southern	Prebake		20000	1.6	32000	32	3		
- 2.C.6 - Zinc Production - 2.C.7 - Rare Earths Production	*	Sodeberg		1000	1.7	1700	1.7		a 🤊	X
- 2.C.8 - Other (please specify)	*							3		
D - Non-Energy Products from Fuels and Solvent Us	Total									
- 2 D 1 - Lubricant Lise				46000		76200	76.2			

When Tier 1 Equations are applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheets **CO₂ Emissions from Aluminium Production and PFC Emissions from Aluminium Production,** row by row, as follows:

 <u>Column | Type of Technology |</u>: input from the drop-down menu the default type of technology or input manually country-specific type of technology (the technology can be repeated with a different name if it has different EFs, e.g. Prebake 1 or HSS 1). <u>Note that, for CO₂ emissions, the distinction is between Prebake or Soderberg. For PFC Emissions, the user has the choice of CWPB, SWPB, HSS,</u>

<u>Note that</u>, for CO₂ emissions, the distinction is between Prebake or Søderberg. For PFC Emissions, the user has the choice of CWPB, SWPB, H33, and VSS.

2. <u>Column |P|</u>: input the amount/mass of aluminium produced by each type of technology, in tonnes.

Example: AD input for CO₂ – Tier 1

CO2 Emissions from Bake Furnace Packing Material (Prebake) - Tier 2/3 CO2 Emissions from paste consumption (Søderberg) - Tier 2/3 PFC Emissions from Aluminium production - Slope method - Tier 2/3 PFC Emissions from Aluminium production - Overvoltage method - Tier 2/3 Capture and storage or other reduction CO2 Emissions from Aluminium Production PFC Emissions from Aluminium Production CO2 Emissions from Prebake Anode Consumption - Tier 2/3 CO2 Emissions from Pitch Volatiles Combustion (Prebake) Worksheet Industrial Processes and Product Use Sector: Category Metal Industry 2.C.3 - Aluminium production Subcategory: Sheet: CO2 Emissions from Aluminium production Data ation 4.20 CO2 Emission Factor CO2 Emissions (tonnes CO2) CO2 Emissions (Gg CO2) E = P * EF E/1000 Sodeberg National 42500 1.6 Prebake 20000 32000 Southern 45000 74500 74.5

Example: AD input for PFCs – Tier 1

O2 Emissions from Bake Furnace Packing	storial (Probake)	Tier 2/3 CO2 Emission	s from paste consumption (Se	derberg) - Tier 2/3 PFC Emissio	ns from Aluminium production -	Slope method - Tier 2/3	
O2 Emissions from Aluminium Production	PFC Emissions fro	m Aluminium Production	CO2 Emissions from Preba	ke Anode Consumption - Tier 2/3	CO2 Emissions from Pitch Volatiles Combustion (Pre		
ector: Industrial Processes and Pro ategory: Metal Industry ubcategory: 2.C.3 - Aluminium production heet: PFC Emissions from Aluminiu Jata							
Gas PFC-116 (C2F6) ~	F-Gases Manager						
			Equa	tion 4.25			
Subdivision	Type of Technology		Amount of Aluminium Production (tonne)	C2F6 Emission Factor (kg CF4 / tonne produced)	C2F6 Emissions (kg CF4)	C2F6 Emissions (Gg CF4)	
Δγ		۵ 7	Р	EF	E = P * EF	E / 1000000	
Unspecified	CWPB		200	0.04	8	0.00001	
0	HSS		20000	0.03	600	0.0006	
*		Type of Technology					
Total	CW	PB					
	HS	6	20200		608	0.0006	
	SW	PB					
	VSS						

When Tier 2/Tier 3 Equations are applied:

The Tier 2 methods for both Prebake and Søderberg processes make use of typical industry values for impurities while the Tier 3 methods use actual concentrations of impurities. The choice of method between the Tier 2 and Tier 3 method will depend on whether anode or paste composition data are available at the individual plant level. For CO2 emissions, the choice of worksheet depends on if the technology type is Prebake or Søderberg. For PFC emissions, the choice of worksheet depends of if the slope or overvoltage method are selected.

i. CO2 Emissions

Prebake:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from Prebake Anode Consumption-Tier 2/3, row by row, as follows:

- 1. <u>Column | MP |</u>: input the amount/mass of aluminium produced by Prebake technology in tonnes.
- 2. <u>Column |NAC|</u>: input net prebaked anode consumption per tonne of aluminium produced, in tonnes of C per tonne Al.

PFC Emissions from Alum	inium productio	n - Overvoltage method - T	Tier 2/3 Capture and st	orage or other reduction			
CO2 Emissions from Alumi Worksheet	nium Productio	n PFC Emissions from	Aluminium Production	CO2 Emissions from Preb	ake Anode Consumption -	Tier 2/3 CO2 Emissions from Pitch Volatiles (Combustion (Prebake) -
Category: Metal In Subcategory: 2.C.3 -	Aluminium produ		Consumption - Tier 2/3				
				Equ	ation 4.21		
Subdivisio		Amount of Aluminium Production (tonne)	Net prebaked anode consumption (tonnes C / tonne Al)	Sulphur content in baked anodes (%)	Ash content in baked anodes (%)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	۵⊽	MP	NAC	Sa	ASHa	E = [NAC * MP * (100-Sa-ASHa)/100] * 44/12	E / 1000
		5000	0.3	0.2	.4	5379	5.37
ALUMICO		5000					

Example: AD input for prebake anode consumption – Tier 2/3

Then, data are entered in worksheet CO_2 Emissions from Pitch Volatiles Combustion (Prebake) – Tier 2/3, row by row, as follows:

- 1. <u>Column |GA|</u>: input the amount/mass of the initial weight of green anodes, in tonnes.
- 2. <u>Column |BA|</u>: input the amount/mass of baked anode production, in tonnes.

Example: AD input for pitch volatiles combustion – Tier 2/3

FC Emissions from Aluminium productio	n - Overvoltage method	- Tier 2/3 Capture and	d storage or other reduct	ion				_	
D2 Emissions from Aluminium Productio	n PFC Emissions fro	m Aluminium Production	CO2 Emissions from	Prebake Anode Consump	tion - Tier 2/3	CO2 Emissions from Pitch Volatile	s Combustion (Prebake) - T	ier 2/3	
orksheet ector: Industrial Processes an ategory: Metal Industry ubcategory: 2.C.3 - Aluminium produ neet: CO2 Emissions from Pito ata		(Prebake) - Tier 2/3			_				199
				Equation 4.22				_	
Subdivision	Initial weight of green anodes (tonne)	Hydrogen content in green anodes (tonne)	Baked anode production (tonne)	Waste tar collected (tonne)		CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
۵7	GA	Hw	BA	wт	E = (GA - Hw - BA - WT) * 44/12	E / 1000		
ALUMICO	1500	5	900	1		21	78 2.178	3	2
K								2	Ć
otal									

Then, data are entered in worksheet CO_2 Emissions from Bake Furnace Packing Materials (Prebake) – Tier 2/3, row by row, as follows:

- 1. <u>Column |BA|:</u> input the amount/mass of baked anode production in tonnes.
- 2. <u>Column |PCC|</u>: input the amount/mass of packing coke consumed per tonnne of based anode production.

Example: AD input for bake furnace packing material (Prebake) - Tier 2/3

PFC Emissions from A				oture and storage or oth			
CO2 Emissions from Al				duction CO2 Emiss	ions from Prebake Anode	Consumption - Tier 2/3 CO2 Emissions from Pitch Volatiles	Combustion (Prebake) - T
CO2 Emissions from B	ake Furnace Pa	acking Material (Preba	ike) - Tier 2/3 CO2	Emissions from paste c	consumption (Søderberg) -	Tier 2/3 PFC Emissions from Aluminium production - Slop	e method - Tier 2/3
Category: Met Subcategory: 2.C.	al Industry 3 - Aluminium pi		umace Packing Materia	l - Tier 2/3			
					Equation 4.23		
Subdivisio	on	Baked anode production (tonne)	Packing coke consumption (tonnes / tonne BA)	Sulphur content in packing coke (%)	Ash content in packing coke (%)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	۵۵	ВА	PCC	Spc	ASHpc	E = [PCC * BA * (100-Spc-ASHpc)/100] * 44/12	E / 1000
ALUMICO		32000	0.25	5	2.5	27133.	33333 27.133
*							
Total							
		32000	0.25			27133.	33333 27.133

Søderberg:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from paste consumption (Søderberg) - Tier 2/3, row by row, as follows:

- 1. <u>Column | MP</u> |: input the amount/mass of aluminium produced by Soderberg technology, in tonnes.
- 2. <u>Column |PC|:</u> input the amount/mass of paste consumption, in tonnes per tonne of aluminium produced.

Example: AD input for paste consumption – Tier 2/3

D2 Emissions from Alumi D2 Emissions from Bake orksheet ector: Industria ategory: Metal In	Furnace Packing	Material (Preba		and the second	and the second se	sumption (Søder	And the second s				atiles Combustion (Preba Slope method - Tier 2/3	
ubcategory: 2.C.3 - A	Numinium product issions for Søderb		Consumption - Ti	er 2/3		Equation	4.24					
Subdivision	Amount of Aluminium Production (tonne)	Paste consumption (tonnes / tonne Al)	Emissions of cyclohexane soluble matter (kg CSM / tonne Al)	Binder content in paste (%)	Sulphur content in pitch (%)	Ash content in pitch (%)	Hydrogen content in pitch (%)	Sulphur content in calcined coke (%)	Ash content in calcined coke (%)	Carbon in skimmed dust from Søderberg cells (tonnes C / to	CO2 Emissions (tonnes CO2)	CO2 Emission (Gg CO2
	мр	PC	CSM			ASHp		Sc			E = (PC*MP- (CSM*MP/1000)- (BC/100)*PC*MP* ((Sp+ASHp+Hp)/100) -((100-BC)/100) *PC*MP*	
											((Sc+ASHc)/100)- MP*CD)*(44/12)	

ii. PFC Emissions

Slope method

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **PFC Emissions from Aluminium Production – Slope method – Tier 2/3,** row by row, as follows:

- 1. <u>Column |Type of Technology|</u>: input from the drop-down menu the default type of technology or input manually country-specific type of technology (the technology can be repeated with a different name if it has different EFs, e.g. HSS 1, HSS 2).
- 2. <u>Column | MP |</u>: input the amount/mass of aluminium produced, in tonnes.
- 3. <u>Column | AEM |</u>: manually input the anode effect in minutes per cell-day.

Example: AD for PFC emissions from aluminium production (slope method) - Tier 2/3

PFC Emissions from Alu	uminiur	m production - Overvoltage	method - Tier 2/3	Capture and st	orage or other reductio	n				
02 Emissions from Alu	uminiur	m Production PFC Emiss	sions from Alumini	um Production	CO2 Emissions from P	rebake Anode Consu	mption - Tier 2/3 CC	2 Emissions from Pitch	Internation (P	rehake) - Tier 2
/orksheet iector: Indus Category: Meta Subcategory: 2.C.3	strial Pr al Indust 3 - Alum	nace Packing Material (Pre ocesses and Product Use try inium production nns from Aluminium Productio			from paste consumption	n (Søderberg) - Tier 2/	3 PFC Emissions f	rom Aluminium production	n - Slope method - Tier	2/3
					Ē	Equation 4.26				
Subdivision		Type of Technology	Amount of Aluminium Production (tonne)	Anode effect minutes per cell -day, AEM (AE-Mins/cell- day)	Slope coefficient for CF4, SCF4 ((kg CF4/tonne Al)/ (AE-Mins/cell-day))	CF4 emissions from aluminium production (kg CF4)	Weight fraction of C2F6/CF4 (kg C2F6/kg CF4)	C2F6 emissions from aluminium production (kg C2F6)	CF4 emissions from aluminium production (Gg CF4)	C2F6 emissions fro aluminium productior (Gg C2F6)
				AEM	SCF4	ECF4 = SCF4 * AEM * MP		EC2F6 = ECF4 * F	ECF4 / 1000000	EC2F6 / 1000000
ALUMIA		HSS	1000	5	0.099	495	0.085	42.075	0.0005	0.00
		SWPB	1500	2	0.272	816	0.252	205.632	0.00082	0.000
		CWPB	2000	4	0.143	1144	0.121	138.424	0.00114	0.00
		VSS	3000	5	0.092	1380	0.053	73.14	0.00138	0.00
*		CWPB								
otal		SWPB								
		VSS	7500			3835		459.271	0.00384	0.00

Overvoltage method

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **PFC Emissions from Aluminium Production – Overvoltage method – Tier 2/3,** row by row, as follows:

1. <u>Column |Type of Technology</u>|: input from the drop-down menu the default type of technology or input manually country-specific type of technology (the technology can be repeated with a different name if it has different EFs, e.g. HSS 1, HSS 2).

- 2. <u>Column | MP |:</u> input the amount/mass of aluminium produced, in tonnes.
- 3. <u>Column | AEO</u> |: input anode effect overvoltage, in mV.

Example: AD for PFC emissions from aluminium production (overvoltage method) – Tier 2/3

orksheet ector:		Processes and Product Use	(
ategory: ubcategory: heet: Data		ustry uminium production sions from Aluminium Produc	tion - Overvoltage	e method - Tier 2/	3						
F-Gases Man	ager										
						Equation 4.2					
Subdivis	ion	Type of Technology	Amount of Aluminium Production (tonne)	Anode effect overvoltage, AEO (mV)	Overvoltage coefficient for CF4, OVC ((kg CF4/tonne Al)/mV)	Aluminium production process current efficiency expressed, CE	CF4 emissions from aluminium production (kg CF4)	Weight fraction of C2F6/CF4 (kg C2F6/kg CF4)	C2F6 emissions from aluminium production (kg C2F6)	CF4 emissions from aluminium production (Gg CF4)	C2F6 emission from aluminiun productio (Gg C2F6
		V	MP			CE	ECF4 = OVC * AEO / (CE/100) * MP		EC2F6 = ECF4 * _A	ECF4 / 1000000	EC2F6 100000
		CWPB	5000	400	1,16	100	2320000	0.121 🗸	280720	2.32	0.28

Emission factor input

Sections <u>4.4.2.2</u> and <u>4.4.2.3</u> in Chapter 4 Volume 3 of the *2006 IPCC Guidelines* contain information on the choice of EFs for Aluminium Production. There are four sets of default EFs:

- i) Tier 1 EFs for CO_2 (Table 4.10)
- ii) Tier 2/3 EFs for CO₂ (Tables <u>4.11</u>, <u>4.12</u>, <u>4.13</u> and <u>4.14</u>)
- iii) Tier 1 EFs for PFCs (<u>Table 4.15</u>)
- iv) Tier 2/3 EFs for PFCs (<u>Table 4.16</u>)

The default EFs are embedded in the *Software*. Users may manually over-write EFs with country-specific values. See examples of input of EFs for CO_2 emissions, followed by PFCs emissions, for different Tiers below.

When Tier 1 Equations are applied:

i. CO2 Emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **CO**₂ **Emissions from Aluminium Production,** row by row in <u>Column |EF|</u>. The user selects either default CO_2 EFs from the drop-down menu or enters manually country-specific EFs, in tonne of CO_2 per tonne of aluminium produced.

Example: Tier 1 EFs for CO₂

CO2 Emissions f	rom Bake Furnace Packing Ma	terial (Prebake) - Tier 2/3 CO2 Emission	ns from paste consumption (S	øderberg) - Tier 2/3 PFC Emis	sions from Aluminium production	- Slope method - Tier 2/3
PFC Emissions fr	rom Aluminium production - Ov	vervoltage method - Tier 2/3 Capture and	storage or other reduction			
CO2 Emissions fr	rom Aluminium Production	PFC Emissions from Aluminium Production	CO2 Emissions from Preba	ake Anode Consumption - Tier 2/3	CO2 Emissions from Pitch Vo	latiles Combustion (Prebak
Vorksheet						
Sector:	Industrial Processes and Proc	duct Use				
Category:	Metal Industry					
Subcategory:	2.C.3 - Aluminium production					
Sheet:	CO2 Emissions from Aluminiur	m production				
Data						
			Equa	ition 4.20		
	Subdivision	Type of Technology	Amount of Aluminium Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produce	CO2 Emissions d) (tonnes CO2)	CO2 Emissions (Gg CO2)
	۵7 ۲	Δ ₇	Р	EF	E = P * EF	E / 1000
National		Sodeberg	25000	1.7	42500	42.5
Southern		Prebake	20000	Type of Technology	CO2 Emission Factor tonnes CO2 / tonne produced)	
Total				Sodeberg		+-10%
			45000		/45001	74.5

ii. PFC Emissions

For each combination of subdivision, gas and type of technology, data are entered in worksheet **PFC Emissions** from Aluminium Production, row by row in <u>Column |EF|</u>. The user selects either default CF₄ or C₂F₆ EFs from the drop-down menu or enters manually country-specific EFs in kg of CF₄ or C₂F₆ per tonne of aluminium produced. <u>Note that</u> the user shall select "PFC-14(CF₄)" or "PFC-116(C₂F₆)" in the "Gas" bar at the top, to enter data for each GHG one by one

CO2 Emissions from Bake Furnace Packing Ma	aterial (Prebake) - Tier 2/3 CO2 Emission	is from paste consumption (Se	derberg) - Tier 2/3 PFC Emiss	sions from Aluminium produc	tion - Slope method - Tier 2/3
PFC Emissions from Aluminium production - O	vervoltage method - Tier 2/3 Capture and	storage or other reduction			
CO2 Emissions from Aluminium Production		CO2 Emissions from Preba	ke Anode Consumption - Tier 2/3	CO2 Emissions from Pito	ch Volatiles Combustion (Prebake) -
Sector: Industrial Processes and Pro Category: Metal Industry Subcategory: 2.C.3 - Aluminium production Sheet: PFC Emissions from Aluminiu Data Gas PFC-116 (C2F6)					
		Equa	tion 4.25		
Subdivision	Type of Technology	Amount of Aluminium Production (tonne)	C2F6 Emission Factor (kg CF4 / tonne produced)	C2F6 Emissions (kg CF4)	C2F6 Emissions (Gg CF4)
Δ 🖓	۵. ک	Р	EF	E = P * EF	E / 1000000
Unspecified	CWPB	200	0.		8 0.00001
•	HSS	20000	0.03	 ✓ 	0.0006
* Total			Type of Technology	? Emission Factor kg CF4 / tonne produced)	Remark
		20200	HSS	0.03	-80%/+180%

Example: Tier 1 EFs input for PFCs

When Tier 2/3 Equations are applied:

i.CO2 Emissions

Prebake

For each subdivision in worksheet CO₂ emissions from Prebake Anode Consumption – Tier 2/3::

- 1. <u>Column |Sa|</u> input either the default Tier 2 value of 2% sulphur content in baked anodes or plant-specific Tier 3 parameters, in %
- 2. <u>Column |ASHa|</u> input either the default Tier 2 value of 0.4% ash content in baked anodes or plant-specific Tier 3 parameters, in %.

Example: Tier 2/3 EFs (parameters) Input for Prebake Anode Consumption for CO2

PFC Emissions from Aluminium produc	ction - Overvoltage me	thod - Tier 2/3 Cap	ture and storage or othe	er reduction			
CO2 Emissions from Bake Furnace Pa	cking Material (Prebal	(e) - Tier 2/3 CO2 E	Emissions from paste co	onsumption (Søderberg)	- Tier 2/3 PFC Emissio	ns from Aluminium production - Slope m	ethod - Tier 2/3
O2 Emissions from Aluminium Produc lorksheet	ction PFC Emission	s from Aluminium Prod	duction CO2 Emissi	ons from Prebake Anode	e Consumption - Tier 2/3	CO2 Emissions from Pitch Volatiles Co	ombustion (Prebake) - Ti
iector: Industrial Processes iategory: Metal Industry iubcategory: 2.C.3 - Aluminium pro heet: CO2 Emissions for Pr Data	oduction	Anode Consumption - 1	Tier 2/3				
				Equation 4.21			
Subdivision	Amount of Aluminium Production (tonne)	Net prebaked anode consumptior (tonnes C / tonne Al)	Sulphur content in baked anodes (%)	Ash content in baked anodes (%)		CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
v	MP	NAC	Sa ∆	ASHa	E = [NAC * MP	* (100-Sa-ASHa)/100] * 44/12	E / 1000
ALUMICO	5000	0.3	2	0.4		53	68 5.36
*							
Total							

Then, for each subdivision in worksheet CO_2 Emissions from Pitch Volatiles Combustion (Prebake) – Tier 2/3:

1. <u>Column |Hw</u>|: the user has the option to specify the hydrogen content in green anodes directly, in tonnes, or calculate it, as follows:

<u>Specified:</u> User enters the hydrogen content in green anodes directly in the cell, in tonnes, noting the default assumption of 0.005 multiplied by the value entered in <u>Column [GA]</u> for the initial weight of green anodes processed.

<u>Calculated (to be added)</u>: User selects the drop-down table and selects from the drop-down menu the IPCC default hydrogen content in green anodes (fraction) of 0.005 or enter in a plant-specific Tier 3 parameter. This is then multiplied by the value entered in <u>Column |GA|</u> to calculate the total hydrogen content in green anodes processed.

2. <u>Column |WT|</u>: the user has the option to specify the waste tar collected, in tonnes, or calculate it, as follows:

<u>Specified:</u> User enters the mass of waste tar collected directly in the cell, in tonnes, noting the default assumption of 0.005 multiplied by the value entered in <u>Column |GA|</u> (for Riedhammer furnaces), and insignificant for all other furnace types.

<u>Calculated (to be added)</u>: User selects the drop-down table and selects from the drop-down menu the appropriate IPCC default value for waste tar collected (0.005 for Riedhammer furnaces or enter in a plant-specific Tier 3 parameter. This value is then multiplied by the value entered in <u>Column |GA|</u> to calculate the total tonnes of waste tar collected.

Example: Tier 2/3 EFs (parameters) input for pitch volatiles combustion for CO₂

CO2 Emissions from Bake Furnace Pac					PFC Emissions from Aluminium production - Slope m	Contraction of the second state of the second	0.0	
D2 Emissions from Aluminium Product	tion PFC Emissions fro	om Aluminium Production	CO2 Emissions from	Prebake Anode Consumption	n - Tier 2/3 CO2 Emissions from Pitch Volatiles Co	ombustion (Prebake) - Ti	er 2/3	
Vorksheet Sector: Industrial Processes a Category: Metal Industry Subcategory: 2.C.3 - Aluminium pro Sheet: CO2 Emissions from F Data		(Prebake) - Tier 2/3						199
				Equation 4.22				
Subdivision	Initial weight of green anodes (tonne)	Hydrogen content in green anodes (tonne)	Baked anode production (tonne)	Waste tar collected (tonne)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
Subdivision 쇼 ⊽	anodes (tonne)	green anodes	production					
	anodes (tonne)	green anodes (tonne) Hw	production (tonne)	(tonne)	(tonnes CO2)	(Gg CO2) E / 1000	3 3	2

Then, for each subdivision in worksheet CO₂ Emissions from Bake Furnace Packing Materials (Prebake) – Tier 2/3:

- 1. <u>Column |Spc|</u> input either the default Tier 2 value of 2% of sulphur content in packing coke (wt %) or plant-specific Tier 3 parameters.
- 2. <u>Column | ASHpc |</u> input either the default Tier 2 value of 2.5 % ash content in packing coke (wt %) or plant-specific Tier 3 parameters.

Example: Tier 2/3 EFs (parameters) input for bake furnace packing materials for CO₂

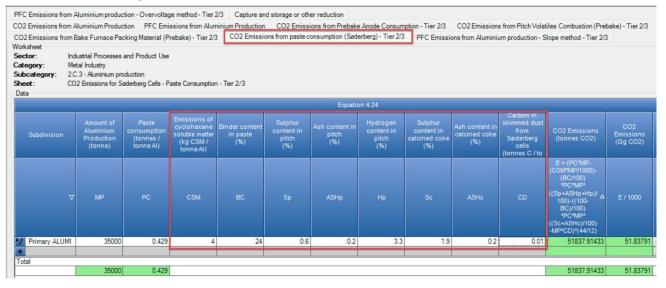
CO2 Emissions from /	Aluminium Production	PFC Emissions from A	Aluminium Production	CO2 Emissions from Prel	bake Anode Consumption -	Tier 2/3 CO2 Emissions from Pitch Volatiles C	ombustion (Prebake)
CO2 Emissions from	Bake Furnace Packing	g Material (Prebake) - Tie	r 2/3 CO2 Emissions f	rom paste consumption (S	Søderberg) - Tier 2/3 Pl	C Emissions from Aluminium production - Slope r	nethod - Tier 2/3
Category: Me Subcategory: 2.0	dustrial Processes and etal Industry C.3 - Aluminium produc D2 Emissions for Prebal		acking Material - Tier 2/3				
				Equ	uation 4.23		
Subdiv	vision	Baked anode production (tonne)	Packing coke consumption (tonnes / tonne BA)	Sulphur content in packing coke (%)	Ash content in packing coke (%)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	AV	BA	PCC	Spc	ASHpc	E = [PCC * BA * (100-Spc-ASHpc)/100] * 44/12	E / 1000
	- •						28.013
ALUMICO		32000	0.25	2	2.5	28013.33333	28.01.
ALUMICO		32000	0.25	2	2.5	28013.33333	28.01.

Søderberg

Then, for each subdivision in worksheet CO₂ Emissions from paste consumption (Soderberg) – Tier 2/3:

- 1. <u>Column |CSM|</u>:select from the drop-down menu the emissions of cyclohexane soluble matter in kg per tonne Al (the default Tier 2 value for HSS =4.0 and for VSS = 0.5 kg/tonne) or enter a user-specific value.
- 2. <u>Column |BC|</u>: select from the drop-down menu the binder content in paste in % (the default Tier 2 value is for Dry Paste 24% and for Wet Paste 27%) or enter a user-specific value.
- 3. <u>Column |Sp|:</u> select from the drop-down menu the sulphur content in pitch in % (the default Tier 2 value is 0.6%) or enter a user-specific value.
- 4. <u>Column | ASHp|</u>: select from the drop-down menu the ash content in pitch in % (the default Tier 2 value is 0.2%) or enter a user-specific value.
- 5. <u>Column |Hp|</u>: select from the drop-down menu the hydrogen content in pitch in % (the default Tier 2 value is 3.3%) or enter a user-specific value.
- 6. <u>Column |Sc|</u>: select from the drop-down menu the sulphur content in calcined coke in % (the default Tier 2 value is 1.9%) or enter a user-specific value.
- 7. <u>Column | ASHc|</u>: select from the drop-down menu the ash content in calcined coke in % (the default Tier 2 value is 0.2%) or enter a user specific value.
- 8. <u>Column |CD|</u>: select from the drop-down menu the carbon in skimmed dust from Soderberg cells in tonnes per tonne Al (the default Tier 2 value is 0.01 tonne/tonne) or enter a user specific value.

Example: Tier 2/3 EFs (parameters) input for paste consumption for CO2



ii. PFC Emissions

Slope method

For each subdivision and type of technology (CWPB, SWPB, VSS and HSS) in worksheet **PFC Emissions from Aluminium Production – Slope Method – Tier 2/3**:

- 1. <u>Column | S CF4</u> |: select from the drop-down menu the default slope coefficient for CF4 or input a plantspecific Tier 3 parameter, in (kg CF4/tonne Al)/(AE-Mins/cell-day)
- 2. <u>Column |F|</u>: select from the drop-down menu the weight fraction of C₂F₆ per CF₄ or input a plant-specific Tier 3 parameter in kg C₂F₆ per kg CF₄.

Example: Tier 2/3 EFs (parameters) input for aluminium production (slope method) for PFCs

2 Emissions from	n Aluminiur	n Production PFC Emiss	ions from Alumini	um Production	CO2 Emissions from P	rebake Anode Consur	notion - Tier 2/3 CC	2 Emissions from Pitch	/olatiles Combustion (P	rebake) - Tier
		nace Packing Material (Pre						om Aluminium productio		
ector: ategory: ubcategory:	Metal Indust 2.C.3 - Alum	ocesses and Product Use iry inium production ons from Aluminium Productio	n - Slope method -	Tier 2/3						
F-Gases Manag	jer									
						quation 4.26	0			
Subdivisi	on	Type of Technology	Amount of Aluminium Production (tonne)	Anode effect minutes per cel -day, AEM (AE-Mins/cell- day)	Slope coefficient for CF4, SCF4 ((kg CF4/tonne AI)/ (AE-Mins/cell-day))	CF4 emissions from aluminium production (kg CF4)	Weight fraction of C2F6/CF4 (kg C2F6/kg CF4)	C2F6 emissions from aluminium production (kg C2F6)	CF4 emissions from aluminium production (Gg CF4)	C2F6 emissions f aluminiu productio (Gg C2F6
	۵v	۵۷	MP		SCF4	ECF4 = SCF4 * AEM * MP	F	EC2F6 = ECF4 * F	ECF4 / 1000000	EC2F6/ 1000000
ALUMIA		CWPB	2000	4	0.143	1144	0.121	138.424	0.00114	0.0
		HSS	1000	5	0.099	495	0.085	42.0 5	0.0005	0.0
		SWPB	1500	1	0.272	816	0.252	205.632	0.00082	0.0
		VSS	3000	5	0.092 🗸	1380	0.053 🗸	73.14	0.00138	0.0
1						0.092 👙		0.053 🚖		
otal							L			

Overvoltage method

For each subdivision and type of technology (CWPB, SWPB, VSS and HSS) in worksheet **PFC Emissions from** Aluminium Production – Overvoltage Method – Tier 2/3:

- 1. <u>Column |OVC</u>|: select from the drop-down menu the default overvoltage coefficient for CF₄ or input a plant-specific Tier 3 parameter, in (kg CF₄/tonne Al) per mV.
- 2. <u>Column |CE|</u>: aluminium production process current efficiency expressed in % (<u>Equation 4.27</u> provides an example of 95 %).
- 3. <u>Column |F|</u>: select from the drop-down menu the default weight fraction of C₂F₆ per CF₄ or input a plant-specific Tier 3 parameter, in kg C₂F₆ per kg CF₄.

Example: Tier 2/3 EFs (Parameters) input for aluminium production (overvoltage method) for PFCs

the second design of the secon	urnace Packing Material (Pr	and the second se	-			- Tier 2/3 PFC Er	nissions from Alumini	ium production - Slope	e method - Tier 2	13
ategory: Metal Indu ubcategory: 2.C.3 - Alu	Processes and Product Use	1		storage or other red	uction					
F-Gases Manager					Equation 4.27					
	i i				Aluminium				-	
Subdivision	Type of Technology	Amount of Aluminium Production (tonne)	Anode effect overvoltage, AEO (mV)	Overvoltage coefficient for CF4, OVC ((kg CF4/tonne Al)/mV)	production process current efficiency expressed, CE	CF4 emissions from aluminium production (kg CF4)	Weight fraction of C2F6/CF4 (kg C2F6/kg CF4)	C2F6 emissions from aluminium production (kg C2F6)	C ² 4 emissions from aluminium production (Gg CF4)	C2F6 emissions fro aluminium production (Gg C2F6)
Subdivision		Aluminium Production	overvoltage, AEO	ovefficient for CF4, OVC ((kg CF4/tonne)	production process current efficiency	from aluminium production	C2F6/CF4	from aluminium production	from aluminium production	emissions fro aluminium production
		Aluminium Production (tonne)	overvoltage, AEO (mV)	oefficient for CF4, OVC ((kg CF4/tonne Al)/mV)	production process current efficiency expressed, CE	from aluminium production (kg CF4) ECF4 = OVC * AEO / (CE/100) *	Č2F6/CF4 (kg C2F6/kg CF4)	from aluminium production (kg C2F6)	from aluminium production (Gg CF4) ECF4 /	emissions fro aluminium production (Gg C2F6) EC2F6 /
		Aluminium Production (tonne)	overvoltage, AEO (mV)	oefficient for CF4, OVC ((kg CF4/tonne Al)/mV)	production process current efficiency expressed, CE	from aluminium production (kg CF4) ECF4 = OVC * AEO / (CE/100) *	Č2F6/CF4 (kg C2F6/kg CF4)	from aluminium production (kg C2F6)	from aluminium production (Gg CF4) ECF4 /	emis: alı pro (G
۵٦		Aluminium Production (tonne) MP	overvoltage, AEO (mV) AEO	coefficient for CF4, OVC ((kg CF4/tonne Al)/mV) OVC	production process current efficiency expressed, CE CE	from aluminium production (kg CF4) ECF4 = OVC * AEO / (CE/100) * MP	Č2F6/CF4 (kg C2F6/kg CF4) F	From aluminium production (kg C2F6) EC2F6 = ECF4 * F	from aluminium production (Gg CF4) ECF4 / 1000000	emissions aluminin producti (Gg C2F EC2F6 100000

Results

CO₂ and PFC emissions from Aluminium Production are estimated in mass units (tonnes and Gg for CO₂ and kg and Gg for PFCs) by the *Software* in the following worksheets:

CO₂ emissions:

- ✓ CO₂ emissions from Aluminium Production
- ✓ CO₂ emissions from Prebake Anode Consumption Tier 2/3
- ✓ CO₂ emissions from Pitch Volatiles Combustion (Prebake) Tier 2/3
- ✓ CO₂ emissions from Bake Furnace Packing Material (Prebake) Tier 2/3
- ✓ CO₂ emissions from Paste Consumption (Soderberg) Tier 2/3

PFCs emissions:

- ✓ PFC Emissions from Aluminium Production
- ✓ PFC Emissions from Aluminium Production Slope Method Tier 2/3
- ✓ PFC Emissions from Aluminium Production Overvoltage Method Tier 2/3:

Total CO_2 and PFC emissions from aluminium production is the sum of all emissions in the above worksheets, taking into account any capture and storage or other reduction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions.

In the worksheet **Capture and storage or other reduction** for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the drop-down menu, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂ or PFC emissions, in tonnes.

<u>Note that</u>: <u>Column |B|</u> may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.

Example: Capture and storage or other reduction

CO2 Emissions fr	om Bake Furnace Packing N	laterial (Prebake) - Tier 2	/3 CO2 Emissions	from paste consumption (Søde	rberg) - Tier 2/3 PFC Emiss	ions from Aluminium productio	on - Slope method - Tier 2/3		
CO2 Emissions fro	om Aluminium Production	PFC Emissions from Alu	minium Production	CO2 Emissions from Prebake	Anode Consumption - Tier 2/3	CO2 Emissions from Pitch	Volatiles Combustion (Prebak	e) - Tier	2/3
PFC Emissions fr	om Aluminium production - (vervoltage method - Tier	r 2/3 Capture and st	torage or other reduction					
Worksheet									
Sector:	Industrial Processes and Pr	duct Use							
Category:	Metal Industry								
Subcategory:	2.C.3 - Aluminium productio	1							
Sheet:	Capture and storage or othe	r reduction							
Data									
Gas CARBO	ON DIOXIDE (CO2)	~							
L									
								ř	
	Subdivision		urce	Amount CO2 captured and stored	Other reduction	Total reduction	Total reduction		
	Subdivision		uice	(tonne)	(tonne)	(tonne)	(Gg)		
	S 🛆	⊽ SRC) 🗛	A	В	C = A + B	C / 1000		
* ALUMINA		Stream#A		2		2	0.002	2	
*								3	
Total				1					
						2	0.002		

2.C.4 Magnesium Production

Information

The 2006 IPCC Guidelines provide guidance for estimation of CO_2 and SF_6 emissions from Magnesium Production, nothing however that other possible GHG emissions include fluorinated ketone and various fluorinated decomposition products such as PFCs

For CO₂, the Tier 1 method is based on national production data on and default EFs, while the Tier 2 - EF method relies on company or plant-specific EFs. For SF₆, the Tier 1 is also based on national production data and default EFs while the Tier 2 relies on statistics national or sub- national consumption of SF₆ in the industry and default EFs. Tier 3 methods for both CO₂ and SF₆ are based on direct measurements.

GHGs

The *Software* allows for the estimation of the following GHGs for the Magnesium Production source category, noting that only methods for CO₂ and SF₆ are provided in the 2006 IPCC Guidelines.

<u>Note that</u> for users using the Software for reporting to the UNFCCC ETF Reporting Tool, the MPGs provide for reporting of all F-gases (except NF3) for this category. Users may consider whether the methods for SF6 may also be applicable for other fluorinated gases. All fluorinated gases can be reported in the Software.

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X			Χ	X	Χ	X

IPCC Equations

GHG emissions from the Magnesium Production source category are estimated by applying the following IPCC equations (Chapter 4 Volume 3 of the 2006 IPCC Guidelines):

For CO₂

- \checkmark <u>Tier 1</u>: <u>Equation 4.28</u>
- ✓ <u>Tier 2</u>: <u>Equation 4.29</u>
- ✓ <u>Tier 3:</u> no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines; emissions based on direct measurement

For SF₆

- ✓ <u>Tier 1</u>: <u>Equation 4.30</u>
- $\checkmark \quad \underline{\text{Tier } 2}: \underline{\text{Equation } 4.31}$
- ✓ <u>Tier 3:</u> no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines; emissions based on direct measurement

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

The *Software* calculates CO₂ and F-gas emissions from the Magnesium Production source category using the following six worksheets:

CO₂ emissions:

- ✓ CO₂ Emissions from Magnesium Production: contains for each subdivision and each type of raw material used (e.g. dolomite, magnesite) information on the amount magnesium produced and default CO₂ EFs. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Magnesium Production Tier 2: contains for each subdivision information on the amount of magnesium produced and country/plant-specific CO₂ EFs. The worksheet calculates the associated CO₂ emissions for Tier 2.

F-gas emissions:

- ✓ 1.1.2 F-gases Manager: contains data on F-gases used (including imported) and/or produced and exported in the country.
- ✓ F-gases from Magnesium Casting: contains for each subdivision information on the amount of magnesium casting and corresponding default EF (SF₆ only). The worksheet calculates the associated emissions for Tier 1.
- ✓ SF₆ emissions from Magnesium Casting Tier 2: contains for each subdivision information on the company/plant-specific consumption of the fluorinated gas. Emissions are equal to consumption.

Capture and storage or other reduction (CO₂ and F-gas):

✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂ and SF₆ not accounted previously in the worksheets for different Tiers.

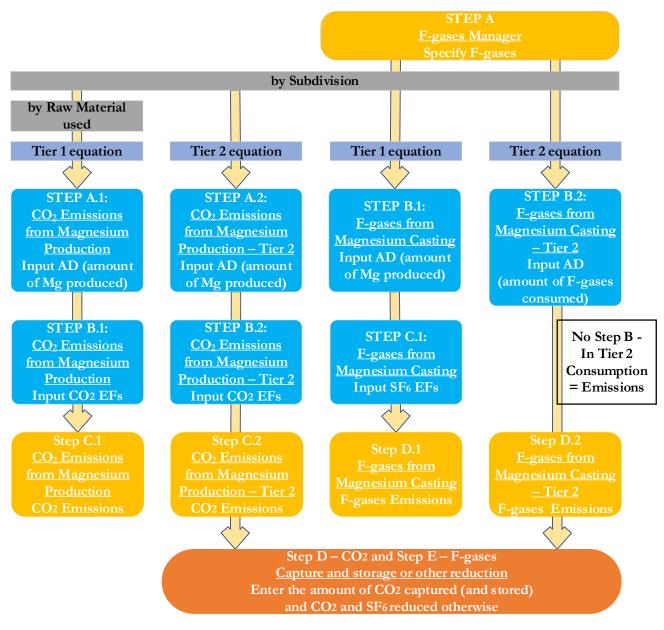
User's work Flowchart

Consistent with the key category analysis and the decision trees in Figure 4.13 (for CO_2) and Figure 4.14 (for SF_6) of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for the estimation of CO_2 and SF_6 emissions from magnesium production.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Magnesium Production - flowchart



Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When Tier 1 Equations are applied:

i. CO2 emissions

Step A.1, in the worksheet **CO**₂ **Emissions from Magnesium Production,** for each type of raw material used (e.g. dolomite, magnesite) users collect and input in the *Software* information on the amount of magnesium produced.

Step B.1, in the worksheet CO_2 Emissions from Magnesium Production, for each type of raw material used users input the respective CO_2 EFs.

Step C.1, in the worksheet CO_2 Emissions from Magnesium Production the *Software* calculates the associated emissions for each subdivision in mass units (tonnes and Gg). In addition, the total emissions of all subdivisions are shown.

ii. F-gas emissions

Step A, **1.1.2 F-gases Manager**, users ensure that all F-gases emitted for this source category have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Step B.1, in the worksheet F-Gases from Magnesium Casting, users collect and input in the *Software* information on the amount of magnesium casting or handling in the country, by casting system.

Step C.1, in the worksheet F-Gases from Magnesium Casting, users input respective EFs (default EF available for SF_6 only).

Step D.1, in the worksheet **F-Gases from Magnesium Casting**, the *Software* calculates the associated emissions for each subdivision in mass units (kg and Gg). In addition, the total emissions of all subdivisions are shown.

When Tier 2 Equations are applied:

i. CO2 emissions

Step A.2, in the worksheet CO₂ Emissions from Magnesium Production– Tier 2, users collect and input in the *Software* information on the amount of primary magnesium produced at each plant.

Step B.2, in the worksheet **CO**₂ **Emissions from Magnesium Production – Tier 2**, users input country/plant-specific CO₂ EFs.

Step C.2, in the worksheet CO_2 Emissions from Magnesium Production – Tier 2 the *Software* calculates the associated emissions for subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown in each worksheet.

ii. F-gas emissions

Step A, **1.1.2 F-gases Manager**, users ensure that all F-gases emitted for this source category have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Step B.2, in the worksheet **F-gases from Magnesium Casting – Tier 2**, users collect and input information on the amount of F-gases consumed in magnesium smelters and foundries.

Step C.2, in the worksheet **F-gases from Magnesium Casting – Tier 2**, the *Software* automatically calculates emissions as equal to consumption in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

Then, for each tier, as appropriate:

Step D (CO₂)/Step E (F-gases), in the worksheet Capture and storage or other reduction, if applicable for higher-tiered methods, users collect and input information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., re-conversion to carbonates) or other GHG, not otherwise captured in the worksheets above.

Activity data input

Section 4.5.2.3 in Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of AD for Magnesium Production.

As a **Starting step**, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases to be reported for the source category Magnesium Production.

<u>Note that</u> if relevant gases are not checked in the F-gases Manager, then it will not be possible to enter any data. If data entry is not possible, select the **F-Gases Manager** from any tab for F-Gases from Magnesium Production. This will open the F-gases Manager – applicability at IPCC Category Level. Either select the relevant gases, or if none are available for selection, navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level- F-gases Manager to select the relevant gases. Save and close the dialogue box for the country level F-gases Manager and the user returns to the Category level F-gases Manager to indicate those gases used for Magnesium Production.

<u>For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool:</u> If emissions for this category are considered confidential, the user may check the box UNFCCC CRT Confidentiality. If checked, "IE" will be reported for emissions in the JSON file generated for the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate.

Example: Populating the F-gases manager and designating confidentiality for category: Magnesium Production

per
Equation 4.30
Amount of Magnesium Emission Factor Emissions Emissions
Casting (kg F-Gas / tonne casting) (kg F-Gas) (Gg F-Gas)
Δ7 C EF E=C*EF E/1000000
3000 😣
3000 0
cals and Blends - applicability at IPCC Category level
Chemical group
Consumed
and/or UNFCCC CF
and/or UNECCC CE
Chemical Formula and/or VINFCCC Ci Exported at Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or UNFCCC CI Exported at V category level
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or Exported at category level UNFCCC CF Confidential Ir Hexafluoride SF6 Image: Confidential
Chemical Formula and/or 모 Exported at Category level

Second, input of AD for the Magnesium Production source category requires the user to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

2006 IPCC Categories 🗸 🦊	CO2 Emissions from Magnesium Production	CO2 Emissions from Magnesium Productio	n - Tier 2 F-Gases from Ma	agnesium Casting F-Gases from M	lagnesium Casting - Tier 2	Capture and storage or other	reduction		
28.9.6 - Fugitive Emissions -28.10 - Hydrogen Production -28.11 - Other (Please specify) 2C - Metal Industry -2.C - Ferroalloys Production -2.C - Ferroalloys Production	Worksheet Sector: Industrial Processes and Prod Category: Metal Industry Subcategory: 2.C.4 - Magnesium production Sheet: CO2 Emissions from Magnesiu Data							1	990
- 2.C.3 - Aluminium production			Equi	ation 4.28					
2.C.4 - Magnesium production - 2.C.5 - Lead Production - 2.C.6 - Zinc Production - 2.C.7 - Rare Earths Production - 2.C.8 - Other (please specify)	Subdivision		Amount of Primary Magnesium Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
2.D - Non-Energy Products from Fuels and Solvent Us		۵7	P	EF	E = P * EF	E / 1000			
- 2.D.1 - Lobricant Use - 2.D.2 - Paraffin Wax Use - 2.D.3 - Solvent Use	Unspecified	Dolomite	2000	5.13 🗸	1026	0 10.26	3 6	1 2	×
2.D.4 - Other (please specify) 2.E - Electronics Industry	Total		2000		1026	0 10.26			_
2.E.1 - Integrated Circuit or Semiconductor									

Example: single subdivision (unspecified)

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example:	multiple	subdivisions
----------	----------	--------------

2006 IPCC Categories 🗸 🗸 🦊	CO2 Emissions from Magnesium Production	CO2 Emissions from Magnesium Production	on - Tier 2 F-Gases from M	lagnesium Casting F-Gases from Mi	agnesium Casting - Tier 2	Capture and storage or othe	er reducti	ion	
2.8.9.6 - Fugitive Emissions 2.8.10 - Hydrogen Production 2.8.11 - Other (Please specify) 2.C - Metal Industry 2.C - I - Iron and Steel Production 2.C - 2- Ferrolloys Production	Worksheet Sector: Industrial Processes and Pro Category: Metal Industry Subcategory: 2.C.4 - Magnesium producti Sheet: F-Gases from Magnesium C Data	on							1990
= 2.C.3 - Aluminium production	Gas Sulphur Hexafluoride (SF6)	✓ F-Gases Manager							
2.C.4 - Magnesium production 2.C.5 - Lead Production			Equ	ation 4.30					
2.C.6 - Zinc Production 2.C.7 - Rare Earths Production 2.C.8 - Other (please specify) 2 Non-Energy Products from Fuels and Solvent Us	Subdivision	Casting System	Amount of Magnesium Casting (tonne)	Emission Factor (kg F-Gas / tonne casting)	Emissions (kg F-Gas)	Emissions (Gg F-Gas)			
- 2.D.1 - Lubricant Use									
-2.D.2 - Paraffin Wax Use -2.D.3 - Solvent Use	Δ 7					E / 1000000			
2.D.3 - Solvent Use 2.D.4 - Other (please specify)	Northern	All Casting Processes	3000	1	3000		3 📝		
2.0.4 - Other (please specify)	Southern	All Casting Processes	2000	1	2000	0.002	2 🕜		7 X
2.E.1 - Integrated Circuit or Semiconductor		-					3		
2.E.2 - TFT Flat Panel Display	Total						-		
-2.E.3 - Photovoltaics			5000		5000	0.005	5		

When Tier 1 Equations are applied

i.CO2 emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **CO**₂ **Emissions from Magnesium Production** row by row, as follows:

- 1. <u>Column |Raw Material Source|</u>: input from the drop-down menu the default type of raw material used (dolomite or magnesite) or input manually the country-specific raw material used.
- 2. <u>Column | P |</u>: input the amount/mass of magnesium produced, in tonnes.

	1							19	99
		Equa	ition 4.28						
bdivision	Raw Material Source	Amount of Primary Magnesium Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)				
Δ7	Δ 🗸	Р	EF	E = P * EF	E / 1000				
A Y				10000	10.00		1.1.1	-	
	Dolomite	2000	5.13	10260	10.26	1		2	-
	etal Industry C.4 - Magnesium productior D2 Emissions from Magnesiu	etal Industry C.4 - Magnesium production 22 Emissions from Magnesium production	etal Industry C.4 - Magnesium production D2 Emissions from Magnesium production Equa odivision Raw Material Source Magnesium Production	etal Industry C.4 - Magnesium production D2 Emissions from Magnesium production Equation 4.28 Solivision Raw Material Source Amount of Primary CO2 Emission Factor (Songer CO2 Magnesium Production	etal Industry C.4 - Magnesium production D2 Emissions from Magnesium production Equation 4.28 Description 4.	etal Industry C.4 - Magnesium production D2 Emissions from Magnesium production Equation 4.28 Solivision Raw Material Source Amount of Primary CO2 Emission Factor (CO2 Emissions CO2 Emissions (CO2 Emis) (CO2 Emission	etal Industry C.4 - Magnesium production D2 Emissions from Magnesium production Equation 4.28 Sdivision Raw Material Source Amount of Primary CO2 Emission Factor (CO2 Emissions CO2 Emissions (CO2 Emis)	etal Industry C.4 - Magnesium production D2 Emissions from Magnesium production Equation 4.28	etal Industry C.4 - Magnesium production 22 Emissions from Magnesium production Equation 4.28 Solivision Raw Material Source Amount of Primary CO2 Emission Factor (CO2 Emissions CO2 Emissions (CO2 Emis) (CO2 Emission

ii. F-gas emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **F-gases from Magnesium Casting** row by row, as follows:

- 1. <u>Column |Casting system|</u>: input from the drop-down menu the default type of casting system or input manually country-specific system.
- 2. <u>Column |C|</u>: input the amount/mass of magnesium casting, in tonnes.

CO2 Emissions from Magnesium Production	CO2 Emissions from Magnesium Production	n - Tier 2 F-Gases from Ma	agnesium Casting F-Gases from M	agnesium Casting - Tier 2	Capture and storage or other	reduction		
Worksheet Sector: Industrial Processes and I Category: Metal Industry Subcategory: 2.C.4 - Magnesium produc Sheet: F-Gases from Magnesium Data	tion						1	990
Gas Sulphur Hexafluoride (SF6)	V F-Gases Manager							
		Equ	ation 4.30		,			
Subdivision	Casting System	Amount of Magnesium Casting (tonne)	Emission Factor (kg F-Gas / tonne casting)	Emissions (kg F-Gas)	Emissions (Gg F-Gas)			
4		с	EF	E = C * EF	E / 1000000			
Northern	All Casting Processes	3000	1	3000	0.003	3		
Southern	All Casting Processes	2000	1	2000	0.002		2	
*						2		
Total								
		5000		5000	0.005			

Example: Tier 1 AD input for SF₆

When Tier 2 Equations are applied

i.CO2 emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 emissions from Magnesium Production – Tier 2 row by row, as follows:

1. <u>Column |P|</u>: input the amount/mass of primary magnesium produced, in tonnes.

$\textit{Example: Tier 2 AD input for CO}_2$

	om Magnesium Production	CO2 Emiss	ions from Magnesium Production - Ti	er 2 F-Gases from Magnesium Cast	ing F-Gases from Magnesium Cas	sting - Tier 2 Capture and storage		
Worksheet Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Pro Metal Industry 2.C.4 - Magnesium production CO2 Emissions from Magnesi	on	n - Tier 2					
			Equation 4.29					
	Subdivision		Amount of Primary Magnesium Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
		ΔV	P	EF	E = P * EF	E / 1000		
Unspecified			233	2	466	0.466		
*								
Total		1	233		466	0.466		

ii. F-gas emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **F-gases from Magnesium Casting** – **Tier 2** row by row, as follows:

1. Column |Ci|: input the amount of F-gas consumed in magnesium smelters and foundries, in tonnes.

Example: Tier 2 AD for SF_{6f}

CO2 Emissions fro	om Magnesium Production CO2 Emissions from	Magnesium Production - Tier 2 F-Gases from	Magnesium Casting F-Gases from Magnes	sium Casting - Tier 2 Capture and
Vorksheet				
Sector:	Industrial Processes and Product Use			
Category:	Metal Industry			
Subcategory:	2.C.4 - Magnesium production			
Sheet:	F-Gases from Magnesium casting - Tier 2			
Data				
Gas Sulphur H	exafluoride (SF6) V F-Ga	ases Manager		
		Fr	uation 4.31	
	Subdivision (subnational / facility)	Consumption of F-Gas in magnesium smelters and foundries (tonne)	Emissions (tonne F-Gas)	Emissions (Gg F-Gas)
	i AV	ci	Ei = Ci	E / 1000
Magnesium C	0	2500	2500	1
*				
Total				
and the second se		2500	2500	

Emission factor input

Section 4.5.2.2 in Chapter 4 Volume 3 of the 2006 IPCC Guidelines contains information on the choice of EFs for Magnesium Production. There are two sets of default EFs:

- i) Tier 1 EFs for CO_2 (Table 4.19)
- ii) Tier 1 EFs for SF_6 (Table 4.20)

When the Tier 1 Equations are applied:

i. CO2 emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **CO**₂ **Emissions from Magnesium Production,** row by row in <u>Column |EF|</u>. The user selects either default $CO_2 EFs$ from the drop-down menu or enters manually country-specific EFs, in tonne of CO_2 per tonne of magnesium produced.

<i>Example:</i> Tier 1 EFs for CO ₂	
--	--

CO2 Emissions fro	om Magnesium Production	CO2 Emissions from Magnesium Produc	ion - Tier 2 F-Gases from M	agnesium Casting F-Gases f	irom M	lagnesium Casting - Tier 2 (Capture and storage or other	reduct	ion		
Vorksheet Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Proc Metal Industry 2.C.4 - Magnesium production CO2 Emissions from Magnesi	n								1	99(
		(Equ	ation 4.28							
	Subdivision	Raw Material Source	Amount of Primary Magnesium Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produc	ced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)				
	ΔΥ	۵	P	EF		E = P * EF	E / 1000				
Unspecified		Dolomite	2000	5.1	13 ~	10260	10.26	2		っ	
* Total				Raw Material Source		CO2 Emission Factor nes CO2 / tonne produced)		emark			
			2000	Dolomite		5.13					_

ii. F-gas emissions

For each gas and each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **F-Gases from Magnesium Casting,** row by row in <u>Column |EF|</u>. The user selects either default EFs from the drop-down menu (available for SF₆ only) or enters manually country-specific EFs, in kg F gas per tonne of magnesium casting. <u>Note that</u> the user shall the relevant gas in the "Gas" bar at the top, to enter data for each F-gas one by one

Example: Tier 1 EFs for SF₆

O2 Emissions from lorksheet	m Magnesium Production	CO2 Emissions from Magnesium Production	on - Tier 2 F-Gases fro	m Magnesium Casting	F-Gases from Ma	gnesium Casting - Tier	2 Capture and storage	or other r	reducti
ector: ategory: ubcategory:	Industrial Processes and Pro Metal Industry 2.C.4 - Magnesium productio F-Gases from Magnesium Ca	n							
Gas Sulphur Hex	kafluoride (SF6)	✓ F-Gases Manager							
		I.		Equation 4.30					
	ubdivision	Casting System	Amount of Magnesin Casting (tonne)	Emissio	n Factor onne casting)	Emissions (kg F-Gas)	Emissions (Gg F-Gas)		
	ΔΥ	Δγ	C		F	E = C * EF	E / 1000000		
Northern		All Casting Processes		3000	1	3	3000	0.003	
Southern		All Casting Processes		2000	1 🗸	2	2000	0.002	
* Total				Casting Sy		Emission Factor -Gas / tonne casting)		Remark	
				5000 All Casting Proce	1000 C		1		_

When Tier 2 Equations are applied:

i. CO2 emissions

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet **CO**₂ **Emissions from Magnesium Production – Tier 2,** row by row in <u>Column |EF|</u>. For Tier 2, the user must input a company or plant-specific EF, in tonnes of CO_2 / tonne of magnesium produced.

ii. F-gas emissions

The Tier 2 approach for estimating F-gases assumes that consumption equals emissions. There is no user entry required.

Results

CO₂ and SF₆ emissions from Magnesium Production are estimated in mass units (tonnes/kg and Gg) by the *Software* in the following worksheets:

CO₂ emissions:

- ✓ CO₂ Emissions from Magnesium Production
- ✓ CO₂ Emissions from Magnesium Production Tier 2

F-gases:

- ✓ F-Gases from Magnesium Casting
- ✓ F-Gases from Magnesium Casting Tier 2

Total CO_2 and F-gas emissions from magnesium production is the sum of all emissions in the above worksheets, taking into account any capture and storage or other reduction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions.

In the worksheet **Capture and storage or other reduction** for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the drop-down menu, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂ or F-gas emissions, in tonnes.

<u>Note that</u>: <u>Column</u> [B] may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.

CO2 Emissions f Worksheet	rom Magnesium Production	CO2 Emissions from Magnesiun	n Production -	Tier 2 F-Gases from Magne	sium Casting F-Gases from	n Magnesium Casting - Tier 2	Capture and storage or othe	r reduct	tion
Sector: Category: Subcategory: Sheet:	Industrial Processes and Prod Metal Industry 2.C.4 - Magnesium production Capture and storage or other r								
CARBON HFC-125	Hexafluoride (SF6) I DIOXIDE (CO2) (CHF2CF3)	F-Gases Manag	ger						
PFC-14 (PFC-116 PFC-218	(C2F6) (C3F8)	Source		Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)		
	Hexafluoride (SF6) Trifluoride (NF3)	SRC	۵V	A	В	C = A + B	C / 1000		
Unspecifier	1	Unspecified			144	144	0.144		
Total						144	0.144		

Example: Capture and storage or other reduction

2.C.5 Lead Production and 2.C.6 Zinc Production

Information

This section groups guidance for the following source categories according to their common methodological approaches applied in the *Software*:

- ✓ 2.C.5 Lead Production
- ✓ 2.C.6 Zinc Production

The 2006 IPCC Guidelines provide three Tiers to estimate CO2 emissions from these source categories.

Tier 1 is a simple method which multiplies default EFs by AD (lead production or zinc production). If information is known, production should be disaggregated by furnace type. Tier 2 recognizes that there are differences in CO_2 emissions for production of lead and zinc depending on the production methodology and the source of the raw materials, either from secondary sources (for example, such as recycled batteries for lead production), or, from primary production from ores. Emissions can be calculated using country-specific EFs based on the use of reducing agents, furnace types and other process materials of interest. Factors can be developed based on carbon contents applicable to those materials. Tier 3 is based on directly measured CO_2 emissions data available from lead and zinc facilities or plant-specific data on use of reducing agents and other process materials.

<u>GHGs</u>

The Software includes the following GHG for the Lead Production and Zinc Production source categories:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X						

IPCC Equations

- ✓ <u>Tier 1</u>: <u>Equation 4.32</u> (Lead) and <u>Equations 4.33 and 4.34</u> (Zinc)
- ✓ <u>Tier 2</u>: No Tier 2 Equation provided; the *Software* implements the description for Tier 2 in <u>Section 4.6.2.1</u> (Lead) and <u>Section 4.7.2.1</u> (Zinc) of Chapter 4 Volume 3 of the *2006 IPCC Guidelines*
- ✓ <u>Tier 3</u>: no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines, emissions based on direct measurement or plant-specific data

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

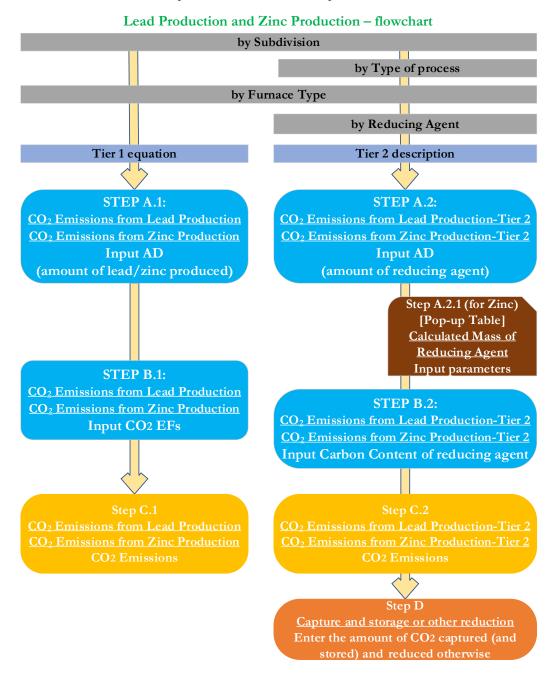
CO2 emissions from Lead Production source category are estimated using the following three worksheets:

- ✓ CO₂ Emissions from Lead Production and CO₂ Emissions from Zinc Production: contains for each subdivision and each type of furnace/source/process, if known (e.g. direct smelting, imperial smelting furnace, from secondary materials, Waelz Kiln) information on the amount of lead or zinc produced and default CO₂ EFs. The worksheets calculate the associated CO₂ emissions.
- ✓ CO₂ Emissions from Lead Production- Tier 2 and CO₂ Emissions from Zinc Production Tier 2: contains for each subdivision, type of production (primary or secondary) and type of furnace, information on the type, amount and carbon content of reducing agent or process input consumed. The worksheets calculate the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision trees in Figure 4.15 (Lead Production) and Figure 4.16 (Zinc Production) of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for the estimation of CO_2 emissions from lead production and from zinc production.



¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Thus, for the relevant source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step A.1, in the worksheet **CO**₂ **Emissions from Lead Production** or **CO**₂ **Emissions from Zinc Production,** for each type of furnace/source/process, if known, (e.g. direct smelting, imperial smelting furnace, from secondary materials, Waelz Kiln) users collect and input in the *Software* information on the amount of lead or zinc produced.

Step B.1, in the worksheet CO₂ Emissions from Lead Production or CO₂ Emissions from Zinc Production, for each type of furnace/source/process users input respective CO₂ EFs.

Step C.1, in the worksheet CO₂ Emissions from Lead Production or CO₂ Emissions from Zinc Production, the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

When the Tier 2 Equation is applied:

Step A.2, in the worksheet CO_2 Emissions from Lead Production – Tier 2 or CO_2 Emissions from Zinc Production – Tier 2, for each type production (primary / secondary) and each furnace type, users collect and input in the *Software* information on the type and amount of reducing agent consumed (may be calculated through Step A.2.1 for Zinc Production), and if reducing agent is of biogenic origin.

Step B.2, in the worksheet CO_2 Emissions from Lead Production – Tier 2 or CO_2 Emissions from Zinc Production – Tier 2, for each type of production and furnace type, users input the carbon content(s) of reducing agent(s) or other process inputs consumed.

Step C.2, in the worksheet CO_2 Emissions from Lead Production – Tier 2 or CO_2 Emissions from Zinc Production – Tier 2, the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

Then, for each tier, as appropriate:

Step D, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., reconversion to carbonates), not otherwise captured in the worksheets above.

Activity data input

The following sections in Chapter 4, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of AD:

- ✓ <u>Section 4.6.2.3</u> contains information on the choice of AD for Lead Production.
- ✓ <u>Section 4.7.2.3</u> contains information on the choice of AD for Zinc Production.

Input of AD for the Lead Production and Zinc Production source categories requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

Example: single subdivision (unspecified) - lead production

iec Cate	ksheet tor: egory: pcategory: set: a	Metal In 2.C.5 - L	I Processes and Product dustry ead Production issions from Lead produc									19	99
	Subdivisio		Type of Production Process (Primary or Secondary)	Furnace type	Reducing agent or other process input	Biogeni C	Mass of reducing agent or other process input	Carbon content of reducing agent or other process input (tonnes C / tonne	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
		۵ 7	ΔŢ	۵Ţ	i AV	V		CCi	E = Mi * CCi * (44/12)	E / 1000			
			Primary lead produc	Imperial smelting fu	Petroleum Coke		1000	0.8645	3169.83333	3.16983	3		2
*	Unspecified												
*	Unspecified					8					3		

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions – zinc production

⇒ 2.8.8 - Petrochemical and Carbon Black Pr		Vorksneet Sector: Category: Subcategory: Sheet: Data	Industrial Processes Metal Industry 2.C.6 - Zinc Product CO2 Emissions from	ion						199
2.B.8.f - Carbon Black					Equation	4.33, 4.34				
2.8.8.x - Other petrochemical productio 2.8.9 - Fluorochemical Production 2.8.9 - Fluorochemical Production 2.8.9.b - Fugitive Emissions 2.8.9.b - Fugitive Emissions 2.8.10 - Hydrogen Production	I	Sut	division	Type of Process	Amount of Zinc Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)		
2.B.11 - Other (Please specify) 2.C - Metal Industry			Δ 7	Δ	V P		E = P * EF	E / 1000		
2.C - Metal Industry 2.C 1 - Iron and Steel Production		north		Default Factor	100	11	1100	1.1	2	
2.C.2 - Ferroalloys Production		Unspecified	0	Default Factor	100	1.72	172	0.172	3	2
2.C.3 - Aluminium production				Electro-thermic	100	1	100	0.1	2	
- 2.C.4 - Magnesium production									3	
- 2.C.5 - Lead Production		Total							_	
2.C.6 - Zinc Production					300		1372	1.372		

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from Lead Production, or CO_2 Emissions from Zinc Production row by row, as follows:

 <u>Column | Source and Furnace Type |</u>: input from the drop-down menu the type of furnace/source, if known (i.e. direct smelting, imperial smelting furnace, from secondary materials for lead production and electrothermic distillation, pyrometallurgical or Waelz Kiln process for zinc production) or input manually a country-specific type of process.

<u>Note that</u> if the type of furnace is unknown, select Default, which assumes the default allocation of 80% imperial smelling furnace and 20% direct smelling for lead production and 60% imperial smelling furnace and 40% Waelz Kiln for zine production.

1. <u>Column |P|</u>: input the amount/mass of lead or zinc produced, in tonnes.

CO2 Emissions fr	om Lead Production		CO2 Emissions from Lead Prod	uction - Tier 2 Captur	re and storage or other redu	tion				
Sector: Category: Subcategory: Sheet: Data	Industrial Processe Metal Industry 2.C.5 - Lead Produ CO2 Emissions from	ctic	n						19	90
				Equati	on 4.32					
Subc			Source and Furnace Type	Amount of Lead Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
	7 ۵		ΔΥ	Р	EF	E = P * EF	E / 1000			
National		si	on Factor (80% ISF, 20% DS) 🗸	2555	0.52	1328.6	1.3286	2	?	X
Tokyo City		F	Source and Furnace Type	1000	0.59	590	0.59	- and the second		
* Total		_	Default Emission Factor (80% ISF, 20% DS)							
		_	From Direct Smelting (DS) Production	3555		1918.6	1.9186			_
			From Imperial Smelt Furnace (ISF) Production							
			From Treatment of Secondary Raw Materials							

Example: Input Tier 1 AD (default assumption for furnace type) - lead production

When the Tier 2 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from Lead Production – Tier 2 or CO_2 Emissions from Zinc Production – Tier 2, row by row, as follows:

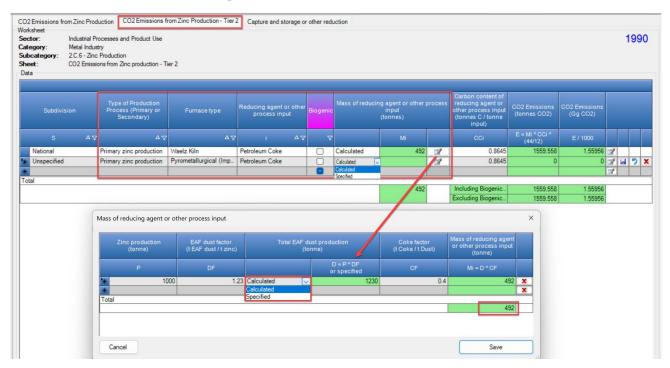
- 1. <u>Column |Type of Production|</u>: select from the drop-down menu whether emissions are estimated for primary production or secondary production.
- 2. <u>Column |Furnace type|</u>: select from the drop-down menu the default type of furnace or input manually a country-specific type of furnace.
- 3. <u>Column |i|</u>: select from the drop-down menu the default type of reducing agent or input manually a country-specific type of carbon input.

<u>Note that</u> the selections in the drop-down menu are from the Fuel Manager. If the user selects a fuel from the Fuel Manager, the carbon content of that fuel will automatically be populated in <u>Column | CCi|</u>. If a user-specific reducing agent or process fuel is input, the user will be required to manually enter <u>Column | CCi|</u>. See section **1.1.1 Fuel Manager** for more information on how to populate the Fuel Manager.

- 4. <u>Column | Biogenic |</u>: indicate with a check if the reducing agent or other process input is of biogenic origin.
- 5. <u>Column | Mi</u>]: input the amount/mass of reducing agent or other process input consumed, in tonnes. <u>Note that</u> for **Zinc Production**, the user has the choice to **specify** directly the mass of reducing agent or other process input used (the same as lead production), or the user may **calculate** this value based on the amount of electric are furnace dust produced.

To calculate the mass of reducing agent or other process input based on total EAF dust production, the user selects the pop-up table and then:

- 6. <u>Column [D]:</u> the user first determines whether the total amount of EAF dust produced is to be Specified (thus input directly) or Calculated.
 - <u>- If Column |D| is Specified, Column |P| and Column |DF|</u> are grayed out.
 - <u>If Column |D|</u> is Calculated, the user inputs the amount of zinc produced, in tonnes in <u>Column |P|</u>. A default EAF dust factor of 1.23 t EAF dust/t zinc will automatically populate In <u>Column |DF|</u>, or the user may manually enter in a country-specific value.
- 7. <u>Column |CF|:</u> A factor of 0.4 for the amount of coke used per tonne of dust produced is automatically populated ;or the user may manually enter in a country specific value.



Example: Input Tier 2 AD – zinc production

Emission factor input

The following sections in Chapter 4, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of EFs:

- ✓ <u>Section 4.6.2.2</u> contains information on the choice of EFs for Lead Production. Tier 1 EFs for CO₂ are presented in <u>Table 4.21</u>. Tier 2 default carbon contents for input materials are presented in <u>Table 4.22</u>, but are to be used only if the compiler does not have country-specific information.
- ✓ <u>Section 4.7.2.2</u> contains information on the choice of EFs for Zinc Production. Tier 1 EFs for CO₂ are presented in <u>Table 4.24</u>.

When the Tier 1 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from Lead Production or CO_2 Emissions from Zinc Production, row by row, as follows:

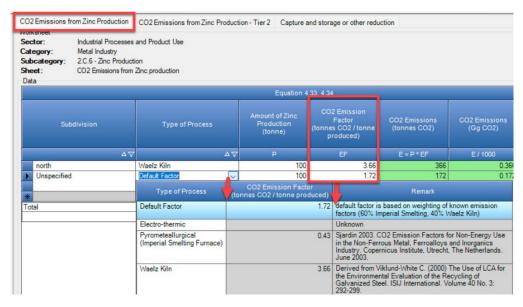
1. <u>Column |EF|:</u> Select from the drop-down menu or manually overwrite the EFs with country-specific values.

<u>Note that:</u> for Lead production, the user selection for the default in <u>Column |EF|</u> depends on the type of furnace in <u>Column |Source and Furnace Type|</u>. For zinc production, Column |EF| is automatically populated based on the selection in <u>Column |Source and Furnace Type|</u>.

Example: Tier 1 EFs for CO₂-lead production

vonksneet Sector: Category: Subcategory: Sheet: Data	Industrial Processe Metal Industry 2.C.5 - Lead Produc CO2 Emissions from	ction				
			Equat	ion 4.32	_	
Sut	division	Source and Furnace Type	Amount of Lead Production (tonne)	CO2 Emission Factor (tonnes CO2 / tonne produced)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	ΔV	Δ.	∀ P	EF	E = P * EF	E / 1000
National		Default Emission Factor (80%	- 2555	0.52	1328.6	1.32
Tokyo City		From Imperial Smelt Furnace.	. 1000	0.59	590	0.
* Unspecified	ł	From Direct Smelting (DS) Pr.		P		
* Total			Source and Furnace Typ	CO2 Emission Fa (tonnes CO2 / tonne p		Rem
			From Direct Smelting (DS Production		0.25	





When the Tier 2 Equation is applied:

For each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from Lead **Production – Tier 2** or CO_2 Emissions from Zinc Production – Tier 2, row by row, in <u>Column |CCi|</u>. The default carbon content is automatically populated from the Fuel Manager if the user selects a reducing agent/process input from the drop-down menu in <u>Column |CCi|</u>. Users may manually over-write the carbon content with country-specific values.

<u>Note that if</u> the user changes from a pre-selected reducing agent / process input material from the drop-down menu and then decides to write in a user-defined reducing agent / process input, the value in <u>Column | CCi |</u> will not automatically change and the user-defined carbon content must be input.

Results

CO₂ emissions from Lead Production are estimated in mass units (tonnes and Gg) by the *Software* in the following worksheets:

✓ CO₂ Emissions from Lead Production

✓ CO₂ Emissions from Lead Production – Tier 2

CO₂ emissions from Zinc Production are estimated in mass units (tonnes and Gg) by the *Software* in the following worksheets:

✓ CO₂ Emissions from Zinc Production

✓ CO₂ Emissions from Zinc Production – Tier 2

Total CO_2 from lead production and zinc production is the sum of all emissions in the above worksheets, respectively, taking into account any capture and storage or other reduction. The worksheet **Capture and storage** or other reduction is provided in the *Software* for each source category to estimate these reductions.

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the drop-down menu, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂, in tonnes. <u>Note that: Column |B|</u> may include short-term reductions only in cases where the subsequent CO₂ emissions from use are included elsewhere in the GHG inventory.
- 4. <u>Column | Biogenic</u> |: indicate with a check if the reductant/process input material is of biogenic origin. Note that consistent with Volume 2, Chapter 2 of the 2006 IPCC Guidelines, capture of biogenic CO₂ for long-term storage may lead to negative CO₂ emissions.

Example: Capture and storage or other reduction-lead production

CO2 Em Workshe		om Lead Productio	n CO2 Emissions from	m Lead Pro	oduction - Tier 2	apture and storage or	other reduction					
Sector: Categor Subcate Sheet: Data	ry:	Metal Industry 2.C.5 - Lead Prod	es and Product Use uction ge or other reduction								19	90
Gas	CARB	ON DIOXIDE (CO2)		~								
	Subd	ivision	Source		Amount CO2 captured and stored	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)	Biogenic			
		ΔV	SRC	ΔV			C = A + B	C / 1000	V			
M Tol	kyo Smel	ter	Capture- stream A	~	22	10	32	0.032		2	2	X
*									8	2		
Total												
						Total:	32	0.032				
						Total Biogenic CO2:	0	0				

2.C.7 Rare Earths Production

Information

Section 4.8 Chapter 4, Volume 3 of the 2019 IPCC Guidelines provides methods to estimate CO2 and PFC emissions from Rare Earths Production.

There are two Tiers to estimate CO_2 emissions from primary production of rare earth (RE) metals and alloys. The Tier 1 method relies on production data for each type of RE metal or alloy multiplied by a default CO_2 EF. Since only a default CO_2 EF is available for neodymium (Nd), that EF is adjusted for production of other RE metals based on the relative atomic weight of that metal or alloy compared to Nd. The Tier 3 method is a mass balance approach, assuming the carbon content of net anode consumption is ultimately released to the atmosphere, taking into account any impurities in the anode. There is no Tier 2 method to estimate CO_2 emissions.

Tier 1 and Tier 3 methods are also provided to estimate PFC emissions (mainly CF_4 and C_2F_6 , but also C_3F_8) released during the reaction of the carbon anode with a fluoride melt. Both methods employ EFs applied to metal production, and either default (Tier 1) or facility specific (Tier 3) EFs.

<u>GHGs</u>

The Software includes the following GHGs for the Rare Earths Production source category:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X				X		

IPCC Equations

GHG emissions from the Rare Earths Production source category are estimated by applying the following IPCC equations (Chapter 4 Volume 3 of the *2019 IPCC Refinement*):

For CO₂

- ✓ Tier 1: Equation 4.35 (NEW)
- ✓ Tier 3: Equation 4.36 (NEW)

For PFCs

- ✓ Tier 1: Equation 4.37 (NEW)
- ✓ Tier 3: Same equation as Tier 1, although with plant-specific EF information.

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

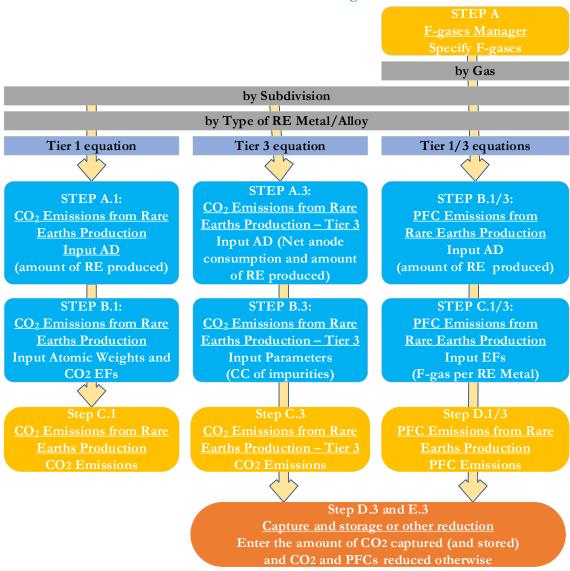
The *Software* calculates CO₂ and PFC emissions from Rare Earths Production using the following five worksheets:

- ✓ CO₂ Emissions from Rare Earths Production: contains for each subdivision and each type of RE metal/alloy, information on the amount of the metal/alloy produced and default CO₂ EFs. The worksheet calculates the associated CO₂ emissions.
- ✓ CO₂ Emissions from Rare Earths Production Tier 3: contains for each subdivision, facility and each type of RE metal/alloy, information on the amount of the metal/alloy produced and the total content of non-carbon impurities. The worksheet calculates the associated CO₂ emissions.
- ✓ 1.1.2 F-gases Manager: contains data on F-gases used (including imported) and/or produced and exported in the country.
- ✓ PFC Emissions from Rare Earths Production: contains for each subdivision and each type of RE metal/alloy, information on the amount of the metal/alloy produced and corresponding EFs. The worksheet calculates the associated PFC emissions.
- ✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂ and PFCs, not accounted previously in the worksheets for different Tiers.

User's work Flowchart

Consistent with the key category analysis and the decision trees in <u>Figure 4.17 (NEW)</u> (for CO₂) and <u>Figure 4.18</u> (NEW) (for PFCs) of the 2019 Refinement, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for the estimation of CO_2 and PFC emissions from the Rare Earths Production source category



Rare Earths Production - CO2 and F-gases- flowchart

Thus, for the source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Then, for each subdivision, if any:

i. CO2 emissions

When the Tier 1 Equation is applied:

Step A.1, in the worksheet CO₂ Emissions from Rare Earths Production, users collect and input in the *Software* information on the type and amount of each RE metal/alloy produced.

Step B.1, in the worksheet CO_2 Emissions from Rare Earths Production, users collect and input CO_2 EFs for each type of RE metal/alloy, including the atomic weight of the RE metal/alloy as compared to the base case, Nd.

Step C.1, in the worksheet **CO**₂ **Emissions from Rare Earths Production,** the *Software* calculates the associated CO₂ emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

When the Tier 3 Equation is applied:

Step A.1, in the worksheet CO₂ Emissions from Rare Earths Production- Tier 3, users collect and input in the *Software* information on the type and amount of each RE metal/alloy produced and net anode consumption.

Step B.1, in the worksheet CO_2 Emissions from Rare Earths Production- Tier 3, users collect and input the total carbon content of non-carbon impurities.

Step C.1, in the worksheet CO_2 Emissions from Rare Earths Production- Tier 3, the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown.

ii. PFC emissions

Step A, **1.1.2 F-gases Manager**, users ensure that all F-gases emitted for this source category (in this case, PFCs) have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

When the Tier 1 Equation is applied:

Step B.1/3, in the worksheet PFC Emissions from Rare Earths Production, users collect and input in the *Software* information on the type and amount of each RE metal/alloy produced.

Step C.1/3, in the worksheet **PFC Emissions from Rare Earths Production**, users collect and input the EF for each F-gas.

Step D.1/3, in the worksheet **PFC Emissions from Rare Earths Production,** the *Software* calculates the associated PFC emissions for each subdivision in mass units (kg and Gg). In addition, the total emissions of all subdivisions are shown.

Then, for each tier, and each gas, as appropriate:

Step D.3/E.3, in the worksheet **Capture and storage or other reduction**, if applicable for higher-tiered methods, users collect and input information on the amount of CO₂ captured (with subsequent storage) and other reduction of CO₂ (e.g., re-conversion to carbonates) or other GHG, not otherwise captured in the worksheets above.

Activity data input

Section 4.8.2.5 in Chapter 4 Volume 3 of the 2019 Refinement contains information on the choice of AD for Rare Earths Production.

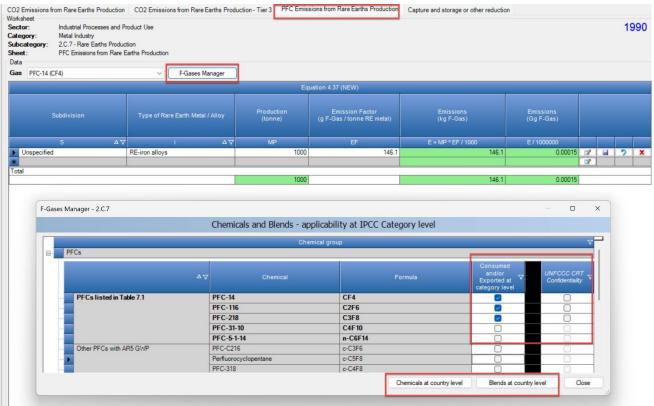
As a **Starting step**, users must ensure that the **1.1.2 F-gases Manager** has been populated for all F-gases to be reported for the source category Rare Earths Production.

<u>Note that</u> if no PFCs are checked in the F-gases Manager, then it will not be possible to enter any data. If data entry is not possible, select the **F-Gases Manager** in worksheet **PFC Emissions from Rate Earths Production**. This will open the F-gases Manager – applicability at IPCC Category Level. Navigate to the bottom of the pop-up box and select Chemicals at country level. This will take the user back to the country level- F-gases Manager to check the relevant F-gases for this category. Save and close the dialogue box for the country level F-gases Manager and the user returns to the Category level F-gases Manager.

The user then selects the relevant F-gases for this category in the Category-level F-gases Manager.

<u>For users intending to use data entered in the Software for reporting in the UNFCCC ETF Reporting Tool:</u> If emissions for this category are considered confidential, the user may check the box UNFCCC CRT Confidentiality. If checked, "IE" will be reported for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT, as unspecified mix of HFCs and PFCs, in tonnes CO₂ equivalents.

Example: Populating the F-gases manager and designating confidentiality for category: Rare Earths Production



Second, input of AD for the Rare Earths Production source category requires the user to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |S| [e.g. "country name" or "Unspecified" as selected from the drop-down menu].</u>

Example: single subdivision

	Worksheet Sector: Industrial Processe Category: Metal Industry Subcategory: 2.C.7 - Rare Earths Sheet: PFC Emissions from Data	Production	n							199
2.B.9.b - Fugitive Emissions	Gas PFC-14 (CF4)		F-Gases Manager							
2.B.10 - Hydrogen Production 2.B.11 - Other (Please specify)				Ea	uation 4.37 (NEW)					
2.C - Metal Industry	1					in the second		1		_
2.C.1 - Iron and Steel Production 2.C.2 - Ferroalloys Production 2.C.3 - Aluminium production	Subdivision			Production (tonne)	Emission Factor (g F-Gas / tonne RE metal)	Emissions (kg F-Gas)	Emissions (Gg F-Gas)			
2.C.4 - Magnesium production										
- 2.C.5 - Lead Production	S	AV	A √	MP	EF	E = MP * EF / 1000	E / 1000000			
2.C.6 - Zinc Production 2.C.7 - Rare Earths Production	National level	V R	E-iron alloys	1000	146.1	146.1	0.00015	2	la	2
- 2 C.8 - Other (please specify)		_						3		
2.D - Non-Energy Products from Fuels and Sol	Total									-
- 2.D.1 - Lubricant Use				1000		146.1	0.00015			

Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

∠ 2.8.9.a - By-knoduct insistems ∠2.8.9.a - Fugitive Emissions ∠2.8.9.a - Fugitive Emissions ∠2.8.11 - Other (Please specify) ⊒ 2.C - Metil Industry −2.C.1 - Iron and Steel Production −2.C.2 - Promology Production		Net anode	Equation 4.36					1	990
−2.8.10 - Hydrogen Production −2.8.11 - Other (Please specify) □ 2.0 - Metal Industry −2.0.1 - Iron and Steel Production −2.0.2 - Foreallys Production	voe of Bare Farth Metal / Allov	Net anode	Equation 4.36				_		
-28.11 - Other (Please specify) 2C - Metal Industry -2C.1 - Iron and Steel Production -2.C.2 - Ferroalloys Production	voe of Bare Farth Metal / Allov								
		consumption (t anode / t RE metal)	Total metal production (tonne)	Total content of non- carbon Impurities (%)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
p = 2.C.3 - Aluminium production S △ ▽					E = (NACi * MPi) * [(100 - IMPa)/100] * (44/12)				
-2.C.4 - Magnesium production -2.C.5 - Lead Production Plant 2342 C	erium	344	300	3	367048	367.048			
-2.C.6 - Zinc Production Plant X S	candium	1000	150	2.2	537900	537.9	2	M 7	
2.C.7 - Rare Earths Production							3		
2.C.8 - Other (please specify) Total Z.D - Non-Energy Products from Fuels and Sol		1344	450		904948	904.948			

When the Tier 1 Equations are applied (CO₂ and PFCs):

For each subdivision in <u>Column |S|</u>, data are entered in worksheets CO₂ Emissions from Rare Earths Production and PFC Emissions from Rare Earths Production, row by row, as follows:

- 1. <u>Column |i|</u>: select from the drop-down menu the RE metal/alloy produced.
- 2. <u>Column | MPi |</u>: input the amount/mass of RE metal/alloy produced, in tonnes.

Example: **AD** input for **CO**₂ – Tier 1

CO2 Emissions fr Vorksheet	rom Rare Earths Proc	CO2 Emissions from Ra	re Earths Production -	Tier 3 PFC Emission	s from Rare Earths Pro	duction Capture and	storage or other reduction	
Vorksneet Sector: Category: Subcategory: Sheet: Data	Industrial Processe Metal Industry 2.C.7 - Rare Earths CO2 Emissions from							
				Equat	ion 4.35 (New)			
Subdivision		Type of Rare Earth Metal / Alloy	Production (tonne)	Atomic Weight of base case rare earth metal (g / mol)	Atomic weight of rare earth metal type (i) (g / mol)	Emission Factor (t CO2 / t metal)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	; Δ 7	i AV	MPi	AWbase	AWi	EFCO2	E = MPi * (AWbase / AWi) * EFCO2	E / 1000
Unspecified		Erbium	122	144.24	167.259	0.56	58.91747	0.058
*								
Total								
			122				58.91747	0.05

When the Tier 3 Equation is applied (CO₂):

For each subdivision in <u>Column |S|</u>, data are entered in worksheet CO₂ Emissions from Rare Earths Production – Tier 3, row by row, as follows:

- 1. <u>Column |i|</u>: select from the drop-down menu the RE metal/alloy produced.
- 2. <u>Column |NACi|</u>: input facility-specific net anode consumption, in tonnes anode/t RE metal produced.
- 3. <u>Column | MPi |</u>: input the amount/mass of RE metal/alloy produced, in tonnes.

Example: AD input for CO₂ – Tier 3

	m Rare Earths Produc	tion CO2 Emis	isions non nale co	arths Production - Tier 3	PPC Emissions from P	Rare Earths Production	Capture and storage or other reduction	
ategory: ubcategory:	Industrial Processes a Metal Industry 2.C.7 - Rare Earths Pri CO2 Emissions from R	duction	tion - Tier 3					
					Equation 4.36	(New)		
Subd	livision	Type of Rare E	arth Metal / Alloy	Net anode consumption (t anode / t RE metal)	Total metal production (tonne)	Total content of non- carbon Impurities (%)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
s	۵v	1	Δ 🖓	NACI	MPi	IMPa	E = (NACi * MPi) * [(100 - IMPa)/100] * (44/12)	E / 1000
Plant 2342		Cerium		344	300	3	367048	367.0
Plant X		Scandium		1000	150	2.2	537900	53
*								
otal								
				1344	450		904948	904.9

Emission factor input

Sections <u>4.8.2.2</u> and <u>4.8.2.4</u> in Chapter 4 Volume 3 of the *2019 Refinements* contain information on the choice of CO₂ and PFC EFs, respectively, for Rare Earths Production; specifically:

- Tier 1 EFs for CO₂ (<u>Table 4.26 (NEW</u>)) <u>Note that</u>: the CO₂ EF provided is for the RE metal Nd. For other RE metals/alloys, the user must scale the EF based on the atomic weight of the produced RE metal, as compared to Nd. This explanation is provided in Section <u>4.8.2.1</u>.
- ii) Tier 1 EFs for PFCs (<u>Table 4.28 (NEW</u>))

The default EFs are embedded in the *Software*. Users may manually over-write EFs with country-specific values. Tier 3 requires use of facility specific EFs.

When Tier 1 Equations are applied:

i. CO2 Emissions

For each subdivision in <u>Column |S|</u>, in worksheet CO₂ Emissions from Rare Earths Production, the *Software* automatically populates the following columns after the user enters information in <u>Column |i|</u>:

- 1. <u>Column |EF|</u>: the *Software* automatically populates the default EF for Nd; the user may manually overwrite.
- 2. <u>Column |AW_{base}|</u>: the *Software* automatically populates the atomic weight of the base case RE metal, Nd; in g/mole.
- 3. <u>Column $|AW_i|$ </u>: the *Software* automatically populates the atomic weight of the produced RE metal, i, in g/mole.

O2 Emissions from	Rare Earths P	roduction CO2 En	nissions fro	m Rare Earths Produ	ction - Tier 3 PFC	Emissions from Ran	e Earths Production	Capture and storage or other reduction	
ategory: Mubcategory: 2	Metal Industry 2.C.7 - Rare Earl	ses and Product Use ths Production rom Rare Earths Produ							
						Equation 4.35 (N	ew)		
Subdivision		Type of Rare Earth Alloy	n Metal /	Production (tonne)	Atomic Weight of base case rare earth metal (g / mol)	Atomic weight of rare earth metal type (i) (g / mol)	Emission Factor (t CO2 / t metal)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	V		ΔV	MPi	AWbase	AWi	EFCO2	E = MPi * (AWbase / AWi) * EFCO2	E/1000
Unspecified		Promethium		200	144.24	145	0.56	111.41297	0.1114
		Yttrium		1000	144.24	88.90585	0.56	908.53864	0.9085
*									
Fotal			_						
				1200				1019.9516	1.0199

Example: Tier 1 EFs for CO₂

ii. PFC Emissions

For each subdivision in <u>Column |S|</u>, in worksheet **PFC Emissions from Rare Earths Production**, the *Software* automatically populates <u>Column |EF|</u> after the user enters information in <u>Column |i|</u>, with the IPCC default EF for the gas selected. For Tier 3, the user shall manually overwrite the EF with facility-specific values. <u>Note that</u> the user shall select the relevant PFC in the "Gas" bar at the top, to enter data for each GHG one by one

Example: EFs input for PFCs (Tiers 1 and 3)

CO2 Emissions fi Vorksheet	rom Rare Earths Production	n CO2 Emissi	ons from Rare Earths Prod	uction - Tier 3 PFC Emis	sions from Rare Earths Production	Capture and storage or other reduction	
Sector: Setegory: Subcategory: Sheet: Data	Industrial Processes and Metal Industry 2.C.7 - Rare Earths Produ PFC Emissions from Rare	iction	1				
Gas PFC-14 (0	CF4)	~	F-Gases Manager				
		-		Eq	uation 4.37 (NEW)		
	Subdivision	Type of Ra	ire Earth Metal / Alloy	Production (tonne)	Emission Factor (g F-Gas / tonne RE metal)	Emissions (kg F-Gas)	Emissions (Gg F-Gas)
	S 🛆 T	7	i ∆⊽	MP	EF	E = MP * EF / 1000	E / 1000000
National lev	el	RE-iron alloys		1000	146.1	146.1	0.0001
Unspecified		RE-iron alloys		2000	146.1	292.2	0.0002
*							
Total				0000		100.0	0.000
				3000		438.3	0.000

When the Tier 3 Equation is applied:

For each subdivision in <u>Column |S|</u>, in worksheet CO₂ Emissions from Rare Earths Production-Tier 3, the user inputs the facility specific total content of non-carbon impurities (e.g. sulphur, ash, etc) in the based anodes in <u>Column |IMPa|</u>, in wt%.

Example: EFs input for CO₂ (Tiers 3)

CO2 Emissions fr Vorksheet	om Rare Earths Produ	ction	CO2 Emissio	ons from Rare Ea	arths Production - Tier 3	PFC Emissions from F	Rare Earths Production	Capture and storage or other reduction	
Sector: Category: Subcategory: Sheet: Data	Industrial Processes Metal Industry 2.C.7 - Rare Earths F CO2 Emissions from I	roductio	n	n - Tier 3					
						Equation 4.36	ŝ (New)		
Sut	odivision	Туре	of Rare Earth	h Metal / Alloy	Net anode consumption (t anode / t RE metal)	Total metal production (tonne)	Total content of non- carbon Impurities (%)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)
	s Av		1	ΔŢ	NACI	MPi	IMPa	E = (NACi * MPi) * [(100 - IMPa)/100] * (44/12)	E / 1000
Plant 2342		Ceriur	n		344	300	3	367048	367.0
Plant X		Scand	lium		1000	150	2.2	537900	53
*									
Total								p	
					1344	450		904948	904.9

Results

CO₂ and PFC emissions from Rare Earths Production are estimated in mass units (tonnes and Gg for CO₂ and kg and Gg for PFCs) by the *Software* in the following worksheets:

CO₂ emissions:

- ✓ CO₂ Emissions from Rare Earths Production
- ✓ CO₂ Emissions from Rare Earths Production-Tier 3

PFCs emissions:

✓ PFC Emissions from Rare Earths Production

Total CO_2 and PFC emissions from rare earths production is the sum of all emissions in the above worksheets, taking into account any capture and storage or other reduction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions.

In the worksheet Capture and storage or other reduction for each subdivision and each gas:

- 1. <u>Column |SRC|</u>: users either select from the drop-down menu, or preferably, input information on the source where the capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂ or PFC emissions, in tonnes.

<u>Note that</u>: <u>Column |B|</u> may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.

Example: Capture and storage or other reduction

CO2 Emissions fro Worksheet	om Rare Earths Production	CO2 Emissions from Rare Eart	hs Production - T	Tier 3 PFC Emissions from	Rare Earths Production	Capture and storage or other rea	duction
Sector: Category: Subcategory: Sheet: Data	Industrial Processes and Produce Metal Industry 2.C.7 - Rare Earths Production Capture and storage or other m	1					
Gas PFC-14 (C	F4)	✓ F-Gases Mana	ager				
	Subdivision	Source	ľ	Amount CO2 captured and stored (tonne)	Other reduction (tonne)	Total reduction (tonne)	Total reduction (Gg)
	S ∆⊽		۵V	A		C = A + B	
* Unspecified		Plant X				25 25	0.025
* Total							
Total						25	0.025

2.C.8 Other

Information

This section describes calculation of other sources of emissions in the metal industry not included in source categories 2.C.1-2.C.7.

This category also allows for estimating of GHG emissions from categories for which specific methods are not provided in the 2006 IPCC Guidelines or the 2019 Refinement, but for which information is contained in the common reporting tables of the MPGs, specifically:

- ✓ F-gases used in Aluminium Foundries
- ✓ CH₄ and N₂O emissions from Rare Earths Production

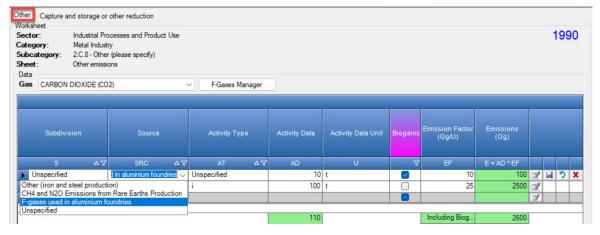
GHGs

Other emissions from the metal industry source category include the following GHGs:

CO ₂	CH ₄	N_2O	HFCs	PFCs	\mathbf{SF}_{6}	NF ₃
X	X	X	X	X	X	Χ

For more information_on **IPCC Equations, Software Worksheets, User's work Flowchart. Activity data input, Emission factor input** and **Results**_refer to the corresponding information and figures in section 2.B.11 Other. The same information applies to filling in the worksheets for source category 2.C.8 Other (Metal Industry).

Example: 2.C.8 Other – Generic worksheet



2.D Non-Energy Products from Fuels and Solvent Use

This section provides methods for estimating emissions from the first use of fossil fuels as a product for primary purposes other than i) combustion for energy purposes and ii) use as feedstock or reducing agent. Emissions from the latter two uses are accounted for by methods described in the **2.B Chemical Industry** and **2.C Metal Industry**.

The products covered here comprise lubricants, paraffin waxes, bitumen/asphalt, and solvents. Emissions from further uses or disposal of the products after first use (i.e., the combustion of waste oils such as used lubricants) are to be estimated and reported in the Waste Sector when incinerated or in the Energy Sector when energy. To illustrate the scope and allocation of GHG emissions from various uses of lubricants and waxes, refer to Figure 5.1 in Chapter 5 Volume 3 of the 2006 IPCC Guidelines.

Note that the use of lubricants in engines is primarily for their lubricating properties and associated emissions are therefore considered as non-combustion emissions to be reported in the IPPU Sector. However, in the case of 2-stroke engines, where the lubricant is mixed with another fuel and thus on purpose co-combusted in the engine, the emissions should be estimated and reported as part of the combustion emissions in the Energy Sector.

This chapters covers the following source categories:

- ✓ 2.D.1 and 2.D.2 Lubricant Use and Paraffin Wax Use- description of the use of the *Software* for these two source categories is provided together owing to the common methodologies.
- ✓ 2.D.3 Solvent Use- the *Software* does not contain calculation worksheets for this category as it is not a source of direct GHG emissions (category 2.D.3 is black in the navigation tree and cannot be selected). The common reporting tables of the MPGs include reporting of CO₂, CH₄ and N₂O emissions from this source category and thus use of the *Software* to estimate these emissions is described further below.
- ✓ 2.D.4 Other− contains relevant information for use of the *Software* for other emissions from non-energy products from fuels and solvent use.

2.D.1 and 2.D.2 Lubricant Use and Paraffin Wax Use

Information

This section groups guidance for the following source categories according to their common methodological approaches applied in the *Software*:

- ✓ 2.D.1 Lubricant Use
- ✓ 2.D.2 Paraffin Wax Use

The 2006 IPCC Guidelines provide two Tiers to estimate CO_2 emissions from these source categories. In Tier 1 – CO_2 emissions are calculated from data on the non-energy use of fuels for lubricants or paraffin waxes, the carbon content of that fuel, and a oxidised during use (ODU) factor that represents the fraction of fossil carbon oxidized during use. Tier 2 method relies on detailed data of the lubricants and greases consumed or paraffin waxes produced and country-specific EFs based on fuel type specific carbon content and ODU factors.

GHGs

The Software includes the following GHGs for the Lubricant Use and Paraffin Wax Use source categories:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X						

The 2006 IPCC Guidelines do not contain methods for estimating CH₄ and N₂O emissions from Lubricant Use or Paraffin Wax Use, however for interoperability with the UNFCCC ETF Reporting Tool, the *Software* allows these emissions to be calculated in category **2.D.4 Other**. The sources "CH₄ and N₂O emissions from lubricant use" and "CH₄ and N₂O emissions from paraffin wax" are provided as a default options in the drop-down menu in <u>Column</u> <u>|SRC|</u>. For further information, see description under section **2.D.4 Other**.

IPCC Equations

 CO_2 emissions from Lubricant Use source category for Tier 1 are estimated by applying Equations 5.2 and for Tier 2 – Equation 5.3 Chapter 5 Volume 3 of the 2006 IPCC Guidelines.

- ✓ <u>Tier 1</u>: <u>Equation 5.2</u> (Lubricant Use), <u>Equation 5.4</u> (Paraffin Wax Use)
- ✓ <u>Tier 2: Equation 5.3</u> (Lubricant Use), <u>Equation 5.5</u> (Paraffin Wax Use)
- ✓ <u>Tier 3:</u> no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines for these source categories.

As explained in section **1.1.3 Use of multiple Tiers for reporting**, GHG estimates prepared with user-specific Tier 3 methods can be reported in the *Software* worksheets that implement the IPCC Tier 1 equation.

Software Worksheets

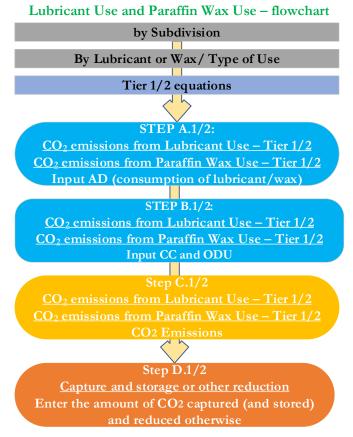
GHG emissions from each source category are estimated using the following worksheets:

- ✓ CO₂ emissions from Lubricant Use Tier 1/2 or CO₂ emissions from Paraffin Wax Use Tier 1/2: contains for each subdivision and each NEU product type/use (e.g. lubricating oil, grease, paraffin wax) information on the amount of lubricant/paraffin wax consumed, its carbon content and ODU factor. The worksheet calculates the associated CO₂ emissions.
- ✓ **Capture and storage or other reduction** contains information on CO₂ capture (with subsequent storage) and other reduction of CO₂, not accounted previously.

User's work Flowchart

Consistent with the key category analysis and the decision trees in Figure 5.2 (Lubricant Use) or Figure 5.3 (Paraffin Wax Use) of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier for each source category, or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements for that source category.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Nitric Acid Production.



Thus, for each relevant source-category:

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision, if any:

Step A.1/2, in the worksheet CO_2 emissions from Lubricant Use – Tier 1/2 or CO_2 emissions from Paraffin Wax Use – Tier 1/2, for each subdivision and each type of use (lubricating oil, grease, paraffin wax) users collect and input in the *Software* information on the amount of lubricant or paraffin wax consumed.

Step B.1/2, in the worksheet CO_2 emissions from Lubricant Use – Tier 1/2 or CO_2 emissions from Paraffin Wax Use – Tier 1/2, for each subdivision and each type of use, users input the carbon content and ODU factor.

Step C.1/2, in the worksheets CO_2 emissions from Lubricant Use – Tier 1/2 or CO_2 emissions from Paraffin Wax Use – Tier 1/2, the *Software* calculates the associated CO_2 emissions for each subdivision in mass units (tonne and Gg). In addition, the total emissions of all subdivisions are shown in the worksheet.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

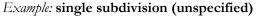
Step D.1/2, in the worksheet Capture and storage or other reduction, users collect and input in the *Software* information on the amount of CO_2 captured (with subsequent storage) and other reduction of CO_2 (e.g., reconversion to carbonates).

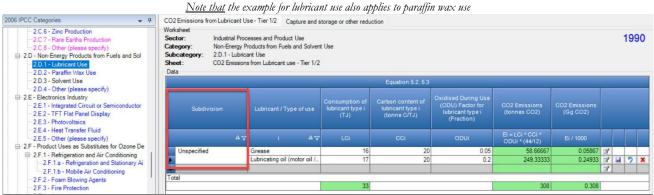
Activity data input

The following sections in Chapter 3, Volume 5 of the 2006 IPCC Guidelines contain information on the choice of AD:

- ✓ <u>Section 5.2.2.3</u> contains information on the choice of AD for Lubricant Use.
- \checkmark Section 5.3.2.3 contains information on the choice of AD for Paraffin Wax Use.

Input of AD for the Lubricant Use and Paraffin Wax Use source categories requires the user first to enter information on the subdivisions in the country. Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in <u>Column |Subdivision|</u> [e.g. "country name" or "Unspecified" as selected from the drop-down menu].

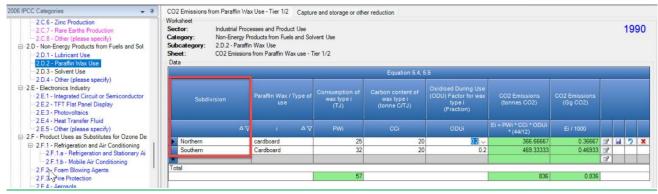




Where subnational aggregations are input, provide the univocal name/code into <u>Column |Subdivision|</u> for each subdivision.

Example: multiple subdivisions

Note that the example for paraffin wax use also applies to lubricant use



Then, for each subdivision in <u>Column |Subdivision|</u>, data are entered in worksheet CO_2 Emissions from Lubricant Use – Tier 1/2 or CO_2 Emissions from Paraffin Wax Use – Tier 1/2, row by row, as follows:

 <u>Column |i|</u>: select from the drop-down menu (for lubricant use) the default lubricant/type of use (lubricating oil, grease) or input manually a country-specific lubricant. For paraffin wax use, input the type of paraffin wax consumed.

<u>Note that:</u> for lubricant use, if information is not known on the types and quantities of different types of lubricants consumed, the user shall select "IPCC default for total lubricants".

<u>Recall that</u> the use of lubricants in engines is primarily for their lubricating properties and associated emissions are therefore considered as non-combustion emissions to be reported in the IPPU Sector. However, in the case of 2-stroke engines, where the lubricant is mixed with another fuel and thus on purpose co-combusted in the engine, the emissions should be estimated and reported as part of the combustion emissions in the Energy Sector.

- 2. <u>Column |LCi | (Lubricant Use)</u>: input the amount/mass of lubricant consumed in TJ.
- 3. <u>Column | PWi | (Paraffin Wax Use)</u>: input the amount/mass of lubricant consumed in TJ.

Example: AD input – Tier 1

Note that the example for paraffin wax use also applies to lubricant use

CO2 Emissions fro	om Paraffin Wax	Use - Tier 1/2	Captu	re and storage or	othe	er reduction						
Vorksheet Sector: Category: Subcategory: Sheet: Data	Non-Energy Pr 2.D.2 - Paraffin	esses and Produ oducts from Fue Wax Use from Paraffin W	ls and Sol								19	90
						Equation 5.4, 5						
Subdivi		Paraffin Wax / use	/ Type of	Consumption (wax type i (TJ)	of	Carbon content of wax type i (tonne C/TJ)	Oxidised During Use (ODU) Factor for wax type i (Fraction)	CO2 Emissions (tonnes CO2)	CO2 Emissions (Gg CO2)			
	۵Ţ	1	۵Ţ	PWi		CCi	ODUi	Ei = PWi * CCi * ODUi * (44/12)	Ei / 1000			
Morthern		Cardboard			25	20	0.2	366.66667	0.36667	2	2)
Southern		Cardboard			32	20	0.2	469.33333	0.46933	2		
*										2		
Total												_
					57			836	0.836			

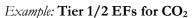
Emission factor input

The following sections in Chapter 3, Volume 5 of the 2006 IPCC Guidelines contain information on choice of EFs:

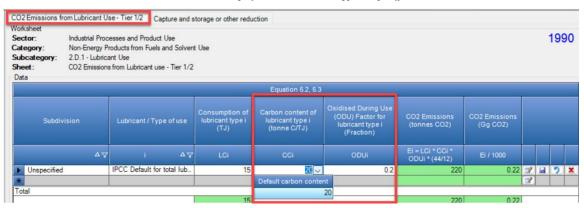
- ✓ <u>Section 5.2.2.2</u> contains information on the choice of EF for Lubricant Use. Default values are presented in <u>Table 5.2</u>.
- \checkmark <u>Section 5.3.2.2</u> contains information on the choice of EF for Paraffin Wax Use.

For each combination of subdivision/ type of use in worksheet CO_2 Emissions from Lubricant Use – Tier 1/2 or CO_2 Emissions from Paraffin Wax Use – Tier 1/2:

- 1. <u>Column |CCi|</u>: select from the drop-down menu, the IPCC default carbon content (20 tonnes C/TJ on a lower heating value basis) or manually enter in a user-specific value.
- <u>2.</u> <u>Column |ODUi|</u>: select from the drop-down menu the IPCC default ODU, depending on the type of lubricant/paraffin wax used (lubricating oil 0.2, grease 0.05, IPCC default for all lubricants 0.2, paraffin wax 0.2) or manually enter in a user-specific value.



Note that the example for lubricant use also applies to paraffin wax



Results

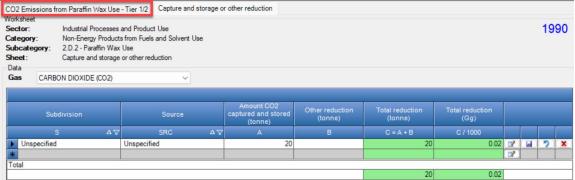
 CO_2 emissions from Lubricant Use are estimated in mass units (tonnes and Gg) by each subdivision and total in the Software in the worksheets CO_2 emissions from Lubricant Use – Tier 1/2 or CO_2 Emissions from Paraffin Wax Use – Tier 1/2.

Total CO_2 emissions from each source category is the sum of all subdivisions in the relevant worksheet above, taking into account any capture and storage or other reduction. The worksheet **Capture and storage or other reduction** is provided in the *Software* to estimate these reductions.

In the worksheet Capture and storage or other reduction for each subdivision:

- 1. <u>Column |SRC|</u>: users either select from the dropdown, or preferably, input information on the source where CO₂ capture or other reduction occurs (e.g. the facility, stream, or other identifying information).
- 2. <u>Column |A|</u>: users collect and input information on the amount of CO₂ captured (with subsequent storage), in tonnes.
- 3. <u>Column |B|:</u> users collect and input information on any other long-term reduction of CO₂, in tonnes. <u>Note that</u>: Column |B| may include short-term reductions only in cases where the subsequent GHG emissions from use are included elsewhere in the GHG inventory.





2.D.3 Solvent Use

Category 2.D.3 Solvent Use is not a source category that emits direct GHGs (CO₂, CH₄, N₂O or F-gases), therefore no methodological guidance (including worksheets) is provided in the 2006 IPCC Guidelines for this source category. Solvent Use is one of the largest source categories of NMVOC emissions (such guidance on NMVOC emissions from Solvent Use was previously provided in the *Revised 1996 IPCC Guidelines*). The sectoral summary tables, and thus the *Software* allows for reporting of these precursor emissions from the main menu (tab **Reports – IPPU – Sectoral**).

Although the *Software* contains no worksheets for this source category in the category tree, the common reporting tables contained in the MPGs do include reporting of CO₂, CH₄ and N₂O emissions from CRT category 2.D.3.a Solvent use. Users using the *Software* for purposes of preparing a GHG inventory for upload to the UNFCCC ETF Reporting Tool may estimate GHG emissions Solvent use in the worksheets for IPCC Category **2.D.4 Other** (see next section).

2.D.4 Other

Information

This section describes calculation of other sources of emissions from Non-Energy Products from Fuels and Solvent Use not included in source categories 2.D.1 and 2.D.2.

This category also allows for estimating of GHG emissions from categories for which specific methods are not provided in the 2006 IPCC Guidelines or the 2019 Refinement, but for which information is contained in the common reporting tables of the MPGs, specifically:

- ✓ CH₄ and N₂O emissions from Lubricant Use
- \checkmark CH₄ and N₂O emissions from Paraffin Wax Use
- ✓ CO₂, CH₄ and N₂O emissions from Solvent Use
- ✓ CO₂, CH₄ and N₂O emissions from Road Paving with Asphalt
- ✓ CO₂, CH₄ and N₂O emissions from Asphalt Roofing

GHGs

Emissions from the Non-Energy Products from Fuels and Solvent Use source category include the following GHGs:

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
Χ	X	X	-	-	-	-

For more information on IPCC Equations, Software Worksheets, User's work Flowchart. Activity data input, Emission factor input and Results_refer to the corresponding information and figures in section 2.A.5 Other. The same information applies to filling in the worksheets for source category 2.D.4 Other.

Example: 2.D.4 Other – Generic worksheet

ategory: ubcategory: heet:	Non-Energ	Processes and Product Use y Products from Fuels and Solvent Us er (please specify) sions	se							199
Data Gas CARBON D	IOXIDE (C	02) ~								
										_
Subdivisio		Source		Activity Type	Activity Data	Activity Data Unit	Emission Factor (Gg/U)	Emissions (Gg)		
Subdivisio	on A V	Source	ΔĄ			Activity Data Unit	Factor			
			∆ ⊽			U	Factor (Gg/U)	(Gg) E = AD * EF	3	1 2
S	۵V	SRC Asphalt roofing Solvent use		AT AV	AD	U	Factor (Gg/U) EF	(Gg) E = AD * EF		1 7
S	∆ ⊽	SRC Asphalt roofing Solvent use Road paving with asphalt		AT 스文 Unspecified	AD 3000	U t t	Factor (Gg/U) EF 156	(Gg) E = AD * EF 468000	2	1 2
S	۵V	SRC Asphalt roofing Solvent use	V	AT △∀ Unspecified Unspecified	AD 3000 2000	U t t t	Factor (Gg/U) EF 156 20	(Gg) E = AD * EF 468000 40000 25000	2	1 7

2.F Product Uses as Substitutes for Ozone Depleting Substances (ODS)

2.F.1 and 2.F.3 Refrigeration and Air Conditioning, and Fire Protection

This section groups guidance for the following source categories according to their common methodological approaches applied in the *Software*:

- ✓ 2.F.1 Refrigeration and Air Conditioning
 - 2.F.1.a Refrigeration and Stationary Air Conditioning
 - 2.F.1.b Mobile Air Conditioning
- ✓ 2.F.3 Fire Protection

Section 7.5 in Chapter 7 Volume 3 of the 2006 IPCC Guidelines provides single methodological guidance for all subapplications (e.g., domestic, commercial, industrial, etc.) of source category 2.F.1 Refrigeration and Air Conditioning and divides them in two sub-categories: i) 2.F.1.a Refrigeration and Stationary Air Conditioning and ii) 2.F.1.b Mobile Air Conditioning. Please note that the sub-application "Transport refrigeration", which comprises equipment and systems used in refrigerated trucks, containers, reefers, and wagons, is included under sub-category 2.F.1.a. The sub-category 2.F.1.b is for the sub-application "Mobile air-conditioning" which comprises systems used in passenger cars, truck cabins, buses, and trains.

The guidance for Refrigeration and Air Conditioning has two Tiers (Tier 1 and Tier 2) with differentiation between Tier 2a (EF approach) and Tier 2b (mass-balance approach). Tier 1 is considered a mixed Tier 1 a/b method.

For source category 2.F.3 Fire Protection, the *Software* follows the Tier 1 method for Refrigeration and Air Conditioning, and thus these two source categories are presented together.

Information

The Tier 1 method estimates emissions from each of the source categories refrigeration and air conditioning and fire protection as a whole across the country (not by sub-application) and requires the following data input:

- i) Year of introduction of the refrigerant (F-gas)
- ii) Growth rate in sales of new equipment
- iii) Assumed equipment lifetime
- iv) EF from installed base
- v) Fraction (%) of refrigerant destroyed at the end-of-life
- vi) Production (sales) of refrigerant/fire protectant (i.e. agent) in the current reporting year
- vii) Export of agent in the current reporting year
- viii) Import of agent in the current reporting year

Then the Tier 1 method back-calculates the development of the bank of the agent from the current reporting year to the year of its introduction. The bank is the amount of agent stored in products. The *Software* then calculates emissions from the bank in the current reporting year plus emissions from the retired equipment in the current reporting year (if they happen, assuming the lifetime of equipment).

Tier 2 methods apply to the source category refrigeration and air conditioning only. Emissions can be estimated, by sub-application (e.g. commercial and domestic refrigeration are estimated separately), using a Tier 2a and/or Tier 2b method.

The Tier 2a method is an EF approach and requires the data input and respective EFs for each stage of operation:

- i) Management of refrigerant containers
- ii) Charge of refrigerant
- iii) Operation and servicing of refrigerant systems (emissions from the bank)
- iv) Disposal of refrigerant systems (end-of-life).

The Tier 2b method is a mass-balance approach for refrigeration across the whole country in the current reporting year and overall needs data to estimate the flow of refrigerants across the industry, including:

- i) Annual sales of new refrigerant
- ii) Total charge of new equipment
- iii) Original total charge of retiring equipment
- iv) Amount of refrigerant destroyed

<u>GHGs</u>

The *Software* includes the following GHGs for the Refrigeration and Air Conditioning and Fire Protection source categories:

CO_2	CH ₄	N_2O	HFCs	PFCs	SF_6	NF ₃
-			X	X	X	X

IPCC Equations

- ✓ <u>Tier 1</u>: <u>Equation 7.1 and 7.2A/B</u> (Refrigeration and Air Conditioning (RAC)), <u>Equation 7.17</u> (Fire Protection)
- ✓ <u>Tier 2a</u>: <u>Equations 7.10, 7.11, 7.12, 7.13</u> and <u>7.14 (RAC)</u>
- ✓ <u>Tier 2b</u>: <u>Equation 7.9</u> (RAC)

Software Worksheets

The *Software* calculates emissions of F-gases from **Refrigeration and Air Conditioning** (sub-category 2.F.1.a and 2.F.1.b) and **Fire Protection,** using the following worksheets as described:

- ✓ 1.1.2 F-gases Manager: is applicable to both source categories and contains data on F-gases used (including imported) and/or produced and exported in country.
- ✓ F-gas Emissions (RAC)/Emissions from Fire Protection (Fire Protection): These worksheets are exactly the same and contain for each subdivision and each F-gas, information on the year of introduction, growth rate in sales of new equipment, assumed equipment lifetime, EF from installed base, fraction (%) of agent destroyed at the end-of-life, production, export and import. The worksheet calculates the associated F-gas emissions for Tier 1.
- ✓ F-gas Parameters Tier 2 (RAC only), this worksheet is required for users applying either Tier 2a or Tier 2b, and allows input of necessary information: subdivisions, sub-applications, chemicals (i.e. gases) consumed and which Tier 2 method is applied for that subdivision/sub-application/F-gas (Tier 2a or 2b). Additional parameters are available for data input, depending on the method selected for each gas. These parameters are automatically transferred into the Tier 2a and/or Tier 2b worksheets for calculation of emissions. The user may also indicate in this worksheet if a specific combination of subdivision/sub-application/F-gas is confidential.
- ✓ F-gas Emissions Tier 2a (RAC only), allows the user to enter in the relevant AD to estimate GHG emissions for each subdivision /sub-application / F-gas, based on the EFs and parameters entered in worksheet F-gas Parameters- Tier 2 and using the Tier 2a method (EF approach).
- ✓ F-gas Emissions Tier 2b (RAC only), allows the user to enter in the relevant AD to estimate GHG emissions for each subdivision/sub-application/F-gas, based on the parameters entered in worksheet F-gas Parameters- Tier 2 and using the Tier 2b method (mass balance approach).

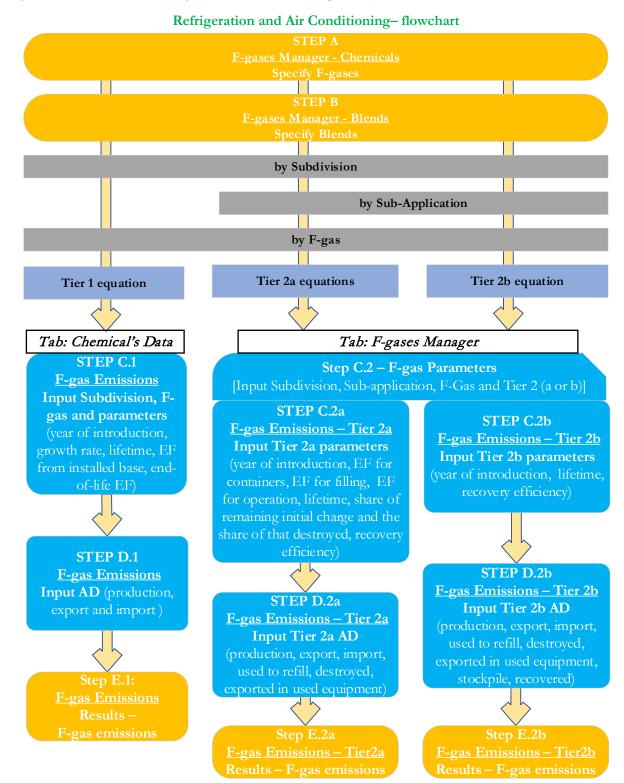
User's work Flowchart

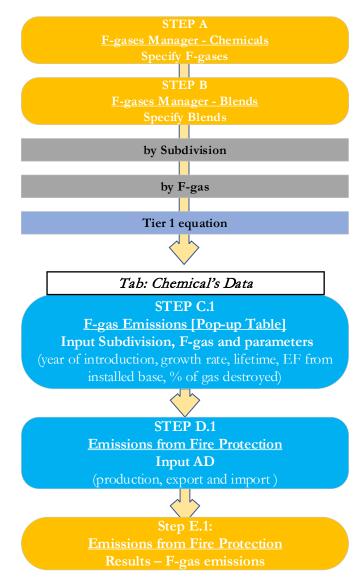
For Refrigeration and Air Conditioning, consistent with the key category analysis and the decision tree in Figure 7.6 of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific¹ EFs or direct measurements.

For Fire Protection, GHG estimates are calculated following the decision tree in Figure 7.9.

¹ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowcharts for Refrigeration and Air Conditioning and Fire Protection, respectively.





Fire Protection – flowchart

Thus, for the relevant source-category:

Steps A and B, 1.1.2 F-gases Manager, users ensure that all F-gases/blends consumed (including imported for consumption) or produced and exported and related to each source category have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision:

Data may be entered as a single application (e.g. all mobile air conditioning or all fire protection equipment) as in **Step C.1** or, for refrigeration and air conditioning, in distinct sub-applications (e.g. domestic refrigeration is calculated separately from commercial refrigeration as in **Step C.2**). See the section below on EF/Parameter input to customize the *Software* to fit the users' needs to designate subdivisions, sub-applications and gases.

Then, for each subdivision/sub-application, if any:

When the Tier 1 Equation is applied:

Step C.1, in the worksheet **F-gas Emissions** or **Emissions from Fire Protection**, users collect and input in the tab **Chemical's Data** information on subdivision(s), relevant F-gases and their year of introduction, growth rate in sales of new equipment, assumed equipment lifetime, EF from installed base, and fraction (%) of refrigerant/fire protectant destroyed at the end-of-life.

Step D.1, in the worksheet **F-gas Emissions** or **Emissions from Fire Protection**, for each subdivision and each F-gas identified in **Step A** or blend identified in **Step B**, users collect and input information on the production, export and import of that gas in the current reporting year (the worksheet allows to enter such information for previous years as well).

Step E.1, in the worksheets F-gas Emissions or Emissions from Fire Protection, the *Software* calculates the associated emissions for each F-gas, in tonnes.

When Tier 2 Equations are applied (Refrigeration and Air Conditioning only):

Step C.2, in the worksheet F-gas Parameters – Tier 2, users collect and input in the *Software* the information on subdivisions, sub-applications and Tier 2 methods (Tier 2a and/or Tier 2b). For Tier 2a, users collect and input the information on year of introduction, EF for containers, EF for filling, EF for operation, lifetime, share of remaining initial charge, the percent of that share that is destroyed and the recovery efficiency (Step C.2a). For Tier 2b it contains information on year of introduction, lifetime, and recovery efficiency (Step C.2b).

Then for Tier 2a:

Step D.2a, in the worksheet **F-gas Emissions – Tier 2a**, for each subdivision/sub-application/F-gas, users collect and input information on the amount of F-gas produced domestically for refrigeration, imported and exported in bulk or equipment, the amount used to refill equipment, the amount destroyed, and exported in used equipment for subsequent use (for the current reporting year as well as it is possible to enter such information for previous years).

Step E.2a in the worksheet **F-gas Emissions – Tier 2a**, the *Software* calculates the associated emissions for each F-gas in kg and Gg.

Then for Tier 2b:

Step D.2b, in the worksheet **F-gas Emissions – Tier 2b,** for each subdivision/sub-application/F-gas/blend, users collect and input information on the amount of F-gas produced domestically, imported and exported in bulk or equipment, the amount used to fill equipment factory- and not-factory-charged, the amount stockpiled (i.e. not used in the inventory year), the amount recovered and recycled/reclaimed, the amount destroyed and the amount exported in used equipment (for the current reporting year as well as it is possible to enter such information for previous years).

Step E.2b, in the worksheets **F-gas Emissions – Tier 2b**, the *Software* calculates the associated emissions for each F-gas in kg and Gg.

<u>Customizing the Software for Refrigeration and Air Conditioning and Fire Protection: subdivision/sub-application/F-gases/blends</u>

For both the Tier 1 and Tier 2 methods, users must first identify the applicable subdivision/sub-application/F - gases/blends applicable to the chosen method that will be used to estimate GHG emissions.

When the Tier 1 Equation is applied:

For the Tier 1 method, the user customizes the *Software* to identify the relevant subdivision and F-gases used. There are no sub-applications for the Tier 1 method for either Refrigeration and Air Conditioning or Fire Protection. By definition, Tier 1 estimates emissions from Refrigeration and Air Conditioning in two major applications: Refrigeration and Stationary Air Conditioning (2.F.1.a) and Mobile Air Conditioning (2.F.1.b) and Fire Protection is a single application.

<u>Note that</u> for users that apply a Tier 1 method for Refrigeration and Stationary Air Conditioning (2.F.1.a) and intend to prepare a JSON file for submission of the GHG inventory into the UNFCCC ETF Reporting Tool all data will transfer to the UNFCCC as commercial refrigeration. This is because the structure of the CRT accommodates reporting at the sub-application level (i.e. Tier 2). Users reporting a Tier 1 method for Refrigeration and Air Conditioning should indicate that emissions from any other possible sub-application (domestic refrigeration, industrial refrigeration, etc) are "IE" (included elsewhere). See Annex I for further information.

Important: When the user first enters the *Software*, there is only a single subdivision (Unspecified) and no F-gases available for selection for data entry for these source categories. Thus, the user must identify subdivisions and enter the relevant F-gas(es)/blends to be able to enter data in the worksheet.

Example: Landing page when user first enters category 2.F.1.a and 2.F.1.b

2006 IPCC Categories - 4	F-Gas Emissions F-Gas Parameters - Tier 2 F-Gas Emissions - Tier 2a F-Gas Emissions - Tier 2b	
2.E.5 - Other (please specify) - Product Uses as Substitutes for Ozon 2.F.1 - Refrigeration and Air Conditionin - 2.F.1.5 - Mobile Air Conditioning 2.F.2 - Four Blowing Acents	Worksheet	990
2.F.3 - Fire Protection	Subdivision Unspecified V Gas V Chemical's Data IY NA GR (%) NA d (years) NA EF (%) NA X	(2) NA
2.F.4 - Aerosols 2.F.5 - Solvents 2.F.6 - Other Applications (please speci - Other Product Manufacture and Use 2.G.1 - Electrical Equipment	I. Total Chemical Agent Inputs (across the time series) (ΣD) NA Bank(t) + ΣE + ΣF NA II. Total Chemical Agent in equipment in use (last year of the time series) (Bank(t)) NA III. Total Chemical Agent Emissions (across the time series) (ΣE) NA IV. Total Chemical Agent Emissions (across the time series) (ΣE) NA	
- 2.G.1.a - Manufacture of Electrical I - 2.G.1.b - Use of Electrical Equipme - 2.G.1.b - Use of Electrical Equipme - 2.G.2.b - SF6 and PFCs from Other Prod - 2.G.2.b - Military Applications - 2.G.2.b - Accelerators - 2.G.2.b - Accelerators - 2.G.2.b - Accelerators - 2.G.3.a - Nedical Applications - 2.G.3.a - Medical Applications - 2.G.3.a - Medical Applications - 2.G.3.a - Medical Applications		

Example: Landing page when user first enters category 2.F.3

2006 IPCC Categories 4 2.E.5 - Other (please specify) - Product Uses as Substitutes for Ozon 2.F.1 - Refrigeration and Air Conditionin - 2.F.1.a - Refrigeration and Stationer 2.F.1.b - Mobile Air Conditioning 0.5.2. See Mobile Air Conditioning	Emissions from Fire Protection Worksheet Sector: Industrial Processes and Product Use Category: Product Uses as Substitutes for Ozone Depleting Substances Subcategory: 2.F.3 - Fire Protection Sheet: Emissions Data						1990
2.F.2 - Foam Blowing Agents 2.F.3 - Fire Protection		Chemical's Data	IY NA	GR (%) NA	d (yr) NA	EF (%) NA	X (%)
2.F.4 - Aerosols 2.F.5 - Solvents	I. Total Chemical Agent Inputs (across the time series) (∑D)		NA	Bank(t) + ΣE + ΣF	NA		
2.F.6 - Other Applications (please speci	II. Total Chemical Agent in equipment in use (last year of the time series) (Bank(t))		NA	-			
- Other Product Manufacture and Use	III. Total Chemical Agent Emissions (across the time series) (ΣE)		NA				
2.G.1 - Electrical Equipment - 2.G.1.a - Manufacture of Electrical	IV. Total Chemical Agent Recovered/Destroyed/Exported from equipment at end-of-life (across the t	time series) (∑F)	NA				
2.G.1.b - Use of Electrical Equipme 2.G.1.c - Disposal of Electrical Equi 2.G.2 - SF6 and FFCs from Other Prod 2.G.2.a - Military Applications 2.G.2.b - Accelerators							

Entering subdivision(s)

- 1. If the user intends to apply a single subdivision (e.g. national) they may either leave as is (subdivision =Unspecified) or add its univocal name/code [e.g. "country name"].
- 2. To add a univocal name/code in worksheet **F-Gas Emissions** or **Emissions from Fire Protection,** users must click on the tab **Chemical's Data** to open a pop-up window and to enter a new subdivision(s).

Example: Adding a subdivision for Tier 1

<u>Note that</u> this figure is for Refrigeration and Air Conditioning but applies also to Emissions from Fire Protection worksheet.

F-Gas Emissions F-Gas Parameters - Tier 2 F-Gas Emissions - Tier 2 Worksheet Sector: Industrial Processes and Product Use Category: Product Uses as Substitutes for Ozone Depleting Substar Subcategory: 2.F.1.a Refrigeration and Stationary Air Conditioning Sheet: Emissions Data		2b			1990
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$		1's Data IY NA GR (*2) Ν. ΝΑ Bank(t) + ΣΕ ΝΑ ΝΑ		EF (2) <u>NA</u> X (2) <u>NA</u>	
	Country/Tenitory Category Subdivision Gas - Data - Year of introduction (IY) Growth Rate in New E Assumed Equipment L Emission Factor from in % of Gas Destroyed at	Equipment Sales (GR) Jetime (yean) (d) nstalled base (EF)	2.F.1.a - Subdi	Subdivision	

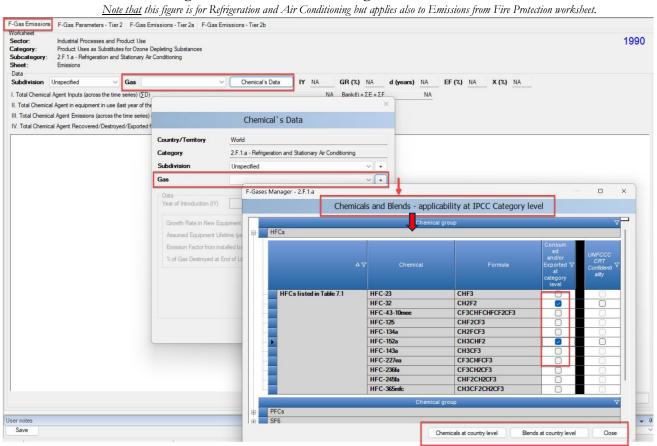
Identifying relevant F-gases /blends at the IPCC category level

Upon first entering the *Software* and selecting **Gas** in the worksheet **F-Gas Emissions** or **Emissions from Fire Protection,** the user will not see any F-gases (or blends) pre-populated in the drop-down menu. This is because users must first identify the specific F-gases /blends consumed for each relevant source category; selected from all F-gases/blends that have already been identified by the user at the national level in the **1.1.2 F-gases Manager**.

To select the F-gases used in this IPCC category:

- 1. select Chemical's Data
- 2. select the [+] next to the drop-down menu for Gas
- 3. check all F-gas(es)/blends consumed for refrigeration and air conditioning and for fire protection. Note that: any F-gases/blends selected here will be available for all subdivisions in each source category. If a needed gas is not available for selection, it is because it has not been added at the national level as a gas produced/used in this country. To enter Fgases (or blends thereof) at the national level, select **Chemicals at National Level** or **Blends at National Level** from the bottom of the screen.
- 4. For users intending to use the Software for reporting in the UNFCCC ETF Reporting Tool: If AD and/or emissions for a particular F-gas consumed in this category are considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. If checked, "C" will be reported for AD and "IE" for emissions in the JSON file generated for the CRT. Further, all confidential emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate (for further information, see Annex I: Mapping between the IPCC Inventory Software and the UNFCCC ETF Reporting Tool).

Example: Populating the F-gases manager and designating confidentiality for category: Refrigeration and Air Conditioning and Fire Protection – Tier 1



Once information on subdivisions and relevant F-gas(es) for category 2.F.1.a, 2.F.1.b and 2.F.3, as appropriate, have been identified, the user is ready to input relevant EF/parameters following the Tier 1 method.

When Tier 2 Equations are applied (Refrigeration and Air Conditioning only):

Similar as for Tier 1, users must customize the *Software* to identify the relevant subdivision(s) and F-gas(es) used for Refrigeration and Air Conditioning following a Tier 2 method. In addition, the Tier 2 method requires information on sub-applications (e.g. commercial refrigeration is calculated separately from domestic).

The worksheet **F-Gas Parameters- Tier 2** is used to define subdivision(s), sub-application(s), and F-gases and/or blends used in the Tier 2a and Tier 2b methods, as well as additional parameters needed for these methods (input of additional parameters is described in the next section).

Entering subdivision(s) and sub-application(s)

At the beginning, the worksheet is empty and users need to input firstly subdivision(s) in the grey cell as follows.

- 1. Select the drop-down menu. If the user intends to apply a single subdivision (e.g. national) they may either leave as is (select subdivision =Unspecified) or add its univocal name/code [e.g. "country name"].
- 2. Then the *Software* introduces the expanding window below the entered subdivision, see [+] sign in below figure. By clicking on the [+] sign, the window explands and allows the user to enter sub-applications (domestic, commercial, etc.), which are available in the drop-down table. Users may enter country-specific sub-applications manually.

For users intending to use the Software for reporting in the UNFCCC ETF Reporting Tool: The user should avoid changing the pre-defined subapplications in the drop-down menu, as the existing naming convention has been used to map to the appropriate category in the UNFCCC CRT. Any additional sub-applications added by the user (or modifications of the names of existing sub-applications) will map to the source category stationary air conditioning in Table 2(II)B-Hs2 of the UNFCCC CRT.

Example: Identifying subdivision(s) / sub-application(s) - Tier 2

	F-Gas Parameters - Tie	² F-Gas Emis	sions - Tier 2a F-Gas Er	missions - Tier 2b		
Worksheet Sector: Category: Subcategory: Sheet: Data	Industrial Processes and I Product Uses as Substitut 2.F.1.a - Refrigeration and F-Gas Parameters - Tier 2	es for Ozone Dep Stationary Air Cor				1990
F-Gases Mar	nager					
			Subdivis	ion		
*						<u> </u>
	as Parameters - Tier 2 F-Gas Emiss	ons - Tier 2a F-Gas E	missions - Tier 2b			
Category: Produ Subcategory: 2.F.1.	strial Processes and Product Use uct Uses as Substitutes for Ozone Deple .a - Refrigeration and Stationary Air Con s Parameters - Tier 2					
F-Gases Manager						
			5	Subdivision		
National						•
sheet tor: Industria egory: Product category: 2.F.1.a	Parameters - Tier 2 F-Gas Emissions al Processes and Product Use Uses as Substitutes for Ozone Depleting - Refingeration and Stationary Air Condition Parameters - Tier 2		ons - Tier Zb			1990
ksheet	al Processes and Product Use t Uses as Substitutes for Ozone Depleting - Refrigeration and Stationary Air Condition	Substances	ons - Tier 2b			1990
csheet dor: Industria egory: Product scategory: 2.F.1.a set: F.Gas P a F.Gases Manager	al Processes and Product Use t Uses as Substitutes for Ozone Depleting - Refrigeration and Stationary Air Condition	Substances	ons - Tier 2b Subdivis	ion		1990
ksheet stor: Industria gory: Product scategory: 2.F.1.a - set: F-Gas P a	al Processes and Product Use t Uses as Substitutes for Ozone Depleting - Refrigeration and Stationary Air Condition	Substances	Subdivis			1990
csheet dor: Industria egory: Product scategory: 2.F.1.a set: F.Gas P a F.Gases Manager	al Processes and Product Use t Uses as Substitutes for Ozone Depleting - Refrigeration and Stationary Air Condition	Substances				
csheet dor: Industria egory: Product scategory: 2.F.1.a set: F.Gas P a F.Gases Manager	al Processes and Product Use t Uses as Substitutes for Ozone Depleting - Refrigeration and Stationary Air Condition	Substances	Subdivis	lication	Recovery efficiency of charge (to be reclaimed/recycled) remaining at end of life in retired equipment (%)	1990 Share of initial charge remaining at the end of life
kaheet tor: Industrie egory: Product category: 2.F.1a + et: FGase Manager FGases Manager	al Processes and Product Use Uses as Substitutes for Ozone Depleting - Refigeration and Stationary Ar Condition Parameters - Tier 2	Substances ing Lifetime of equipment	Subdivis Sub-app Emission factor for filling (production/manufacturing) of nev equipment (% initial chargelyr) 02 < k < 1	lication Emission factor for equipment operation (leakage/servicing)	(%) 0 < ŋrec.d < 70	Share of initial charge remaining at the end of life
kaheet tor: Industrie egory: Product category: 2.F.1a ret: F.Gas P I a F.Gases Manager National ***	al Processes and Product Use Luses as Substrates for Ozone Depleting - Refrigeration and Stationary Ar Condition Parameters - Tier 2 Sub-application Domestic Refrigeration Stand-stone Commercial Applications	Lifetime of equipment (years) 12 ≤ d ≤ 20 10 ≤ d ≤ 15	Subdivis Sub-app Emission factor for filling (production/manufacturing) of nex equipment (% initial chargelyr) (2 ≤ k ≤ 1 0 5 ≤ k ≤ 3	Ication Emission factor for equipment operation (leakage/servicing) (% initial charge/yr) 0.1 £ x £ 0.5 1 £ x £ 15	(%) 0 < ŋrec,d < 70 0 < ŋrec,d < 70	Share of initial charge remaining at the end of life (%) 0 < p < 80 0 < p < 80
kaheet tor: Industrie egory: Product category: 2.F.1a - est: FGase Manager P A FGases Manager National	al Processes and Product Use Uses as Substitutes for Ozone Depleting - Refrigeration and Stationary Ar Condition arameters - Tier 2 	Substances ing Lifetime of equipment (years) 12 < d < 20	Subdivis Sub-app Emission factor for filling (production/manufacturing) of nev equipment (% initial chargelyr) 02 < k < 1	Ication Emission factor for equipment operation (leakage/servicing) (% inibia charge/yr) 0.1 ≤ x ≤ 0.5	(%) 0 < ŋrec.d < 70	Share of initial charge remaining at the end of life (%) 0 < p < 80
sheet tor: Industrie egory: Product category: 2.F.1.a et: F.Gase A F.Gases Manager National	al Processes and Product Use Luses as Substrates for Ozone Depleting - Refrigeration and Stationary Ar Condition Parameters - Tier 2 Sub-application Domestic Refrigeration Stand-stone Commercial Applications	Lifetime of equipment (years) 12 ≤ d ≤ 20 10 ≤ d ≤ 15	Subdivis Sub-app Emission factor for filling (production/manufacturing) of nex equipment (% initial chargelyr) (2 ≤ k ≤ 1 0 5 ≤ k ≤ 3	Ication Emission factor for equipment operation (leakage/servicing) (% initial charge/yr) 0.1 £ x £ 0.5 1 £ x £ 15	(%) 0 < ŋrec,d < 70 0 < ŋrec,d < 70	Share of initial charge remaining at the end of life (%) 0 < p < 80 0 < p < 80
sheet tor: Industrie egory: Product category: 2.F.1.a et: F.Gase A F.Gases Manager National	al Processes and Product Use Uses as Substitutes for Ocone Depleting - Refigeration and Stationary Ar Condition Parameters - Tier 2 Sub-application Stand-alone Commercial Applications Medium & Large Commercial Refigeration Transport Refigeration Transport Refigeration	Substances ing Lifetime of equipment (years) 12 ≤ d ≤ 20 10 ≤ d ≤ 15 7 ≤ d ≤ 15	Subdivis Sub-app Emission factor for filling (production/manufacturing) of nev equipment (% initial charge/yr) 0.2 clk cl 0.5 clk c.3 0.5 clk c.3	ication Emission factor for equipment operation (leakage/servicing) (% initial charge/yr) 0.1 ≤ x ≤ 0.5 1 ≤ x ≤ 15 10 ≤ x ≤ 35	(%) 0 < nrec.d < 70 0 < nrec.d < 70 0 < nrec.d < 70	✓ ✓
kaheet tor: Industria egory: Product category: 2.F.1a - set: FGas P a F-Gases Manager National	al Processes and Product Use Uses as Substitutes for Ozone Depleting Refigeration and Stationary Ar Condition arameters - Tier 2 Sub-application Sub-application Stand-alone Commercial Applications Medium & Large Commercial Refigeration Transport Refigeration	Lifetime of equipment (years) 12 < d < 20 10 < d < 15 7 < d < 15 6 < d < 9	Subdivis Sub-app Emission factor for filling (production/manufacturing) of nex- equipment 0.2 stk 1 0.5 stk 2 0.5 stk 2 0.5 stk 2 0.2 stk 1	Ication Emission factor for equipment operation (leakage/servicing) (% initial charge/yr) 0.1 ≤ x ≤ 0.5 1 ≤ x ≤ 1.5 10 ≤ x ≤ 3.5 15 ≤ x ≤ 50	(%) 0 < nyrec, d < 70 0 < nyrec, d < 70 0 < nyrec, d < 70 0 < nyrec, d < 70	Share of initial charge remaining at the end of life (%) □ 0 ○ 0 ○ 50 ○ 0 □

Identifying relevant F-gases/blends at the IPCC category level

After identifying the subdivision(s) and sub-application(s), users must then identify the specific F-gases /blends consumed for Refrigeration and Air Conditioning; selected from all F-gases/blends that have already identified by the user at the national level in the **1.1.2 F-gases Manager**.

To select the F-gas(es)/blends used in this IPCC category:

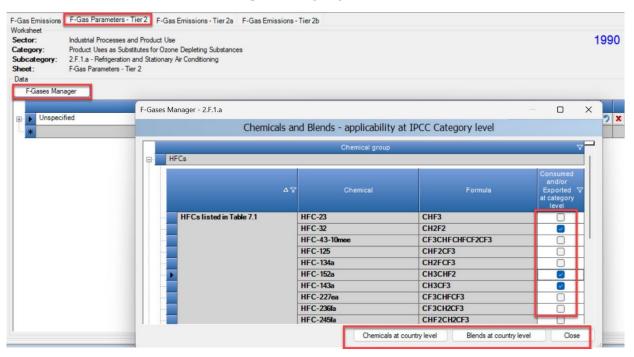
 For first time use of the *Software* it is necessary to enter F-gas(es)/blends consumed in the Refrigeration and Air Conditioning source category. To do this, select F-Gases Manager and check all F-gas(es)/blends consumed for refrigeration and air conditioning.

<u>Note that</u>: the list of possible blends is also accessible in the drop-down menu, after Other GHGs. <u>Note that</u>: if a gas/ blend is not available for selection, it is because it has not been added at the national level as a gas/ blend produced/ used in this country. To enter F-gases (or blends thereof) at the national level, select **Chemicals at National Level** or **Blends at National Level** from the bottom.

2. After identifying the subdivision, selecting a specific sub-application (e.g. Domestic Refrigeration in the image below), and ensuring the F-gases Manager includes all gases/blends consumed in the category, the user selects the [+] plus sign to select the F-gas(es)/blends for which emissions are to be calculated. Each F-gas /blend, is entered row by row in <u>Column |Chemical|</u>.

Note that: the drop-down for chemical will be blank until a user identifies the specific F-gas(es) / blends used for the IPCC source category in previous step.

Example: Adding F-gas(es)/blends for Tier 2



3. For users intending to use the Software for reporting in the UNFCCC ETF Reporting Tool: If AD and/or emissions for a particular F-gas consumed in this category is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. For Tier 2, the designation of confidentiality occurs row by row, for each gas consumed in the subdivision/sub-application (see Annex I: Mapping between the IPCC Inventory Software and the UNFCCC ETF Reporting Tool).

<u>Note that:</u> if checked, "C" will be reported for AD and "IE" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate (for further information, see Annex I).

Example: Populating the F-gases manager and designating confidentiality for category: refrigeration and air conditioning - Tier 2

egory: bcategor eet: ta	Product Use	rigeration and	es for Ozone I Stationary Air	Depleting Substanc Conditioning	es							1	99
F-Gases	Manager												
Line	pecified					Subdivision							
Ons	pecilieu												_
						Sub-application							
Đ	Domestic Refriger	ation											
	Chemical	Tier	Year of Introducti on	Emission factor for containers management (%/yr)	Emission factor for filling (production/ma nufacturing) of new equipment (% initial charge/yr)	Emission factor for equipment operation (leakage/servici ng) (% initial charge/yr)	Lifetime of equipme nt (years)	Share of initial charge remaining at the end of life (%)	Share of charge remaining at the end of life that is destroyed (%)	Recovery efficiency of charge (to be reclaimed/recyc led) remaining at end of life in retired equipment (%)	UNF CCC CRT Confi dentit lity		
			t(start)	EFc	EFk	EFx	d	р	D	η(rec,d)			
													2
	¥ ✓												-

EF/parameters input¹

The following sections in Chapter 7, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of EF/parameters:

- ✓ <u>Section 7.5.2.2</u> contains information on the choice of EFs/parameters for Refrigeration and Air Conditioning.
- ✓ <u>Section 7.6.2.2</u> contains information on the choice of EFs/parameters for Fire Protection.

When the Tier 1 Equation is applied:

- 1. In worksheet **F-Gas Emissions** or **Emissions from Fire Protection,** users must click on the tab **Chemical's Data** to open a pop-up window and to enter the parameters and EFs needed for estimation of each F-gas/blend consumed in that subdivision.
- 2. **Gas:** user selects the relevant F-gas/blend from the drop-down menu (refer to previous section on customizing the *Software* if an additional F-gas or blend needs to be added to the drop-down menu).
- 3. <u>Window | Year of Introduction |</u>: year of introduction of the agent in the country for use in RAC (e.g., 1990).
- 4. <u>Window | Growth Rate in New Equipment Sales |</u>: growth rate in sales of new equipment, usually assumed linear across the period of assessment (e.g. 3%).
- <u>Window | Assumed Equipment Lifetime |:</u> equipment lifetime number of years: <u>Note that:</u> the average lifetime for refrigeration and air conditioning equipment is 15 years. <u>Note that:</u> for fire protection, the average lifetime is 15 years.
- 6. <u>Window</u> <u>Emission Factor from Installed Base</u>: EF from installed base or bank, in percent. <u>Note that:</u> the average EF from installed base for refrigeration and air conditioning equipment is 15 % annually. <u>Note that:</u> for fire protection, the average EF from installed base is 4% annually.
- 7. <u>Window |% of Gas Destroyed at End-of-Life</u>: fraction of agent destroyed at the end-of-life, percent (the default assumption of 0% means no F-gas is destroyed at the end-of-life, thus all the amount in retired equipment is emitted).

¹ Unlike other source categories in the IPCC sector, this Users' Guidebook explains first the input of EF/parameter inputs, then AD inputs, due to the structure of the *Software*.

Example: Entering EF/parameter information- Tier 1

Note that this figure is for Refrigeration and Air Conditioning but applies also to Emissions from Fire Protection worksheet. The IPCC default values for Fire Protection, identified below, will automatically appear but may be manually updated.

F-Gas Emissions F-Gas Parameters - Tier 2 F-Gas Emissions - Tier 2a			uppear our may ee mannaay apaarea	
Worksheet Industrial Processes and Product Use Category: Product Uses as Substitutes for Ozone Depleting Substance Subcategory: 2.F.1.a Refrigeration and Stationary Air Conditioning Sheet: Emissions Data	es			1990
Subdivision Unspecified V Gas	Chemical's Data	IY NA GR (%) NA	d (years) NA EF (%) NA X (%) NA	
I. Total Chemical Agent Inputs (across the time series) (∑D)		NA Bank(t) + ΣE + Σ	F NA	
II. Total Chemical Agent in equipment in use (last year of the time series) (Bank)	t))	NA		
III. Total Chemical Agent Emissions (across the time series) (ΣE)		NA		
IV. Total Chemical Agent Recovered/Destroyed/Exported from equipment at en	nd-of-life (across the time series) (Σ F)	NA		
	Country/Territory Category Subdivision Gas Data Year of Introduction (IY) Growth Rate in New Equip Assumed Equipment Lifeti Emission Factor from instal % of Gas Destroyed at Enc	ne (yearn) (d) led base (EF) d of Life (X)	× # Conditioning	

8. Then, users need to Save and Close the pop-up window Chemical's Data to return to the worksheet and to enter agent production, export and import data. The user can see information entered in Chemical's Data tab in the main calculation window. In the image below, the gas consumed in the subdivision appears (i.e. HFC-32), and the parameters are visible. Input of AD (in red-orange cells) and the QA/QC check in the green cells of steps I-IV just below the gas and EF information, is explained in the next section.

Example: Grid ready for entry of AD – Tier 1- refrigeration and air conditioning

ector: ategory: ubcategory heet: Data	Product L r: 2.F.1.a - F	Processes and F Jses as Substitut Refrigeration and CH2F2) Emission:	es for Ozone [Stationary Air	Depleting Substance Conditioning	95										199
Subdivision	Unspecified	~	Gas HFC	C-32 (CH2F2)	~	Chemical's Da	ta IY	1990 GR (1	K) 3 d(years) 15	EF (%) 15	X (%) 0			
Total Chemic	cal Agent Input	s (across the time	e series) (∑D)					0 Bank	t) + ΣE + ΣF	0					
Total Chem	ical Agent in eq	uipment in use (last year of the	time series) (Bank)	t))			0							
		ssions (across th						0							
				rom equipment at er	d of life (some	the time and all	50	0							
7. Total Chen	nical Agent He	covered/Destroy	ea/Exported fi	rom equipment at er	nd-or-life (across	the time series) (25)	U				_			
					Equ	ation 7.2B						Informa	tion for UNFCC		
Year	Agent production (tonnes)	Agent export (tonnes)	Agent impo (tonnes)	rt Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent in all equipment installed in service (tonnes)	
t ∆⊽		Exp	Imp	D = P - Exp + Imp	R = [L(t-d) - (L(t-d)) * EF/100)] - [S_needed - S_done](t-d)	F = R * (X / 100)		Bank = Bank(t- 1) + D - R - I	i = IF(M * EF/100 > ΣD- ΣR-ΣΙ: M * EF/100; ΣD- ΣR-ΣΙ)	E = G + I	EE = E / 1000	$ \begin{split} & K = IF(D > [I(t-1) - M(t-d+1) \\ & *EF(100); [I(t-1) - M(t-d+1) \\ & *EF(100); D) \end{split} $	L = D - K	$M = \sum_{\substack{(L(t, t-(d-1)))}} L(t, t-(d-1))$	
1990				0				0	0	0			0		3 🖬 🤊
1991				0			0	0		0	0	0	0	0	
1992				0			0	0		0	0	0		0	
1993 1994				0		0	0	0		0	0	0	0	0	
Contraction Contraction				0		0	0	0		0	0	0		0	
1995 1996				0		0	0	0		0	0	0		0	

Example: Grid ready for entry of AD – Tier 1- fire protection

orksheet ector:		Processes and F													199
itegory: ibcategory:			es for Ozone De	epleting Substance	es										
eet:			2CF3) Emissions												
lata	To the second second											1.00000			
ubdivision	Unspecified	~	Gas HFC	C-365mfc (CH3CF	2CH2CF3	Chemical's D	ata IY	1990 G	R (%) 3	d (yr) 15	EF (%) 4	X (%) 0			
Total Chemic	al Agent Inputs	s (across the tim	e series) (∑D)					0 Bank	t) + ΣE + ΣF	0					
Total Chemic	ical Agent in eq	upment in use	last year of the	time series) (Bank	(đ))			0							
	and for all is a	eren er forson er for	ne time series) ()					0							
	and the second second							0							
. Total Chemi	nical Agent Rec	covered/Destroy	/ed/Exported fro	om equipment at e	end-of-life (across t	he time series) (ΣF)	U							
					Equa	tion 7.17						Inform	ation for UNFCC	CCCRT	
												initiatina			
	Agent production (tonnes)	Agent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent in all equipment installed in service (tonnes)	
	production			agent to domestic market	equipment at end-of-life	of agent in retired equipment	agent from retired equipment		from installed equipment	Emissions	Emissions	Agent for servicing	Agent in new equipment installed in year t	Agent in all equipment installed in service	
	production (tonnes)	(tonnes)	(tonnes)	agent to domestic market (tonnes) D = P - Exp +	equipment at end-of-life (tonnes) R = [L(t-d) - (L (t-d) * EF/100)] - [S_needed -	of agent in retired equipment (tonnes) F = R * (X /	agent from retired equipment (tonnes)	(tonnes) Bank = Bank(t-	from installed equipment (tonnes) I = IF(M* EF/100 > ΣD- ΣR-ΣI; M* EF/100; ΣD- ΣR-ΣI)	Emissions (tonnes)	Emissions (Gg) EE = E / 1000	Agent for servicing (tonnes) K = IF(D>[I(t- 1) - M(t-d+1) *EF/100]; [I(t- 1) - M(t-d+1)	Agent in new equipment installed in year t (tonnes)	Agent in all equipment installed in service (tonnes) $M = \sum (L(t, t-(d -1))$	7 2 7
t AV	production (tonnes)	(tonnes)	(tonnes)	agent to domestic market (tonnes) D = P - Exp +	equipment at end-of-life (tonnes) R = [L(t-d) - (L (t-d) * EF/100)] - [S_needed -	of agent in retired equipment (tonnes) F = R * (X /	agent from retired equipment (tonnes)	(tonnes) Bank = Bank(t- 1) + D - R - I	from installed equipment (tonnes) I = IF(M* EF/100 > ΣD- ΣR-ΣI; M* EF/100; ΣD- ΣR-ΣI) 0	Emissions (tonnes) E = G + I	Emissions (Gg) EE = E / 1000	Agent for servicing (tonnes) K = IF(D>[I(t- 1) - M(t-d+1) *EF/100]; [I(t- 1) - M(t-d+1)	Agent in new equipment installed in year t (tonnes) L = D - K	Agent in all equipment installed in service (tonnes) $M = \sum (L(t, t-(d -1)))$	
t ∆ ⊽ 1990	production (tonnes)	(tonnes)	(tonnes)	agent to domestic market (tonnes) D = P - Exp +	equipment at end-of-life (tonnes) R = [L(t-d) - (L (t-d) * EF/100)] - [S_needed - S_done](t-d)	of agent in retired equipment (tonnes) F = R * (X /	agent from retired equipment (tonnes) G = R - F	(tonnes) Bank = Bank(t- 1) + D - R - I 0 0	from installed equipment (tonnes) I = IF(M* EF/100 > ΣD- ΣR-ΣI; M* EF/100; ΣD- ΣR-ΣI) 0	Emissions (tonnes) E = G + I	Emissions (Gg) EE = E / 1000 0	Agent for servicing (tonnes) K = IF(D>[I(t- 1) - M(t-d+1) *EF/100]; [I(t- 1) - M(t-d+1)	Agent in new equipment installed in year t (tonnes) L = D - K	Agent in all equipment installed in service (tonnes) $M = \sum (L(t, t-(d -1)))$	2
t ∆⊽ 1990 1991	production (tonnes)	(tonnes)	(tonnes)	agent to domestic market (tonnes) D = P - Exp +	equipment at end-of-life (tonnes) R = [L(t-d) - (L (t-d) * EF/100)] - [S_needed - S_done](t-d) 0	of agent in retired equipment (tonnes) F = R * (X / 100)	agent from retired equipment (tonnes) G = R - F	(tonnes) Bank = Bank(t- 1) + D - R - I 0 0 0	from installed equipment (tonnes) i = IF(M * EF/100 > ΣD- ΣR-ΣI; M * EF/100; ΣD- ΣR-ΣI) 0 0 0 0 0	Emissions (tonnes) E = G + I 0 0	Emissions (Gg) EE = E / 1000 0 0	Agent for servicing (tonnes) K = IF(D>f](t- 1) - M(t-d+1) *EF/100]; [](t- 1) - M(t-d+1) *EF/100]; D)	Agent in new equipment installed in year t (tonnes) L = D - K 0 0 0	Agent in all equipment installed in service (tonnes) $M = \sum (L(t, t-(d -1)))$	3

When Tier 2 Equations are applied (Refrigeration and Air Conditioning only):

- 1. In worksheet **F-Gas Parameters-Tier 2,** users use the [+] plus sign to allow data entry for each subdivision/ sub-application.
- 2. <u>Column |Chemical|</u>: user selects the relevant F-gas/blend from the drop-down menu (refer to previous section on customizing the *Software* if an additional F-gas or blend needs to be added to the drop-down menu).
- 3. <u>Column |Tier|</u>: After selecting the F-gas/blend, the specific Tier 2 method applied (i.e. either Tier 2a or Tier 2b) should be selected.

Then, for different Tiers (Tier 2a and/or Tier 2b) users input the following EFs/parameters (consult <u>Table 7.9</u> Chapter 7 Volume 3 of the *2006 IPCC Guidelines* for IPCC default values, if needed).

- For Tier 2a, for each subdivision, sub-application and each F-gas/blend, enter the following information:

 <u>Column | t (start)|</u>: the year of introduction of refrigerant (F-gas/blend).
 - b. <u>Column | EFc|</u>: EF for containers management (percent per year).
 - c. <u>Column | EFk |:</u> EF for filling new equipment (percent of initial charge per year).
 - d. <u>Column | EFx |:</u> EF for equipment operation (percent of initial charge per year).
 - e. <u>Column |d|</u>: lifetime of equipment, years.
 - f. <u>Column</u> |p|: share of initial (full) charge remaining at end-of-life, percent. Note that: this cell requires direct entry. By default, the user should enter into this cell the value that is equal to 1-EFx. Since the annual operation EFs assume full charge, at the end of the year, the assumption is that the emissions remaining are equal to full charge minus annual operating emissions in that year. When a value equal to 1-EFx is entered into this cell, it will turn green. Additional values may be possible to account for country specific circumstances (and note the range of default p value in Table 7.9 may differ). But if alternative data are entered, the cell will turn either orange or red. An orange colour means that p estimates a quantity of charge that is less than the initial charge minus all annual losses across the period d-1, under the assumption of full servicing. A red colour means that p estimates a quantity of charge that is larger than the initial charge minus all annual losses across the period d-1, under the assumption of full servicing. If this cell turns a colour, the user should ensure that mass conservation of the gases is ensured at the end of the calculations (see discussion of the QA/QC check in the AD section below).
 - g. <u>Column |D|</u>: share of charge remaining at the end of life that is destroyed, percent.
 - h. <u>Column $|\eta \text{ (rec,d)}|$ </u>: recovery efficiency of charge to be reclaimed/recycled, percent. <u>Note that</u>: the sum of <u>Column |D| + <u>Column $|\eta \text{ (rec,d)}|$ </u> must be ≤ 100 because gas is either emitted, destroyed or reclaimed/recycled.</u>
- 5. <u>Tier 2b: for each sub-division, sub-application and each F-gas/blend, enter the following information:</u>
 - 1. <u>Column | t (start) |</u>: year of introduction of refrigerant (F-gas/blend).
 - 2. <u>Column |d|</u>: lifetime of equipment, years.
 - 3. <u>Column |D|</u>: share of charge remaining at the end of life that is destroyed, percent.

<u>Column |η (rec,d)|</u>: recovery efficiency at disposal, which is the ratio of recovered HFC referred to the HFC contained in the system, percent.
 <u>Note that:</u> the sum of <u>Column |D|</u> + <u>Column |η (rec,d)|</u> must be ≤ 100 because gas is either emitted, destroyed or reclaimed/recycled.

Please note that EFs are based on the initial (full) charge.

Example: Entering EF/parameter information- Tier 2

a F-Gases	Manager												
					5	Subdivision				. Ж.)			
Uns	specified												_
					S	Sub-application							
₽-	Domestic Refrig	eration	20.		P								
	Chemical	Tier	Year of Introducti on	Emission factor for containers management (%/yr)	Emission factor for filling (production/ma nufacturing) of new equipment (% initial charge/yr)	Emission factor for equipment operation (leakage/servici ng) (% initial charge/yr)	Lifetime of equipme nt (years)	Share of initial charge remaining at the end of life (%)	Share of charge remaining at the end of life that is destroyed (%)	Recovery efficiency of charge (to be reclaimed/recyc led) remaining at end of life in retired equipment (%)	UNF CCC CRT Confi denti ality		
			t(start)	EFc	EFk	EFx				η(rec,d)			
	HFC-143a (Tier 2a	1990	5	0.1	0.25		99.75	20				
	HFC-152a (Tier 2b 🗸	1990				14		50	50		2	X
-	*	Tier 2a Tier 2b	-								8		-
			5		5	Sub-application							4

_				_	5	Subdivision							
*													
otes						▼ ₽ 2F.1a	- Time Seri	ion i					_
ve						Gas		43a (CH3CF3)					

5. The same procedure is to be applied for all subdivisions/sub-applications.

Example: Subdivisions and sub-applications entered for the entire category 2.F.1.a

Note that the same table structure applies to category 2.F.1.b

-Gas Em	imissions F-Gas Parameters - Tier 2 F-Gas Emissions - Tier 2a F-Gas Emissions - Tier 2b	
ector: ategor	Industrial Processes and Product Use Product Use as Substitutes for Ozone Depleting Substances teopory: 2.F.1.a. Refrigeration and Stationary Air Conditioning	19
	iases Manager	
	Subdivision	
-	Tokyo	
	Sub-application	
	Domestic Refrigeration	
	Medium & Large Commercial Refrigeration	
	Residential and Commercial A/C, including Heat Pumps	
	*	
	Subdivision	
2	Rest of Country	
	Sub-application	
æ	Domestic Refrigeration	
	Medium & Large Commercial Refrigeration	
Đ	Residential and Commercial A/C, including Heat Pumps	
	Transport Refrigeration	
	Industrial Refrigeration including Food Processing and Cold Storage	

6. After EF and parameter information is entered for all subdivisions /sub-applications/ F-gases/blends, the user navigates to the worksheet **F-Gas Emissions – Tier 2a** and/or **F-Gas Emissions – Tier 2b** and

enters the corresponding AD. The user can see information entered in the **F-Gas Parameters-Tier 2** tab in the main calculation window of those worksheets. Input of AD (white cells) and the QA/QC check in green below the EFs/parameters is explained in the next section.

Note that: worksheets may be for individual F-gas species, or blends. The figure below illustrates entry of information for a blend. The blend will be disaggregated to individual F-gas species for reporting, including when preparing a JSON file for reporting to the UNFCCC ETF Reporting Tool.

lorksheet	ns F-Gas Par	ameters - Tier 2	F-Gas Emissi	ons - Tier 2a F	-Gas Emissions	- Tier 2b									
ector: ategory: ubcategory: heet: Data	Product Us 2.F.1.a - Re	rocesses and Pro es as Substitutes efrigeration and St sions - Emission P	for Ozone Deplet tationary Air Cond	litioning											199
Subdivision	Unspecified		V Sub-app	lication Dome	stic Refrigeration		√ Ga	s HFC-152a (CH3CHF2)	~					
Intro Year	1990 E	Fc [%] 5	EFk [%]	0.1	EFx [%] 0.25	Lifetim	ne (d) [yr] 15	p [%]	99.75 D [7	c] 20 r	n(rec.d) [%] 8	0			
Total Chemic	al Agent Inputs	(across the time s	series) (∑F + ∑H)					0 Σ	G + Bank(t) + ΣV +	-ΣQ +ΣS +ΣΤ	0				
Total Chemi	ical Agent in nev	w equipment expo	rted (across the t	time series) (∑G)				0							
Total Chemi	ical Agent in eq	uipment in use (la	ist year of the time	e series) (Bank(t))				0							
Total Chem	nical Agent Emis	sions (across the	time series) (SV)				-	0							
						time series) (万Q +		-							
. Total Crient	ical Agent Necu	vereu/Destroyed	/ Exported from e	quipment at enu-	ornire (across the i	une selles) (Zor +	23+211	v							
												Equati	on 7.10 - 7.14		
	Amount in the bank on January 1st of year t (kg)	Domestically Manufactured Chemical in year t (kg)	Imported in bulk in year t (kg)	Exported in bulk in year t (kg)	Contained in factory- charged Imported equipment in year t	Contained in factory- charged Exported new -equipment in year t	Domestic Sales of new & recovered chemical (in bulk) in year t (kg)	Emitted by containers managemen (during transfer from bulk to small	new equipment in	equipment in	Contained in new equipment filled in country in year t	Equati Contained in new equipment consumed in year t (kg)	on 7.10 - 7.14 Emitted from equipment in use in year t, including servicing (kg)	Used to re (k	efill i <g)< th=""></g)<>
	bank on January 1st of year t	Manufactured Chemical in year t	bulk in year t	bulk in year t	factory- charged Imported equipment in	factory- charged Exported new -equipment in	of new & recovered chemical (in bulk) in year t	containers managemen (during transfer from	domestically t manufactured new equipment in year t	filling of new equipment in year t	new equipment filled in country in	Contained in new equipment consumed in year t	Emitted from equipment in use in year t, including servicing		(g)
Year , t	bank on January 1st of year t (kg) Bank(t-1)	Manufactured Chemical in year t (kg) C	bulk in year t (kg)	bulk in yeart (kg)	factory- charged Imported equipment in year t	factory- charged Exported new -equipment in year t	of new & recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 0	containers managemen (during transfer from bulk to small I = H * (EFc / 100)	domestically manufactured new equipment in year t J = H - I - O 0 C	filling of new equipment in year t (kg) K = J * (EFk / 100)	new equipment filled in country in year t L = J - K	Contained in new equipment consumed in year t (kg)		(k	(g)
Year t Δ 1990 1991	bank on January 1st of year t (kg) Bank(t-1) 0 0	Manufactured Chemical in year t (kg) C	bulk in year t (kg)	bulk in yeart (kg)	factory- charged Imported equipment in year t	factory- charged Exported new -equipment in year t	of new & recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 0	containers managemen (during transfer from bulk to small I = H * (EFc / 100)	domestically manufactured new equipment in year t J = H - I - O 0 0 0	filling of new equipment in (kg) K = J * (EFk / 100) 0 0	new equipment filled in country in year t L = J - K 0 0	Contained in new equipment consumed in year t (kg) M = L + F - G 0	Emitted from equipment in use in year t, including servicing (kg) $N = \sum(M(t-d+1,t))^*$ (EFx / 100) 0 0	(k Calculated	(g)
Year t 1990 1991 1992	bank on January 1st of year t (kg) Bank(t-1) 0 0 0	Manufactured Chemical in yeart (kg) C	bulk in year t (kg)	bulk in yeart (kg)	factory- charged Imported equipment in year t	factory- charged Exported new -equipment in year t	of new & recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 0 0	containers managemen (during transfer from bulk to small i = H * (EFc / 100)	domestically manufactured new equipment in year t / J = H - I - O 0 C 0 C 0 C	filling of new equipment in year t (kg) K = J * (EFk / 100) 0 0 0 0	new equipment filled in country in year t L = J - K 0 0 0	Contained in new equipment consumed in year t (kg) M = L + F - G 0 0 0	Emitted from equipment in use in year t, including servicing (kg) N = ∑(M(t- d+1,t))* (EFx / 100) 0 0 0	(k Calculated Calculated	(g)
Year t 1990 1 1991 1 1992 1 1993 1	bank on January 1st of yeart (kg) Bank(t-1) 0 0 0 0 0	Manufactured Chemical in year (kg) C	bulk in year t (kg)	bulk in yeart (kg)	factory- charged Imported equipment in year t	factory- charged Exported new -equipment in year t	of new & recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 0 0 0 0	containers managemen (during transfer from bulk to small I = H * (EFc) 100)	domestically manufactured new equipment in yeart J = H - I - O 0 C 0 C 0 C 0 C 0 C	filling of new equipment in year t (kg) K = J * (EFk / 100) 0 0 0 0 0 0 0 0	new equipment filled in country in year t L = J - K 0 0 0 0	Contained in new equipment consumed in year t (kg) M = L + F - G 0 0 0 0	Emitted from equipment in use in year t, including servicing (kg) $N = \sum(M(t-d+1,t))^*$ (EFx / 100) 0 0 0 0 0 0	(k Calculated Calculated Calculated	(g)
Year t 1990 1 1991 1 1992 1	bank on January 1st of year t (kg) Bank(t-1) 0 0 0	Manufactured Chemical in year t (kg) C	bulk in year t (kg)	bulk in yeart (kg)	factory- charged Imported equipment in year t	factory- charged Exported new -equipment in year t	of new & recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 0 0	containers managemen (during transfer from bulk to small I = H * (EFc) 100)	domestically manufactured new equipment in year t / J = H - I - O 0 C 0 C 0 C	filling of new equipment in yeart (kg) K = J * (EFk / 100) 0 0 0 0 0 0 0 0 0	new equipment filled in country in year t L=J-K 0 0 0 0 0 0 0 0 0 0 0	Contained in new equipment consumed in year t (kg) M = L + F - G 0 0 0	Emitted from equipment in including servicing (kg) N = ∑(Mt- d+1,1)* (EFx / 100) 0 0 0 0 0 0 0 0	(k Calculated Calculated	

Example: Grid for ready for entry of AD – Tier 2a- refrigeration and air conditioning

Activity data input

The following sections in Chapter 7, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of AD:

- ✓ <u>Sections 7.5.2.3</u> contains information on the choice of AD for Refrigeration and Air Conditioning.
- \checkmark Sections 7.6.2.3 contains information on the choice of AD for Fire Protection.

Important to highlight for data entry is the need to avoid double counting of F-gas consumption. The possibility of double counting can be mitigated in two ways:

- 1. Ensure that consumption of a unique quantity of F-gases is not counted simultaneously in multiple applications, both within Refrigeration and Air Conditioning (e.g. the same quantity of HFC-134a should not be added into worksheets for both domestic and commercial refrigeration) or across sub-categories (e.g. the same quantity should not be included in both Refrigeration and Air Conditioning (2.F.1) and Foams (2.F.2) or Fire Protection (2.F.3)). AD entered in each worksheet should be unique to that subdivision/application/sub-application.
- 2. Do not count for both consumption of an F-gas species as well as the consumption of a blend that is then produced from that same quantify of F-gases. Possible double counting can be mitigated where data are entered all as individual F-gases, or all as blends. Where both are available, care should be taken not to include the same quantity of F-gases twice in the AD.

In addition, the *Software* contains a check for categories 2.F.1, 2.F.2, 2.F.3 and 2.F. 6 (contained applications) to ensure that the data input is consistent with the fundamental principle of mass conservation of the gases. This QA/QC check appears just below the EFs/input parameters and will be discussed below after describing input of AD.

The *Software* will be updated in the future to include a validation check to indicate if the total consumption of F gases across all source categories and applications/sub-applications is equal to or less than the total supply of that F-gas, calculated as *Production of the gas* + *imports (bulk and equipment)*+ *amount recycled* – *exports (bulk and in equipment)*– F-gases used to produce blends.

Input of AD requires the following steps for different Tiers for both Refrigeration and Air Conditioning and Fire Protection.

When the Tier 1 Equation is applied:

As noted in the section **EF/parameters** above, parameters from the tab **Chemical's Data** will be visible in the worksheet **F-Gas Emissions** or **Emissions from Fire Protection**. Next, users need to enter the AD in the redorange cells, by subdivision/gas, and for each year, as follows:

- 1. <u>Column |t|</u>: year t (from the year of introduction of agent to the last inventory year). This column is automatically populated based on the year of introduction of the agent in **Chemical's Data** tab.
- 2. <u>Column |P|</u>: enter the amount of the respective chemical identified in **Gas** produced for consumption in the designated subdivision. For RAC, the amount for category 2.F.1.a should be entered separately from the amount used for 2.F.1.b.
- 3. <u>Column|Exp|</u>: if applicable, enter the amount of the respective chemical identified in **Gas** that was produced for consumption in the designated subdivision, but exported, in tonnes. This amount should not be considered in the calculation of emissions.
 - Note that: exports must be equal to or less than the amount produced plus imported for a given year.
- 4. <u>Column | Imp |</u>: enter the amount of the respective chemical identified in **Gas** that was imported for consumption in the designated subdivision, in tonnes. <u>Note that:</u> data on production, export and import of the agent (F-gas/blends) should be entered for the reporting (inventory) year in <u>Column | t |</u> and all other year(s) for which data are known and available. The Software will fill in the gaps to complete the time series, as described below.

Once known AD are input, the *Software* makes several calculations:

1. The *Software* back-calculates production, export and import back to the year of introduction, or interpolates between two known years for which data are known .

Note that this cell is based on the assumed parameters entered in the tab Chemical's Data (specifically the equipment growth rate).

2. <u>Column|D|</u>: The total new agent to the market each year is estimated. A fraction of this is assumed to be used for servicing existing equipment (<u>Column|K|</u>) and a fraction for newly installed equipment ((<u>Column|L|</u>).

<u>Note that</u>, if the total new agent to the market is greater than the previous year's emissions, the new agent is assumed to replace gas in equipment to compensate for all of the previous year's emissions, with any remainder used to fill new equipment. If the total new agent is less than that required to replace the previous year's emissions, all of the new agent is assumed to be used for servicing.

Note that: information in <u>Column | K |</u> and <u>Column | L |</u> will be included in the JSON file for upload to the UNFCCC ETF Reporting Tool.

3. <u>Column | R |</u>: The Software tracks the amount of agent in retired equipment. <u>Note that:</u> following the assumption that equipment is serviced to full charge every year (see step 2), this is equal to the full initial charge of the equipment, minus operational emissions from the current year. However, in cases where the total new agent to the market is not sufficient for full servicing of emissions from the previous year (S_needed), equipment may only be partially serviced (referred to as S_done), and thus the amount in the retired equipment may be less than full charge. The Software calculates the difference between "S_needed" and "S-done" and subtracts this from the full charge less annual emissions, to calculate the amount in the retired equipment.

N	0		Q R	S	Т	U	V	W
Int	formation for CR	Г		I	HIDDEN	CALCULAT	ION	
K	L	М		N		0		Р
agent for servicing	agent in new equipment installed in year t	agent in all equipment installed	needed agent :	across lifetime		actua	l agent used across tim	e
(tonnes)	(tonnes)	(tonnes)						
K=IF(D>I ₍₍₋₁₎ ,I ₍₍₋₁₎ , D)	L=D-K	$M = \sum_{t-(d-1)}^t (L)$		S_neeeded				S_done
NO	D	L		NO		NO		NO
$IF(D{>}I_{\scriptscriptstyle(t{\text{-}}1)},I_{\scriptscriptstyle(t{\text{-}}1)},D)$	D-K	$SUM(L_{\tau\cdot(d\cdot1)};L_{\tau})$	for equipment	L _{t-1} *(d-1)*EF/100		equal to K	for equipment X installed in a year Y	$SUM(K_d)$ for X_d
NO	1,000.000	1,000.000	installed in year t-13	450.000	year t-13	NO	installed in year t-13	100.000
50.000	950.000	1,950.000	installed in year t-12	427.500	year t-12	50.000	installed in year t-12	47.500
0.000	0.000	1,950.000	installed in year t-11	0.000	year t-11	0.000	installed in year t-11	0.000
97.500	902.500	2,852.500	installed in year t-10	406.125	year t-10	97.500	installed in year t-10	0.000
0.000	0.000	2,852.500	installed in year t-9	0.000	year t-9	0.000	installed in year t-9	0.000
0.000	0.000	2,852.500	installed in year t-8	0.000	year t-8	0.000	installed in year t-8	0.000
0.000	0.000	2,852.500	installed in year t-7	0.000	year t-7	0.000	installed in year t-7	0.000
0.000	0.000	2,852.500	installed in year t-6	0.000	year t-6	0.000	installed in year t-6	0.000
0.000	0.000	2,852.500	installed in year t-5	0.000	year t-5	0.000	installed in year t-5	0.000
0.000	0.000	2,852.500	installed in year t-4	0.000	year t-4	0.000	installed in year t-4	0.000
0.000	0.000	1,852.500	installed in year t-3	0.000	year t-3	0.000	installed in year t-3	0.000
0.000	0.000	902.500	installed in year t-2	0.000	year t-2	0.000	installed in year t-2	0.000
0.000	0.000	902.500	installed in year t-1	0.000	year t-1	0.000	installed in year t-1	0.000
0.000	0.000	0.000						
neg	ative values not allow	ed			negative v	alues not allo	owed	
			servicing occurs ad	cross lifetime from	year after	installation t	o the end of lifetime yea	ur (so for a perio
			_					
amount of total net chemical input in year t that is used for servicing	amount of total net chemical input in year t that is used for new equpment	cumulated amount of chemical input in year t that has not reached endlife yet		cumulated amount of chemical to be serviced across lifetime of equipment X installed in the relevant year Y based on information in column L		amount of chemical serviced in a year t		cumulated amount of chemical actual serviced across lifetime of equipment X installed in the relevant year Y

Example: Calculation of S-needed and S-done for source categories 2.F.1 and 2.F.3

X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK
		[Each o	ell cal	culated	l as: if a	amoun	t need	ed for s	ervicino	o of ec	auipme	ent
			installe the	d in pro	evious e is full	year is servici	less th ng. If tl	nan the ne amo	agent a	availabÌ agent a	le for s vailab	servicir le for	ng,
			servic	ing is I	ess tha	at is nee	eded (S_nee	ded) the	en this d	cell is e	equal t	0
				Ī	the am	ount of	agent	availa	ble for s	servicin	g.		

to calcula	ate actual installed	servicing o	ccurred in	each year s	ubsequent	to the insta	lation of	the equipn	nent installe	d in a year	Y		
		installed in	installed	installed	installed in	installed in	installed	installed in	installed				
	in year t- 13	year t-12	yes, t-11	year t-10	year t-9	year t-8	in year t-7	in year t-6	year t-5	year t-4	in year t-3	year t-2	in year t-
	100.000	47,500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
year t-12	50.000												
year t-11	0.000	0.000											
year t-10	50.000	47.500	0.000										
year t-9	0.000	0.000	0.000	0.000									
year t-8	0.000	0.000	0.000	0.000	0.000								
year t-7	0.000	0.000	0.000	0.000	0.000	0.000							
year t-6	0.000	0.000	0.000	0.000	0.000	0.000	0.000						
year t-5	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000					
year t-4	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000				
year t-3		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000			
year t-2			0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000		
year t-1				0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	
					0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

- 4. <u>Column |F|</u> is the amount of agent in the retired equipment destroyed in the year of retirement. <u>Note that</u> the % destroyed was added in **Chemical's Data** tab.
- 5. $\underline{\text{Column} | G |}$ is the total amount of agent retired in the year, minus the amount destroyed.
- 6. <u>Column | Bank |</u>: the *Software* back-calculates the development of the bank of the agent from the current reporting year to the year of its introduction <u>Note that</u> the bank for a given year (t) is calculated as the sum of the bank at the end of the previous year (t-1) plus total new agent to the market in year (t), minus the amount in retired equipment in year (t), minus emissions from all installed equipment (calculated based on the lifetime entered in **Chemical's Data** tab and the amount in installed equipment).
- 7. <u>Column | I |</u>: contains emissions from installed equipment in year t.
- 8. <u>Column | E |</u>: total emissions are calculated, in tonnes. <u>Note that</u> total emissions are calculated as emissions from installed equipment plus emissions from retired equipment.

9. <u>Column | EE |</u>: total emissions are calculated, in Gg.

Green cells are estimated by the *Software* and cannot be modified. Cell calculations are provided below the column header.

Ensuring mass conservation of gases

A QA/QC check has been introduced into the worksheets for categories 2.F.1, 2.F.2, 2.F.3 and 2.F.6 (contained applications only) to ensure that the data, EFs and parameters entered by the users ensure conservation of mass of gases over time.

To ensure mass conservation, the Software tracks and visually presents the inputs and outputs over time as follows:

- I. Total chemical agent inputs, across time $(\sum D)$
- II. Total chemical agent in equipment in use (Bank(t))
- III. Total chemical agent emissions, across time (ΣE)
- IV. Total chemical agent recovered/destroyed/exported in equipment at end-of-life(ΣF)

For Tier 1, mass conservation has been ensured if:

$$\sum D = Bank(t) + \sum E + \sum F$$

Example #1: Import – 10 000 tonnes of HFC-143a for mobile air conditioning, no production and export in the current year 2020 (only one entry, year of introduction – 1998)

Note that this figure is for Refrigeration and Air Conditioning but applies also to Emissions from Fire Protection worksheet.

Gas Emissic Jorksheet Sector: Category:	Industrial Product U	Processes and F Jses as Substitut	Product Use es for Ozone De	ssions - Tier 2a		ons - Tier 2b		11						
Subcategory Sheet: Data		Mobile Air Conditi a (CH3CF3) Emis												
Subdivision	Unspecified	~	Gas HFC-	143a (CH3CF3)	~	Chemical's Da	ta IY	1998 GR (%) 3 d(years) 15	EF (%) 15	X (%) 0		
II. Total Chem III. Total Chen	iical Agent in eo nical Agent Emi	issions (across th	last year of the ti time series) (Σ	ime series) (Bank (E) m equipment at er		the time series) (19,849 216,14	3.788181 Bank 9.327154 4.461027 0	(t) + ΣE + ΣF 2	35,993.788181		ration of conser total input s missions+recove	s =	
					Equ	ation 7.2B						Informa	tion for UNFCC	C CRT
Year	Agent production (tonnes)	Agent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent ir equipm installed servic (tonne
t ∆⊽	P	Exp	Imp	D = P - Exp + Imp	R = [L(t-d) - (L(t-d)) * EF/100)] - [S_needed - S_done](t-d)	F = R * (X / 100)	G = R - F	Bank = Bank(t- 1) + D - R - I	I = IF(M * EF/100 > ΣD- ΣR-ΣΙ; M * EF/100; ΣD- ΣR-ΣΙ)	E = G + I	EE = E / 1000	$ \begin{split} & \mathcal{K} = IF(D > [1](t-1) - M(t-d+1) \\ & *EF/100]; \ [1](t-1) - M(t-d+1) \\ & *EF/100]; \ D \end{split} $	L = D - K	M = Σ(L) (d-1))
2006			6,611.17806	6,611.17806	0	0	0	26,447.85354	4,667.26827	4,667.26827	4.66727	4,324.22537	2,286.95269	31,115
2007			6,809.5134	6,809.5134	0	0	0	28,268.7619	4,988.60504	4,988.60504	4.98861	4,667.26827	2,142.24513	33,257
2008			7,013.7988	7,013.7988	0	0	0	29,990.1766	5,292.38411	5,292.38411	5.29238	4,988.60504	2,025.19376	35,282
2009			7,224.21277	7,224.21277	0	0	0	31,632.23096	5,582.1584	5,582.1584	5.58216	5,292.38411	1,931.82866	37,214
2010 2011			7,440.93915	7,440.93915	0	0	0	33,212.19459 34,744.90763	5,860.97552 6,131.45429	5,860.97552 6,131.45429	5.86098 6.13145	5,582.1584 5,860.97552	1,858.78074 1,803.19181	40.876
2011	-		7,894.09234	7,664.16732	0	0	0	34,744.90763	6,513.27581	6.513.27581	6.51328	5,860.97552	2,545.47681	40,676
2012			8,130,91511	8,130,91511	4,436.08626	0	4,436.08626	33,626,70954	6,193.84348	10,629.929	10.62993	5,041,53896	3.089.37616	41,292
2014			8.374.84257	8.374.84257	3.903.75591	0	3.903.75591	31,953,47746	6,144.31874	10,048.074	10.04807	4,112.35352	4,262.48904	40,962
2015			8,626.08784	8,626.08784	3,455.26759	0	3,455.26759	30,823.7624	6,300.53532	9,755.80291	9.7558	3,519.62323	5,106.46461	42,00
2016			8,884.87048	8,884.87048	3,078.16477	0	3,078.16477	30,018.6756	6,611.79251	9,689.95728	9.68996	3,188.45224	5,696.41824	44.07
2017			9,151.41659	9,151.41659	2,761.86299	0	2,761.86299	29,369.96137	7,038.26783	9,800.13082	9.80013	3,058.99722	6,092.41937	46,92
2018			9,425.95909	9,425.95909	2,497.36916	0	2,497.36916		7,548.90328	10,046.272	10.04627	3,083.64142	6,342.31767	50,326
2019			9 708 73786	9,708.73786	2,277.04298	0	2,277.04298	28,061.66174	8,119.68116	10,396.724	10.39672	3,224.67791	6,484.05995	54,13
2020			10,000	10,000		0	2,094.39411	27,235.04737	8,732.22026	10,826.614	10.82661	3,452.41288	6,547.58712	58,214
2021			10,300	10,300	1,943.90979	0	1,943.90979	26,218.50251	9,372.63508	11,316.544	11.31654	3,743.61522	6,556.38478	62,48

Note that:

- 1. White cells show where data were entered manually.
- 2. In the red-orange cells the *Software* interpolates or back-calculates the input. The user should use caution in modifying any redorange cells, unless data are known. If data are manually entered in an interim year, the *Software* will recalculate the trend between the two known data entry points. **DO NOT ADD ZERO** unless "0" is the known value, as the *Software* will interpolate values assuming the zero. To delete an incorrect entry, instead of using zero, simply delete/clear the value from the cell.
- 3. Green cells are calculated by the *Software* they cannot be modified.
- 4. Note conservation of mass, 235,993 tonnes of HFC-143a were input into mobile refrigeration and air conditioning and the same amount either remains in equipment, was emitted, or is destroyed/recovered/exported in equipment.

Example #2: AD available only for four years – 2005, 2010, 2015 and 2020 (year of introduction – 1998, current reporting year – 2020)

Note that this figure is for Refrigeration and Air Conditioning but applies also to Emissions from Fire Protection worksheet.

orksheet ector: ategory: ubcategory heet: hata	Product U 2.F.1.b - I HFC-143a	Mobile Air Conditi a (CH3CF3) Emis	es for Ozone De ioning sions	pleting Substance										
	Unspecified		Gas HFC-1	143a (CH3CF3)	~	Chemical's Da				years) 15	EF (%) 15	X (%) 0		
		s (across the time			2014				t) + ΣE + ΣF 1	50,470.046241				
. Total Chem	nical Agent in ea	quipment in use (last year of the ti	me series) (Bank (t))		40,40	8.788799						
I. Total Cher	mical Agent Emi	ssions (across th	e time series) (∑	E)			110,06	1.257442						
V. Total Cher	mical Agent Re	covered/Destroy	ed/Exported from	n equipment at er	nd-of-life (across t	the time series) (ΣF)	0						
					Eous	ation 7.2B						Informa	tion for UNFCC	C CRT
Year	Agent production (tonnes)	Agent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent in equipme installed service (tonnes
t 🏹	P	Exp	Imp 🛆	D = P - Exp + Imp	R = [L(t-d) - (L(t-d)) * EF/100)] - [S_needed - S_done](t-d)	F = R * (X / 100)	G = R - F	Bank = Bank(t- 1) + D - R - I	i = IF(M * EF/100 > ΣD- ΣR-ΣI; M * EF/100; ΣD- ΣR-ΣI)	E = G + I	EE = E / 1000	K = IF(D>[I(t-1) - M(t-d+1)] + M(t-d+1)] + EF/100]; [I(t-1) - M(t-d+1)] + EF/100]; D)	L = D - K	M = Σ(L((d-1))
2000			1,293.91318	1,293.91318	0	0	0		486.43403	486.43403	0.48643	343.93771	949.97547	3,242.8
2001			1,332.73057	1,332.73057	0	0	0		613.37851	613.37851	0.61338	486.43403	846.29654	4,089.1
2002			1,372.71249	1,372.71249	0	0	0		727.27861	727.27861	0.72728	613.37851	759.33398	4,848.5
2003			1,413.89386	1,413.89386	0	0	0	Sector State State State State State State State	830.2709	830.2709	0.83027	727.27861	686.61526	5,535.1
2004			1,456.31068	1,456.31068	0	0	0		924.17686	924.17686 1.010.55033	0.92418	830.2709	626.03978	6,161.1
2005			1,500		0	0	0		1,010.55033	1,128.96778	1.01055	924.17686 1,010.55033	575.82314 789.44967	6,737.0
2006			2,100		0	0	0		1,120.50770	1.274.62262	1.27462	1,128,96778	971.03222	8.497.4
2007			2,100		0	0	0		1.443.42922	1,443.42922	1.44343	1,274.62262	1,125.37738	9.622.8
2009			2,700		0	0	0	International Advances of the American State	1.631.91484	1.631.91484	1.63191	1.443.42922	1.256.57078	10,879
2010			3,000	3,000	0	0	0		1,837.12761	1,837,12761	1.83713	1,631.91484	1,368.08516	12,247
2011			3,400	3,400	0	0	0	11,738.83134	2.071.55847	2,071.55847	2.07156	1,837.12761	1,562.87239	13,810
2012			3,800	3,800	0	0	0	13,180.5648	2,358.26654	2,358.26654	2.35827	1,888.61288	1,911.38712	15,721.
2013			4,200	4,200	1,036.69168	0	1,036.69168		2,503.17163	3,539.8633	3.53986	2,014.32883	2,185.67117	16,687
2014		-	4.600	4,600	912.28868	0	912.28868		2,729.66887	3,641.95754	3.64196	2,016.7376	2,583.2624	18,197.
2015			5,000	5,000	807.47915	0	807.47915	Summit and the state of the state of the last sector of the	3,019.72899	3,827.20814	3.82721	2,116.29036	2,883.70964	20,131.
2016		-	6,000	6.000	719.35206	0	719.35206		3,448.91695	4,168.26901	4.16827	2,292,45039	3,707.54961	22,992
2017 2018			7,000	7,000	645.43388 583.62297	0	645.43388 583.62297		3,992.21995 4,629.0212	4,637.65383 5,212.64417	4.63765 5.21264	2,618.64606 3,068.04308	4,381.35394 4,931.95692	30,860
2018			9,000	9.000	532,13382	0	532.13382	and the second se	5.342.3446	5.874.47842	5.87448	3,068.04308	5.381.52914	35,615.
2019			10,000	10,000	489.44967	0	489.44967		6,123.96461	6,613,41427	6.61341	4,213.37682	5,786.62318	40.826
2020			10,300		671.03222	0	671.03222		6.823.14586	7,494,17807	7.49418	4.849.34199	5.450.65801	45.487

Note that:

- 1. As noted above, only enter 0 for a cell if this is the known value (for production, export and import).
- 2. If zero is entered, the *Software* understands that in that year there was no production/export/import and the *Software* back-calculates the data assuming zero production/export/import. It will be a white cell.
- 3. If nothing is entered for a given year, the cell remains red-orange and the *Software* interpolates that cell assuming inputs in other years.
- 4. Note conservation of mass, 150,470 tonnes of HFC-143a were input into mobile refrigeration and air conditioning and the same amount either remains in equipment, was emitted, or is destroyed/recovered/exported in equipment.

Example #3: AD for 2020 and 2010, zero AD (2015) and user AD removed (2005)

Note that this figure is for Refrigeration and Air Conditioning but applies also to Emissions from Fire Protection worksheet.

Gas Emissio Jorksheet Sector: Category: Subcategory Sheet: Data	Industrial I Product U r: 2.F.1.b - N HFC-143a	Processes and Pr	oduct Use s for Ozone Dep ning ions	leting Substances	2 (1)									
Subdivision		~		13a (CH3CF3)	 ✓ Ch 	emical's Data	IY 1998	GR (%) 3	d (years)		(%) 15 X	(%) 0		
II. Total Chem III. Total Cher	ical Agent in eq nical Agent Emis	ssions (across the	ist year of the time series) (ΣE		-of-life (across the t	ime series) (∑F)	135,486.6337 37,466.6540 98,019.9797	155	+ΣF 135,486.0	533789				
					Equa	ation 7.2B						Informa	tion for UNFCC	C CRT
Year	Agent production (tonnes)	Agent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent in all equipment installed in service (tonnes)
t ∆⊽	Р	Exp	Imp	D = P - Exp + Imp	R = [L(t-d) - (L(t- d)) * EF/100)] - [S_needed - S_done](t-d)	F = R * (X / 100)	G = R - F	Bank = Bank(t- 1) + D - R - I	I = IF(M * EF/100 > ΣD- ΣR-ΣΙ; M * EF/100; ΣD- ΣR-ΣΙ)	E=G+1	EE = E / 1000		L = D - K	M = Σ(L(t, t-(c 1))
2005			2,587.82635	2,587.82635	0		0		1,743.41919	1,743.41919	1.74342	1,594.40616	993.42019	11,622.79
2006			2,665.46114	2,665.46114	0		0		1,881.72548	1,881.72548	1.88173	1,743.41919	922.04195	12,544.836
2007			2,745.42498	2,745.42498	0		0		2,011.28041	2,011.28041	2.01128	1,881.72548	863.69949	13,408.536
2008			2,827.78773	2,827.78773	0		0		2,133.75651	2,133.75651	2.13376	2,011.28041	816.50732	14,225.043
2009			2,912.62136	2,912.62136	0	-	0		2,250.58623	2,250.58623	2.25059	2,133.75651	778.86485	15,003.908
2010			3,000	3,000 2,400	0	-	0		2,362.9983 2,368.54855	2,362.9983 2,368.54855	2.363 2.36855	2,250.58623 2,362.9983	749.41377 37.0017	15,753.32 15,790.32
2011			2,400	2,400	0	0	0		2,368.54855	2,368.54855	2.36855	2,362.5983	37.0017	
2012			1,800	1,200	1,788.51869	0	1,788.51869	10,211,78028	2,052.92761	3,841,4463	3.84145	1,000	0	13,686,184
2014			600	600	1,573.89645		1,573.89645	7,462.70266	1,775.18118	3,349.07763	3.34908	600	0	11,834.54
2015			0	0	1,393.07721	0	1,393.07721	4,540.28142	1,529.34402	2,922.42123	2.92242	0	0	10,195.62
2016		1	2,000	2,000	1,022.03196	0	1,022.03196	3,949.10682	1,569.14264	2,591,17461	2.59117	274.63019	1,725.36981	10,460.950
2017			4,000	4,000	855.66497	0	855.66497	5,141.31336	1,952.12849	2,807.79346	2.80779	136.74471	3,863.25529	13,014.18
2018			6,000	6,000	511.01262		511.01262	8,009.5147	2,620.78603	3,131.79866	3.1318	357.72233	5,642.27767	17,471.90
2019			8,000	8,000	191.22849		191.22849		3,527.17278	3,718.40128	3.7184	877.36684	7,122.63316	23,514.48
2020			10,000	10,000	99.34202	0	99.34202	17,560.42875	4,631.34266	4,730.68468	4.73068	1,645.4473	8,354.5527	30,875.61
2021			10,300	1.0.00	0		0		5,645.02703	5,645.02703	5.64503	2,620.06225	7,679.93775	37,633.51
2022			10,609	10,609	0	0	0	26,244.27019	6,580.13153	6,580.13153	6.58013	3,511.27052	7,097.72948	43,867.5

In the above example, user-specific import information has been added for 2010 (3,000 tonnes), 2015 (0 tonnes) and 2020 (10,000 tonnes). The *Software* understands that AD are available for three years 2020, 2015 and 2010 and interpolates data between 2020 and 2015 from 10000 tonnes to 0 and between 2015 and 2010 from 0 to 3000 tonnes. From 2010 back to 1998 (the year of introduction) the *Software* extrapolates backwards based on the data entered in 2010 and the provided growth rate of new equipment (3%).

When Tier 2 Equations are applied (Refrigeration and Air Conditioning only):

As noted in the section **EF/parameters** above, parameters from the tab **F-Gas Parameters – Tier 2** will be visible in the worksheets **F-Gas Emissions – Tier 2a** and **F-Gas Emissions – Tier 2b**. Next, users need to enter the AD in the white cells of these worksheets for each year, as applicable.

Tier 2a:

If Tier 2a was specified in the worksheet **F-Gas Parameters – Tier 2**, then the worksheet **F-gas Emissions – Tier 2a** will be active, so that users can select subdivisions, sub-applications and F-gases/blends and estimate emissions. Data are entered as follows:

- 1. Users first need to select subdivision, then sub-application and F-gas/blend for which AD are to be entered. <u>Note that</u> if a subdivision/sub-application/F-gas / blend is not available for selection, the user should refer back to the description for Tier 2 in Customizing the Software for Refrigeration and Air Conditioning: subdivision/sub-application/F-gases
- Then for each subdivision, sub-application and F-gas/blend for which Tier 2a was specified in the worksheet F-Gas Parameters – Tier 2, users need to populate AD in the white cells of worksheet F-gas Emissions – Tier 2a.

Example: F-gas Emissions – Tier 2a (subdivisions, sub-applications and F-gases)

				100	unpu	·· - 5	,		,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,		a (00			,	≁~ ~p	phet		o un	<u>~ 5</u>	<i>a</i> uceo <i>j</i>			
Gas Emis	sions F-Ga	is Parameters - T	Tier 2 F-Ga	as Emissions	Tier 2a F-	Gas Emissions	s - Tier 2b																
orksheet					_																		
ector:		trial Processes ar																					
ategory:		ict Uses as Subst																					
ubcatego		a - Refrigeration																					
heet: Data	F-Gas	Emissions - Emis	Ision Factor A	pproacn - He	r Za																		
	Rest of C	Countra		Cub applica	lion	c Refrigeration		_	Gan		105 (50												
SUDUIVISI	Tokyo	country	· ·	Sun-abblica		c Refrigeration		~		(HFC-32/HFC													
Intro Ye	ar Rest of C	Country		EFk [%] 1	Medium	C Reingeration & Large Comme	ercial Refrigeratio	n		4a (CH2FCF3)	125 (50.0/55)	ŋ(n	ec.d) [%] 70)									
Total Che	mical Agent I	nputs (across the	time series) (2E + 2H)	Resident	tial and Comme	ercial A/C. includi	na Heat Pump		ZQ + Darikit		75+7T	0										
	-	in new equipmen			(27)				0														
	-								U														
	a contra de la contr	in equipment in u			ies) (Bank(t))				0														
V. Total C	nemical Agent	t Emissions (acros	ss the time ser	ries) (∑V)					0														
V. Total Ch	emical Agent	Recovered/Dest	roved/Export	ed from equip	ment at end-of	life (across the	e time series) (5Q	$+\Sigma S + \Sigma T$	0														
												Equation 7.10											
	Amount in the bank			Exported in	Contained in factory-	Contained in factory-	Domestic Sales of new	Emitted by containers	Used to fill domestically	Emitted during filling	Contained in new	Contained in new	Emitted from equipment in				Recovered and			Exported	Amount in the bank		
	on		in bulk in	bulk in	charged	charged	& recovered	management		of new	equipment	equipment			refill in year t		recycled/re			equipmen	on December 31st		emissions in
	January	Chemical in year t	year t	year t	Imported	Exported	chemical (in	(during		equipment in			including		(kg)	retired in year t	claimed	life in vear t	yeart (kg)	t at end-o		in year t (kg)	year t
	1st of year	(kg)			equipment	new-	bulk) in year t			year t	country in	in year t	servicing			(kg)		(kg)		-life in			(Gg)
	1				in year t	equipment i	(kg)	bulk to small,	year t	(kg)	year t	(kg)	(kg)			P = M(t-d)	equipment			year t			
													N = ∑(M(t-			* (p/100) -							
	Bank(t-1)						H = C + D - E + Q(t-1)	I = H * (EFc / 100)		K = J * (EFk / 100)			d+1,t)) *		O = Sdone or specified		Q = P * (η (rec,d)/100)		D/100 or		Bank(t) = Bank(t-1) + M + O - N - P		W = V / 1000000
															of specified	- Sdone)(t-			specifie	d			
1000																d)							
> 1990	0						0	0	0	0	0	0	0	Calcul					Calc	0	0	0	0
1991 1992	0						0	0	0	0	0	0	0	Calcul	0	0	0		Calc	0	0	0	0
1992	0					-	0	0	0	0	0	0		Calcul.	0	0	0		Calc	0	0		0
1993	0					-	0	0	0	0	0			Calcul.	0	0	0		Calc	0	0	0	
1995	0	-					0	0	0	0	0			Calcul.	0	0	0		Calc	0	0	0	0
1996	0						0	0	0	0	0	0		Calcul	0	0	0		Calc	0	0		0
1997	0	-				-	0	0	0	0	0			Calcul.	0	0	0		Calc	0	0	0	0

Example: AD Input: F-gas Emissions – Tier 2a

-Gas Emissi /orksheet	ions F-Gas Par	ameters - Tier	2 F-Gas	Emissions - Ti	ier 2a F-Gi	as Emissions	- Tier 2b																	
iector: lategory: lubcategor liheet: Data	Product Use y: 2.F.1.a - Re	ocesses and Pr es as Substitute frigeration and sions - Emission	s for Ozone Stationary A	ir Conditioning																				
ubdivisio	n Tokyo		∼ Su	b-applicatio	n Domestic	Refrigeration		∨ Ga	s R-410A (HFC	-32/HFC-125 (50.	~													
Intro Yea	r 1990 E	Fc [%] 2	E	Rk [2] 1	EF	x [2] 1	Lifetime	(d) [yr] 15	P [%] 8	0 D [%]	0	n(rec,d) [%	1 70											
Total Chen	nical Agent Inputs									i + Bank(t) + ΣV + 1			-											
	mical Agent in nev				ion) (SG)			10,7	1.073	- Dariety) - 2		10,100.010	102											
	emical Agent in equ							12.0	08.452329															
	emical Agent in equ emical Agent Emiss				(Loan K(L))				57.701755															
				17 C		(. (time series) ($\Sigma Q + \Sigma$	and see a second	51.461708															
v. Total Che	mical Agent Neco	vered/Destroye	d/Exported	from equipment	nt at end-or-in	te (across the	ume series) (20 + 2	5+21) 14,0	51.461706															
	_											Equation 7.10												
	Amount in the bank on January 1st of year t (kg)	Domestically Manufacture d Chemical in year t (kg)	Imported in bulk in year t (kg)	Exported in bulk in year t (kg)	in factory- charged Imported equipment		of new & recovered chemical (in bulk) in year t	Emitted by containers management (during transfer from bulk to small.	Used to fill domestically manufactured new equipment in year t	Emitted during filling of new equipment in year t (kg)	Contained in new equipment filled in country in year t	Contained in new equipment consumed in year t (kg)	Emitted from equipment in use in year t, including servicing (kg)		o refill in year t (kg)	In equipment retired in year t (kg)	Recovered and recycled/reclai med from equipment retired in year	Emitted at end of life in year t (kg)		oyed in year t (kg)	Exported in equipment at end-of-life in year t (kg)	Amount in the bank on December 31st of year t (kg)	Total emissions in year t (kg)	Total emissions i year t (Gg)
t A	Bank(1-1)	с	D	E	F	G	H = C + D - E + Q(t-1)	I = H * (EFc / 100)	J=H-I-O	K = J * (EFk / 100)	L=J-K	M+L+F-	$N = \sum (M(t-$		O = Sdone	P = M(t-d) * (p/100) -	Q = P*(n	R=P-		S = P * D/100	_	Bank(t) =	V=I+K+N+	W = V / 1000000
1990	0												d+1,t)) * (EFx / 100)		or specified	(Sneeded - Sdone)(t-d)						Bank(t-1) + M + O - N - P		
1991	V	2,000	1,000		25			60		29.4	2,910.6	G 1.935.6	(EFx / 100) 19.356		or specified	(Sneeded - Sdone)(t-d)				or specified	T	+O-N-P 1.916.244	108.756	0.000
	1,916.244	200	2,000		23		2,200	44	2.136.644	29.4 21.36644	2,910.6 2,115.277	G 1,935.6 2,138.27756	(EFx / 100) 19.356 40.73878	Calc	or specified	(Sneeded - Sdone)(t-d) 0		Q - S - T -15	Cal	or specified	15	+ O - N - P 1.916.244 4.033.13878	108.756 91.10522	0.000
1992	4.033.13878	200 1,303	2,000		23 100		2,200 3,303	44 66.06	2.136.644 3,196.20122	29.4 21.36644 31.96201	2,910.6 2,115.277 3,164.239	G 1.935.6 2.138.27756 3.264.23921	(EFx / 100) 19.356 40.73878 73.38117	Calc Calc	or specified 19.356 40.73878	(Sneeded - Sdone)(t-d) 0		Q - S - T -15 -10	Cal Cal	or specified	1 15 10	• O - N - P 1.916.244 4.033.13878 7.264.7356	108.756 91.10522 161.40318	0.000
1993	4.033.13878 7,264.7356	200 1,303 340	2,000 2,000 1,000		23 100 200		2,200 3,303 1,340	44 66.06 26.8	2.136.644 3.196.20122 1.239.81883	29.4 21.36644 31.96201 12.39819	2,910.6 2,115.277 3,164.239 1,227.420	G 1,935.6 2,138.27756 3,264.23921 1,427.42064	(EFx / 100) 19.356 40.73878 73.38117 87.65537	Calc Calc Calc	or specified 19.356 40.73878 73.38117	(Sneeded - Sdone)(t-d) 0 0		Q - S - T -15 -10 -10	Cal Cal Cal	or specified 0 0 0	15 10 10	+ O - N - P 1.916 244 4.033.13878 7.264 7356 8.677.88204	108.756 91.10522 161.40318 116.85356	0.000 0.000 0.000 0.000
1993 1994	4.033.13878 7.264.7356 8.677.88204	200 1,303 340 1,000	2,000 2,000 1,000 2,005	50	23 100 200 100	30	2,200 3,303 1,340 2,955	44 66.06 26.8 59.1	2.136.644 3.196.20122 1.239.81883 1.895.9	29.4 21.36644 31.96201 12.39819 18.959	2,910.6 2,115.277 3,164.239 1,227.420 1,876.941	G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,946.941	(EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478	Calc Calc Calc Spe	or specified 19.356 40.73878 73.38117 1.000	(Sneeded - Sdone)(t-d) 0 0 0		Q - S - T -15 -10 -10 -10	Cal Cal Cal Cal	or specified 0 0 0 0		+ O - N - P 1,916.244 4,033.13878 7,264.7356 8,677.88204 11.517.69826	108.756 91.10522 161.40318 116.85356 175.18378	0.000 0.000 0.000 0.000 0.000
1993 1994 1995	4.033.13878 7.264.7356 8.677.88204 11.517.69826	200 1,303 340 1,000 120	2,000 2,000 1,000 2,005 1,003	50 44	23 100 200 100 32	30	2,200 3,303 1,340 2,955 1,079	44 66.06 26.8 59.1 21.58	2.136.644 3.196.20122 1.239.81883 1.895.9 950.29522	29.4 21.36644 31.96201 12.39819 18.959 9.50295	2,910.6 2,115.277 3,164.239 1,227.420 1,876.941 940.79226	G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,946.941 929.79226	(EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478 116.42271	Calc Calc Calc Spe Calc	or specified 19.356 40.73878 73.38117 1.000 107.12478	(Sneeded - Sdone)(t-d) 0 0 0		Q - S - T -15 -10 -10 -10 -10	Cal Cal Cal	or specified 0 0 0 0 0 0 0		+ O - N - P 1.916 244 4.033.13878 7.264.7356 8.677.88204 11.517.69826 12,438.1926	108.756 91.10522 161.40318 116.85356 175.18378 137.50566	0.000 0.000 0.000 0.000 0.000 0.000
1993 1994	4.033.13878 7.264.7356 8.677.88204	200 1,303 340 1,000	2,000 2,000 1,000 2,005 1,003 2,000	50 44	23 100 200 100	30 43	2,200 3,303 1,340 2,955	44 66.06 26.8 59.1	2.136.644 3.196.20122 1.239.81883 1.895.9 950.29522 2.823.57729	29.4 21.36644 31.96201 12.39819 18.959 9.50295 28.23577	2,910.6 2,115.277 3,164.239 1,227.420 1,876.941	G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,946.941	(EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478	Calc Calc Calc Spe Calc Calc	or specified 19.356 40.73878 73.38117 1.000	(Sneeded - Sdone)(I-d) 0 0 0 0 0 0 0 0		Q - S - T -15 -10 -10 -10 -10 -10	Cal Cal Cal Cal Cal	or specified 0 0 0 0 0 0 0 0 0 0 0	10 10	+ O - N - P 1,916.244 4,033.13878 7,264.7356 8,677.88204 11.517.69826	108.756 91.10522 161.40318 116.85356 175.18378	0.000 0.000 0.000 0.000 0.000 0.000 0.000
1993 1994 1995 1996	4.033.13878 7.264.7356 8.677.88204 11.517.69826 12.438.1926	200 1,303 340 1,000 120 1,000	2,000 2,000 1,000 2,005 1,003	50 44	23 100 200 100 32 300	30 43	2,200 3,303 1,340 2,955 1,079 3,000	44 66.06 26.8 59.1 21.58 60	2.136.644 3.196.20122 1.239.81883 1.895.9 950.29522 2.823.57729 3.291.44388	29.4 21.36644 31.96201 12.39819 18.959 9.50295 28.23577	2,910.6 2,115.277 3,164.239 1,227.420 1,876.941 940.79226 2,795.341	G 1,935.6 2,138.27756 3.264.23921 1,427.42064 1,946.941 929.79226 3,095.34152 3,658.52944	(EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478 116.42271 147.37612	Calc Calc Calc Spe Calc Calc Calc	or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271	(Sneeded - Sdone)(t-d) 0 0 0 0 0 0 0 0 0 0		Q - S - T -15 -10 -10 -10 -10 -10 -10 -10 -10	Cal Cal Cal Cal Cal Cal	or specified 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10 10 10	+ O - N - P 1.916 244 4.033.13878 7.264.7356 8.677.88204 11.517.69826 12,438.1926 15,502.5807	108.756 91.10522 161.40318 116.85356 175.18378 137.50566 225.61189	0.000 0.000 0.000 0.000 0.000 0.000
1993 1994 1995 1996 1997	4.033.13878 7.264.7356 8.677.88204 11,517.69826 12,438.1926 15,502.5807	200 1,303 340 1,000 120 1,000	2,000 2,000 1,000 2,005 1,003 2,000 3,000	50 44	23 100 200 100 32 300 400	30 43	2,200 3,303 1,340 2,955 1,079 3,000 3,509	44 66.06 26.8 59.1 21.58 60 70.18	2,136,644 3,196,20122 1,239,81883 1,895,9 950,29522 2,823,57729 3,291,44388 796,03858	29.4 21.36644 31.96201 12.39819 18.959 9.50295 28.23577 32.91444	2.910.6 2.115.277 3.164.239 1.227.420 1.876.941 940.79226 2.795.341 3.258.529	G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,945.941 929.79226 3,095.34152 3,658.52944 1,188.0782	(EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478 116.42271 147.37612 183.96142	Calc Calc Spe Calc Calc Calc Calc Calc	or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271 147.37612	(Sneeded - Sdone)(I-d) 0 0 0 0 0 0 0 0 0 0 0 0 0		Q - S - T -15 -10 -10 -10 -10 -10 -10 -10 -10 -18	Cal Cal Cal Cal Cal Cal Cal	or specified 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10 10 10 18	+ O - N - P 1,916.244 4,033.13878 7,264.7355 8,677.88204 11,517.69826 12,438.1926 15,502.5807 19,124.52485	108.756 91.10522 161.40318 116.85356 175.18378 137.50566 225.61189 277.05586	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000
1993 1994 1995 1996 1997 1998	4.033.13878 7.264.7356 8.677.88204 11.517.69826 12.438.1926 15.502.5807 19.124.52485	200 1,303 340 1,000 120 1,000	2,000 2,000 1,000 2,005 1,003 2,000 3,000 1,000 1,000	50 44	23 100 200 100 32 300 400 400	30	2,200 3,303 1,340 2,955 1,079 3,000 3,509 1,000	44 66.06 26.8 59.1 21.58 60 70.18 20	2,136,644 3,196,20122 1,239,81883 1,895,9 950,29522 2,823,57729 3,291,44388 796,03858 784,1578	29.4 21.36644 31.96201 12.39819 9.50295 28.23577 32.91444 7.96039	2,910.6 2,115,277 3,164,239 1,227,420 1,876,941 940,79226 2,796,341 3,258,529 788,0782 776,31622	G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,945.941 929.79226 3,095.34152 3,658.52944 1,188.0782	(EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478 116.42271 147.37612 183.96142 195.8422	Calc Calc Spe Calc Calc Calc Calc Calc Calc Calc	or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271 147.37612 183.96142	(Sneeded - Sdone)(I-d) 0 0 0 0 0 0 0 0 0 0 0 0 0		Q - S - T -15 -10 -10 -10 -10 -10 -10 -10 -10 -10 -10	Cal Cal Cal Cal Cal Cal Cal Cal	or specified 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	10 10 10 18	+ O - N - P 1.916.244 4.033.13878 7.264.7356 8.677.88204 11.517.69826 12.438.1926 15.502.5807 19.124.52485 20.300.72226	108.756 91.10522 161.40318 116.85356 175.18378 137.50566 225.61189 277.05588 205.80258	0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000 0.000

AD are entered for each subdivision/sub-application/ F gas/blend, and for each year (based on the year of introduction of the refrigerant) in worksheet **F-Gas Emissions – Tier 2a,** as follows:

<u>Note that:</u> the Tier 2a worksheet requires AD entry for each year, it does not interpolate data as in Tier 1. If there is a need to apply IPCC splicing techniques to fill data gaps, this should be done outside the Software, and the results manually input.

- 1. <u>Column |C|</u>: amount of domestically manufactured F-gas/blend used in that subdivision/subapplication, in year t, kg
- 2. <u>Column |D|:</u> amount imported in bulk in year t, kg
- 3. <u>Column |E|</u>: amount exported in bulk in year t, kg_____ <u>Note that</u>: bulk exports must be equal to or less than the amount produced plus imported for a given year, otherwise the QA/QC check that appears below the EF/parameters will turn orange, indicating that mass of F-gases is not conserved (see discussion below <u>Ensuring mass conservation of gases</u>).
- 4. <u>Column |F|</u>: amount contained in factory-charged imported equipment in year t, kg
- 5. <u>Column |G|:</u> amount contained in factory-charged exported new-equipment in year t, kg.
- 6. <u>Column |O|</u>: amount used to refill equipment in year t, kg. In <u>Column |O|</u> there is a drop-down menu for two options:
 - a. *Calculated* (green cell) the *Software* estimates the amount of gas available for refill of operating equipment. The *Software* calculates the amount for servicing as equal to the losses from operating equipment in the previous year, plus any additional servicing needs for operating equipment that could not be met by gas sales in previous years (i.e. if servicing needs in a previous year could not be met by new gas sales in that year, there is a deficit and the new sales in the current year are used to meet that deficit).
 - If domestic sales for the year (<u>Column |H|</u>) are equal to or greater than the servicing needs, the full service needs are met, and any remaining gas is used to fill domestically sold equipment in the current year (<u>Column |J|</u>).
 - If domestic sales for that year (<u>Column |H|</u>) are less than the servicing needs, all domestic sales are used to refill equipment and no gas is used to fill domestically sold equipment in the current year (<u>Column ||</u>).
 - b. *Specified* (white cell) users enter country-specific AD manually.
- 7. <u>Column |S|</u>: amount destroyed in year t, kg. In <u>Column |S|</u> there is a drop-down menu for two options:
 - a. Calculated (green cell) the Software estimates the amount of gas destroyed in year t. The Software calculates the amount destroyed as equal to the amount of gas contained in the retired equipment, <u>Column |P|</u> (taking into account whether that equipment was fully serviced up to the time of retirement), and the share of the remaining charge that is entered by the user (D) in the worksheet F-Gas Parameters Tier 2.
 - b. *Specified* (white cell) users enter country-specific AD manually.
- 8. <u>Column |T|:</u> amount exported in used equipment in year t, kg.

Once AD are input, the *Software* makes several calculations in green cells (these cannot be modified):

9. <u>Column | Bank (t-1) |</u>: amount in the bank (i.e. the amount of refrigerant stored in products) on January 1st of year t, kg.

Note that this column is automatically calculated and is equal to the bank at the end of the previous year.

- 10. <u>Column |H|:</u> domestic sales of new chemical (in bulk) in year t, kg. Note that this cell is calculated as total domestic manufactured F-gas/blend, plus import (bulk), minus exports (bulk), plus any refrigerant recovered and recycled/reclaimed from the previous year.
- 11. <u>Column |1|:</u> emitted by containers management (during transfer from bulk to small, and as leftover if not recovered), kg.

<u>Note that</u> this cell is calculated as the total amount of domestic sales in year (t) multiplied by the EF for containers $|EF_c|$, as indicated in worksheet **F-Gas Parameters-Tier 2** (2% in this example).

- 12. <u>Column |J|:</u> amount used to fill domestically manufactured new equipment in year t, kg. <u>Note that</u> this cell is calculated as the total domestic sales in year (t) minus any emissions from filling of containers, minus the amount used to service/refill other equipment.
- <u>Column |K|:</u> emitted during filling of new equipment in year t, kg. <u>Note that</u> this cell is calculated as the amount in <u>Column |J|</u> multiplied by the EF for filling <u>|EFk|</u>, as indicated in worksheet **F-Gas Parameters-** Tier 2 (1% in this example).
- 14. <u>Column |L|:</u> amount contained in new equipment filled in country in year t, kg. <u>Note that</u> this cell is calculated as the total amount used to fill new equipment minus emissions from filling.

- 15. <u>Column |M|: amount contained in new equipment consumed in year t (i.e. going to the bank), kg.</u> <u>Note that</u> this cell is calculated as the amount in new equipment, plus gas contained in imports of new equipment, minus agent exported in new equipment.
- 16. <u>Column |N|:</u> amount emitted from equipment in use in year t, kg. <u>Note that</u> this cell is calculated as the sum of agent in all equipment in use, based on the lifetime selected in worksheet F-Gas Parameters- Tier 2(15 years in this example), and EF |EFx| for equipment operation in the same worksheet (1% in the example).
- 17. <u>Column |P|</u>: amount in equipment retired in year t, kg. <u>Note that</u> this cell is calculated based on the amount of agent in equipment reaching the end of its lifetime, based on the lifetime added in worksheet F-Gas Parameters- Tier 2, and the share of initial charge remaining in the equipment provided in that same worksheet |p| (80% in this example), taking into account whether there was sufficient agent to fully service the equipment.
- 18. <u>Column |Q|:</u> amount recovered and recycled/reclaimed from equipment retired in year t, kg. <u>Note that this cell is calculated based on the agent in equipment reaching the end of its lifetime Column |P| and the percentage of that which is recycled/reclaimed $\underline{|\eta (rec.d)|}$, provided by the user in worksheet **F-Gas Parameters- Tier 2**, (70% in this example).</u>
- 19. <u>Column |R|:</u> amount emitted at end of life in year t, kg. <u>Note that this cell is calculated as the total amount in the retired equipment, less any agent recovered/recycled, destroyed, or exported in equipment to another country.</u>
- 20. <u>Column | Bank_(t) |:</u> amount in the bank on December 31st of year t, kg. <u>Note that</u> this cell is calculated as the bank in the beginning of the year plus the amount contained in new equipment going to the bank in that year, plus the amount used to refill/service existing equipment, minus emissions from equipment in use during the year, minus the amount in retired equipment.
- 21. <u>Column |V|:</u> total emissions in year t, kg. <u>Note that</u> this cell is calculated as the sum of emissions from containers, equipment filling, equipment in use, and at end of life.
- 22. Column |W|: total emissions in year t, Gg

Ensuring mass conservation of gases in Tier 2a

A QA/QC check has been introduced into the worksheets for categories 2.F.1, 2.F.2, 2.F.3 and 2.F.6 (contained applications only) to ensure that the data, EFs and parameters entered by the users ensure conservation of mass of gases over time.

To ensure mass conservation, the Software tracks and visually presents the inputs and outputs over time as follows:

- I. Total chemical agent inputs, across time $(\Sigma F + \Sigma H)$
- II. Total chemical agent in new equipment exported, across time (ΣG)
- III. Total chemical agent in equipment in use, (last year of the time series) (Bank(t))
- IV. Total chemical agent emissions, across time $(\sum V)$
- V. Total chemical agent recovered/destroyed/exported in equipment at the end of life $(\sum Q + \sum S + \sum T)$

In the case of Tier 2a, mass conservation has been ensured if:

$$\Sigma F + \Sigma H = \Sigma G + Bank(t) + \Sigma V + \Sigma Q + \Sigma S + \Sigma T$$

If mass has been conserved, all cells are green. An orange colour signals that the amount of chemical input is smaller than the amount of chemical stored in the system and the subsequent emissions, while a red colour means that the chemical input is greater than the amount stored in the system and the subsequent emissions. If the check results in orange or red shading, refer back to worksheet F-Gas Parameters to ensure that all parameters are coherent.

Example: Demonstration of mass conservation – Tier 2a

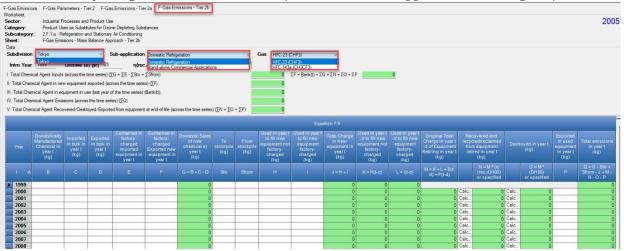
Note that the change of EFx from 1 to 30 results in incoherent inputs and outputs greater than inputs, thus the check became orange.

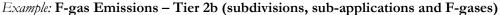
Intro Year 1990 EFc [%] 2 EFk [%] 1 EFx [%] 1 Lifetime (d) [yr]	15 p [%] 99 D [%] 30 η(rec.d) [%] 70
I. Total Chemical Agent Inputs (across the time series) ($\Sigma F + \Sigma H$)	45,025.215477 ΣG + Bank(t) + ΣV + ΣQ + ΣS + ΣT 45,025.215477
II. Total Chemical Agent in new equipment exported (across the time series) (∑G)	1,073
III. Total Chemical Agent in equipment in use (last year of the time series) (Bank(t))	10,056.705721
IV. Total Chemical Agent Emissions (across the time series) (\sum V)	6,266.011217
$V. \ Total \ Chemical \ Agent \ Recovered/Destroyed/Exported \ from \ equipment \ at \ end-of \ Hife \ (across \ the \ time \ series) \ (\nabla Q \ + \ \Sigma S \ + \ \Sigma T)$	27,629.498539
Intro Year 1990 EFc [%] 2 EFk [%] 1 EFx [%] 30 Lifetime (d) [yr]	15 p [%] 99 D [%] 50 η(rec.d) [%] 70
I. Total Chemical Agent Inputs (across the time series) (ΣF + ΣH)	26,590.717 ΣG + Bank(t) + ΣV + ΣQ + ΣS + ΣT 49,483.695987
II. Total Chemical Agent in new equipment exported (across the time series) (ΣG)	1.073
III. Total Chemical Agent in equipment in use (last year of the time series) (Bank(t))	0
IV. Total Chemical Agent Emissions (across the time series) (ΣV)	48,255.323987
V. Total Chemical Agent Recovered/Destroyed/Exported from equipment at end-of-life (across the time series) ($\Sigma Q + \Sigma S + \Sigma T$)	155.372

Tier 2b:

If Tier 2b was specified in the worksheet **F-Gas Parameters – Tier 2**, then worksheet **F-gas Emissions – Tier 2b** becomes active so users can select subdivisions, sub-applications and F-gases/blends and respective parameters. Data are entered, row by row, for each subdivision/sub-application/F-gas/blend, as follows:

- 1. Users first need to select subdivision, then sub-application and F-gas/blend for which AD are to be entered. <u>Note that</u> if a subdivision/sub-application/F-gas / blend is not available for selection, the user should refer back to the description for Tier 2 in Customizing the Software for Refrigeration and Air Conditioning: subdivision/sub-application/F-gases
- Then for each subdivision, sub-application and F-gas/blend for which Tier 2b was specified in the worksheet F-Gas Parameters Tier 2, users must populate AD in the white cells of worksheet F-gas Emissions Tier 2b.





Then AD are entered for each subdivision/sub-application/ F gas/blend, and for each year (based on the year of introduction of the refrigerant), in worksheet **F-Gas Emissions – Tier 2b,** as follows:

<u>Note that:</u> the Tier 2b worksheet requires AD entry for each year, it does not interpolate data as in Tier 1. If there is a need to apply IPCC splicing techniques to fill data gaps, this should be done outside the Software, and the results manually input.

- 1. <u>Column |B|</u>: amount of domestically manufactured F-gas/blend in year t, kg
- 2. <u>Column |C|:</u> amount imported in bulk in year t, kg
- 3. <u>Column |D|:</u> amount exported in bulk in year t, kg <u>Note that</u> bulk exports must be equal to or less than the amount produced plus imported for a given year, otherwise the QA/QC check that appears below the EF/parameters will turn orange, indicating that mass of F-gases is not conserved (see discussion below <u>Ensuring mass conservation of gases</u>).
- 4. <u>Column |E|</u>: amount contained in factory-charged imported equipment in year t, kg
- 5. <u>Column | F |</u>: among contained in factory-charged exported new-equipment in year t, kg <u>Note that</u> exports of gas contained in factory charged new equipment must be equal to or less than the amount produced plus imported in bulk for a given year, otherwise the QA/QC check that appears below the EF/parameters will turn orange, indicating that mass of F-gases is not conserved (see discussion below <u>Ensuring mass conservation of gases</u>).

- 6. <u>Column |Sto|</u>: amount of F-gas/blend available (from production or import) but not used in year (t), i.e. stockpiled.
- 7. <u>Column | S_{from} |:</u> amount of F-gas/blend removed from the stockpile in year (t). <u>Note that</u> the Software contains a check for the user of the cumulative amount of the stockpile. The cumulated stockpile should always be positive. If the available stockpile turns negative owing to user entry, the cell will become red (see image below where the stockpile turned negative owing to values entered for 1991).
- 8. <u>Column |H|</u>: amount of F-gas/blend used to fill new equipment not factory-charged in year t, kg <u>Note that</u> this column, as well as the subsequent <u>Column |I|</u> will turn red or orange immediately upon entering any information in columns B, C, D, E or F. These are QA/QC checks to alert the user that inconsistent information has been entered. Specifically, all domestic sales of a gas/blend must have a fate, and either be used to fill new equipment (Columns H and or I) or be added to the stockpile. Any exports from the system in a given year, must be equal to or less than the amount produced/imported. A red cell means that the chemical agent has entered the system (e.g. via import) and has not yet been allocated to use. If the cells turn orange, this means that exports from the system are greater than the chemical input. The user must ensure that these cells turn to white.
- 9. <u>Column |||</u>: amount of F-gas/blend used to fill equipment factory-charged in year t, kg (see note above on <u>Column ||H|</u>.

Example: Indicator that stockpile should be reviewed

Note that the negative stockpile has resulted in overall QA/QC for mass conservation to turn orange.



- 10. <u>Column |N|:</u> amount recovered and recycled/reclaimed from equipment retired in year t, kg. In <u>Column</u> |N| there is a drop-down menu for two options:
 - a. Calculated (green cell) the *Software* estimates the amount of gas recovered and recycled/reclaimed in year t. The *Software* calculates the amount as equal to the amount of gas contained in the retired equipment <u>Column |M|</u> multiplied by the percentage share of that amount that was indicated by the user as recovered/reclaimed (η (rec,d)) in worksheet **F-Gas Parameters Tier 2**.
 - b. Specified (white cell) users enter country-specific AD manually. <u>Note that</u> the amount recovered and recycled/reclaimed plus any values entered in <u>Column |O|</u> plus <u>Column |P|</u> must be equal to or less than the total chemical agent in retired equipment (<u>Column |M|</u>). If the value is Columns N+O+P is greater than the amount in <u>Column |M|</u>, then the QA/QC check will change to orange and the user should check the values entered.
- 11. <u>Column |O|</u>: amount destroyed in year t, kg. In Column |O| there is a drop-down menu for two options:
 - a. Calculated (green cell) the *Software* estimates the amount of gas destroyed in year t. The *Software* calculates the amount destroyed as equal to the amount of gas contained in the retired equipment, <u>Column | M|</u> multiplied by the share of that amount that was indicated by the user as destroyed (D) in the worksheet F-Gas Parameters Tier 2.
 - b. Specified (white cell) users need to enter country-specific AD manually. <u>Note that</u> the amount destroyed plus any values entered in <u>Column |N|</u> plus <u>Column |P|</u> must be equal to or less than the total chemical agent in retired equipment (<u>Column |M|</u>). If the value is Columns N+O+P is greater than the amount in <u>Column |M|</u>, then the QA/QC check will change to orange and the user should check the values entered.

12. <u>Column |P|:</u> amount exported in used equipment in year t, kg.

<u>Note that</u> the amount exported plus any values entered in <u>Column |N| plus Column |O|</u> must be equal to or less than the total chemical agent in retired equipment (<u>Column |M|</u>). If the value is Columns N+O+P is greater than the amount in <u>Column |M|</u>, then the QA/QC check will change to orange and the user should check the values entered.

Once AD are input, the *Software* makes several calculations in green cells (these cannot be modified):

- <u>Column |G|:</u> domestic sales of new chemical in year t, kg. <u>Note that</u> this cell is calculated as the total domestic manufactured F-gas/blend, plus bulk import minus bulk export.
- 10. <u>Column | J |:</u> total charge in new equipment in year t, kg. <u>Note that</u> this cell is calculated as the sum of the amount used to fill new equipment not factory-charged plus the amount used to fill new equipment factory-charged.
- 11. <u>Column |K|:</u> amount used in the year t-d to fill new equipment not factory-charged, kg. <u>Note that</u> this cell is calculated based on the lifetime entered in worksheet **F-Gas Parameters- Tier 2** and is used to estimate the original charge in retired equipment. For example, in the year 1990 it was 20 kg, so after 15 years, in the year 2005, it will be 20 kg).
- 12. <u>Column |L|</u>: amount used in the year t-d to fill new equipment factory-charged, kg. <u>Note that</u> this cell is calculated based on the lifetime entered in worksheet **F-Gas Parameters-** Tier 2 and is used to estimate the original charge in retired equipment. For example, in the year 1992 it was 25 kg, so after 15 years, in the year 2007, it will be 25 kg).
- 13. <u>Column | M|:</u> the original total charge in year t-d of equipment retiring in year t, kg. <u>Note that</u> this cell is calculated as information entered in <u>Column | K|</u> plus <u>Column | L|</u> plus the amount of agent that was imported contained in factory-charged imported equipment in the year t-d and subtracting any agent that was contained in factory-charged new equipment in year t-d.
- 14. <u>Column |Q|:</u> Total emissions in year t, kg. <u>Note that</u> this cell is calculated as the sum of domestic sales plus the total agent in retired equipment in the year plus any agent withdrawn from the stockpile (these are the total possible emissions), and subtracting the sum of any agent added to the stockpile, the amount in all new equipment, and any agent recovered/reclaimed/destroyed or exported in equipment at the end of life.
- 15. <u>Column |R|:</u> Total emissions in year t, Gg
- 16. <u>Column |Bank_(t)|:</u> This column is applicable for users intending to use the *Software* for reporting in the UNFCCC ETF Reporting Tool and calculates the bank (i.e. the amount of refrigerant stored in products) in year (t).

<u>Note that</u> this cell is the total charge of equipment operating within its lifetime, as determined based on the lifetime added in worksheet **F-Gas Parameters – Tier 2.** The value is calculated as the total amount imported in equipment or added to new equipment in the country in that year, plus the bank of all agent in currently operating equipment, minus the sum of any agent exported in new equipment in that year and the original charge of equipment retired in that year.

ricsheet ector: alegory: abcategor aeet: ata	Industrial Pro Product Use	cesses and F s as Substituti igeration and	Product Use es for Ozone I Stationary Ai	Depleting Subst ir Conditioning	2a F-Gas Emi ances	ssions - Her 2b																
bdivisio	n Tokyo		⊻ Sul	b-application	Domestic Refrig	eration		~	Gas HFC-23	ICHF3)	~											
Intro Yea	r 1990 I	ifetime (d)	(yr) 12	n(rec.	d) [7.] 12	Stock	pile 0															
otal Chen	ical Agent Inputs (cross the tim	ie series) (∑G	+ ΣE · ΣSto + Σ	ESfrom)				19,700	ΣF + Bank(t) +	ΣQ + ΣN + ΣO +	ΣΡ 1	9,700									
Total Che	mical Agent in new	equipment ex	ported (acros	as the time series) (ΣF)			1	100													
Total Che	mical Agent in equ	pment in use	(last year of t	he time series) (E	Bank(t))				0													
Total Che	enical Agent Emissi	ons (across th	time series) (<u>Σ</u> Q)					1,780													
Total Che	mical Agent Recov	ered/Destrow	ed/Exported	from equipment a	at end of life (acri	oss the time serie	e) (ΣN + Σ	0 + 5P)	17,820													
	-																					Informa
																						UNFCO
	Domestically Manufactured Chemical in year f (kg)	Imported in bulk in year t (kg)	Exported in bulk in year t (kg)	Contained in factory- charged Imported equipment in year t	Contained in factory- charged Exported new -equipment in year 1	Domestic Sales of new chemical in year t (kg)	To stockpile (kg)	From stockpile (kg)	Used in year 1 to fill new equipment not factory- charged (kg)	Used in year t to fill new equipment factory- charged (kg)	Total Charge in new- equipment in year t (kg)	Used in year f -d to fill new equipment not factory- charged (kg)	Used in year 1 -d to fill new equipment factory- charged (kg)	Original Total Charge in year t-d of Equipment Retiring in year t (kg)	recycled/recuipment r	rered and eclaimed from retired in year t kg)		(ed in yeart (kg)	Exported in used equipment in year t (kg)	Total emissions in yeart (kg)	Total emissions in year 1 (Gg)	Bar (Ag
																N = M * (n (rec,d)/100) or specified		O = M* (D/100) or specified		Q = G . Sto + Sfrom - J + M - N - O - P	R = Q / 1000000	Bank(t) - F - M (t-
1990	1,000				100		0			60		0	0	2	-	1	<u> </u>			0	0	
1991 1992	2,000				-	2,000	0	0			2,000		0		Calculated		Calculated	0		0	0	
1992	2,500				-	2,500			2,500		2,500		0		Calculated Calculated		Calculated Calculated	0		0	0	
1994	2.000	-			-	2.000	-	-	2.000	-	2.000		0		Calculated		Calculated	0		0	0	
1995	2,000		-		-	2,000	-	-	2,000	-	2,000		0		Calculated		Calculated	0		0	0	
1996		100	-			100	0	-	100	-	100		0		Calculated		Calculated	0		0	0	
1997			0			0	0	0		-	D	0	0	0	Calculated	0	Calculated	0		0	0	
1998				100		0					0	0	0	0	Calculated	1	Calculated	0		0	0	
1999					0	0	0				0	0	0		Calculated	(Calculated	0		0	0	
2000						0		5	6		0		0		Calculated		Calculated	0		0	0	
2001		-				0					D	0	Ó		Calculated		Calculated	-		0	0	
002						0					0		600		Calculated	10	Specified	500		292	0.00029	
2003						0	-				0		0		Calculated Calculated		Specified Specified	1,60		160 200	0.00016	
2004			-		-	0		-	-		0		0		Calculated		Specified	2,000		200	0.0002	
005						0		-	-	-	0		0		Calculated		Specified	1.60		160	0.00016	
2007					-	0					0		0		Calculated		Calculated	1,600		160	0.00016	
2008		-	-			0				-	0		0		Specified	2	Calculated	80		0	0	
2009						0					0	0	0		Calculated	0	Calculated	0		0	0	
2010						0			-		0	0	Ô	100	Calculated	1	Calculated	80		8	0.00001	
2011		3				0		8			0	0	0		Calculated	(Calculated	0		0	0	
						0					0	0	0	0	Calculated	1	Calculated				0	
2012						0					v	V.	0									
						0		-			0		0	0	Calculated	0	Calculated	0		0	0	

Example: AD Input: F-gas Emissions - Tier 2b

Ensuring mass conservation of gases in Tier 2b

A QA/QC check has been introduced into the worksheets for categories 2.F.1, 2.F.2, 2.F.3 and 2.F.6 (contained applications only) to ensure that the data, EFs and parameters entered by the users ensure conservation of mass of gases over time.

To ensure mass conservation, the Software tracks and visually presents the inputs and outputs over time as follows:

- I. Total chemical agent inputs, across time $(\sum G + \sum E + \sum S_{to} + \sum S_{from})$
- II. Total chemical agent in new equipment exported, across time (ΣF)
- III. Total chemical agent in equipment in use (last year of the time series) (Bank(t))
- IV. Total chemical agent emissions, across time $(\sum Q)$
- V. Total chemical agent recovered/destroyed/exported in equipment at the end of life $(\Sigma N + \Sigma O + \Sigma P)$

In the case of Tier 2b, mass conservation has been ensured if:

$$\sum G + \sum E + \sum S_{to} + \sum S_{from} = \sum F + Bank(t) + \sum Q + \sum N + \sum O + \sum P$$

If mass has been conserved, all cells are green. An orange colour signals that the amount of chemical input is smaller than the amount of chemical stored in the system and the subsequent emissions, while a red colour means that the chemical input is greater than the amount stored in the system and the subsequent emissions. If the check results in orange or red shading, refer back to worksheet F-Gas Parameters to ensure that all parameters are coherent.

Some common scenarios leading to orange cells (chemical stored in the system and subsequent emissions are greater than inputs) include:

- Agent going to the stockpile (Column S_{to}) for a given year is also included in Column H and/or I as being used to fill new equipment.
- The amount used to fill new equipment (factory charged and non-factory charged) (Columns H and I) is greater than the amount available from domestic sales (Column G) and stockpile withdraw (S_{from}).
- The sum of the amount recovered/recycled/reclaimed/destroyed/exported in equipment in year t (Columns ∑N+∑O+∑P) is greater than the original total charge in year t-d of equipment retiring in the current year (Column M).
- In worksheet F-Gas Parameters- Tier 2, the share of charge remaining at the end of life that is destroyed (D) plus the recovery efficiency of charged to be reclaimed/recycled)(η(rec,d))must be ≤ 1, if greater than 1 this is not possible and more gas is estimated to be destroyed/reclaimed/recovered than available.



Example: Demonstration of mass conservation - Tier 2b

Example: Mass not conserved over time- Tier 2b

I. Total Cher II. Total Cher V. Total Che	1990 ical Agent Inputs nical Agent in req mical Agent in eq mical Agent Emis	v equipment expr uipment in use (R sions (across the	r] 12 series) ($\Sigma G + \Sigma E$ orted (across the t ast year of the time time series) (ΣQ)	ime series) (∑F) e series) (Bank(t))	20	Stockpile 0	Γ	iaes HFC-23 (Cl 19,700 Σ 0 0 19,800	HF3) EF + Bank(t) + ΣQ	+ΣN+ΣO+ΣP	19,8	0	be	Mass ecause used great	e the to fill	amo equi	unt t ipme	o sto ent in	ckpil 1990	e and) is	
Year	Domestically Manufactured Chemical in year t (kg)	Imported in bulk in year t (kg)	Exported in bulk in year t (kg)	Contained in factory- charged Imported equipment in year t	Contained in factory- charged Exported new -equipment in year t	Domestic Sales of new chemical in year t (kg)	To stockpile (kg)	From stockpile (kg)	Used in year t to fill new equipment not factory- charged (kg)	Used in year t to fill new equipment factory- charged (kg)	Total Charge in new- equipment in year t (kg)	Used in year t -d to fill new equipment not factory- charged (kg)	t Used in year t -d to fill new t equipment factory- charged (kg)	Original Total Charge in year I-d of Equipment Retiring in year t (kg)	Recove recycled/rec equipment re (k)	red and laimed from lired in year t	Destroy	ed in year t	Exported in used equipment in year t (kg)	Total emissions in year t (kg)	Total emissions in year t (Gg)
t 🛆	в	c	D	E	F	G = B + C - D	Sto	Sfrom	н	1	J=H+1	K = H(t-d)	L = I(t-d)			N = M * (n (rec,d)/100) or specified		O = M * (D/100) or specified	Р	Q = G - Sto + Sfrom - J + M - N - O - P	R = Q / 1000000
1990	1.000				0	1.000	900	0	200		200	0	0							0	0
1991 1992	2.000					2,000	0	900	2.000	900	2.900				Calculated Calculated		Calculated Calculated	0		0	0
1992	2,500					2,500			2,500		2,500				Calculated		Calculated	0		0	0

Results

GHG emissions from Refrigeration and Air Conditioning are estimated one row for each year of the time series, in the following worksheets:

- ✓ F-Gas Emissions
- ✓ F-Gas Emissions Tier 2a
- ✓ F-Gas Emissions Tier 2b

Total F-gas emissions from refrigeration and air conditioning is the sum of all emissions from all subdivisions in the above worksheets. The *Software* calculates the associated emissions for each F-Gas/blend in the following units: Tier 1 - metric tonnes; Tier 2 - kg and Gg. The full time series of emissions estimates will appear in the worksheets for each year (e.g. in the image below for Tier 1, the user is in the 1990 inventory year worksheet but is able to view the entire time series of emissions estimates for F gases/blends. Please see the examples of worksheets below with final estimates/results for different Tiers.

The user will note that Refrigeration and Air Conditioning is one of the few categories in the IPPU sector of the *Software* that does not contain a worksheet for **Capture and storage or other reduction.** This is because all capture and other reductions are already accounted for in the worksheets noted above.

Example: Results: F-Gas Emissions – Tier 1

<u>Note that</u> this figure is for Refrigeration and Air Conditioning but applies also to Emissions from Fire Protection worksheet. F-Gas Parameters - Tier 2 F-Gas Emissions - Tier 2 F-Gas

Gas Emissi	ions F-Gas F	Parameters - T	ier 2 F-Gas E	missions - Tier	2a F-Gas Emi	ssions - Tier 2b)							
Worksheet Sector: Category: Subcategor Sheet: Data	Product y: 2.F.1.a -		tutes for Ozone nd Stationary Ai	Depleting Subst ir Conditioning	ances									
Subdivision	n Unspecified	đ	✓ Gas HF	C-23 (CHF3)	~	Chemical	s Data	IY 1998	GR (%) 3	d (years)	15 EF (?	a) 15 X (%)	0	
I. Total Chem	ical Agent Inpu	ts (across the t	ime series) (ΣD)					34,906,768679	Bank(t) + ΣE + Σ	F 34.906.7	68679			
				e time series) (Ba	ank(t))			3.244.538383						
			the time series)					31.662.230296						
					at end-of-life (acro	oss the time seri		0						
TV. Total cito	aniour Agont He	covered/best	oyea/ Exponed	from equipment i	1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -			-						
	x		y y		Equa	tion 7.2B	04	(b)				Informa	tion for UNFC	CC CRT
Year	Agent production (tonnes)	Agent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t	Agent in all equipment installed in service (tonnes)
t ∆⊽	Ρ	Ехр	Imp	D = P - Exp + Imp	R = [L(t-d) - (L (t-d)) * EF/100)] - [S_needed - S_done](t-d)	F = R * (X / 100)	G = R - F	Bank = Bank(t -1) + D - R - I	I = IF(M * EF/100 > ΣD- ΣR-ΣΙ; M * EF/100; ΣD- ΣR-ΣΙ)	E = G + I	EE = E / 1000	K = IF(D>[I](t-1) - M(t-d+1)) * $EF/100]; [I](t-1) - M(t-d+1)$ * $EF/100]; D)$	L = D - K	$M = \sum_{i=1}^{\infty} (L(t, t-(d -1)))$
2007	848.72	0	212.18	1,060.9	0	0	0	4,404.18099	777.20841	777.20841	0.77721	727.14519	333.75481	5,181.38941
2008	874.1816	0	218.5454	1,092.727	0	0	0	4,672.3718	8 824.5362	824.5362	0.82454	777.20841	315.51859	5,496.90799
2009	900.40705	0	225.10176	1,125.50881	0	0	0	4,928.19851	869.68209	869.68209	0.86968	824.5362	300.97261	5,797.88061
2010	927.41926	0	231.85481	1,159.27407	0		0	5,174.3517	913.12089	913.12089	0.91312	869.68209	289.59198	6,087.47259
2011	955.24184	0	238.81046	1,194.0523	0	0	0	5,413.1434	955.2606	955.2606	0.95526	913.12089	280.93141	6,368.404
2012	983.89909	0	245.97477	1,229.87387	0	0	0	5,628.27011	1,014.74715	1,014.74715	1.01475	833.29687	396.57699	6,764.98099
2013	1,013.41607	0	253.35402	1,266.77008	691.12778	0	691.12778	5,238.93178	964.98063	1,656.10842	1.65611	785.45534	481.31474	6,433.20422

Example: Results: F-gas Emissions – Tier 2a

ksheet			_																					
tor:	Industrial Pri	cesses and Pr	oduct Use																					
egory:		is as Substitute																						
categor		frigeration and !																						
et:	F-Gas Emiss	ions - Emission	Factor Appr	oach - Tier 2	a																			
ta																								
bdivision	Tokyo		~ Sul	o-applicatio	n Domestic	Refrigeration		∨ Ga	s R-410A (HFC	-32/HFC-125 (50.	~													
Im Year	1990 F	Fc [%] 2	FF	k [%] 1	FF	[2] 1	Lifetime	(d) [yr] 15	P [%] 8	0 D [%	0	ŋ(rec,d) [3	1 70											
						-																		
stal Chem	ical Agent Inputs i	across the time	series) (2F	+ ΣH)				40.7	90.615792 ZG	+ Bank(t) + ΣV + 2	2Q+25+21	40,790.61	5792											
iotal Cher	nical Agent in new	equipment exp	orted (acros	s the time se	tee) (ΣG)				1,073															
otal Che	mical Agent in equ	ioment in use (last year of t	he time series	(Bankit))			12.9	08.452329															
	mical Agent Emiss								57.701755															
				-																				
stal Cher	nical Agent Recov	vered/Destroye	d/Exported	from equipme	nt at end-of-If	e (across the	time series) ($\Sigma Q + \Sigma$	5 + ΣT) 14.8	51.461708															
												Equation 7.1	1 - 7 14											
	Amount in the				in factory-	Contained in factory-	Domestic Sales of new &	Emitted by containers	Used to fill domestically	Emitted during	Contained in new	Cantained in new	Emilted from equipment in					Emitted			Exported in	Amount in the		
					in factory- charged	in factory- charged	of new & recovered	containers management	domestically manufactured	filling of new	in new equipment	new equipment	equipment in use in year t,				and recycled/reclai		Destro				Total emissions	
	bank on January 1st of year t	Manufacture d Chemical in year t	in bulk in year t	in bulk in year t	in factory- charged Imported	in factory- charged Exported	of new & recovered chemical (in	containers management (during	domestically manufactured new	filling of new equipment in year t	in new equipment filled in	new equipment consumed in	equipment in use in year t, including		to refill in year t (kg)		and recycled/reclai med from	at end of life in year t	Destro	oyed in yeart (kg)	equipment at end-of-life in year t	bank on December 31st of year t	Total emissions in year t (kg)	emissio yéar
	bank on January 1st of	Manufacture d Chemical			in factory- charged imported equipment	in factory- charged Exported new-	of new & recovered chemical (in bulk) in year t	containers management	domestically manufactured	filling of new equipment in	in new equipment	new equipment consumed in year t	equipment in use in year t, including servicing				and recycled/reclai	at end of life in	Destro		equipment at end-of-life in	bank on December		emissio yéar
/ear	bank on January 1st of year t	Manufacture d Chemical in year t	in bulk in year t	in bulk in year t	in factory- charged imported equipment	in factory- charged Exported	of new 8 recovered chemical (in bulk) in year t (kg)	containers management (during transfer from	domestically manufactured new equipment in	filling of new equipment in year t (kg)	in new equipment filled in country in	new equipment consumed in	equipment in use in year t; including servicing (kg)	Used t	(kg)	retired in year t (kg) P = M(t-d) *	and recycled/reclai med from equipment retired in year	at end of life in year t	Destro		equipment at end-of-life in year t	bank on December 31st of year t (kg)		emissio year (Gg
Year	bank on January 1st of year t (kg)	Manufacture d Chemical in yeart (kg)	in bulk in year t (kg)	in bulk in yeart (kg)	in factory- charged imported equipment	in factory- charged Exported new- equipment	of new & recovered chemical (in bulk) in year t (kg) H = C + D - E +	containers management (during transfer from bulk to small, I = H * (EFc /	domestically manufactured new equipment in year t	filling of new equipment in year t (kg) K = J * (EFk /	in new equipment filled in country in year t	new equipment consumed in year t (kg) M = L + F -	equipment in use in year t, including servicing (kg) N = Σ(M()-	Used t	(kg) O = Sdone	retired in year t (kg) P = M(t-d) = (p/100) -	and recycled/rectai med from equipment retired in year Q = P* (n	at end of life in year t (kg) R = P -	Destro	(kg) S = P * D/100	equipment at end-of-life in year t	bank on December 31st of year t (kg) Bank(t) =		emissio year (Gg W = 1
∕ear t Δ	bank on January 1st of year t	Manufacture d Chemical in year t	in bulk in year t	in bulk in year t	in factory- charged imported equipment	in factory- charged Exported new-	of new 8 recovered chemical (in bulk) in year t (kg)	containers management (during transfer from bulk to small,	domestically manufactured new equipment in	filling of new equipment in year t (kg)	in new equipment filled in country in	new equipment consumed in year t (kg)	equipment in use in year t; including servicing (kg)	Used t	(kg)	retired in year t (kg) P = M(t-d) * (p/100) - (Sneeded -	and recycled/reclai med from equipment retired in year	at end of life in year t (kg)	Destro	(kg)	equipment at end-of-life in year t	bank on December 31st of year t (kg)	in year t (kg)	emissic yea (Gg W =
1 4	bank on January 1st of year t (kg)	Manufacture d Chemical in year t (kg) C	in bulk in yeart (kg) D	in bulk in yeart (kg)	in factory- charged Imported equipment in year t	in factory- charged Exported new- equipment G	of new 8 recovered chemical (in bufk) in year t (kg) H = C + D - E + Q(t-1)	containers management (during transfer from bulk to small, I = H * (EFc / 100)	domestically manufactured new equipment in year t	filling of new equipment in year t (kg) K = J * (EFk / 100)	in new equipment filled in country in year t	new equipment consumed in year t (kg) M=L+F- G	equipment in use in year t, including servicing (kg) N = Σ(M(I- d+1,t)) * (EFx / 100)		(kg) O = Sdone	retired in year t (kg) P = M(t-d) = (p/100) -	and recycled/rectai med from equipment retired in year Q = P* (n	at end of life in year t (kg) R = P -	Destro	(kg) S = P * D/100	equipment at end-of-life in year t	bank on December 31st of year t (kg) Bank(t) = Bank(t-1) + M + O - N - P	in year t (kg) V = I + K + N + R	emissio year (Gg W = 1 10000
t A	bank on January 1st of year t (kg) Bank(t-1) 0	Manufacture d Chemical in yeart (kg) C 2,000	in bulk in year t (kg) D	in bulk in yeart (kg)	in factory- charged Imported equipment in year t F	in factory- charged Exported new- equipment G 1,000	ot new & recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 3,000	containers management (during transfer from bulk to small, I = H * (EFc / 100)	domestically manufactured new equipment in year t J = H - I - O 2,940	filling of new equipment in year t (kg) K = J * (EFk / 100) 29.4	in new equipment filled in country in year t L = J - K 2,910.6	new equipment consumed in year t (kg) M=L+F- G 1,935.6	equipment in use in year t, including servicing (kg) N = Σ(M(I- d+1,t)) * (EFx / 100) 19,356		(kg) O = Sdone or specified	retired in year t (kg) P = M(t-d) * (pr100) - (Sneeded - Sdone)(t-d)	and recycled/reclai equipment retired in year Q = P * (n (rec.d)/100)	at end of life in year t (kg) R = P - Q - S - T	Destro	(kg) S = P * D/100	equipment at end-of-life in year t (kg) T	bank on December 31st of year t (kg) Bank(I) = Bank(I-1) + M + O - N - P 1,916.244	in year t (kg) V = 1 + K + N + R 108.756	emissio year (Gg W = \ 10000
t ∆ 1990 1991	bank on January 1st of year t (kg) Bank(t-1) 0 1,916.244	Manufacture d Chemical in year t (kg) C 2.000 200	in bulk in year t (kg) D 1,000 2,000	in bulk in yeart (kg)	in factory- charged imported equipment in year t F 25 23	in factory- charged Exported new- equipment G 1,000	of new 8 recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 3,000 2,200	containers management (during transfer from bulk to small, I = H * (EFc / 100) 60 44	domestically manufactured new equipment in year t J = H - I - O 2.940 2.136.644	filling of new equipment in year t (Kg) K = J * (EFk / 100) 29.4 21.36644	in new equipment filled in country in year t L = J - K 2,910.6 2,115.277.	new equipment consumed in year t (kg) M = L + F - G 1,935.6 2,138.27756	equipment in use in year t, including servicing (kg) N - Σ(M(t- d+1,t)) * (EFx / 100) 19,356 40,73878	Calc.	(kg) O = Sdone or specified 19.356	retired in year t (kg) P = M(t-d) * (pr100) - (Sneeded - Sdone)(t-d)	and recycled/rectai med from equipment retired in year Q = P* (n	at end of life in year t (kg) R = P - Q - S - T	Cal_	(kg) S = P * D/100	equipment at end-of-life in year t	bank on December 31st of year t (kg) Bank(t) = Bank(t-1) + M + O - N - P 1,916,244 4,033,13878	In year t (kg) V = I + K + N + R 108.756 91.10522	Tots emissio (Gg W = V 10000 0) 0)
t A 1990 1991 1992	bank on January 1st of year (kg) Bank(t-1) 0 1,916.244 4,033.13878	Manufacture d Chemical in year t (kg) C 2.000 200 1.303	in bulk in year t (kg) 1,000 2,000 2,000	in bulk in yeart (kg)	F 25 23 100	in factory- charged Exported new- equipment G 1,000	of new 8 recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 3,000 2,200 3,303	containers management (during transfer from bulk to small, I = H * (EFc / 100) 60 44 66.06	domestically manufactured new equipment in year t J = H - I - O 2,340 2,136,644 3,196,20122	filing of new equipment in year t (kg) K = J * (EFk / 100) 29.4 21.36644 31.96201	in new equipment filled in country in year t L = J - K 2,910.6 2,115.277. 3,164.239.	new equipment consumed in yeart (kg) M = L + F - G 1,935.6 2,138.27756 3,264.23921	equipment in use in year t, including servicing (kg) N - Σ(M(t- d+1,t))* (EFx / 100) 19.356 40.73878 73.38117	Calc Calc	(kg) O = Sdone or specified 19.356 40.73878	retired in year t (kg) P = M(t-d) * (pr(00) - (Sneeded - Sdone)(t-d) 0 0	and recycled/rectai med from equipment retired in year Q = P * (n (rec.d)/100)	at end of life in year t (kg) R = P - Q - S - T -15 -10	Cal_ Cal_	(kg) S = P * D/100	equipment at end-of-life in year t (kg) T 15	bank on December 31st of year t (kg) Bank(t) = Bank(t-1) + M + O - N - P 1,916.244 4,033.13878 7,264.7356	In year t (kg) V=I+K+N+ R 108.756 91.10522 161.40318	emissio year (Gg 10000 0) 0) 0)
t ∆ 1990 1991 1992 1993	bank on January 1st of year t (kg) Eank(t-1) 0 1,916,244 4,033,13878 7,264,7356	Nanufacture d Chemical in year t (kg) C 2,000 200 1,303 340	in bulk in year t (kg) 1,000 2,000 2,000 1,000	in bulk in year t (kg) E	in factory- charged imported equipment in year t F 25 23 100 200	in factory- charged Export new- equipment G 1,000	of new 8 recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 3,000 2,200 3,303 1,340	containers management (during transfer from bulk to small, I = H * (EFc / 100) 60 44 66.06 26.8	domestically manufactured new equipment in year 1 J = H - I - O 2.940 2.136.644 3.196.20122 1.239.81883	Filing of new equipment in year t (Kg) K = J * (EFk / 100) 29,4 21,36644 31,96201 12,33819	in new equipment filled in country in year t L = J - K 2,910.6 2,115.277. 3,164.239. 1,227.420.	new equipment consumed in yeart (kg) M = L + F - G 1.935.6 2.138.27756 3.264.23921 1.427.42064	equipment in use in year t, including servicing (kg) N = Σ(M(t- d+1,t))* (EFx / 100) 19.356 40.73878 73.38117 87.65537	Calc Calc Calc	(kg) O = 5done or specified 19.356 40.73878 73.38117	retired in year t (kg) P = M(t-d) * (p/100) - (Sneeded - Sdone)(t-d) 0 0 0 0 0	and recycled/rectai med from equipment retired in year Q = P * (n (rec.d)/100)	at end of life in year t (kg) R = P - Q - S - T -15 -10 -10	Cal. Cal. Cal.	(kg) S = P * D/100	equipment at end-of-life in yeart (kg) T 15 10 10	bank on December 31st of year t (kg) Bank(1) = Bank(1-1) + M + 0 - N - P 1,916,244 4,033,13678 7,264,7356 8,677,88204	In year t (kg) V=1+K+N+ R 108.756 91.10522 161.40318 116.85356	emissio year (Gg 10000 0. 0. 0. 0. 0. 0.
t ∆ 1990 1991 1992 1993 1994	bank on January 1st of yeart (kg) Eank(t-1) 0 1.916.244 4.033.13878 7.264.7356 8.677.88204	Nanufacture d Chemical in year t (kg) 2,000 2,000 1,303 340 1,000	in bulk in year t (kg) 1,000 2,000 2,000 1,000 2,005	in bulk in yeart (kg)	F F 25 23 100 200 100	in factory- charged Export new- equipment G 1,000 30	of new 8 recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(t-1) 3,000 2,200 3,303 1,340 2,955	containers management (during) transfer from buik to small, i = H * (EFc / 100) 60 44 66.06 26.8 59.1	domestically manufactured new equipment in year t J = H - I - O 2,940 2,136,644 3,196,20122 1,239,81883 1,835,9	Filing of new equipment in year (Kg) K = J * (EFk / 100) 29.4 21.36644 31.96201 12.39819 18.959	in new equipment filled in country in year t L = J - K 2,910.6 2,115.277. 3,164.239. 1,227.420. 1,876.941	new equipment consumed in year t (Kg) M = L + F - G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,946.941	equipment in including servicing (kg) N - <u>C(M(-</u> d+1,0)* (EFx / 100) 19.386 40.73878 73.38117 87.65537 107.12478	Calc Calc Calc Spe	(kg) O = Sdone or specified 19.356 40.73878 73.38117 1.000	retired in year t (kg) (P = M(E-d) * (priod) - (Sneeded - Sdone)(E-d) 0 0 0 0	and recycled/rectai med from equipment retired in year Q = P * (n (rec.d)/100)	at end of life in year t (kg) R = P - Q - S - T -15 -10 -10 -10 -10	Cal. Cal. Cal. Cal.	(kg) S = P * D/100	equipment at end-of-life in year t (kg) T 15	bank on December 31st of year t (kg) Bank(t) = Bank(t) = Bank(t) + M + O - N - P 1,916.244 4,033.13878 7,264.7356 6,677.88204 11.517.69626	in year t (kg) V=I+K+N+ R 108.755 91.10522 161.40318 116.85356 175.18378	emissic yda (Gg 10000 0 0 0 0 0 0 0 0
t ∆ 1990 1991 1992 1993 1994 1995	bank on January 1st of year t (kg) Bank(t-1) 0 1.916.244 4.033.13878 7.264.7386 8.667.788204 11.517.68626	Nanufacture d Chemical in year (kg) C 2,000 200 1,303 340 1,000 120	in bulk in year t (kg) 1,000 2,000 2,000 1,000 2,005 1,003	in bulk in year t (kg) E	in factory- charged Imported equipment in yeart F 25 23 100 200 100 32	in factory- charged Exported new- equipment G 1,000 30 43	of new 8 recovered chemical (in buk) in year 1 (kg) H = C + D - E + Q(t-1) 3,000 2,200 3,303 1,340 2,955 1,079	containers management (during) transfer from bulk to small, 1 = H * (EFc / 100) 60 44 66.06 26.8 59.1 21.58	domestically manufactured new equipment in year t J = H - I - O 2.940 2.136.644 3.196.20122 1.239.81863 1.835.9 950.29522	Rilling of new equipment in year t (kg) K = J * (EFk / 100) 29.4 21.36644 31.96201 12.39819 18.999 9.50295	in new equipment filled in country in year t L = J - K 2,910.6 2,115.277. 3,164.239 1.227.420 1.876.941 940.79226	new equipment consumed in year t (kg) M = L + F - G 3.264.23921 1.427.42064 1.946.941 929.79226	equipment in including servicing (kg) N - <u>C(M(t- d+1(t))*</u> (EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478 116.42271	Calc Calc Calc Spe Calc	(kg) O = Sdone or specified 19.356 40.73878 73.38117 1.000 107.12478	refired in year t (kg) P = M(t-d) * (p/100) - (Sneeded - Sdone)(t-d) 0 0 0 0 0 0 0 0 0 0 0 0 0	and recycled/rectail med from equipment retired in year Q = P + (n (rec.d)/100) 0 0 0 0 0 0 0 0	at end of life in year t (kg) R = P - Q - S - T -15 -10 -10 -10 -10 -10 -10	Cal. Cal. Cal. Cal. Cal. Cal.	(kg) S = P * D/100	equipment at end-of-life in yeart (kg) T 15 10 10	bank on December 31st of yeart (kg) Bank(t) = Bank(t) + M • O - N - P 1,916.244 4,033.13678 7.264.7356 8,677.88204 11.517.59526 12.438.1926	In year t (kg) V = 1 + K + N + R 108.756 91.10522 161.40318 116.85356 175.18378 137.50566	emissio year (Gg W = 1 10000 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
1 △ 1990 1991 1992 1993 1994 1995 1996	bank on January 1st of yeart (kg) Eank(t-1) 0 1.916.244 4.033.13878 7.264.7356 8.677.8820 11.517.69826 11.517.69826	Manufacture d Chemical in year ((kg) C 2,000 200 1,303 340 1,000 1,000	In bulk in year t (kg) 1,000 2,000 1,000 2,000 1,000 2,005 1,003 2,000	in bulk in year t (kg) E	in factory- charged imported equipment in year t F 25 23 100 200 100 32 300	in factory- charged Exported new- equipment G 1,000 30 43	of new 8 recovered chemical (in buk) in year t (kg) H = C + D - E + Q(L-1) 3,000 2,200 3,203 1,340 2,2955 1,079 3,000	containers management (during transfer from bulk to small, I = H * (EFc / 100) 60 44 66.06 26.8 59.1 21.58 60	domestically new idactured new equipment in year t J = H - I - O 2.346 3.396.20122 1.239.81883 1.835 9 950.29522 2.823.57729	Filling of new equipment in year t (kg) K = J * (EFk / 100) 29.4 21.36644 31.96201 12.39819 18.559 9.50295 28.23577	in new equipment filled in country in year t L = J - K 2,910.6 2,115.277. 3,164.239. 1,227.420. 1,876.941 940.79228 2,795.341	new equipment consumed in yeart (kg) M = L + F - G 2.138.27756 3.264.23921 1.427.42064 1.946.941 929.79226 3.095.34152	equipment in use in year (, including servicing (kg) N - Σ(M(t- d+1,t))* (EFx / 100) 19.356 40.73878 73.38117 87.65537 107.12478 116.42271 147.37612	Calc Calc Calc Spe Calc Calc	(kg) O = 5done or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271	refired in year t (kg) P = M(t-d) + (p/100) - (Sneeded - Sdone)(t-d) 0 0 0 0 0 0 0 0 0 0 0 0 0	and recycled/rectail med from equipment retired in year Q = P + (n (rec.d)/100) 0 0 0 0 0 0 0 0	at end of life in year t (kg) R = P - Q - S - T -10 -10 -10 -10 -10 -10 -10 -10 -10	Cal. Cal. Cal. Cal. Cal. Cal. Cal. Cal.	(kg) S = P * D/100	roupment at end-of-life in year t (kg) T 15 10 10 10 10 10 10 10 10	bank on December 31st of yeart (kg) Bank(1) - B 8ank(1) - H + O - N - P 1,916,244 4,033,13678 7,264,7356 8,677,88204 11,517,68926 12,438,1926 15,502,5807	In year 1 (kg) V = 1 + K + N + R 108.756 91.10522 151.40318 116.85356 175.18378 137.50566 225.61189	emissio year (Gg 10000 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0. 0.
0990 991 992 993 994 995 996 997	bank on January 1st of year t (kg) Bank(t-1) 0 1.916.244 4.033.13878 7.264.7356 8.677.88204 11.517.69826 12,438.126 15,502.5807	Nanufacture d Chemical in year (kg) C 2,000 200 1,303 340 1,000 120	In bulk in year t (kg) 1,000 2,000 2,000 1,000 2,000 1,003 2,000 3,000	in bulk in year t (kg) E	In factory- charged imported equipment in year t F 255 233 100 200 100 320 300 400	in factory- charged Exported new- equipment G 1,000 1,000 43	of new 8 recovered chemical (in bulk) in year 1 (kg) H + C + D - E + Q(t-1) 3,000 2,200 3,303 1,340 2,355 1,079 3,000 3,309	containers management (during transfer from bulk to small, bulk to small, 1 = H * (EFc / 100) 60 44 66 06 26 8 59 1 21 58 60 70.18	domestically nanufactured new equipment in year1 J = H - I - O 2,940 2,136,644 3,196,20122 1,239,81883 1,835,9 950,29522 2,823,57729 3,291,44388	Filling of new equipment in year t (Ks) K = J * (EFk / 100) 29.4 21.3644 31.96201 12.33819 18.959 9.50295 28.2357 32.21444	in new equipment filled in country in yeart L = J - K 2,910.6 2,115.277. 3,164.239. 1,227.420. 1,876.941 940.79226 2,795.341 3,258.529.	new equipment consumed in yeart (kg) M = L + F - G 1,935.6 2,138.27756 3,264.23921 1,427.42064 1,946.941 929.79226 3,095.34152 3,658.52944	equipment in use in year (, including servicing (kg) N - S(M(t- d+1,t))* (EFx/100) 19.366 40.73878 73.38117 87.65537 107.12478 116.42271 116.42271 116.42271 116.356142	Calc Calc Calc Spe Calc Calc Calc	(kg) O = Sdone or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271 147.37612	retired in year t (kg) P = M(b:d) * (pr100) - (Sneeded - Sdone)(t-d) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	and recycled/rectail med from equipment retired in year Q = P + (n (rec.d)/100) 0 0 0 0 0 0 0 0	at end of life in year t (kg) R = P - Q - S - T -10 -10 -10 -10 -10 -10 -10 -10 -10 -10	Cal. Cal. Cal. Cal. Cal. Cal.	(kg) S = P * D/100	equipment at end-of-life (kg) T 15 10 10 10 10 10 10 10 10 10 10 10 10	bank on December 31st of year t (kg) Bank(t) = Bank(t) + 4 - 0 - N - P 1,916.244 4.033.13878 7.264.7356 8.677.88204 11.517.5826 12.438.1925 15.502.580 15.502.580 19.124.52485	In year t (kg) V=I+K+N+ R 108.765 91.10522 161.40318 116.80318 116.83378 137.50566 225.61189 227.05886	emissie yea (Gr 1000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
1990 1991 1992 1993 1994 1995 1996 1997 1998	bank on January 1st of year t (kg) Bank(t-1) 0 1.916.244 4.033.13878 7.264.7356 8.677.88204 11.517.68626 12.438.1826 15.502.5807 19.124.52485	Manufacture d Chemical in year ((kg) C 2,000 200 1,303 340 1,000 1,000	In bulk in year t (kg) 1,000 2,000 2,000 1,000 2,005 1,003 2,000 3,000 1,000	in bulk in year t (kg) E	In factory- charged imported equipment in year t F 28 23 100 200 100 300 400 400	in factory- charged Exported new- equipment G 1,000 1,000 43	of new 8 recovered chemical (in bulk) in year t (kg) H = C + D - E + Q(L-1) 3,000 2,200 3,303 1,340 2,955 1,079 3,000 3,509 1,000	containers management (during) transfer from bulk to small, bulk to small, bulk to small, bulk to small, bulk to small, transfer for 00) 44 660.66 26.8 59.1 21.58 60 70.18 20	domestically new equipment in year 1 J = H - I - O 2,340 2,136,644 3,196,20122 1,239,81803 1,835,9 9550,29522 2,823,57729 3,291,4835 796,03858	Riling of new equipment in year t (kg) K = J * (EFk / 100) 29.4 21.36644 31.96201 12.39819 9.50295 9.50295 28.23577 32.291444 7.96038	in new equipment filled in country in year t L = J - K 2.910.6 2.115.277. 3.164.239 1.62.739 1.627.420. 1.876.941 940.79226 2.795.341 3.258.529 788.0782	new equipment consumed in year t (kg) M = L + F - G 3.264.23921 1.427.42064 1.946.941 929.79226 3.095.34152 3.658.52944 1.188.0782	equipment in use in year (; including servicing (kg) N - Σ(M(I- d+1,1))* (EFx / 100) 19.386 40.73878 73.38117 87.65537 107.12478 116.42271 147.37612 183.96142 183.96142	Calc Calc Calc Spe Calc Calc Calc Calc	(kg) Q = 5done or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271 147.37612 183.356142	retired in year (kg) P = t4(5-d) * (pr100) - (Sneeded - Sdone)(t-d) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	and recycled/rectail med from equipment retired in year Q = P + (n (rec.d)/100) 0 0 0 0 0 0 0 0	at end of life in year t (kg) - 10 - 10 - 10 - 10 - 10 - 10 - 10 - 10	Cal. Cal. Cal. Cal. Cal. Cal. Cal. Cal.	(kg) S = P * D/100	equipment et end-cf-like (kg) T 15 15 10 10 10 10 10 10 10 10 10 10 10 10 10	bank on December 31st of year t (kg) Bank(t) = Bank(t) + M • O • N − P 1,916.244 4,033.13878 7.264.7356 7.264.7356 11.517.6502.507 19.124.52485 20.300.72226	In year ((kg) V = 1 + K + N + R 108.756 91.10522 161.4031 16.8536 175.18375 225.61189 227.6586 205.80258	emissio year (Gg W = 1 10000 0.
Year t Δ 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000	bank on January 1st of year t (kg) Bank(t-1) 0 1.916.244 4.033.13878 7.264.7356 8.677.88204 11.517.69826 12,438.126 15,502.5807	Manufacture d Chemical in year ((kg) C 2,000 200 1,303 340 1,000 1,000	In bulk in year t (kg) 1,000 2,000 2,000 1,000 2,000 1,003 2,000 3,000	in bulk in year t (kg) E	In factory- charged imported equipment in year t F 255 233 100 200 100 320 300 400	in factory- charged Exported new- equipment G 1,000 1,000 43	of new 8 recovered chemical (in bulk) in year 1 (kg) H + C + D - E + Q(t-1) 3,000 2,200 3,303 1,340 2,355 1,079 3,000 3,309	containers management (during transfer from bulk to small, bulk to small, 1 = H * (EFc / 100) 60 44 66 06 26 8 59 1 21 58 60 70.18	domesti sally manufactured equipment in yeari J = H - I - O 2.940 2.136.5442 3.196.2042 1.239.81883 1.835 9 950.25522 2.823.57729 3.291.44388 796.03858 764.1578	Filling of new equipment in year t (Ks) K = J * (EFk / 100) 29.4 21.3644 31.96201 12.33819 18.959 9.50295 28.2357 32.21444	in new equipment filled in country in yeart L = J - K 2,910.6 2,115.277. 3,164.239. 1,227.420. 1,876.941 940.79226 2,795.341 3,258.529.	new equipment consumed in year t (f) M = L + F - G 1,935 6 2,138,27756 3,264,23921 1,427,42064 1,936,341 923,79226 3,095,34152 3,095,34152 1,376,31622	equipment in use in year (, including servicing (kg) N - S(M(t- d+1,t))* (EFx/100) 19.366 40.73878 73.38117 87.65537 107.12478 116.42271 116.42271 116.42271 116.356142	Calc Calc Calc Spe Calc Calc Calc Calc Calc Calc	(kg) O = Sdone or specified 19.356 40.73878 73.38117 1.000 107.12478 116.42271 147.37612	refired in year t (kg) P = M(5-d)* (pri00) - (Sneeded - Sdone)(1-d) 0 0 0 0 0 0 0 0 0 0 0 0 0	and recycled/rectail med from equipment retired in year Q = P + (n (rec.d)/100) 0 0 0 0 0 0 0 0	at end of life in year t (kg) - 115 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 100 - 110 - 110	Cal Cal Cal Cal Cal Cal Cal Cal Cal Cal	(kg) S = P * D/100	equipment et end-cf-like (kg) T 15 15 10 10 10 10 10 10 10 10 10 10 10 10 10	bank on December 31st of year t (kg) Bank(t) = Bank(t) + 4 - 0 - N - P 1,916.244 4.033.13878 7.264.7356 8.677.88204 11.517.5826 12.438.1925 15.502.580 15.502.580 19.124.52485	In year t (kg) V=I+K+N+ R 108.765 91.10522 161.40318 116.80318 116.83378 137.50566 225.61189 227.05886	emissie yea (Gr 1000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Example: Results: F-gas Emissions – Tier 2b



GHG emissions from Fire Protection are estimated in a similar fashion as described above for worksheet **F-Gas Emissions,** but in the following worksheet of source category 2.F.3:

✓ Emissions from Fire Protection

Example: Results: Fire protection – All tiers

missions fror Vorksheet Sector: Category: Subcategory Sheet: Data	Product Use 2.F.3 - Fire F		luct Use or Ozone Depletin	ig Substances					ß					
Subdivision	Unspecified	~	Gas HFC-23 (C	CHF3)	Chemical's Data	IY 1990	GR (%) 0	d (yr) 15	EF (%) 4 X (%	() 0				
I. Total Chemi	ical Agent Inputs	across the time se	eries) (∑D)			8,600	Bank(t) + ΣE + ΣF	8,600						
II. Total Chem	nical Agent in equi	pment in use (last	year of the time s	eries) (Bank(t))		2,927,027862		-						
III. Total Cher	nical Agent Emiss	ions (across the ti	me series) (SE)			5.672.972138								
	- 19 E			upment at end-of-life (ac	ross the time series) (SF)	0								
						uation 7.17						Informat	on for UNFCCC	CRT
Year	Agent production (tonnes)	Agent export (tonnes)	Agent import (tonnes)	Total new agent to domestic market (tonnes)	Retired in equipment at end-of-life (tonnes)	Destruction of agent in retired equipment (tonnes)	Release of agent from retired equipment (tonnes)	Bank (tonnes)	Emissions from installed equipment (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent for servicing (tonnes)	Agent in new equipment installed in year t (tonnes)	Agent in all equipment installed in service (tonnes)
t ≜⊽	P	Exp	Imp	D = P - Exp + Imp	R = [L(t-d) - (L(t-d) * EF/100)] - [S_needed - S_done](t-d)	F = R * (X / 100)	G = R - F	Bank = Bank(t-1) + D - R - I	i = IF(M * EF/100 > ΣD-ΣR-ΣI, M * EF/100; ΣD-ΣR-ΣI)	E=G+1	EE = E / 1000	$\begin{split} & K \approx IF(D \! > \! f!(t \! - \! 1) - M(t \! + \! d \! + \! 1) * \! EF/100]; \; [I(t \! - \! 1) - M \\ & (t \! - \! d \! + \! 1) * \! EF/100]; \; D) \end{split}$	L = D - K	$M = \sum (L(t, t - (d - 1))$
1990	100		25					120	5				125	
1991	100		25		0	(0	235.2	9.8	9.8	0.0098	5	120	24
1992	100		25			(345.792	14.408	14.408	0.01441	9.8	115.2	360.3
1993	100		25 25			(451.96032	18.83168	18.83168	0.01883	14.408	110.592	470.79
1994	100		25			0		553.88191	23.07841	23.07841	0.02308	18.83168	106.16832	
1995	100		25			L.		651.72663 745.65757	27.15528 31.06907	27.15528 31.06907	0.02/16	23.07841 27.15528	101.92159 97.84472	678.8819 776.7266
1996	100		25		0	(4 L	835.83126	34.8263	31.06907	0.03107	31.06907	97.84472	870.6575
1998	100		25			(922 39801	38.43325	38.43325	0.03483	34.8263	90.1737	960.8312
1999	100		25		0		4 T	1.005.50209	41.89592	41.89592	0.0419	38.43325	86.56675	1.047.3980
2000	100		25	125	0	(0	1.085.28201	45.22008	45.22008	0.04522	41.89592	83,10408	1,130.5020

2.F.2 Foam Blowing Agents

Information

The 2006 IPCC Guidelines differentiate open-cell foams and closed-cell foams, each type of foam can then be broken down into further sub-applications (i.e. types of foam), see <u>Table 7.4</u> in Chapter 7 Volume 3.

The division of foams into open-cell or closed-cell relates to the way in which blowing agent is lost from the products. For open-cell foam, emissions (typically HFCs) are used as blowing agents and are likely to occur during the manufacturing process and shortly thereafter. In closed-cell foam, only a minority of emissions occur during manufacturing. For closed cell foams, emissions extend into the in-use phase, with most of the emission not occurring until end-of-life (decommissioning losses).

The 2006 IPCC Guidelines provide two Tiers for estimation of GHG emissions from Foam Blowing Agents:

- Tier 1 is based on known consumption data for a foam blowing agent and default EFs for the first-year loss and annual loss.
- Tier 2 is a more data demanding method and requires data on production, import, export of a foam blowing agent, EFs for the first-year loss, annual losses and for the end-of-life (decommissioning and recovery).

For open-cell foams – the basic assumption (Tier 1) is that all HFCs are released immediately and the emissions will occur in the country of manufacture. The difference in Tier 2 for closed cell and open cell foams is that Tier 2 for closed cell foams estimate end-of-life emissions including estimates for the decommissioned bank and emissions from it.

GHGs

The *Software* includes the following GHGs for the Foam Blowing Agents source category, although emissions are predominantly HFCs:

CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆	NF ₃
			Χ	Χ	Χ	Χ

IPCC Equations

- ✓ <u>Tier 1</u>: <u>Equation 7.7</u> (generic equation for both Closed Cell and Open Cell Foams), <u>Equation 7.8</u> (Open Cell Foams) at the application level
- \checkmark <u>Tier 2a</u>: <u>Box 7.2</u> (sub-application level)
- ✓ <u>Tier 3</u>: No IPCC Tier 3 equation provided in the 2006 IPCC Guidelines

Software Worksheets

GHG emissions from the Foam Blowing Agents source category are estimated using the following worksheet for all Foam Blowing Agents:

✓ **1.1.2 F-gases Manager:** is applicable to both open and closed cell fomas and contains data on F-gases used (including imported) and/or produced and exported in country.

Then, for:

Closed Cell Foams:

✓ F-gas Emissions – Closed Cell Foams: contains for each subdivision and each F-gas (at the application level) information on the year of introduction, product lifetime, EF for the first-year loss and EF for annual loss as well as the growth rate and known consumption of the F-gas. Users may also add information on agent recovery and destruction; but this type of information is not typically available for Tier 1. The worksheet calculates the associated F-gas emissions for closed cell foams for Tier 1.

- ✓ F-gas Parameters Closed Cell Foams Tier 2: allows for input of necessary information: subdivisions, sub-applications and chemicals (i.e. gases) consumed. For each gas, additional parameters are available for data input; information on the year of introduction of each foam blowing agent, growth rate, product lifetime, EFs for the first-year loss and for maximum potential end-of-life loss, EFs for decommissioning, recovery and destruction, and annual rate loss for the decommissioned bank. These parameters are automatically transferred into the calculation of emissions in worksheet F-Gas Emissions- Closed Cell Foams- Tier 2.
- ✓ F-Gas Emissions- Closed Cell Foams- Tier 2: contains for each subdivision/sub-application/F-gas, information on the amount of F-gas produced domestically, imported and exported. Based on these data, and parameters entered above, the worksheet calculates the associated F-gas emissions for closed cell foams for Tier 2.

Open Cell Foams:

- ✓ F-gas Emissions Open Cell Foams: contains for each subdivision and each F-gas (at the application level) information on the year of introduction and the growth rate for the use of agent. The worksheet calculates the associated F-gas emissions for open cell foams for Tier 1 (consumption = emissions).
- ✓ F-gas Parameters Open Cell Foams Tier 2: allows for input of necessary information: subdivisions, sub-applications and chemicals (i.e. gases) consumed. For each gas, additional parameters are available for data input; information on the year of introduction of each foam blowing agent, growth rate, product lifetime, EFs for the first-year loss and annual loss, the maximum potential end-of-life loss, the rate of loss at decommissioning, recovery and destruction rate and the rate of loss from any decommissioned bank, if applicable. These parameters are automatically transferred into the calculation of emissions in worksheet F-Gas Emissions- Open Cell Foams- Tier 2.
- ✓ F-gas Emissions Open Cell Foams Tier 2: contains for each subdivision/sub-application/F-gas information on the amount of F-gas produced domestically, imported and exported. The worksheet calculates the associated F-gas emissions for open cell foams for Tier 2.

User's work Flowchart

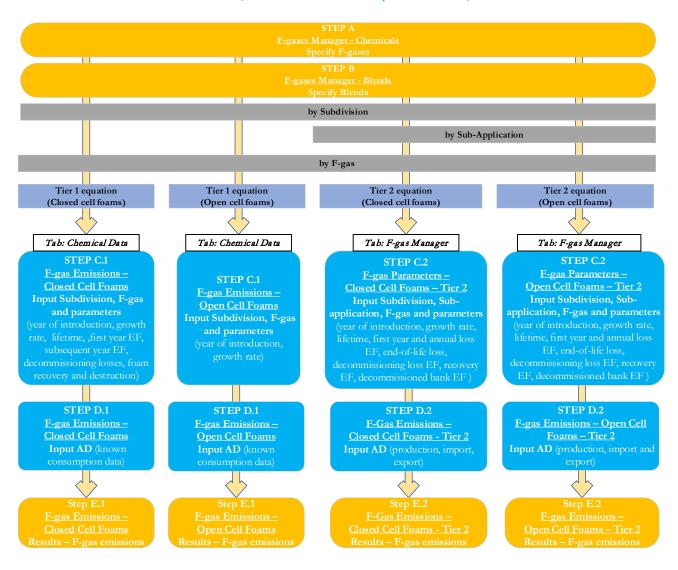
For Foam Blowing Agents, consistent with the key category analysis and the decision tree in Figure 7.4 of the 2006 *IPCC Guidelines*, GHG estimates are calculated using a single methodological tier or by applying a combination of tiers according to the availability of AD and of user-specific⁴⁰ EFs or direct measurements.

To ease the use of the *Software* as well as to avoid its misuse, the user follows the following flowchart for Foam Blowing Agents.

⁴⁰ Where the inventory of the source-category is stratified by subdivisions instead of a single nation-wide aggregate, subdivision-specific AD and EFs may be applied to prepare estimates at Tier 2. For instance, Region A and Region B are 2 subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either applying different region-specific EFs or applying to both regions the country-specific EF.

Foam Blowing Agents- flowchart

(Closed cell foams and Open cell Foams)



Thus, for the source-category:

Steps A and B, 1.1.2 F-gases Manager, users ensure that all F-gases/blends consumed (including imported for consumption) or produced and exported and related to open and closed cell foams have been checked off first in the country level F-gases Manager, and then in the IPCC category level F-gases Manager.

Data can be input as a single total (e.g. national level) or stratified, where AD are available, in subdivisions (e.g. states, regions, provinces; or single facilities or companies).

Then, for each subdivision:

Data may be entered separately for closed cell foams and open cells foams as a single application (i.e. all closed cell foams separate from all open cell foams), as in **Step C.1** or in distinct sub-applications (e.g. flexible foam is calculated separately from other open cell foams as in **Step C.2**). See the section below on EF/Parameter input to customize the *Software* to fit the users' needs to designate subdivisions, sub-applications and gases.

Then, for each subdivision/sub-application, if any:

When the Tier 1 Equation is applied:

Closed Cell Foams

Step C.1, in the worksheet **F-gas Emissions – Closed Cell Foams**, users collect and input in the Tab "Chemical Data" information for each subdivision and F-gas on year of introduction, growth rate, product lifetime, EF for the first-year loss, EF for annual loss, decommissioning loss and foam recovery and destruction.

Step D.1, in the worksheet **F-gas Emissions – Closed Cell Foams**, for each subdivision and each F-gas users collect and input information on known consumption of F-gas for closed cell foams in the current reporting year (the worksheet allows to enter such information for previous years as well).

Step E.1 in the worksheet **F-gas Emissions – Closed Cell Foams** the *Software* calculates the associated emissions for each F-gas, in tonnes.

Open Cell Foams

Step C.1, in the worksheet **F-gas Emissions – Open Cell Foams**, users collect and input in the Tab "Chemical Data" information on F-gases, subdivisions, year of introduction and growth rate.

Step D.1, in the worksheet **F-gas Emissions – Open Cell Foams**, for each subdivision and each F-gas users collect and input information on as known consumption of F-gas for open cell foams in the current reporting year (the worksheet allows to enter such information for previous years as well).

Step E.1, in the worksheet **F-gas Emissions – Open Cell Foams,** the *Software* calculates the associated emissions for each F-gas, in tonnes.

When the Tier 2 Equation is applied:

Closed Cell Foams:

Step C.2, in the worksheet **F-gas Parameters – Closed Cell Foams – Tier 2**, users collect and input in the *Software* information for each subdivision, sub-application, and F-gas on year of introduction, growth rate, product lifetime, EFs for the first-year loss, annual loss and for maximum potential end-of-life loss (all based on initial charge), EFs for decommissioning, recovery and destruction, and annual rate loss for the decommissioned bank.

Step D.2, in the worksheet **F-gas Emissions – Closed Cell Foams – Tier 2**, for each subdivision and each F-gas, users collect and input information on the amount of F-gas produced for closed cell foams domestically, imported and exported (the worksheet allows to enter such information for previous years as well).

Step E.2, in the worksheets **F-gas Emissions – Closed Cell Foams – Tier 2,** the *Software* calculates the associated emissions for each F-gas, in tonnes and Gg.

Open Cell Foams:

Step C.2, in the worksheet **F-gas Emissions – Open Cell Foams – Tier 2**, users collect and input in the *Software* information for each subdivision, sub-application, and F-gas on year of introduction, growth rate, product lifetime, EFs for the first-year loss, annual loss and for maximum potential end-of-life loss (all based on initial charge), EFs for decommissioning, recovery and destruction, and annual rate loss for the decommissioned bank.

Step D.2, in the worksheet **F-gas Emissions – Open Cell Foams – Tier 2**, for each subdivision and each F-gas users collect and input information on the amount of F-gas produced for open cell foams domestically, imported and exported in the current reporting year (the worksheet allows to enter such information for previous years as well).

Step E.2, in the worksheet **F-gas Emissions – Open Cell Foams – Tier 2,** the *Software* calculates the associated emissions for each F-gas, in tonnes and Gg.

Customizing the Software for Foam Blowing Agents: subdivision/sub-application/F-gases/blends

For both the Tier 1 and Tier 2 methods, users must first identify the applicable subdivision/sub-application/F - gases/blends applicable to the chosen method that will be used to estimate GHG emissions.

When the Tier 1 Equation is applied:

For the Tier 1 method, the user customizes the *Software* to identify the relevant subdivision and F-gases used. There are no sub-applications for the Tier 1 method for either open or closed cell foams.

Important: When the user first enters the *Software* for Tier 1 for closed and open cell foams, there is only a single subdivision (Unspecified) and no F-gases available for selection for data entry for Foam Blowing Agents. The user must identify subdivisions and enter the relevant F-gas(es)/blends to be able to enter data in the worksheets.

Example: Landing page when user first enters category 2.F.2 – Tier 1

Note that the example is for closed cell foams, but also applies to open cells foams

2006 IPCC Categories 🚽 👎	F-Gas Emissions F-Gas Parameters - Tier 2 F-Gas Emissions - Tier 2a F-Gas Emissions - Tier 2b						
2 E.5 - Other (please specify) - Product Uses as Substitutes for Ozon 2.5.1 - Refrigeration and Air Conditionin - 2.F.1 a - Refrigeration and Stationar - 2.F.1 b - Mobile Air Conditioning 2.F.2 - Foam Blowing Agents	Worksheet Sector: Industrial Processes and Product Use Category: Product Uses as Substitutes for Ozone Depleting Substances Subcategory: 2.F.1.a - Refrigeration and Stationary Air Conditioning Sheet: Emissions					199	90
2.F.3 - Fire Protection	Subdivision Unspecified V Gas V Chemical's Data	IY NA	GR (%) NA	d (years) NA	EF (%)	NA X (2)	NA
2F4-Aerosols 2F5-Solvents 2F6-Other Applications (please speci - Other Product Manufacture and Use 2.G.1 - Electrical Equipment - 2.G.1.a - Manufacture of Electrical - 2.G.1.b - Use of Electrical Equipme - 2.G.1.c - Disposal of Electrical Equipme	Total Chemical Agent Inputs (across the time series) (ΣD) II. Total Chemical Agent in equipment in use (last year of the time series) (Bankt)) III. Total Chemical Agent Emissions (across the time series) (ΣE) IV. Total Chemical Agent Recovered/Destroyed/Exported from equipment at end of life (across the time series) (ΣF)	NA NA NA		NA			
2.G.1.C - Disposal of Electrical Equil 2.G.2.SF 6 and PFCs from Other Prod -2.G.2.a Military Applications -2.G.2.b Accelerators -2.G.2.c - Other (please specify) 2.G.3. N2D from Product Uses -2.G.3.c Medical Applications -2.G.3.b Propellant for pressure an							

Entering subdivision(s)

For worksheets_F-gas Emissions-Closed Cell Foams and F-gas Emissions Open Cell Foams, entering of subdivisions takes place in Chemical's Data tab, following the same procedure as outlined for Tier 1 in the source category 2.F.1 Refrigeration and Air Conditioning above.

Identifying relevant F-gases /blends at the IPCC category level

For worksheets **F-gas Emissions-Closed Cell Foams** and **F-gas Emissions Open Cell Foams**, entering of Fgases /blends takes place in **Chemical's Data** tab following the same procedure as outlined for Tier 1 in the source category 2.F.1 Refrigeration and Air Conditioning <u>above</u>, with one exception and that is related to where the user identifies if a particular gas used in closed cell or open cell foams is confidential (this is applicable only for those wishing to use the *Software* for reporting to the UNFCCC ETF Inventory Reporting Tool). For Tier 1, the user may designate a gas used in closed cell foams or open cell foams as confidential in the main tab of Chemical's Data (illustrated in EF/parameters input below.).

When the Tier 2 equation is applied:

Similar to Tier 1, users must customize the *Software* to identify the relevant subdivision(s) and F-gas(es) used for open and closed cell foams following a Tier 2 method. In addition, the Tier 2 method requires information on sub-applications (e.g. specific type of open or closed cell foam produced).

Important: When the user first enters the *Software* for Tier 2 in worksheet **F-Gas Parameters- Closed Cell Foams-Tier 2** and **F-Gas Parameters- Open Cell Foams- Tier 2**, there is only a single subdivision (Unspecified) and no F-gases available for selection for data entry for Foam Blowing Agents. The user must identify subdivisions and enter the relevant F-gas(es)/blends to be able to enter data in the worksheet.

$\label{eq:Example:Landing page when user first enters category 2.F.2-Foams-Tier 2$

F-Gas Emiss	ions - Open Cell	Foams - Tier 2													
F-Gas Emissi Worksheet Sector: Category: Subcategor Sheet: Data	Industrial F Product Us y: 2.F.2 - Foa	rocesses and Pr es as Substitute m Blowing Ageni	roduct Use s for Ozone Dep	leting Substance		meters - Closed Ce	II Foams - Tier 2	F-Gas Paramet	ters - Open Cell	Foams - Tier 2	F-Gas Emissions -	Closed Cell Foan	ns - Tier 2		2016
Subdivision	n		Sub-ap	plication			~ G	as		~					
Intro Year	r (Growth Rate (%)	Product lifeum	ie (a) [yr]	ЕНТУІ [4	J E	Fal [%]	MPL [%]		EFd [%]	EFrd [%]	EFa	d [%]	
I. Total Che	emical Agent Inpu	ts (across the tim	ne series) (∑E)					Bank(t) + D	DB(t) + ΣP + ΣJ						
II. Total Ch	emical Agent in e	quipment in use	(last year of the t	time series) (Bank	(t))										
III. Total Ch	nemical Agent in e	equipment dispos	sed (last year of t	he time series) (D	B(t))										
IV. Total Ch	nemical Agent Em	issions (across t	he time series) (S	<u>5</u> P)											
V. Total Ch	emical Agent Re	covered/Destroy	ved/Exported from	m equipment at e	nd-of-life (across	the time series) (∑J)									
							Bo	x 7.2							
Year	Amount in Foams produced domestically (tonnes)	Amount in Foams imported (tonnes)	Amount in Foams exported (tonnes)	Annual domestic consumption (tonnes)	First year loss (tonnes)	Annual loss (tonnes)	Agent at Decommissionir 9 (tonnes)	Amount Recovered and Destroyed at decommissio ning	Emitted at decommissio ning (tonnes)	Decommissione d bank (at the end of the year) (tonnes)	Bank (at the end of the year) (tonnes)	Annual loss from decommission ed bank (tonnes)	Total emissions in year t (tonnes)	Total emissions in year t (Gg)	
t 🛆	Bi			E = Bi + Ci - Di	G = Bi * (EFfyl/100)	H = ∑(IF(E(t-(d- 1),t) * (EFal/100) <= CAremaining (t); E(t-(d-1),t) * (EFal/100); CAremaining(t)))	I = IF(E(t-d) * (MPL/100) = CAremaining(t- d); E(t-d) * (MPL/100); CAremaining(t- d))	J = * (EFrd/100)	K = (I-J) * (EFd/100)	DB = I - J - K - N + DB(t-1)	Bank = Bank(t-1) + E - G - H - I	N = DB(t-1) * (EFad/100)	P=G+H+K +N		

<u>Note that</u> the example is for closed cell foams, but also applies to open cells foams

Entering subdivision(s) and sub-application(s)

For worksheets **F-Gas Parameters- Closed Cell Foams-Tier 2** and **F-Gas Parameters- Open Cell Foams-Tier 2** entering of subdivisions takes place following the same procedure as outlined for Tier 2 in the source category 2.F.1 Refrigeration and Air Conditioning <u>above</u>, but selecting the relevant sub-applications for foams.

Example: Entering subdivision/sub-application for closed cell foams- Tier 2

	s - Closed Cell Foams	F-Gas Emissions - Open Cell Foams	F-Gas Parameters - Closed Cell Foams - Tier 2	F-Gas Parameters - Open Cell Foams - Tier 2	F-Gas Emissions - Closed Cell Foams - Tier 2	F-Gas Emissions - Open Cell Foams - Tier 2	
Worksheet Sector: Category: Subcategory: Sheet:	2.F.2 - Foam Blowing	stitutes for Ozone Depleting Substances					1990
Data							
F-Gases Mar	nager			Subdivision			
- Nationa	4						
				Sub-application			
	uded Polyethylene (PE)						M 2 X
Poly Poly One Phen Phen Extru	urethane - Cont. Lamin urethane - Spray Foam urethane - Pipe-in-Pipe Component Foam (OC tolic - Discontinuous B tolic - Discontinuous L uded Polystyrene (XPS) uded Polystyrene (PB)	F) lock aminate					

Identifying relevant F-gases/blends at the IPCC category level

For worksheets **F-Gas Parameters- Closed Cell Foams-Tier 2** and **F-Gas Parameters- Open Cell Foams-Tier 2** entering of relevant F-gases/blends takes place, following the same procedure as outlined for Tier 2 in the source category 2.F.1 Refrigeration and Air Conditioning <u>above</u>.

Example: Entering F-gases at category level for open cell foams- Tier 2

F-Gas Emissions - Closed Cell Foar Worksheet	ms F-Gas Emissions - Open Cell Foams	F-Gas Parameters - Closed Cell Foams - Tier 2	F-Gas Parameters - Open Cell Foams - Tier 2	F-Gas Emissions - Closed Cell Foams - Tier 2	F-Gas Emissions - Open Cell Foams - Tie	er 2
Sector: Industrial Proces Category: Product Uses as Subcategory: 2.F.2 - Foam Blo	ses and Product Use Substitutes for Ozone Depleting Substances wing Agents 5 - Open Cell Foams - Tier 2					
F-Gases Manager	F-Gases Manager - 2.F.2				- 0 ×	
		Chemicals and Bler	nds - applicability at IPCC Category	level		
			Chemical group		V	
	B HFCs B FFCs C SF6 B NF3 C Ethers and Halogenated Ethers B Other GHGs B Ellends					
			Chemic	Blends at country level Blends at country level	el Close	

EF/parameters input

The following sections in Chapter 7, Volume 3 of the 2006 IPCC Guidelines contain information on the choice of EF/parameters:

- ✓ <u>Table 7.5</u> provides default EF for Tier 1(closed cell foams).
- ✓ Section 7.4.2 describes that for Tier 1 (open cell foams) the first -year loss is typically 100%.
- ✓ <u>Section 7.4.2.2</u> (Tables 7.6 and 7.7) contains information on the choice of EFs/parameters for Tier 2.

When the Tier 1 Equation is applied:

Closed Cell Foams:

- 1. In worksheet **F-Gas Emissions- Closed Cell Foams**, users must click on the tab **Chemical's Data** to open a pop-up window and to enter the parameters and EFs needed for estimation of each F-gas/blend consumed in that subdivision.
- 2. **Gas:** user selects the relevant F-gas/blend from the drop-down menu (refer to previous section on customizing the *Software* if an additional F-gas or blend needs to be added to the drop-down menu).
- 3. <u>Window | Year of Introduction |</u>: year of introduction of the agent in the country for use in foam blowing (closed cells) (e.g., 1990).
- 4. <u>Window | Growth Rate in consumption |</u>: growth rate in consumption, usually assumed linear across the period of assessment, in %.
- 5. <u>Window | First year loss Emission Factor |:</u> EF for the first-year loss in percent of the original charge (IPCC default =10% of the original charge/year.

Note that: according to Table 7.5, the value could drop to 5% if significant recycling takes place during manufacturing.

- 6. <u>Window | Annual loss Emission Factor |:</u> EF for annual loss in percent of the original charge (IPCC default = 4.5% of the original charge/year).
- 7. <u>Window | Product lifetime |: product lifetime, in years (IPCC default =20 years).</u>
- 8. <u>Window |Agent recovery and destruction|:</u> The percent of blowing agent recovered and destroyed from foams at the end of life. In the absence of country specific information this is assumed to be zero.
- 9. Window | Confidentiality |: If AD and/or emissions for a particular F-gas consumed in closed cell foams is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. <u>Note that</u>: if checked, "C" will be reported for AD and "E" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate (for further information, see Annex I).

Example: Entering EFs, parameters information and confidentiality for closed cell foams- Tier 1

F-Gas Emissions - Open Cell Foams - Tier 2 F-Gas Emissions - Closed Cell Foams F-Gas Emissions - Open	Cell Foams F-Gas Parameters - Closed Cell Foar	ms - Tier 2 F-Gas Parameters - (Dpen Cell Foams - Tier 2 F-Gas	Emissions - Closed Cell Foams - Tier 2	
Worksheet Industrial Processes and Product Use Category: Product Uses as Substitutes for Ozone Depleting Subcategory: 2.F.2Foam Blowing Agents Sheet: Emissions - Closed Cell Foams	Substances				1990
Subdivision Unspecified V Gas	✓ Chemical's Data	IY GR (%)	EFfyl (%) EFal (%	a) d (yr) RD (%)	
I. Total Chemical Agent Inputs (across the time series) ($\sum A)$		NA Bank(t) + ΣH + ΣF	NA		
II. Total Chemical Agent in equipment in use (last year of the time ser	es) (Bank(t))		×		
III. Total Chemical Agent Emissions (across the time series) (Σ H) IV. Total Chemical Agent Recovered/Destroyed/Exported from equip	ment at end-of-life (ac	Chemical`s Data			
	Country/Territory	World			
	Category	2.F.2 - Foam Blowing Agents			
	Subdivision	Unspecified	~ +		
	Gas	HFC-23 (CHF3)	~ +		
	Data Year of Introduction (IY)	1990 ≑			
	Growth Rate in consumpt	tion (GR)	_3.00% 🗢		
	First year loss Emission Fa	actor (EFfyl)	10.00% 🗢		
	Annual loss Emisison Fac	tor (EFal)	4.50% ≑		
	Product lifetime (years) (d		_20 🗢		
	Agent recovery and destr	ruction (RD)	0.00% 🖨		
	UNFCCC CRT Confidenti	iality			
			Save Close		

10. Then, users need to **Save and Close** the pop-up window **Chemical's Data** to return to the worksheet and enter agent consumption for closed cell foams. The user can see information entered in **Chemical's Data** tab in the main calculation window. In the image below, the gas consumed in the subdivision appears (i.e. HFC-23), and the parameters are visible. Input of AD (in red-orange cells) is explained in the next section.

Example: Grid ready for entry of AD for closed cell foams – Tier 1

rksheet ctor: tegory:	Industrial Proces	ses and Prod			rameters - Closed Cell Foa						19
bcategory: eet: ta		wing Agents		g Substances							
	Unspecified	~ 1	Gas HFC-23 (C	HF3) 🗸	Chemical's Data	IY 1990 GF	(%) 3 EFfyl (%)	.) 10 EFal (%) 4.5 d (yr	•) 20 RD (%) 0	
Total Chemic	al Agent Inputs (acro: cal Agent in equipmer cal Agent Emissions	nt in use (last	year of the time s	eries) (Bank(t))		0	nk(t) + ΣΗ + ΣF				
				uipment at end-of-life (acros	s the time series) (ΣF)	0					
				uipment at end-of-life (acros	s the time series) (∑F)	0 0 Equation 7.7					
		d/Destroyed, Emissior		uipment at end-of-life (across Annual loss (tonnes)	the time series) (∑F) Bank (at the end of th year) (tonnes)		ing Agent recovery and destruction (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent at Decommissioning (tonnes)	
Total Chemi	cal Agent Recovered Consumption (tonnes)	d/Destroyed/	/Exported from equ	Annual loss	Bank (at the end of th year)	ne Decommission Ioss (tonnes)	destruction	Total Emissions		Decommissioning	
Year t ∆⊽ 1990	Cal Agent Recovered	d/Destroyed/	/Exported from equ ons in first year onnes) • (EFfyl/100) 0	Annual loss (tonnes) C = ∑(B(t-(d-1),t)) * (EFal/100)	Bank (at the end of th year) (tonnes) Bank(t) = A - B - C - I Bank(t-1)	ne Decommission Ioss (tonnes)	destruction (tonnes) F = I * RD/100	H = B + C + E	(Gg)	Decommissioning (tonnes) I = [A(t-d) - A(t-d) * EFkyV100 - A(t-d) * EFaV100 * d]	
. Total Chemi Year t ∆⊽	Cal Agent Recovered	d/Destroyed/	/Exported from equins in first year onnes)	Annual loss (tonnes) C = Σ(B(t-(d-1),t)) * (EFal/100)	Bank (at the end of th year) (tonnes) Bank(t) = A - B - C - I Bank(t-1)	ne Decommission Ioss (tonnes)	destruction (tonnes)	H = B + C + E	(Gg) EE = H / 1000 0 0	Decommissioning (tonnes) i = [A(t-d) - A(t-d) * EFby/100 - A(t-d) * EFal/100 * d]	

Open Cell Foams:

- 1. In worksheet **F-Gas Emissions- Open Cell Foams**, users must click on the tab **Chemical's Data** to open a pop-up window and to enter the parameters and EFs needed for estimation of each F-gas/blend consumed in that subdivision.
- 2. **Gas:** user selects the relevant F-gas/blend from the drop-down menu (refer to previous section on customizing the *Software* if an additional F-gas or blend needs to be added to the drop-down menu).
- 3. <u>Window | Year of Introduction |</u>: year of introduction of the agent in the country for use in foam blowing (open cells) (e.g., 1990).

- 4. <u>Window | Growth Rate in consumption |</u>: growth rate in consumption, usually assumed linear across the period of assessment, in %.
- 5. <u>Window | Confidentiality |:</u> If AD and/or emissions for a particular F-gas consumed in open cell foams is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. <u>Note that:</u> if checked, "C" will be reported for AD and "E" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate (for further information, see Annex I).

Example: Entering EFs, parameters information and confidentiality for open cell foams- Tier 1

as Emissions - Closed Cell Foams F-Ga	s Emissions - Open Cell Foams	F-Gas Parameters - Closed Cell	Foams - Tier 2 F-Gas Parameters - Open Ce	II Foams - Tier 2 F-Gas	Emissions - Closed Cell Foams - T	ier 2
ksheet ctor: Industrial Processes and Pro tegory: Product Uses as Substitutes bcategory: 2.F.2 - Foam Blowing Agents cet: HFC-23 (CHF3) Emissions - 0 ta	for Ozone Depleting Substances					1
	Gas HFC-23 (CHF3)	Chemical's Data	IY 1990 GR (%) 0			
				×		
		Cor	Chemical`s Data			
		Country/Territory	World			
t 🛆	7	Category	2.F.2 - Foam Blowing Agents			
1990 1991					3	a 7
1991		Subdivision	Unspecified	✓ [+]		
1993		Gas	HFC-23 (CHF3)	× +		
1994	2				1	
1995	1	Data	1990 😫		3	
1996		Year of Introduction (IY)	1990 -			
1997		The second	3 (V/X) .			
1998		Growth Rate in consump	otion (GR)	_0.00% 😫	2	
1999						
2000						
2001						
2002						
2003						
2004						
2005						
2006		UNFCCC CRT Confiden	tiality	ר I	3	
2007					3	
2008 2009		-				
2009 2010			C			
2010			Save	Close		

6. Then, users need to **Save and Close** the pop-up window **Chemical's Data** to return to the worksheet and enter agent consumption for open cell foams. The user can see information entered in **Chemical's Data** tab in the main calculation window. In the image below, the gas consumed in the subdivision appears (i.e. HFC-23), and the parameters are visible. Input of AD (in red-orange cells) is explained in the next section.

Example: Grid ready for entry of AD for open cell foams – Tier 1

	ons - Closed Cell Foams F-Ga	Emissions - Open Cell Foams F-Gas Paramet	ters - Closed Cell Foams - Tier 2	2 F-Gas Parameters - Open Cell Foams	- Tier 2 F-Gas Emissions - Close	d Cell Foams - Ti	er 2	
/orksheet Sector: Subcategory: Subcategory: Sheet: Data		or Ozone Depleting Substances						199
Subdivision	Unspecified V	Gas HFC-23 (CHF3)	hemical's Data IY 1990	GR (%) 3				
			Equ					
		Consumption (tonnes)		Total Emissic (tonnes)	ins			
		7 В						×
		· · · ·						
▶ 1990	t ∆			C = B		3		2
1991	t ∆			C = B		3		2
1991 1992	t A			C = 8		2	2	2
1991	t A			C = B		2		2

When the Tier 2 Equation is applied

<u>Closed Cell Foams</u> <u>Open Cell Foams</u>

Entry of EFs and parameters in worksheets **F-Gas Parameters- Closed Cell Foams-Tier 2** and **F-Gas Parameters- Open Cell Foams- Tier 2** is identical. For each subdivision/ sub-application in the respective worksheet, the user enters the following information:

1. <u>Column |Chemical</u>]: user selects the relevant F-gas/blend from the drop-down menu (refer to previous section on customizing the *Software* if an additional F-gas or blend needs to be added to the drop-down menu).

<u>Note that for Closed Cell Foams:</u> for gases for which there are default parameters in <u>Tables 7.6 and 7.7</u>, values for product lifetime, first year losses and annual loss EF will automatically populate (they may be overwritten with country-specific values). For other gases, the user must impact these factors directly. Users should be careful if they change the type of sub-application type after entering the chemical information (e.g. change from integral skin to continuous panel), as the parameter information will not automatically update. The user should delete the row for that chemical and re-enter it, so that the updated parameters are populated.

- 2. <u>Column | t (start) |</u>: year of introduction of F-gas/blend for closed cell foams.
- 3. <u>Window |G|</u>: growth rate in consumption, usually assumed linear across the period of assessment, in %.
- 4. <u>Column |d|</u>: product lifetime, years. <u>Note that for Closed Cell Foams</u>: this column is automatically populated for HFC-134a, 152a, 245fa, 365mfc, and 227ea; the user may manually overwrite the default value. <u>Note that for Open Cell Foams</u>: a product lifetime of 1 year is automatically populated because the default assumption is that all emissions occur in the
- year of manufacturing.
 5. <u>Column | EFfyl|</u>: EF for first year loss (% of initial charge). <u>Note that for Closed Cell Foams</u>: this column is automatically populated for HFC-134a, 152a, 245fa, 365mfc, and 227ea; the user may manually overwrite the default value. <u>Note that for Open Cell Foams</u>: an EFfyl of 100 is automatically populated because the default assumption is that all emissions occur in the year of manufacturing.
- 6. <u>Column | MPL |:</u> EF for maximum potential end-of-life loss (% of initial charge). <u>Note that</u>: this column is automatically populated for HFC-134a, 152a, 245fa, 365mfc, and 227ea for Closed Cell Foams; the user may manually overwrite the default values. For both Closed and Open Cell Foams, the Software tracks the chemical remaining over time. The MPL is only used in calculations when it is consistent with the factors selected for first year and annual losses. In cases where the chemical agent remaining is less than the MPL, the value for the chemical agent, and not the MPL, will be used.
- 7. <u>Column |EFal</u>]: EF for annual loss (% of initial charge). <u>Note that for Closed Cell Foams</u>: this column is automatically populated for HFC-134a, 152a, 245fa, 365mfc, and 227ea; the user may manually overwrite the default value. <u>Note that for Open Cell Foams</u>: an EFal of 0 is automatically populated because the default assumption is that all emissions occur in the year of manufacturing and there are no annual losses.
- 8. <u>Column | EFd|:</u> EF for decommissioning losses (% of decommissioned amount less the amount recovered/destroyed).

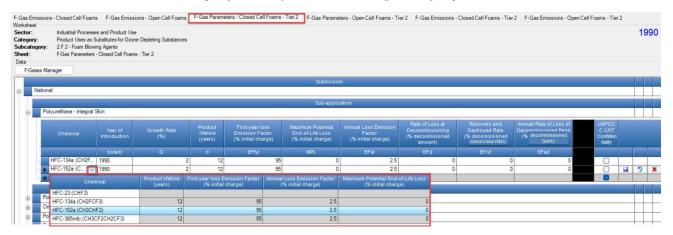
<u>Note that:</u> decommissioning losses are those at the end of service life that occur when the product/equipment is scrapped. This factor is applied to the total agent at decommissioning, less any agent that has been recovered/destroyed.

<u>Note that</u>: inventory compilers should be careful to research decommissioning practices and any recovery and destruction practices within their country closely. If it is not possible to collect data for potential losses upon decommissioning, it should be assumed that all chemical not emitted in manufacturing is emitted over the lifetime of the foam. At the same time, methods should typically assume complete release of blowing agent at decommissioning <u>only where there is</u> <u>definite evidence</u> to support this and should normally attribute emissions to subsequent years based on a more appropriate release function.

- 9. <u>Column |EFrd|</u>: EF for recovery and destruction rate (% of decommissioned amount). <u>Note that</u>: If it is not possible to collect data on recovery and destruction, it should be assumed that 0% is recovered and destroyed. This practice is likely more applicable to closed cell foams than open cell foams.
- 10. Column | EFad |: EF for losses from the decommissioned bank (% of the decommissioned bank).
- 11. <u>Column | Confidentiality |:</u> If AD and/or emissions for a particular F-gas consumed in closed or open cell foams is considered confidential, the user may check the box UNFCCC CRT Confidentiality for that gas. <u>Note that:</u> if checked, "C" will be reported for AD and "E" for emissions in the JSON file generated for the CRT; and all emissions will be reported in category 2.H in Table2(II).B-Hs2 of the CRT. All confidential gases will be reported together as unspecified mix of HFCs and PFCs, SF₆ or NF₃, as appropriate (for further information, see Annex I).

Example: Entering EFs, parameters information and confidentiality for closed cell foams- Tier 2

Note that example is for closed cell foams, but column headings the same for Open Cell Foams



12. The user can see information entered in F-Gas Parameters – Closed Cell Foams- Tier 2 and F-Gas Parameters – Open Cell Foams- Tier 1 tabs in the main calculation window for closed and open cell foams, respectively. In the image below, the gas consumed in the subdivision /sub-application appears (i.e. HFC-134a), and the parameters are visible. Input of AD for closed and open cell foams is explained in the next section.

Example: Grid ready for entry of AD for closed cell foams - Tier 2

orksheet		Il Foams F-Ga	s Emissions - C	pen Cell Foams	-Gas Parameter	s - Closed Cell Foarr	is - Tier 2 F-Gas Pa	arameters - Oper	Cell Foams - Tie	er 2 F-Gas Emission	s - Closed Cell Foams ·	Tier 2 F-Gas	Emissions - Open Cell	Foams - Tier 2	
ector: tegory: bcategory ieet: ita	Product U : 2.F.2 - Foa	Processes and Pro ses as Substitutes am Blowing Agents ssions - Closed Cel	for Ozone Deple	ting Substances											199
ubdivision	National		V Sub-app	lication Polyureth	ane - Integral Skir	1	✓ Gas HFC-	134a (CH2FCF3)	~						
ntro Year	1990	Growth Rate (%	.) 2 F	Product lifetime (d) [yr] 12	EFfyl [%] 95	EFal [%]	2.5 MPI	[%] 0	EFd [%] 0	EFrd [%] 0	EFad	[2] 0		
Total Cher	nical Agent Inpu	its (across the time	series) (SE)				0 Bank	k(t) + DB(t) + ΣP +	ΣJ	0					
				ne series) (Bank(t))			0								
						_									
	-			e time series) (DB(t))		_	0								
Total Che	emical Agent Er	nissions (across the	e time series) (∑l	P)			0								
Total Che	mical Agent Re	covered/Destroye	d/Exported from	equipment at end-of	life (across the tin	ne series) (∑J)	0								
								Box 7.2							
	Amount in Foams produced domestically (tonnes)	Amount in Foams imported (tonnes)	Amount in Foams exported (tonnes)	Annual domestic consumption (tonnes)	First year loss (tonnes)	Annual loss (tonnes)	Agent at Decommissioning (tonnes)	Amount Recovered	Emitted at decommission ing (tonnes)	Decommissioned bank (at the end of the year) (tonnes)	Bank (at the end of the year) (tonnes)	Annual loss from decommission ed bank (tonnes)	Total emissions in year t (tonnes)	Total emissions in year t (Gg)	
Year t A	Foams produced domestically	Foams imported	Foams exported	consumption			Agent at Decommissioning	Amount Recovered and Destroyed at decommission ing	decommission ing	bank (at the end of the year)	the year)	from decommission ed bank		emissions in year t	
	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	(tonnes) G = Bi *	(tonnes) H = Σ(IF(E(t-(d- 1),t) * (EFal/100) <= CAremaining (t); E(t-(d-1),t) * (EFal/100);	Agent at Decommissioning (tonnes) i = IF(E(t-d) * (MPL/100) = CAremaining(t-d), E (t-d) * (MPL/100);	Amount Recovered and Destroyed at decommission ing J = 1 *	decommission ing (tonnes) K = (I-J) *	bank (at the end of the year) (tonnes) DB = I - J - K - N +	the year) (tonnes) Bank = Bank(t-1) +	from decommission ed bank (tonnes) N = DB(t-1) *	year t (tonnes)	emissions in year t (Gg) Q = P / 1000	3 8 7
t 🛆	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	(tonnes) G = Bi *	(tonnes) H = Σ(IF(E(t-(d- 1),t) * (EFal/100) <= CAremaining (t); E(t-(d-1),t) * (EFal/100);	Agent at Decommissioning (tonnes) i = IF(E(t-d) * (MPL/100) = CAremaining(t-d), E (t-d) * (MPL/100);	Amount Recovered and Destroyed at decommission ing J = 1 *	decommission ing (tonnes) K = (I-J) *	bank (at the end of the year) (tonnes) DB = I - J - K - N +	the year) (tonnes) Bank = Bank(t-1) +	from decommission ed bank (tonnes) N = DB(t-1) *	year t (tonnes)	emissions in year t (Gg) Q = P / 1000 0	3 4 7
t ∆ 1990	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	(tonnes) G = Bi *	(tonnes) H = Σ(IF(E(t-(d- 1),t) * (EFal/100) <= CAremaining (t); E(t-(d-1),t) * (EFal/100);	Ageni at Decommissioning (tonnes) i = IF(E(t-d) * (MPU100) =) CAremaining(t-d)) CAremaining(t-d)) 0 0	Amount Recovered and Destroyed at decommission ing J = 1 *	decommission ing (tonnes) K = (I-J) * (EFd/100) 0 0	bank (at the end of the year) (tonnes) DB = I - J - K - N + DB(I-1) 0 0	the year) (tonnes) Bank = Bank(t-1) +	from decommission ed bank (tonnes) N = DB(t-1) *	year t (tonnes)	emissions in year t (Gg) Q = P / 1000 0 0	3

Example: Grid ready for entry of AD for open cell foams – Tier 2

	ns - Closed Ce	I Foams F-Ga	as Emissions - C	Ipen Cell Foams	F-Gas Parameter	ers - Closed Cell Foam	s - Tier 2 F-Gas Para	ameters - Open C	Cell Foams - Tier	2 F-Gas Emissions	- Closed Cell Foams -	Tier 2 F-Gas E	Emissions - Open Cell	Foams - Tier 2	
ksheet ctor: egory: bcategory: eet: ta	Product Us 2.F.2 - Foa	rocesses and Pro ses as Substitutes m Blowing Agent ssions - Open Cell	s for Ozone Deple s	ting Substances											199
bdivision	National		V Sub-app	blication Polyuret	thane - Flexible F	oam	 Gas HFC-36 	5mfc (CH3CF2CH	12CF3 ~						
ntro Year	1990	Growth Rate (2) 0	Product lifetime	e (d) [yr] 1	Effyl [%] 8	0 EFal [%]	5 M P	L[%] 0	EFd [%] 1	EFrd [%] 2	EFac	d [%] 3		
				e time series) (DB(t)			U								
	nical Agent Re		e time series) (∑ ed/Exported from	P) equipment at end-	of-life (across the	time series) (∑J)	0 0 Bo	ox 7.2 Amount	Provide statements	6	6		6		
Total Chen	-				First year loss (tonnes)	time series) (∑J) Annual loss (tonnes)	0 0 Agent at Decommissioning (tonnes)		Emitted at decommissio ning (tonnes)	Decommissioned bank (at the end of the year) (tonnes)	Bank (at the end of the year) (tonnes)	Annual loss from decommission ed bank (tonnes)	Total emissions in year f (tonnes)	Total emissions in year t (Gg)	
Year	Amount in Foams produced domestically	Amount in Foams imported	ed/Exported from Amount in Foams exported	Annual domestic consumption	First year loss	Annual loss	Agent at Decommissioning	Amount Recovered and Destroyed at decommissio ning	decommissio ning	bank (at the end of the year)	the year)	from decommission ed bank	year t	emissions in year t (Gg) Q = P / 1000	
Year t A	Amount in Foams produced domestically (tonnes)	Amount in Foams imported (tonnes)	ed/Exported from Amount in Foams exported (tonnes)	Annual domestic consumption (tonnes)	First year loss (tonnes) G = Bi *	Annual loss (tonnes) H = ∑(IF(E(-I-(1-1),1) * (EFal/100) <= CAremaining(1); E(1- (d-1)),1) * (EFal/100);	Agent at Decommissioning (tonnes) i = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(-d) * (MPL/100); CAremaining(t-d))	Amount Recovered and Destroyed at decommissio ning J = 1 * (EFrd/100)	decommissio ning (tonnes) K = (I-J) * (EFd/100)	bank (at the end of the year) (tonnes) DB = I - J - K - N + DB(t-1)	the year) (tonnes) Bank = Bank(t-1) + E - G - H - I 0	from decommission ed bank (tonnes) N = DB(t-1) *	year t (tonnes)	emissions in year t (Gg) Q = P / 1000	7 11 1
Year	Amount in Foams produced domestically (tonnes)	Amount in Foams imported (tonnes)	ed/Exported from Amount in Foams exported (tonnes)	Annual domestic consumption (tonnes)	First year loss (tonnes) G = Bi *	Annual loss (tonnes) H = ∑(IF(E(-I-(1-1),1) * (EFal/100) <= CAremaining(1); E(1- (d-1)),1) * (EFal/100);	Agent at Decommissioning (tonnes) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(t -d) * (MPL/100);	Amount Recovered and Destroyed at decommissio ning J = I * (EFrd/100)	decommissio ning (tonnes) K = (I-J) * (EFd/100)	bank (at the end of the year) (tonnes) DB = I - J - K - N +	the year) (tonnes) Bank = Bank(t-1) + E - G - H - I 0 0	from decommission ed bank (tonnes) N = DB(t-1) *	year t (tonnes) P = G + H + K + N 0 0	emissions in year t (Gg) Q = P / 1000	3

Activity data input

Sections <u>7.4.2.3</u> in Chapter 7 Volume 3 of the *2006 IPCC Guidelines* contains information on the choice of AD for 2.F.2 Foam Blowing Agents source category.

Important to highlight for data entry is the need to avoid double counting of F-gas consumption. The possibility of double counting can be mitigated in two ways:

- 1. Ensure that consumption of a unique quantity of F-gases is not counted simultaneously in multiple applications, both within Foam Blowing Agents (e.g. the same quantity of HFC-134a should not be added into worksheets for both open and closed cell foams) or across sub-categories (e.g. the same quantity should not be included in both Refrigeration and Air Conditioning (2.F.1) and Foams (2.F.2)). AD entered in each worksheet should be unique to that subdivision/application/sub-application.
- 2. Do not count for both consumption of an F-gas species as well as the consumption of a blend that is then produced from that same quantify of F-gases. Possible double counting can be mitigated where data are entered all as individual F-gases, or all as blends. Where both are available, care should be taken not to include the same quantity of F-gases twice in the AD.

In addition, the *Software* contains a check for categories 2.F.1, 2.F.2, 2.F.3 and 2.F. 6 (contained applications) to ensure that the data input is consistent with the fundamental principle of mass conservation of the gases. This QA/QC check appears just below the EFs/input parameters and will be discussed below after describing input of AD.

The *Software* will be updated in the future to include a validation check to indicate if the total consumption of F gases across all source categories and applications/sub-applications is equal to or less than the total supply of that F-gas, calculated as *Production of the gas* + *imports (bulk and equipment)*+ *amount recycled* – *exports (bulk and in equipment)*– F-gases used to produce blends.

Input of AD requires the following steps for different Tiers for Foam Blowing Agents

When the Tier 1 Equation is applied:

Closed Cell Foams:

As noted in the section **EF/parameters** above, parameters from the tab **Chemical's Data** will be visible in the worksheet **F-Gas Emissions- Closed Cell Foams**. Next, users need to enter the AD in the red-orange cells, by subdivision/gas, and for each year, as follows:

1. <u>Column |A|</u>: The user should enter all known consumption for each subdivision/gas for closed cell foams in this column, in tonnes. Only those years for which data are known should be entered. Data entered, along

with the growth rate entered in the **Chemical's Data** tab, will be used to interpolate a full, consistent time series of AD. Do not add "0" for years unknown as the 0 will be read as zero consumption, impacting the interpolation of the time series.

<u>Note that</u>, unlike many categories in IPPU, AD entry worksheets for source category 2.F.2 (along with 2.F.1 and 2.F.3) are for the entire time series in the open worksheet. AD for all years can be accessed when opening any year.

Once known AD are input, the *Software* makes several calculations based on the factors added in the Chemical's Data tab:

- 2. <u>Column |B|</u>: calculates emissions in the first year based on, in tonnes. <u>Note that</u> this cell is calculated based on the total consumption in that year and the first-year loss EF entered in the tab **Chemical's Data** tab.
- 3. <u>Column |C|</u>: calculates annual emissions from the bank, in tonnes. <u>Note that</u> this cell is calculated based on the development of the bank over the lifetime of currently used closed cell foams, and the annual loss EF entered in the tab **Chemical's Data** tab.
- 4. <u>Column | Bank₍₁₎|</u>: calculates the bank for the current year, in tonnes. <u>Note that</u> this cell is calculated as the bank from the previous year plus consumption for the current year, minus first- year losses, minus annual emissions from the bank, minus amount of agent in decommissioned equipment (<u>Column | I|</u>).
- <u>Column |E|</u>: calculates the decommissioning losses, in tonnes.
 Based on the amount of agent at decommissioning in <u>(Column |I|</u>) minus the amount in <u>Column |F|</u> that is determined to be recovered/destroyed.
- 6. <u>Column |F|</u>: calculates emissions prevented by recovery and destruction of foams and their blowing agent, in tonnes.

<u>Note that</u> this cell is calculated as the total agent at decommissioning <u>(Column |1|</u>) multiplied by the foam recovery and destruction factor enter in the **Chemical's Data** tab.

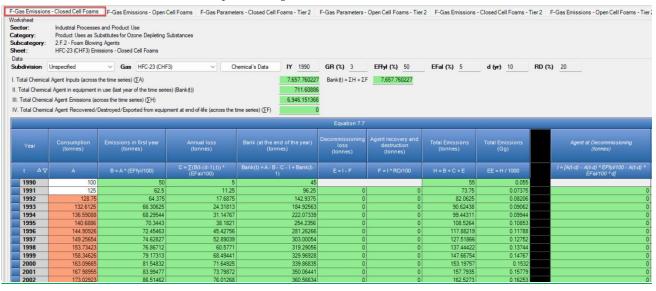
7. <u>Column |H|</u>: calculates total emissions, in tonnes. <u>Note that</u> this cell is calculated as the sum of emissions in first year, plus emissions from the bank, plus emissions from decommissioning.

<u>Column |I|</u>: The amount of agent at decommissioning is shown separately and in italics, as this amount is

calculated for the purposes of reporting to the UNFCCC ETF reporting tool. This is the total amount of agent that is to be decommissioned in a given year (based on the lifetime of the foam). <u>Note that this cell is calculated based on the amount consumed in year (t minus the lifetime), minus the first-year losses during manufacturing in that year, minus the sum of the annual losses across the lifetime of the foam and subtracting any first year and annual losses.</u>

Green cells are estimated by the *Software* and cannot be modified. Cell calculations are provided below the column header.

Example: AD input - closed cell foams-Tier 1



Note that:

1. White cells show where data were entered manually.

- 2. In the red-orange cells the *Software* interpolates or back-calculates the input. The user should use caution in modifying any red-orange cells, unless data are known. If data are manually entered in an interim year, the *Software* will recalculate the trend between the two known data entry points. **DO NOT ADD ZERO** unless "0" is the known value, as the *Software* will interpolate values assuming the zero. To delete an incorrect entry, instead of using zero, simply delete/clear the value from the cell.
- 3. Absent historic consumption data, the *Software* back-calculates consumption based on the growth rate.
- 4. The Software calculates emissions from first and annual losses based on EFs from the initial charge.

Ensuring mass conservation of gases

A QA/QC check has been introduced into the worksheets for categories 2.F.1, 2.F.2, 2.F.3 and 2.F.6 (contained applications only) to ensure that the data, EFs and parameters entered by the users ensure conservation of mass of gases over time.

To ensure mass conservation, the Software tracks and visually presents the inputs and outputs over time as follows:

- I. Total chemical agent inputs, across time $(\sum A)$
- II. Total chemical agent in equipment in use (Bank(t))
- III. Total chemical agent emissions, across time (Σ H)
- IV. Total chemical agent recovered/destroyed (ΣF)

For Tier 1, mass conservation has been ensured if:

$$\sum A = Bank(t) + \sum H + \sum F$$

If mass has been conserved, all cells are green. An orange colour signals that the amount of chemical input is smaller than the amount of chemical stored in the system and the subsequent emissions, while a red colour means that the chemical input is greater than the amount stored in the system and the subsequent emissions. If the check results in orange or red shading you should review data input to ensure that all parameters are coherent.

Some common scenarios leading to orange cells (chemical stored in the system and subsequent emissions are greater than inputs) include:

- First year losses plus annual losses in the first year cannot be greater than 100%, check that $EF_{FYL} + EF_{AL}$ is ≤ 1 .
- Annual losses, summed over the lifetime, cannot be greater than 100%. Check that the EF_{AL} * lifetime ≤ 1

Example: Demonstration of mass conservation – Tier 1

	- Closed Cell Foams	F-Gas Emissions - Open	Cell Foams F-Gas Param	eters - Closed Cell Foams - Tier 2	F-Gas Parameters	Open Cell Foams - Tier 2	F-Gas Emissions	- Closed Cell Foams - Tier 2	P-Gas Emissions - Open Cell Foams - Tie
rksheet ector: tegory: bcategory: ieet: ata	2.F.2 - Foam Blowing	stitutes for Ozone Depleting	Substances						
ubdivision (Jnspecified	V Gas HFC-23 (CH	F3) ~	Chemical's Data IY 1990	GR (%) 3	EFfyl (%) 50	EFal (%) 10	d (yr) 5 RE	0 (%) 20
. Total Chemica	al Agent Emissions (acro		ies) (Bank(t)) pment at end-of-life (across th		0 00 0 Equation 7.7		Mass cor	servation ensured	
Year	Consumption (tonnes)	Emissions in first year (tonnes)	Annual loss (tonnes)	Bank (at the end of the year) (tonnes)	Decommissioning loss (tonnes)		Total Emissions (tonnes)	Total Emissions (Gg)	Agent at Decommissioning (tonnes)
t ∆⊽	A	B = A * (EFfyl/100)	C = ∑(B(t-(d-1),t)) * (EFal/100)	Bank(t) = A - B - C - I + Bank(t 1)	E = I - F	F = I * RD/100	H = B + C + E	EE = H / 1000	i = [A(t-d) - A(t-d) * EFlyV100 - A(t-d) * EFaV100 * d]
1000	100	50		0	0		60	0.06	
1990		0	1	0	0 0	0	10	0.01	
1990	0	U							
1991 1992	0	0	-		0 0	0	10	0.01	
1991 1992 1993	0	0		0	0 0 0 0	0	10 10	0.01	
1991 1992	0 0 0 0 0	0				0 0 0	10 10 10		

Example: Mass not conserved over time – Tier 1

orksheet ector: ategory: ubcategory: heet: Data	2.F.2 - Foam Blowin	ubstitutes for Ozone Depleting	Substances						
bubdivision	Unspecified	V Gas HFC-23 (CHF	F3) ~ O	nemical's Data IY 1990 GR (%)	3 EFfyl (%) 50	EFal (%)	10 d (yr)	6 RD (%) 2	0
I. Total Chemics II. Total Chemic	cal Agent Emissions (ac	in use ≬ast year of the time seri cross the time series) (ΣH)	es) (Bank(t)) oment at end-of-life (across the t	100 Bank(t) + 0 110 ime series) (∑F) 0	ΣH + ΣF 110	los: (1	ses over the cou 60 tonnes) plus tonnes) are gre		
				Equat	on 7.7		consumption	(100 tonnes)	
	Consumption (tonnes)	Emissions in first year (tonnes)	Annual loss (tonnes)	Bank (at the end of the year) (tonnes)		nt recovery and destruction (tonnes)	Total Emissions (tonnes)	Total Emissions (Gg)	Agent at Decommissioning (tonnes)
	A	B = A * (EFfyl/100)	C = ∑(B(t-(d-1),t)) * (EFal/100)	Bank(t) = A - B - C - I + Bank(t-1)	E=I-F F	^F = I * RD/100	H = B + C + E	EE = H / 1000	l = [A(t-d) - A(t-d) EFtyl/100 - A(t-d) EFal/100 * d]
								0.00	
t ∆⊽ 1990	100	50	10	40			60	0.06	
1990 1991	100 0		10	30	0	0	10	0.01	
1990 1991 1992	0		10 10	30	0	0	10 10	0.01	
1990 1991 1992 1993	0		10 10 10	30 20 10	0	0 0 0	10 10 10	0.01 0.01 0.01	
1990 1991 1992	0		10 10	30 20 10 0	0	0 0 0	10 10	0.01 0.01 0.01 0.01	

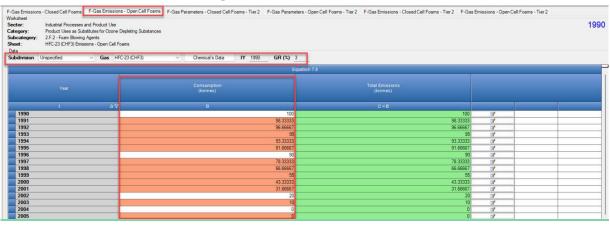
Open Cell Foams:

As noted in the section **EF/parameters** above, parameters from the tab **Chemical's Data** will be visible in the worksheet **F-Gas Emissions- Open Cell Foams**. Next, users need to enter the AD in the red-orange cells, by subdivision/gas, and for each year, as follows:

1. <u>Column |B|</u>: The user should enter all known consumption for each subdivision/gas for open cell foams in this column, in tonnes. Only those years for which data are known should be entered. Data entered, along with the growth rate entered in the **Chemical's Data** tab, will be used to interpolate a full, consistent time series of AD. Do not add "0" for years unknown as the 0 will be read as zero consumption, impacting the calculation of the interpolation of the time series.

<u>Note that</u>, unlike many categories in IPPU, AD entry worksheets for source category 2.F.2 (along with 2.F.1 and 2.F.3) are for the entire time series in the open worksheet. AD for all years can be accessed when opening any year.

Once known AD are input, the *Software* calculates total emissions in <u>Column |C|</u> as equal to the consumption in <u>Column |B|</u>, in tonnes, consistent with Equation 7.8 in the 2006 IPCC Guidelines.



Example: AD input - open cell foams - Tier 1

Note that:

1. White cells show where data were entered manually.

- 2. In the red-orange cells the *Software* interpolates or back-calculates the input. The user should use caution in modifying any redorange cells, unless data are known. If data are manually entered in an interim year, the *Software* will recalculate the trend between the two known data entry points. **DO NOT ADD ZERO** unless "0" is the known value, as the *Software* will interpolate/extrapolate values assuming the zero (see for example 2004/2005 above). To delete an incorrect entry, instead of using zero, simply delete/clear the value from the cell.
- 3. Absent historic consumption data, the *Software* back-calculates consumption based on the growth rate.

When the Tier 2 Equation is applied

<u>Closed Cell Foams</u> <u>Open Cell Foams</u>

Entry of AD in worksheets F-Gas Emissions- Closed Cell Foams-Tier 2 and F-Gas Emissions- Open Cell Foams-Tier 2 is identical.

As noted in the section <u>EF/parameters</u> above, parameters from the tab **F-Gas Parameters – Closed Cell Foams**-**Tier 2** and **F-gas Parameters- Open Cell Foams** will be visible in worksheets **F-Gas Emissions – Closed Cell Foams – Tier 2** and **F-Gas Emissions- Open Cell Foams – Tier** 2, respectively, and the worksheets active so users can select subdivisions, sub-applications and F-gases/blends and estimate emissions.

- 1. Users first need to select subdivision, then sub-application and F-gas/blend for which AD are to be entered. <u>Note that</u> if a subdivision/sub-application/F-gas / blend is not available for selection, the user should refer back to the description for Tier 2 in Customizing the Software for Foam Blowing Agents: subdivision/sub-application/F-gases.
- Then for each subdivision, sub-application and F-gas/blend users need to populate AD in the white cells of worksheet F-gas Emissions – Closed Cell Foams- Tier 2 and/or F-gas Emissions – Open Cell Foams- Tier 2.

Example: F-gas Emissions - Closed Cell Foams - Tier 2 (subdivisions, sub-applications and F-gases)

Note that example is for closed cell foams, but same grid structure (but different sub-applications) applies to Open Cell Foams

orksheet	ons - Closed Cell	Foams F-Gas	Emissions - Open	Cell Foams F-	Gas Parameters	Closed Cell Foams - Tie	er 2 F-Gas Parameter	s - Open Cell Foa	ms - Tier 2 F-0	Gas Emissions - Closed	Cell Foams - Tier 2 F	-Gas Emissions -	Open Cell Foams - Tie	r2	
ector: ategory: abcategory neet:	Product Use 2.F.2 - Foam	ocesses and Produ s as Substitutes fo Blowing Agents ions - Closed Cell	or Ozone Depleting) Substances											199
lata Subdivision	National		Sub-applica	ation Polyurethan	ne - Integral Skin	v	Gas HFC-134a (CH	2FCF3)	~						
Intro Year		OWIT TRACE 140		Juct III Polyurethan			HFC-134a (CH	2FCF3)		d [2] 0 E	Frd [%] 0 E	Fad [%] 0			
				Dre Comp	e - Continuous Pa ment Foam (DCF)	anel	- HPC-1528 (CH					rad [4] 0			
		across the time s	Contraction of the second	Polyurethan	e - Injected Foar		0 Bank(t) + DB(t) + ΣP + ΣJ	0						
, Total Che	mical Agent in eq	uipment in use (las	st year of the time s	eries) (Extruded P	olystyrene (XPS)		0								
I. Total Ch	emical Agent in ec	upment disposed	l (last year of the tin	me series) (DB(t))			0								
. Total Ch	emical Agent Emis	sions (across the	time series) (∑P)				0								
Total Che	mical Agent Reco	overed/Destroyed	/Exported from equ	upment at end-of-lf	e (across the time	series) (SJ)	0								
							Bo	x 7.2							
											,				
	Amount in Foams produced domestically (tonnes)	Amount in Foams imported (tonnes)	Amount in Foams exported (tonnes)	Annual domestic consumption (tonnes)	First year loss (tonnes)	Annual loss (tonnes)	Agent at Decommissioning (tonnes)		Emitted at decommissioni ng (tonnes)	Decommissioned bank (at the end of the year) (tonnes)	Bank (at the end of the year) (tonnes)	Annual loss from decommission ed bank (tonnes)	Total emissions in year t (tonnes)	Total emissions in year t (Gg)	
Year t A	Foams produced domestically	Foams imported	Foams exported (tonnes)	consumption	First year loss	(tonnes) $H = \sum (IF(E(t-(d-1),t) * (EFal/100) <=$	Decommissioning	Recovered and Destroyed at decommissioni ng	decommissioni ng	bank (at the end of the year)		from decommission ed bank (tonnes)		emissions in year t	
t A	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	G = Bi *	(tonnes) H = Σ(IF(E(t-(d-1),t) * (EFal/100) <= CAremaining(t); E(t-(d -1),t) * (EFal/100);	Lecommissioning (tonnes) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d), E(t- d) * (MPL/100);	Recovered and Destroyed at decommissioni ng J = I *	decommissioni ng (tonnes) K = (I-J) *	bank (at the end of the year) (tonnes)	the year) (tonnes) Bank = Bank(t-1) + E	from decommission ed bank (tonnes) N = DB(t-1) *	year t (tonnes)	emissions in year t (Gg) Q = P / 1000 0	3 4
t ∆ 1990 1991	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	G = Bi * (EFfyl/100) 0 0	(tonnes) H = ∑(IF(E(t-(d-1),t)* (EFa)/100; E(t-(d -1),t)*((EFa)/100); CAremaining(t))) 0 0 0 0	Decommissioning (torines) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(t- d) * (MPL/100); CAremaining(t-d)) 0	Recovered and Destroyed at decommissioni ng J = 1 * (EFrd/100)	decommissioni ng (tonnes) K = (i-J) * (EF d/100)	bank (at the end of the year) (tonnes) DB = I - J - K - N + DB(t-1)	the year) (tonnes) Bank = Bank(t-1) + E _G - H - 1 0 0	from decommission ed bank (tonnes) N = DB(t-1) *	yeart (tonnes) P = G + H + K + N 0 0	emissions in year t (Gg) Q = P / 1000 0	3
t △ 1990 1991 1992	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	G = Bi * (EFfy1/100) 0 0 0 0 0	(tonnes) H = ∑(IF(E(t-(d-1),t)* (EFa)/100; E(t-(d -1),t)*((EFa)/100); CAremaining(t))) 0 0 0 0	Lecommissioning (tonnes) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d), E(t- d) * (MPL/100);	Recovered and Destroyed at decommissioni ng J = 1 * (EFrd/100)	decommissioni ng (tonnes) K = (i-J) * (EF d/100)	bank (at the end of the year) (tonnes) DB = I - J - K - N + DB(t-1) 0 0	the year) (tonnes) Bank = Bank(t-1) + E - G - H - I 0 0 0	from decommission (tonnes) N = DB(I-1) * (EFad/100)	yeart (tonnes) P = G + H + K + N 0 0 0	emissions in year t (Gg) Q = P / 1000 0 0 0 0	3
t Δ 1990 1991 1992 1993	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	First year loss (tonnes) G = BI * (EFfyI/100) 0 0 0 0 0 0 0	(tonnes) H = ∑(IF(E(1,(d-1),t)* (EFai/100) <= CAremaining(1), E(1,(d -1),t)*(EFai/100), CAremaining(1)) 0 0 0 0 0 0 0 0 0	Decommissioning (torines) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(t- d) * (MPL/100); CAremaining(t-d)) 0	Recovered and Destroyed at decommissioni ng J = 1 * (EFrd/100)	decommissioni ng (tonnes) K = (i-J) * (EF d/100)	bank (at the end of the year) (tonnes) DB = I - J - K - N + DB(t-1) 0 0	the year) (tonnes) Bank = Bank(t-1) + E - G - H - I 0 0 0 0 0 0	from decommission (tonnes) N = DB(t-1) * (EFad/100) 0 0	yeart (tonnes) P = G + H + K + N 0 0 0 0 0 0	emissions in year t (Gg) Q = P / 1000 0 0 0 0 0 0 0 0	3
t Δ 1990 1991 1992 1993 1994	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	First year loss (tonnes) G = Bi * (EFfyl/100) 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	(tonnes) H = ∑(IF(E(1,(d-1),t)* (EFai/100) <= CAremaining(1), E(1,(d -1),t)*(EFai/100), CAremaining(1)) 0 0 0 0 0 0 0 0 0	Decommissioning (torines) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(t- d) * (MPL/100); CAremaining(t-d)) 0	Recovered and Destroyed at decommissioni ng J = 1 * (EFrd/100)	decommissioni ng (tonnes) K = (i-J) * (EF d/100)	benk (at the end of Bre year) (tonnes) DB = I - J - K - N + DB(t-1) 0 0 0 0 0	the year) (tonnes) Bank = Bank(t-1) + E - G - H - I 0 0 0 0 0 0 0 0 0 0	from decommission ed bank (tonnes) N = DB(I-1) * (EFad/100) 0 0 0 0	yeart (tonnes) P = G + H + K + N 0 0 0	emissions in year ((Gg) Q = P / 1000 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	3
t A 1990 1991 1992 1993	Foams produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	consumption (tonnes)	First year loss (tonnes) G = BI * (EFfyI/100) 0 0 0 0 0 0	(tonnes) H = ∑(IF(E(1,(d-1),t)* (EFai/100) <= CAremaining(1), E(1,(d -1),t)*(EFai/100), CAremaining(1)) 0 0 0 0 0 0 0 0 0	Decommissioning (torines) I = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(t- d) * (MPL/100); CAremaining(t-d)) 0	Recovered and Destroyed at decommissioni ng J = 1 * (EFrd/100)	decommissioni ng (tonnes) K = (i-J) * (EF d/100)	bank (at the end of the year) (tonnes) DB = I - J - K - N + DB(t-1) 0 0	the year) (tonnes) Bank = Bank(t-1) + E - G - H - I 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	from decommission (tonnes) N = DB(t-1) * (EFad/100) 0 0	yeart (tonnes) P = G + H + K + N 0 0 0 0 0 0	emissions in year t (Gg) Q = P / 1000 0 0 0 0 0 0 0 0	3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3

AD are entered for each subdivision/sub-application/ F gas/blend, and for each year (based on the year of introduction of the foam blowing agent) in worksheet **F-Gas Emissions – Closed Cell Foams - Tier 2** and/or worksheet **F-Gas Emissions – Open Cell Foams - Tier 2**, as follows:

<u>Note that</u>, unlike many categories in IPPU, AD entry worksheets for source category 2.F.2 (along with 2.F.1 and 2.F.3) are for the entire time series in the open worksheet. AD for all years can be accessed when opening any year.

 <u>Column |Bi|</u>: enter the_amount of F gases/blends produced domestically, in tonnes. <u>Note that</u>: the user should insert values only for the years known. The Software will interpolate/extrapolate missing values. Insert "0" only if zero is the true value otherwise it impacts the interpolation/extrapolation.

- 2. <u>Column | Ci |</u>: enter the amount of F-gas/blend imported, in tonnes. <u>Note that</u>: the user should insert values only for the years known. The Software will interpolate/extrapolate missing values. Insert "0" only if zero is the true value otherwise it impacts the interpolation/extrapolation.
- 3. <u>Column |Di|:</u> enter the amount of F-gas/blend exported, in tonnes. <u>Note that:</u> the user should insert values only for the years known. The Software will interpolate/extrapolate missing values. Insert "0" only if zero is the true value otherwise it impacts the interpolation/extrapolation.

Once known AD are input, the *Software* makes several calculations based on the factors added in the F-Gas Parameters – Closed Cell Foams- Tier 2 and/or F-Gas Parameters – Open Cell Foams- Tier 2 tabs:

- 4. <u>Column |E|:</u> total amount of F-gas/blend consumed domestically in year t, in tonnes <u>Note that this cell is calculated as the sum of production (Column |Bi|)</u> plus imports (Column |Ci|) minus exports (Column |Di|).
- 5. <u>Column |G|:</u> amount of F-gas/blend lost (emitted) in the first year during manufacture or installation, in tonnes

<u>Note that</u> this cell is calculated by multiplying the amount of agent used in foams produced domestically in the year by the EF for first year losses (EFfyl) entered in the respective worksheet **F-Gas Parameters-** [Closed][Open] Cell Foams-Tier 2. It is assumed all first-year losses occur in the country of production.

- 6. <u>Column |H|:</u> amount of F-gases/blends emitted annually from the bank, in tonnes. <u>Note that</u> this cell is calculated by multiplying the amount of agent in the bank by the EF for annual losses (EFal) entered in worksheet **F-Gas Parameters-** [Closed][Open] Cell Foams-Tier 2. The calculation in this column has been constrained to ensure that the annual losses estimated are not greater than the chemical agent remaining in the system (CA remaining) and thus mass is conserved. CA remaining is calculated as the initial charge of the foam, minus first year losses minus annual losses * years of the lifetime reported between the year of introduction of the foam and the current year. If the annual losses estimated are greater than CA remaining, CA remaining is reported in this column.
- 7. Column |1|: amount of F-gas/blend remaining at decommissioning in year t, in tonnes. <u>Note that</u> this cell is calculated by multiplying the total annual consumption in foams available for decommissioning based on the lifetime by the maximum potential amount of agent in the foam at end of life (MPL) entered in worksheet F-Gas Parameters- [Closed][Open] Cell Foams-Tier 2. The calculation in this column has been constrained to ensure that the amount of agent at decommissioning calculated based on the MPL entered by the user is not greater than the chemical agent remaining in the system (CA remaining) and thus mass is conserved. CA remaining is calculated as the initial charge of the foam, minus first year losses minus annual losses multiplied by years of the lifetime reported between the year of introduction of the foam and the current year. If the agent at decommissioning calculated from the MPL is greater than possible chemical agent remaining in the system, then CA remaining is reported in this column.
- 8. <u>Column |]|:</u> amount of F-gas/blend recovered and destroyed, in tonnes. <u>Note that</u> this cell is calculated by multiplying the amount for decommissioning in <u>Column |I|</u> by the recovery and destroyed rate (EFrd), calculated as a % of decommissioned amount and entered in worksheet **F-Gas Parameters-**[Closed][Open] Cell Foams-Tier 2.
- 9. <u>Column |K|:</u> amount of F-gas/blend emitted at decommissioning in year t, in tonnes. <u>Note that</u> this cell is calculated by multiplying the amount for decommissioning in <u>Column |I|</u>, less the amount of agent recovered/destroyed, multiplied by the rate of loss at decommissioning (EFd), as entered in worksheet **F-Gas Parameters-** [Closed][Open] Cell Foams-Tier 2.
- 10. <u>Column |DB|</u>: decommissioned bank is the quantity of F gas/blend that remains in foams after decommissioning, and will continue to emit, in tonnes. <u>Note that</u> this cell is calculated as the amount of F-gas/blend in the decommissioned bank from the previous year, t-1, plus amount decommissioned in year t, minus recovery/destruction amount minus current year decommissioning emissions and emissions from the decommissioned bank.
- 11. <u>Column | Bank_(t) |:</u> the bank at the end of the year t, in tonnes. <u>Calculated as</u> the amount of F-gas of the bank from the previous year t-1 plus the amount consumed domestically in year t minus first-year and annual emissions minus decommissioned amount, in tonnes.
- 12. <u>Column |N|:</u> annual loss from decommissioned bank, in tonnes. <u>Calculated as the decommissioned bank multiplied by the annual rate of loss of the decommissioned bank (EFad), entered in worksheet **F-Gas Parameters-** [Closed][Open] Cell Foams-Tier 2</u>
- 13. <u>Column |P|:</u> total emissions in year t, in tonnes
- 14. <u>Column |Q|</u>: total emissions in year t, in Gg

Example: AD input for closed and open cell foams- Tier 2

	ons - Closed Cell F	Foams F-Gas	Emissions - Open	Cell Foams F-Ga	s Parameters - Closed Ce	II Foams - Tier 2 F-Gas F	arameters - Open Cell Foar	ns - Tier 2 F-Gas En	nissions - Closed	Cell Foams - Tier 2 F-Ga	s Emissions - Open Cell Foan	ns - Tier 2		
orksheet ector: ategory: ubcategory: heet: lata	Product Uses 2.F.2 - Foam F-Gas Emissi	Blowing Agents ons - Closed Cell F	r Ozone Depleting Foams - Tier 2											
Subdivision	National	Gas Ensistions - Obsed Cell Forms - Ther 2 onal												
Intro Year	1990 Gr	owth Rate (%)	3 Prod	luct lifetime (d) [yr] 50 EFfyl [2	[] 10 EFal [%]	0.5 MPL [%]	55 EFd [%]	50 E	Frd [%] 0 EFad	[%] 50			
L Total Char	nical Acont Incuts	(some the time of	ordera) (SE)			400 700 202227 Pag	00 17. 97. (AD	700 202227						
							K(() + DD(() + 21 + 23	100.302237						
						3/6,691,1391/2								
III. Total Che	emical Agent in eq	uipment disposed	(last year of the tin	ne series) (DB(t))		0								
IV. Total Che	emical Agent Emis	sions (across the t	ime series) (∑P)			33,095.243065								
V. Total Cher	mical Agent Reco	vered/Destroyed/	Exported from equ	upment at end-of-life ((across the time series) (∑J)	0								
							P	x 7.2						
								X 7.2						
	Amount in Foams produced domestically (tonnes)	Amount in Foams imported (tonnes)	Amount in Foams exported (tonnes)	Annual domestic consumption (tonnes)	First year loss (tonnes)	Annual loss (tonnes)	Agent at Decommissioning (tonnes)	Amount Recovered and Destroyed at decommissioning (tonnes)	Emitted at decommission ng (tonnes)	Decommissioned bank (at the end of the year) (tonnes)	Bank (at the end of the year) (tonnes)	Annual loss from decommissione d bank (tonnes)	Total emissions in year t (tonnes)	Total emissions in year t (Gg)
t ∆	Bi	Ci	Di	E = Bi + Ci - Di	G = Bi * (EFfyl/100)	$\begin{array}{l} H = \sum (IF(E(t-(d-1),t) * \\ (EFal/100) <= \\ CAremaining(t); E(t-(d-1),t) * (EFal/100); \\ CAremaining(t))) \end{array}$	I = IF(E(t-d) * (MPL/100) = CAremaining(t-d); E(t- d) * (MPL/100); CAremaining(t-d))	J = I * (EFrd/100)	K = (I-J) * (EFd/100)	DB = I - J - K - N + DB(t- 1)	Bank = Bank(t-1) + E - G - H - I	N = DB(t-1) * (EFad/100)	P=G+H+K+N	Q = P / 1000
1996	106.61845	7,379.00605	0	7,485.62449	10.66184	240.18343	0	0	0	C	47,035.91011	0	250.84527	0.25085
1997	109.817	7,600.37623	0	7,710.19323	10.9817	278.73439	0	0	0	0	54,456.38724	0	289.71609	0.28972
1998	113.11151	7,828.38751		7,941.49902		318.44189	0				02,000.10020			
1999	116.50485					359.34061	0							
2000	120	8,305.13631	0	0,120,10001	12		0							
2001	178	8,554.2904		8,732.2904		445.12774	0				86,157.91881	0		
2002	236		0	9,046.91911	23.6	490.36234	0				01,000.01000	0		
2003 2004	294	9,075.24669 9,347.50409		9,365.08002 9,691,17075		537.18774 585.64359	0							
2004	410		0.33333		30.2	635,77074	0					0		
2005	410	9,916,76709		10.368.10042		687,61124	0		· · · · · · · · ·	•				
2007	526	10.214.2701		10,719,43677	52.6	741,20842	0				141,467,67103			
2008	584	10,520,6982				796,60691	0				151,692,36232			
2009	642	10,836,31915		11,449,15248		853.85268	0		0	0				
2010	700	11,161.40872		11,828.07539	70	912.99305	0	0	0	C				
2011	730	11,496.25099			73	973.93681	0	0	0	C				
2012	760	11,841,13851	41.66667	12,559.47185	76	1,036.73417	0	0	0	C	195,657.09632	0	1,112.73417	1.1127
2013	790	12,196.37267	45.83333	12,940.53934		1,101.43686	0	0	0	C	207,417.19879	0	1,180.43686	1.1804
2014	820				82	1,168.09818	0				219,499.36445			
2015	850				85	1,236.79384	0							
2016	880	13,327.30572				1,307.58037	0							
2017	910					1,380.516	0				207,704.00002			
2018	940					1,455.66069	0							
2019	970					1,533.07622	0							
2020	1.000	15,000	50	15,950	100	1,612.82622	0	0	0	0	299,363.51892	0	1,712.82622	

Note that although example applies to closed cell foams, the data entry grid for open cell foams is exactly the same

Note that:

- 1. White cells show where data were entered manually.
- 2. In the red-orange cells the *Software* interpolates or back-calculates the input. Interpolation takes place between two specified values, e.g. 120 in 2000 and 700 in 2010 and 1000 in 2020. Absent historic consumption data, the Software back-calculates consumption based on the growth rate (see years prior to 2020 in column Ci).
- 3. Green cells in columns from E to Q are estimates and they cannot be modified manually.

Ensuring mass conservation of gases in Closed and Open Cell Foams- Tier 2

A QA/QC check has been introduced into the worksheets for categories 2.F.1, 2.F.2, 2.F.3 and 2.F.6 (contained applications only) to ensure that the data, EFs and parameters entered by the users ensure conservation of mass of gases over time.

To ensure mass conservation, the *Software* tracks and visually presents the inputs and outputs over time as follows:

- I. Total chemical agent inputs, across time (ΣE)
- II. Total chemical agent in equipment in use $(\sum Bank_{(t)})$
- III. Total chemical agent in equipment disposed (last year of the time series) (DB_(t))
- IV. Total chemical agent emissions, across time (ΣP)
- V. Total chemical agent recovered/destroyed $(\sum J)$

In the case of Tier 2, mass conservation has been ensured if:

$$\sum E = Bank(t) + DB_{(t)} + \sum P + \sum J$$

If mass has been conserved, all cells are green. An orange colour signals that the amount of chemical input is smaller than the amount of chemical stored in the system and the subsequent emissions, while a red colour means that the chemical input is greater than the amount stored in the system and the subsequent emissions. If the check results in orange or red shading, refer back to worksheet F-Gas Parameters to ensure that all parameters are coherent.

Example: Demonstration of mass conservation – Tier 2 Open Cell Foams

		-
F-Gas Emissions - Closed Cell Foams F-Gas Emissions - Open Cell Fo	ams F-Gas Parameters - Closed Cell Foams - Tier 2 F-Gas Parameters - Open Cell Foams - Tier 2	F-Gas Emissions - Closed Cell Foams - Tier 2 F-Gas Emissions - Open Cell Foams - Tier 2
Worksheet		
Sector: Industrial Processes and Product Use		1990
Category: Product Uses as Substitutes for Ozone Depleting Substar	lices	
Subcategory: 2.F.2 - Foam Blowing Agents		
Sheet: F-Gas Emissions - Open Cell Foams - Tier 2		
Data		
Subdivision National V Sub-application F	Polyurethane - Rexible Foam V Gas HFC-134a (CH2FCF3) V	
Intro Year 1990 Growth Rate (%) 0 Product li	fetime (d) [yr] 1 EFfyl [%] 100 EFal [%] 0 MPL [%] 0	EFd [%] 0 EFrd [%] 0 EFad [%] 0
 Total Chemical Agent Inputs (across the time series) (∑E) 	658.5 Bank(t) + DB(t) + ΣP + ΣJ 658.5	
II. Total Chemical Agent in equipment in use (last year of the time series) (B	ank(t)) 0	Mass conservation is
III. Total Chemical Agent in equipment disposed (last year of the time series) (DB(t)) 0	
IV. Total Chemical Agent Emissions (across the time series) $(\underline{\Sigma} P)$	658.5	ensured
V. Total Chemical Agent Recovered/Destroyed/Exported from equipment a	at end-of-life (across the time series) (SJ	
	Box 7.2	

Results

GHG emissions from Foam Blowing Agents are estimated one row for each year of the time series, in the following worksheets:

- ✓ F-Gas Emissions Closed Cell Foams
- ✓ F-Gas Emissions Open Cell Foams
- ✓ F-Gas Emissions Closed Cell Foams Tier 2
- ✓ F-Gas Emissions Open Cell Foams Tier 2

Total F-gas emissions from foam blowing agents is the sum of all emissions in the above worksheets. For users reporting to the UNFCCC ETF reporting tool, emissions totals will be reported separately for closed cells foams and open cell foams. The *Software* calculates the associated emissions for each F-Gas/blend in the following units: Tier 1 – metric tonnes; Tier 2 – metric tonnes and Gg.

The user will note that Foam Blowing Agents is one of the few categories in the IPPU sector of the *Software* that does not contain a worksheet for **Capture and storage or other reduction**. This is because all capture and other reductions are already accounted for in the worksheets noted above.

Results – emissions in the current inventory year, e.g. in this example 1000 tonnes of HFC-245fa in the year 2020 (equal to the known consumption data in this year)

	- Closed Cell Foams	F-Gas Emissions - Open	Cell Foams F-Gas Paramet	ers - Closed Cell Foams - Tier 2	F-Gas Parameter	s - Open Cell Foams - Tier	2 F-Gas Emission	is - Closed Cell Foa
orksheet ector: ategory: ubcategory: heet:)ata	2.F.2 - Foam Blowin	ubstitutes for Ozone Depleting						
	Unspecified	✓ Gas HFC-134a (C)	H2FCF3) V Ci	nemical's Data IY 1990	GR (%) 0	EFfyl (%) 10	EFal (%) 4.5	d (yr) 20
Total Chemical	Agent Inputs (across	the time series) (ΣA)		66.7	750 Bank(t) + ΣH +	ΣF 66.750		
		in use (last year of the time seri	ee) (Rank #))	17.1				
		cross the time series) (Σ H)		49.6				
	-				00			
V. Total Chemic	al Agent Recovered/	Destroyed/Exported from equip	ment at end-of-life (across the t	ime series) (<u>></u> F)	0			
					Equation 7.7			
	Consumption (tonnes)	Emissions in first year (tonnes)	Annual loss (tonnes)	Bank (at the end of the year) (tonnes)	Decommissioning loss (tonnes)	Agent recovery and destruction (tonnes)	Total Emissions (tonnes)	Total Emission. (Gg)
t ∆⊽	A	B = A * (EFfyl/100)	$C = \sum (B(t-(d-1),t)) * (EFal/100)$	Bank(t) = A - B - C - I + Bank (t-1)		F = I * RD/100	H = B + C + E	
1990	1,500	150	67.5	1,282.5			217.5	0.2
1991	1,500	150	135	2,497.5	0	0	285	0
1992	1,500	150	202.5	3,645	0	0	352.5	0.3
1993	1,500	150	270	4,725	0	0	420	
1994	1,500	150	337.5	5,737.5	0	0	487.5	0.4
1995	1,500	150	405	6,682.5	0	0	555	0
1996	1,550	155	474.75	7,602.75	0	0	629.75	0.62
1997	1,600	160	546.75	8,496	0	0	706.75	0.70
1998	1,650	165	621	9,360	0	0	786 867.5	0
1999 2000	1,700	170	697.5 776.25	10,192.5 10,991.25	0	0	867.5 951.25	0.0
2000	1,750	1/5	857.25	10,991.25	0	0	1.037.25	1.03
2001	1,850	185	940.5	12,478,5	0	0	1,125.5	1.0
2002	1,850	185	1.026	13,162.5	0	0	1,125.5	1
	1,950	130	1,020	13,803.75	0	0	1.308.75	1.30
2004								

Example: Results: F-Gas Emissions – Closed Cell Foams Tier 1

$\label{eq:complex} \textit{Example: Results: F-Gas Emissions - Open Cell Foams- Tier 2}$

as Emission ksheet	ns - Closed Cell	oams F-Ga	as Emissions - (Open Cell Foams	F-Gas Paramet	ers - Closed Cell Fo	ams - Tier 2 F-C	Gas Parameters	- Open Cell Foar	ms-Tier2 F-Gas B	missions - Closed	Cell Foams - Tie	r 2 F-Gas Emissi	ons - Open Cell F	
tor: egory: category: et:	Product Use 2.F.2 - Foam	Blowing Agent	for Ozone Depl	eting Substances											19
a bdivision	National		✓ Sub-ap	plication Polyure	thane - Flexible F	pam	✓ Gas	HFC-134a (CH2	FCF3)	~					
ntro Year	1990 G	rowth Rate (%) 0	Product lifetime	e (d) [yr] 1	EFfyl [%]	100 EFa	[%] 0	MPL [%]	0 EFd	[%] 0	EFrd [%] 0	EFad [%]	0	
Total Chem	ical Agent Inputs	(across the tim	e series) (ΣE)				765.5	Bank(t) + DB(t)	+ΣP+ΣJ	765.5					
				ime series) (Bank(t))			426								
				he time series) (DB(t			0								
	mical Agent In eq mical Agent Emis	1 - C	1 A A		"		339.5								
	-						339.5								
I otal Cher	nical Agent Reco	vered/Destroy	ed/Exported from	n equipment at end-	of-life (across the	time series) (∑J)	0								
							Bo	ox 7.2							
	Amount in Foams	Amount in	Amount in	Annual			Agent at	Amount Recovered	Emitted at	Decommissioned	Bank (at the end	Annual loss from	Total emissions	Total	1
	produced domestically (tonnes)	Foams imported (tonnes)	Foams exported (tonnes)	domestic consumption (tonnes)	First year loss (tonnes)	Annual loss (tonnes)	Decommissionin g (tonnes)	and Destroyed at decommissio ning	decommissio ning (tonnes)	bank (at the end of the year) (tonnes)	of the year) (tonnes)	decommission ed bank (tonnes)	in year t (tonnes)	emissions in year t (Gg)	
t 🔺	Bi	Ci	Di	E = Bi + Ci - Di	G = Bi * (EFfyl/100)	$\begin{split} H &= \sum (iF(E(t-(d-1),t)*(EFal/100) \\ &<= CAremaining \\ (t); E(t-(d-1)),t)* \\ &(EFal/100); \\ CAremaining(t))) \end{split}$	I = IF(E(t-d) * (MPL/100) = CAremaining(t- d); E(t-d) * (MPL/100); CAremaining(t- d))	J = I * (EFrd/100)	K = (I-J) * (EFd/100)	DB = I - J - K - N + DB(t-1)	Bank = Bank(t-1) + E - G - H - I	N = DB(t-1) * (EFad/100)	P=G+H+K+ N	Q = P / 1000	
1990	100	10				0					10		100	0.1	2
1991	102	10				0		-			20		102	0.102	2
1992	50	10	0			0					30	0	50		2
1993	25	12	0			0					42	0			
1994 1995	20.83333	12			20.83333	0				-	54	0	20.83333 16.66667	0.02083	
1995	16.66667	12				0					78	0	16.66667	0.01667	
1996	8.33333	12			8.33333	0					/8 90	0		0.00833	
1998	4.16667	12			4.16667	0					102	0	4.16667	0.00833	6
1999	4.10007	12				0					102	0			6
2000	0	12				0					126	0			6
								-							
2001	0	12	0	12	0	0	0	0	0	0	138	0	0	0	

2.F.3 Fire Protection

Guidance for the use of the *Software* for source category 2.F.3 Fire Protection is provided above in the section 2.F.1 and 2.F.3 Refrigeration and Air Conditioning, and Fire Protection. Procedures for entering data and information in the *Software* for Fire Protection follows the description for the Tier 1 equations for Refrigeration and Air Conditioning.

2.H Other

Information

This section groups guidance for the following source categories according to their common methodological approaches applied in the *Software*:

- ✓ 2.H.1 Pulp and Paper Industry
- ✓ 2.H.2 Food and Beverages Industry
- ✓ 2.H.3 Other

The 2006 IPCC Guidelines do not provide methodological guidance for estimating GHG emissions from these source categories (including worksheets). Rather, a generic worksheet is provided using the Tier 2 Basic Equation(AD x EF), the same worksheet used for Other categories, such as described above for 2.A.5 Other and 2.B.11 Other.

<u>GHGs</u>

Emissions from the Other (IPPU) source category include the following GHGs (HFCs, PFCs, SF₆ and NF₃ for category 2.H.3 only):

CO ₂	CH ₄	N_2O	HFCs	PFCs	SF ₆	NF ₃
X	Χ	Χ	X	X	X	Χ

For more information_on IPCC Equations, Software Worksheets, User's work Flowchart. Activity data input, Emission factor input and Results_refer to the corresponding information and figures in section 2.A.5 Other for source categories 2.H.1 and 2.H.2 and section 2.B.11 Other for source category 2.H.3.

Example: 2.H.3 Other – Generic worksheet

Note that the example for 2.H.3 also applies to 2.H.1 and 2.H.2 except the biogenic indicator



Annex I: Mapping between the IPCC Inventory Software and the UNFCCC ETF Reporting Tool

The *Software* enables users to calculate national GHG emissions in accordance with the 2006 IPCC Guidelines, and in limited cases where needed for reporting to the United Nations Framework Convention on Climate Change (UNFCCC), the 2019 Refinement to the 2006 IPCC Guidelines. The methods contained in the *Software* are consistent with those required to be used by Parties in preparing a national GHG inventory, consistent with decision 18/CMA.1, under the Enhanced Transparency Framework (ETF) of the Paris Agreement. However, Parties to the UNFCCC have agreed to a specific format for reporting the GHG inventory information, called the common reporting tables (CRT), that differ from the IPCC reporting tables contained in <u>volume 1, chapter 8</u> of the 2006 IPCC Guidelines.

Thus, Parties to the UNFCCC, acknowledging the importance of the *Software* in aiding countries to estimate their national GHG inventory, have invited IPCC to work together to facilitate interoperability between the *Software* and the <u>UNFCCC ETF Reporting Tool</u>. Consequently, the *Software* has been upgraded to operationalize the interoperability. Specifically, users of the *Software* can estimate GHG emissions and removals for all categories and gases that are required to be reported pursuant to the CRT. Once data are entered into the *Software*, users wishing to use these data to facilitate reporting to the UNFCCC must generate a file in the *Software* (in JSON format). This file, can then, through a separate UNFCCC platform and with proper credentials, be uploaded and further processed for transfer to the UNFCCC.

Preparing a JSON file that can be imported into the UNFCCC ETF Reporting Tool required a cell-by-cell mapping to identify where AD and GHG emissions estimates contained in each worksheet of the *Software* reside in the CRT.

This annex contains detailed information to illustrate the mapping of categories and gases between the *Software* and the CRT for reporting of emissions from the IPPU sector and is supplemental to the general information provided in the <u>UNFCCC Interoperability – CRT Export Quick Start Guide</u>.

CRT visualization tables in the IPCC Inventory Software

The mappings between the *Software* and the CRT are visualized in the *Software* to allow the user to properly understand (thus enhancing transparency) and keep for internal use the results of the conversion of IPCC category GHG estimates into UNFCCC NGHGI categories.

To generate the visualization tables, select from the main ribbon "Export/Import" and then "UNFCCC CRT". For complete guidance on how to produce a CRT data set and compile data from the underlying worksheets of the *Software* into the CRT data set, refer to the <u>IPCC Inventory Software -UNFCCC Interoperability – CRT Export</u> <u>Quick Start Guide</u>. The result of the generated tables is presented below for the IPPU sector.

Example: Generating visualized CRT for the IPPU sector

tor IPPU Year 1990 Year ble2(I) Table2(II).A-H Table2(II) Table2(II).B-Hs1 Table2(II).B-Hs2	Refresh v Import CO2 Equivalents NAI Reporting T									
BLE 2(I).A-H SECTORAL BACKGROUND DATA		IOD	JCT USI	E						
issions of CO2, CH4 and N2O (Sheet 1 of 1) GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA		IMPLIED E	MISSION FA	CTORS (1)					
	Production/Consumption quantity		CO2	CH4	N2O	CO2	CH4	N20	CO2 fossil C	02
	Description (5)	(61)	(64)	(6/8)	(83)	(kt)	(kt)	(kt)	(kt)	
2.A. Mineral industry		X	(0.7	104		726.84392539	49569.998	4999.999	-0.265	-
2 A 1. Cement production	Clinker production. Carbonates consumed	13,1612				13.63911143	10000.000	1000.000	-0.102	-
2 A.2. Lime production	Lime produced. Carbonates consumed	14.9	_			11.93836034			-0.003	
2 A.3. Glass production	Glass production. Carbonates consumed	3.01				4.1131475			-0.002	_
2A4. Other process uses of carbonates		3.01				697.15330612	49569.998	4999.999	-0.158	_
2A4 Ceramics	Carbonates consumed	4	-			1 76036	40000.000	4000.000	-0.003	-
2 A 4 b. Other uses of soda ash	Carbonates consumed	0.266	_			0.11996712			-0.007	
2.A.4.c. Non-metallurgical magnesium production	Carbonates consumed	0.6				0.191182			-0.122	_
2A4d. Other (please specify)	Carbonates consumed	0.0	_			695.081797	49569.998	4999 999	-0.026	_
Other process uses of carbonates [IPCC Software 2 A.4.d. 2 A.5]	Carbonates consumed	2,155	_			695.081797	49569.998	4999.999	-0.026	-
2.B. Chemical industry		2.100	_			127783.73955497	3.9039814	3,7142685	-1.47480667	-
2.B.1. Ammonia production (7)	Ammonia production	0.3	_			0.61994233	NE	NE	-0.25080667	-
2.B.2. Nitric acid production	Nitric acid production	211.103 C	_			0.01334233	HL.	0.5262345 C	-0.23000007	
2.B.3. Adipic acid production	Adipic acid production	2.402	_			3000		0.7176	NE	
2.B.4. Caprolactam, glyoxal and glyoxylic acid production	Hulpic acid production	2.402	_		_	275		2.470434	NE	_
2.8.4.a. Caprolactam	Caprolactam production	151	-			100		2.182	NE	_
2.B.4.b. Givoxal	Glyoxal production	0.752				100		0.00605	NE	_
2.B.4.c. Glyoxylic acid	Glyoxylic acid production	60.08				75		0.282384	NE	_
2.B.5. Carbide production	City oxylic acid producation	00.00	_		_	2 26095792	0.0070364	0.202304	-0.01	-
2 B 5 a. Silicon carbide	Carbide production	0.2				1.15405567	0.0019064		-0.002	-
2.B.5.b. Calcium carbide	Carbide production	0.4				1.10690225	0.00513		-0.008	_
2.B.6. Titanium dioxide production	Titanium dioxide production, Reducing agent us	6.6				9.138	0.00010		-0.001	_
2.B.7. Soda ash production	Trona used. Soda ash production	22.556				3.159728			-0.05	-
2.B.8. Petrochemical and carbon black production		22.550				124488.56292672	3.896945		-1.161	-
2.B.8.a. Methanol	Methanol production, Fuel consumed	2005.81				122030.74121667	2.65727341		-1.01	-
2.B.8.b. Ethylene	Ethylene production, Fuel consumed	2 4 4 4		-		42.86214505	0.0988238		NE	-
2.B.8.c. Ethylene dichloride and vinvl chloride monomer	Ethylene dichloride and vinvl monomer productio.	2 5527		-		56 58358333	0.00027814		-0.102	
2.B.8.d. Ethylene oxide	Ethylene oxide production. Fuel consumed	1.25				18.88289833	0.04895253		-0.023	_
		400 405				0070 400715	1 00 107077		0.000	-
										_
đ					• 4	IPCC Inventory Softw	are notes			
In IFA are estimated on the basis of gross emissions as follows: IFF - (emission te amounts recovered (fossi)-fosgenci), oxidized destroyed or transformed) / A la emissions are to be reported (after subtracting the amounts of emission recover, oxidation, destruction or transformation), oxonts of CO2 captured or emission recovery, oxidation, destruction or transformation).	D. I sector in chapter 4 ("Industrial process rery, this documentation box to provide refer information and/or further details are ne	es and product use" rences to relevant se	(CRT sector) ctions of the I	 of the NID. NID, if any add 	Use	key "C". Note that tot 2.B (Chemical indust use), 2.E (Electronics change because of the	als calculated in orange y), 2.C (Metal industry), industry, 2.G (Other pro e input of "C".	cells at the level of ca 2.D (Non-energy pro iduct manufacture and	in this CRT with the notal stegory 2.A (Mineral indu- ducts from fuels and solv d use), 2.H (Other) will n II be calculated automatic	vent not
ation. Quantities of CO2 captured for later use and short-term storage should no							rting tool. No action by t		 De calculated automatie 	ually
ted unless CO2 emissions are accounted for elsewhere in the inventory (see the									G emissions (e.a. Tier 1.	-

IMPORTANT: these visualization tables have been prepared to enhance transparency and demonstrate to the user how the data entered in the *Software* are mapped to the UNFCCC CRT. The data entered in the *Software* are not automatically used to meet the UNFCCC reporting requirements. The user will still be required to formally submit the information through the UNFCCC ETF Reporting Tool, and the user is responsible for reviewing first the information compiled in the CRT visualization tables and second the information once imported into that tool.

How to read mapping tables

The mapping tables have been developed to enhance transparency of the relationship between the categories in the *Software* and the UNFCCC ETF Reporting Tool. For each cell in the CRT, the mapping tables describe the source of the data from the *Software* that is reported in that cell. The majority of cells in the CRT map from the underlying category-specific worksheets of the *Software*. In the case of short-lived climate forcer emissions, data in the sector summary tables of the CRT are mapped from the IPCC sectoral reporting table.

The specific instructions vary, depending on the nature of the category, and how many calculation worksheets from the *Software* map to that cell, but generally, the instruction is written to direct the user to:

- 1. The specific IPCC category in the category tree of the Software.
- 2. The tab in that worksheet that contains the relevant information.
- 3. The gas of interest.
- 4. The column that contains the relevant information (AD, parameter on emissions), with an indication of any mathematical operation needed (e.g. SUM, MULTIPLY BY, etc)
- 5. Any conversions needed to ensure correct units map to the UNFCCC CRT (e.g. DIVIDE by 1,000 to convert tonnes to kilo tonnes)

By illustration, the directions in the mapping file to report CO₂ emissions cement production in the CRT, and the corresponding location of the information in the *Software* are shown below. Generally, white cells in the CRT are mapped from the *Software*. Orange, green, or blue cells in the visualized CRT in the *Software* will be calculated by the UNFCCC ETF Reporting Tool, after import of the JSON file.

The mapping example for CO_2 emissions from cement production below is a good example to highlight some relatively common occurrences in the IPPU sector:

- The 2006 IPCC Guidelines contain multiple tiers to estimate emissions, and due to the nature of the differing methods, they are implemented through different worksheets in the Software. Thus, the mapping instructions must guide the user to different cells in different worksheets. In the example below, there is reference to the worksheet "Cement production (2/2)", "Clinker production = Tier 2" and "CO₂ Emissions Summary- Tier 3 (4/4)" referring to worksheets for the Tier 1, Tier 2 and Tier 3 methods, respectively. This issue is expanded further below, following the example.
- In accordance with the agreed CRTs, final emissions in the IPPU sector are reported after subtracting the amounts of emission recovery, oxidation, destruction or transformation, thus there is typically a parameter to subtract any such reduction (e.g. below there is a subtraction for any CO₂ capture reported in the worksheet **Capture and storage or other reduction**.

The following recurrent key instructions in the mapping are:

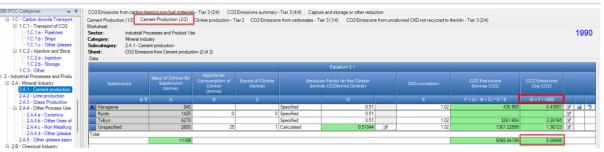
- ✓ The sign "SUM" indicates a summatory of information (numerical or alphabetical) contained across the column/row to which applies.
- ✓ The sign "-SUM" indicates that the result of the summatory is to be reported as a negative value.
- ✓ The sign "AND" indicates an additional element for mapping in the cell, which pertains to the same IPCC category.
- ✓ The sign "PLUS" indicates an additional element for mapping in the cell, which pertains to an additional IPCC category.
- ✓ The sign **"EXCEPT"** indicates all elements for mapping to be included except the listed element, because this element (e.g. category) is already included elsewhere.
- ✓ The signs "**MULTIPLY BY**" and "**DIVIDE BY**" indicate the corresponding mathematical operation to be applied to information sourced from the *Software*.
- ✓ The sign "**ISNOT**" means \neq
- ✓ The text "IF" and "IF NOT" explain a condition for mapping of information to the cell. IF no condition applies based on information populated by user in the *Software*, automatically insert "NE", unless otherwise specified.

Example: How to read mapping between the Software and the UNFCCC CRT

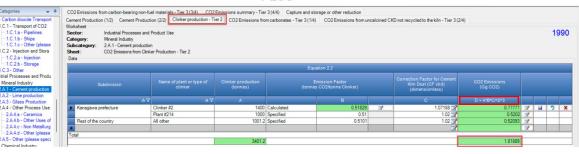
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	CO2
2.A. Mineral industry	SUM (H11:H14)
2.A.1. Cement production	IPCC 2.A.1 <cement (2="" 2)="" production=""> SUM of values in column G PLUS IPCC 2.A.1 <clinker -="" 2="" production="" tier=""> SUM of values in column D PLUS IPCC 2.A.1 <co2 Emissions summary - Tier 3 (4/4)> SUM of values in column E /1,000 MINUS IPCC 2.A.1 <capture and="" or="" other="" reduction="" storage=""> SUM of values in column C / 1,000.</capture></co2 </clinker></cement>

UNFCCC CRT

IPCC Inventory Software



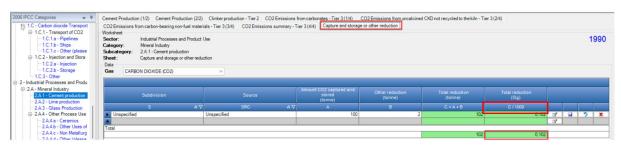
PLUS



PLUS

 Start Production (1/2)
 Center Production (1/2)</th

MINUS



There are several elements for the mapping of IPPU sector emissions relevant to highlight for users:

1. Adding dis-similar types of AD (e.g. production and consumption):

Often, in the IPPU sector, different Tier methods require different types of AD. For example, for cement production (category 2.A.1), Tier 1 and Tier 2 rely on the amount of clinker produced, while Tier 3 emissions estimates are based on the type and amount of carbonates consumed. In the case of HFC-23 emissions from HCFC-22 production (category 2.B.9a), Tier 1 and Tier 2 estimates are based on the amount of HCFC-22 produced, while Tier 3 is a direct measurement method and thus does not have AD.

Users may want to apply different Tier methods in different subdivisions, and in fact this may be desirable if it is possible to use a higher tier for a subset of the GHG inventory, but not the entire inventory. It would not be meaningful, however, to add different types of AD for the purposes of reporting to the CRT. This is because AD, in addition to providing information on how much of some product is produced or consumed, are also used to calculate an implied emission factor (equal to emissions/AD) which is a common metric that can be used to compare information across Parties.

To address this issue, and with a view to enhancing transparency and comparability, AD are aggregated in the visualized CRT, and transferred in the JSON file to the UNFCCC, as follows (see accompanying figure):

- ✓ If all the same type of AD is used for the user's selected Tiers, these AD values are combined and appear in the visualized CRT (scenario #1 below). In the cement example, if a user applies all Tier 1 and/or Tier 2 methods, the total amount of clinker production is aggregated and the visualized CRT 2(I).A-H reports AD as "Clinker production" and the total amount of clinker. Similarly, if all Tier 3 is applied (Scenario #2 below), the AD reported are for the amount of "Carbonates consumed" and the AD are summed accordingly.
- ✓ If the AD differ, as in the case of scenario #3, the cells for description and AD are pale green, and the user can see under **Description** a comma separated list of the types of AD used (e.g. "Clinker production, Carbonates consumed"). This is a signal to the user that the underlying methods applied by the user cannot be simply aggregated. In column (kt) the *Software* provides <u>only the value of the</u> <u>AD for the Tier 1 method (and Tier 2 when the method relies on the same AD, as is the case for</u> <u>cement production</u>). If the user takes no action, he/she would be submitting incomplete AD in the JSON file, representing only that portion of the GHG Inventory covered by the Tier 1 and Tier 2 methods.

Note that: the categories for which it is possible to have different types of AD when using different Tiers are indicated by "T1" in the mapping file linking the Software and the CRT. For further information, see Table 3.

The issue described above affects only AD; in all three scenarios, GHG emissions are the same and reflect total national GHG emissions.

Scenario	How AD are aggrega	How AD are aggregated in visualized CRT									
#1: User applies	GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA									
all Tier 1 and/or		Production/Consumption quanti	y								
Tier 2 methods		Description (5)	(kt)								
The 2 methods	2.A. Mineral industry										
	2.A.1. Cement production	Clinker production	1.95								
#2: User applies	GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA									
all Tier 3 methods		Production/Consumption quantit	у								
an rice 5 methods		Description (5)	(kt)								
	2.A. Mineral industry										
	2.A.1. Cement production	Carbonates consumed	1								

Example: Aggregating AD: cement production example

#3: User applies	GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA	
combination of		Production/Consumption quant	ty
Tier $1/2$ and 3		Description (5)	(kt)
Ther $1/2$ and 5	2.A. Mineral industry		
methods	2.A.1. Cement production	Clinker production, Carbonates consumed	1.95
memous			

- ✓ To transfer complete and meaningful AD, the pale green cells are editable and should be updated to ensure that that the AD reflect the entire inventory. To update the information, the user shall:
 - 1. Right click on the value of the AD and select Edit
 - 2. Select **Description** from the pop-up box. The user will see the comma separated list of AD used in the methods. Select the description that reflects the type of AD the user intends to use for reporting, and for which total national AD are available. In the example below, for instance, the user may delete "Carbonates consumed" if he/she wishes to report total national clinker production. It is important that the user ONLY deletes one of the choices and does not to make any other changes to the text, otherwise the description will not transfer to the CRT.

Important: Note that the UNFCCC ETF Reporting Tool is not currently reading any descriptions for the IPPU sector, as of January 2025 this information must be entered directly in the ETF Reporting Tool. The user is encouraged nevertheless to enter information as described above in the visualized CRT, for ease of future reporting. The updated value, described in step 3 below <u>will</u> be read and <u>must be</u> updated for accurate reporting.

3. With the description change to Clinker production, now **manually edit the value in** <u>Column [kt]</u>: to equal total national amount of clinker produced (0.95 was updated to 3 in the example below).

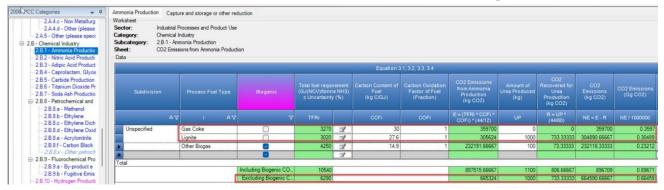
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA			IMPLIE
	Production/Consumption quantit			CO2
	Description (5)	((kt)	(t/t)
2.A. Mineral industry				
2.A.1. Cement production	Clinker production, Carbonates consumed		_	
	Lime produced	2	Edit	
	Glass production	1	Notation Key	
2.A.4. Other process uses of carbonates		15	Refresh value	
	Carbonates consumed	<u> </u>		
2.A.4.b. Other uses of soda ash	Carbonates consumed		JSON Export	•
Summary Description User comment Official comme	one of the types of			
Summary Description User comment Official comme Clinker production, Carbonates consumed	ent one of the types of AD, retaining only that which the use wants to transfer	/ er		
	AD, retaining only that which the use wants to transfer	Y Pr Y DATA		
Clinker production, Carbonates consumed	AD, retaining only that which the use wants to transfer	Y Pr Y DATA		
Clinker production, Carbonates consumed	AD, retaining only that which the use wants to transfer	Y Pr Y DATA		(kt)
Clinker production, Carbonates consumed	AD, retaining only that which the use wants to transfer	Y Pr Y DATA		(kt)

Example: Updating AD when multiple Tiers are used

2. Calculation of CO₂ emissions from biogenic feedstocks in IPPU:

The *Software* allows the user to designate through a checkbox if a feedstock/reductant is of biogenic nature (e.g. biochar in the iron and steel industry). The *Software* then calculates GHG emissions for a category / sector/ national total with and without biogenic CO₂. Biogenic emissions from the IPPU sector are not reported in the UNFCCC ETF Reporting Tool, although the capture of CO₂ emissions of a biogenic origin are included, and thus reflected in the net CO₂ emissions reported for a category, if applicable. This principle is reflected in the mapping.

Example: CO₂ emissions mapped to the CRT is the total, excluding biogenic CO₂. Any capture of biogenic CO₂ would be included as a reduction from CO₂ emissions from ammonia production



3. Reporting emissions from "Unspecified mix of...." HFCs and/or PFCs.

The UNFCCC ETF Reporting Tool does not allow users to separately report all F-gases for which there is a GWP in the AR5; rather the tool requires the user to report these other emissions combined, under "Unspecified mix of HFCs", "Unspecified mix of PFCs" and/or "Unspecified mix of HFCs and PFCs". However, when calculating emissions in the *IPCC Inventory Software*, the user enters all individual gases, and the *Software* assigns the appropriate AR5 GWP. When mapping to the CRT, all F-gases not represented in a separate column of Table 2(II) of the CRT are combined as "Unspecified mix...", and reported in GgCO₂ eq (e.g. either unspecified mix of HFCs, or unspecified mix of HFCs and PFCs, depending on the category).

	-					•							-						, ,					` '											
GREENHOUSE GAS SOURCE AND SINK CATEGORIES	HFC-33	HFC-32	IIFC-41	HPC-43-10mee	IIFC-125	HFC-134	HFC-134a	HFC-143	HFC-143a	HFC-152	HFC-152a		HFC-227ea IIFC-236cb	HFC-236ea	IIFC-236fa	HFC-245ca	IIFC-245fa	HFC-365mfc	Unspecified mix of IIFCs ⁽¹⁾	Total IIFCs	CF,	C2F4	C ₃ F ₁	C4F10	e-C4Fs	C ₅ F ₁₂	CaFie	C ₁₀ F ₁₈	e-C ₃ F ₆	Unspecified mix of PFCs ⁽¹⁾	Total PFCs	Unspecified mix of HFCs and	PPCs ⁽³⁾	SF6	NFA
										(1)									CO2 equiva	lents (kt) (2)					(t)		-			CO2	equivalents	(kt) (2)		(t)	(t)
2. Total actual emissions of halocarbons (by chemical), SF ₆ and NF ₃																																Π			
2.B. Chemical industry								1									6			-															-
2.B.9. Fluorochemical production 2.B.9 a. By-product emissions									Sp	ecifio	HF	Cs							specified of HFCs												Unspe HFC	ecified s and	mix PFC	of	
2.B.9.b. Fugitive emissions										-							1														-			_	
2.B.10. Other																																			

Example: Mapping of individual specifies of F-gases to Table 2(II) of the CRT

4. Reporting emissions from consumption of blends of refrigerants.

The *Software* allows the user to input, and estimate GHG emissions from, the use of refrigerant blends. For reporting, the total emissions of the refrigerant (e.g. R-401A) will be separated into its constituent parts. For example, for R-401A, 13% of the refrigerant is composed of HFC-152a, thus 13% of the emissions from consumption of the refrigerant blend will be mapped to HFC-152a emissions from refrigeration and air conditioning in the *Software* and the UNFCCC ETF Reporting Tool. Other constituents that are covered by the Montreal Protocol and thus not reported under the UNFCCC (e.g. HCFC-22) are not included in the *Software* or the JSON file for transfer to the UNFCCC. For a list of the refrigerants included in the *Software*, refer to the **F-Gases Manager-blends**.

5. Confidentiality.

The UNFCCC ETF Reporting Tool allows Parties to claim information as "C", noting that some level of aggregation may be needed to mask confidential information. Confidential emissions must still be included in totals for a complete GHG inventory. If necessary, users of the *Software* may claim AD or emissions as confidential in the visualized CRT. Cells designated with a "C" (Confidential) will not be included in the JSON file. It is the user's responsibility to understand how confidentiality works, and ensure they understand what is contained in the IPCC JSON file for upload to the UNFCCC ETF Reporting Tool.

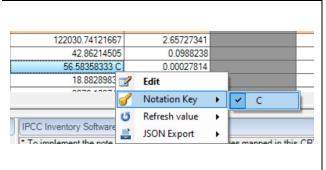
There are two different ways of handling confidentiality in the *Software*; one or non-F-gases (i.e. in CRT 2(I)A-H) and another way for F-gases (CRT 2(II)B-Hs1 and CRT 2(II)B-Hs2).

Designating AD and emissions confidential in CRT 2(I)A-H

Users are allowed to change values in white cells of the visualized CRT to "C". To do this, the user:

- 1. right clicks on the cell and selects Edit
- 2. selects Notation Key
- 3. checks the "C"

4. The value will still appear in the visualized CRT, with a "C" at the end. The value will not be included in the JSON file. Only a "C" will transfer.



For this CRT, the steps above ensure that the AD are "C", and since there are no aggregations of data in CRT 2(I)A-H, the confidential AD cannot be back-calculated. Typically, emissions are not considered confidential. However, efforts have been made to allow a user to designate emissions as confidential, if necessary, while ensuring that total emissions still include the confidential emissions, to ensure a complete GHG inventory.

For CO₂, CH₄ and N₂O emissions, if a user designates a white cell as "C", and there is only one or two categories as "C" it is possible that the confidential emissions could be back-calculated or known. Thus, users may change orange cells to "C" up to a certain category level in each visualization table. At some levels it is not possible to change a value to "C" because to do so would result in no emissions transferring to the UNFCCC in a category. Confidential emissions must still be included in the national inventory.

In the example below, all AD and emissions labelled as "C" for the petrochemical industry will transfer as "C".

Typically, concerns around confidentiality are about AD, not emissions. In the example below, there is no aggregation of AD. The "C" for category 2.B.8.c will transfer and AD will remain fully masked in the transfer.

Example: Designating AD and emissions confidential in CRT 2(I).A-H

GREENHOUSE GAS SOURCE AND SINK CATEGORIES			IMPLIED	EMISSION FA		E
	Production/Consumption quan	tity		CH4	N2O	CO2
	Description (5)	(kt)	(t/t)	(t/t)	(t/t)	(kt)
Other process uses of carbonates [IPCC Software 2.A.4.d, 2.A.5]	Carbonates consumed	2.155		_		695.081797
2.B. Chemical industry				Emissio		127783.73955497
2.B.1. Ammonia production (7)	Ammonia production	0.3		transfer, i		0.61994233
2.B.2. Nitric acid production	Nitric acid production	211.103 C		confide		
2.B.3. Adipic acid production	Adipic acid production	2.402		emiss	ions	3000
2.B.4. Caprolactam, glyoxal and glyoxylic acid production						275
2.B.4.a. Caprolactam	Caprolactam production	151				100
2.B.4.b. Glyoxal	Glyoxal production	0.752				100
2.B.4.c. Glyoxylic acid	Glyoxylic acid production	60.08				75
2.B.5. Carbide production						2.26095792
2.B.5.a. Silicon carbide	Carbide production	0.2				1.15405567
2.B.5.b. Calcium carbide	Carbide production	0.4				1.10690225
2.B.6. Titanium dioxide production	Titanium dioxide production, Reducing agent us	6.6				9.138
2.B.7. Soda ash production	Trona used, Soda ash production	22.556				3.159728
2.B.8. Petrochemical and carbon black production						124488.56292672 C
2.B.8.a. Methanol	Methanol production, Fuel consumed	2005.81		Cells \		122030.74121667
2.B.8.b. Ethylene	Ethylene production, Fuel consumed	2.444	-	transfer a	as "C"	42.86214505
2.B.8.c. Ethylene dichloride and vinyl chloride monomer	Ethylene dichloride and vinyl monomer productio	2.5527 C	-			56.58358333 C

The user cannot change the following rows to "C" in the visualization tables (references to "row" refers to the row in the mapping tables appended to this guidebook).

- ✓ Row 10 -category 2.A. Mineral industry
- ✓ Row 20- category 2.B. Chemical industry
- ✓ Row 50- category 2.C. Metal industry
- ✓ Row 69- category 2.D. Non-energy products from fuels and solvent use
- ✓ Row 80- category 2.E. Electronics industry
- ✓ Row 87- category 2.G. Other product manufacture and use
- ✓ Row 97- category 2.H. Other

Designating AD and emissions confidential in 2(II)B-Hs1 and 2(II)B-Hs2

The structure of UNFCCC reporting tables for F-gases is different than that for non-F gases in table 2(I)A-H. Specifically, there are no aggregations of emissions (or AD) in these tables. This necessitates a different approach for allowing the user to designate F-gases as confidential.

Designation of a gas as confidential is made by the user, category by category, generally (but not always) at the point where the user indicates which F-gases/blend are relevant for the category (i.e. in the F-gases Manager at the category level).

To access the category level F-gases Manager the user shall:

- ✓ select **F-Gases Manager** to open the IPCC category level manager.
- \checkmark check the box(es) for the gas(es) or blends that are confidential

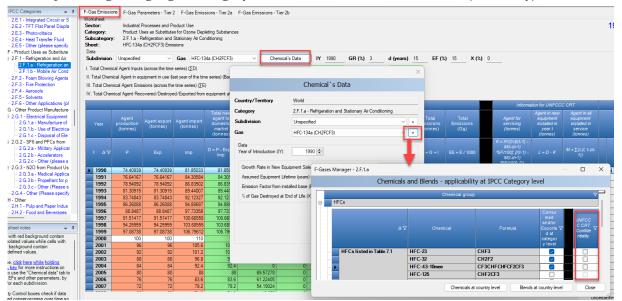
Examples are provided below to show how/where to designate a gas as confidential.

Example: Designating a gas/category combination as confidential for F-gases: most categories

Manufacturing Emissions - EF approach - Tier 3 (1/4) Inst Emissions from Electrical Equipment Manufacturing Emis	allation Emissions - EF approach - Tier 3 (2/4) sions - Mass balance approach - Tier 3 (1/3)	Recycling Emissions - EF approach - Tier 3 (3/4) Installation Emissions - Mass balance approach - T		
Worksheet Industrial Processes and Product Use Category: Other Product Manufacture and Use - Bec Subcategory: 2.6.1 a - Manufacture of Electrical Equipm Sheet: Emissions from Electrical equipment Data Entry	ent			
Gas PFC-14 (CF4) ~	F-Gases Manager			
		Equation 8.1, 8.2		
F-Gases Manager - 2.G.1.a	1	Total Namen	ata	- 🗆 X
	Chemicals and Blends - appl	licability at IPCC Category level		
B- ▶ PFCs	Chemi	cal group		
	∆ ₇ Chemical	Formula	Consumed and/or Exported at category level	UNFCCC CRT _국 Confidentiality 국
PFCs listed in Table 7.1	PFC-14	CF4		
	PFC-116	C2F6		
	PFC-218	C3F8		
	PFC-31-10	C4F10		
	PFC-5-1-14	n-C6F14		
Other PFCs with AR5 GWP	PFC-C216	c-C3F6		
	Perfluorocyclopentane	c-C5F8		

Due to the structure of the *Software* and the mapping to the CRT, the user will find the designation of confidentiality differs from the explanation above, as follows:

1. For 2.F.1, worksheet **F-Gas Emissions** and 2.F.3, worksheet **Emissions from Fire Protection**, the designation of confidentiality can be found in the **Chemical's Data** tab



Example: Designating a gas/category combination as confidential: 2.F.1 (tier 1 only) and 2.F.3

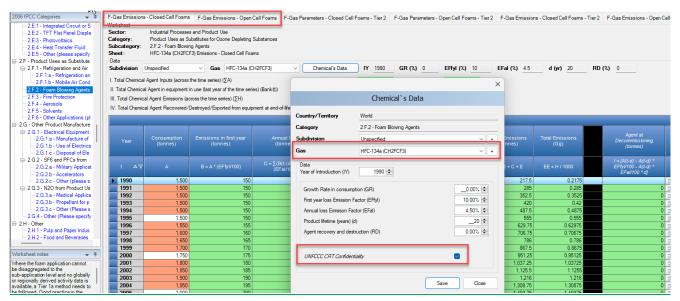
2. For 2.F.1, worksheet **F-Gas Parameters- Tier 2** and 2.F.2, worksheets **F-Gas Parameters- Open cell** foams- Tier 2 and **F-Gas Parameters- closed cell foams- Tier 2**, the gases may go to multiple applications, so confidentiality is designated at the level gases are added to a sub-application.

06 IPCC Categories 🗢 🗣	F-Gas Em		eters - Tier 2 F-G	as Emissions - Tier	2a F-Gas Emissions -	Tier 2b						
− 2.C.6 - Zine Production − 2.C.7 - Rare Earths Production − 2.C.8 - Other [please specifier 2.D.8 - Other [please specifier 2.D.1 - Lubricant Use − 2.D.1 - Lubricant Use − 2.D.2 - Paraffin Wax Use − 2.D.3 - Solvent Use	Workshee Sector: Category Subcate Sheet: Data F-Ga	Industrial Proce r: Product Uses	eration and Stationa	one Depleting Substa	inces							200
2.D.4 - Other (please specif 2.E - Electronics Industry						Sut	division					
2.E - Electronics Industry 2.E.1 - Integrated Circuit or		Unspecified					and the second se					2 7 X
- 2.E.2 - TFT Flat Panel Displ							and the second					
2.E.3 - Photovoltaics		Stand-alone Comme	2.14 P. 2			Sub	application					
2.E.4 - Heat Transfer Fluid 2.E.5 - Other (please specif	0	Stand-alone Comme	rcial Applications									
2.F - Product Uses as Substitut □ 2.F.1 - Refrigeration and Air □ 2.F.1.a - Refrigeration a □ 2.F.1.b - Mobile Air Con □ 2.F.2 - Foam Blowing Agent		Chemical	Tier	Year of Introduction	Emission factor for containers management (%/yr)	Emission factor for filling (production/manufactu ring) of new equipment (% initial charge/yr)	Emission factor for equipment operation (leakage/servicing) (% initial charge/yr)	Lifetime of equipment (years)	Share of initial charge remaining at the end of life (%)	Recovery efficiency of charge (to be reclaimed/recycled) remaining at end of life in retired equipment (%)	UNFCCC CRT Confidentiality	
2.F.3 - Fire Protection		the second second second		t(start)		EFk				ŋ(rec,d)		
- 2.F.4 - Aerosols - 2.F.5 - Solvents		HFC-23 (CHF3)	Tier 2a	1990	5	5	2	20	80	0.9		
2.F.6 - Other Applications (p		HFC-32 (CH2F2)	Tier 2b	1990				20		0.9		
2.G - Other Product Manufactur		HFC-41 (CH3F)	Tier 2a	1990	1	2	3	4	5	6		
- 2.G.1 - Electrical Equipment		HFC-43-10mee	- Tier 2b	1990				15		11		
-2.G.1.a - Manufacture of		HFC-125 (CHF2		1990				15		11		
-2.G.1.b - Use of Electric		HFC-134 (CHF2	- Tier 2b	1990		· · · · · · · · · · · · · · · · · · ·		15		11		
2.G.1.c - Disposal of Ele		HFC-134a (CH2		1990	1	2	2	15	1	90		
E 2.G.2 - Sho and Phus from		UEC 150 /CU3	T. 01	1000								

Example: Designating a gas/category combination as confidential: 2.F.1 and 2.F.2 (both Tier 2)

3. For 2.F.2, worksheets **F-Gas Emissions- Closed Cell Foams** and **F-Gas Emissions – Open Cell Foams** designation of confidentiality occurs in the **Chemical's Data** tab, at the bottom of the pop-up box for each selected gas. In this example, the user would first select the [+] plus sign to select the relevant gas(es) and then at the bottom of the box, designate that gas as confidential.

Example: Designating a gas/category combination as confidential: 2.F.2 (both Tier 1)



In all cases, where F-gases are designated as confidential, the AD will not be included in the JSON file for transfer to the UNFCCC CRT. Emissions of F-gases will all be reported, combined as "from stocks", in unspecified mix of HFCs and PFCs, and/or SF_6 and/or NF_3 in category 2.H, in tCO₂ eq.

REENHOUSE GAS SOURCE AND SINK CATEGORIES		ACTIVITY DATA Amount		1	MPLIED EMISSION FACTORS (1)	N	EMISSIONS (2)			
	Filled into new manufactured products	In operating systems (average annual stocks)	Remaining in products at decommissioning	Product manufacturing factor	Product life factor	Disposal loss factor	From manufacturing	From stocks	From disposal	
SF6	11229.8	300	333.3	1			7154.72	145.4	70451.63	
G.2. SF6 and PFCs from other product use (12)										
2.G.2.a. Military applications										
Unspecified mix of PFCs	IE	22	IE		-		IE	-1296518.74	1	
SF6	IE	22	IE				IE	185.293	1	
2.G.2.b. Accelerators					1	-				
Unspecified mix of PFCs	IE	0.14428	IE				IE	-19533741.66331	1	
SF6	IE	198.9332	IE				IE	33.335183	1	
2.G.2.c. Soundproof windows										
SF6	2	NE	NE				0.66	NE	N	
2.G.2.d. Adiabatic properties: shoes and tyres										
Unspecified mix of PFCs	NE	NE	NE				NO	NE	N	
SF6	IE	2	IE				IE	2	1	
2.G.2.e. Other						1				
2.G.2.e.i. Waterproofing electronic circuits										
CF4	NE	NE	NE				NE	NE	N	
C2F6	NE	NE	NE				NE	NE	N	
Unspecified mix of PFCs	NE	NE	NE	0			NO	NE	N	
2.G.2.e.ii. Other (please specify)										
her prompt emissive applications [IPCC Software 2.G.2.c]										
Unspecified mix of PFCs	IE	8	NA	1 V.			IE	53040	N	
SF6	NO	NE	NA				NO	NE	N	
G.4. Other (please specify)										
ther product manufacture and use [IPCC Software 2.G.4]										
Unspecified mix of HFCs and PFCs	IE	125	IE				IE	12431250000	1	
SF6	NO	NE	NO				NO	NE	N	
NF3	NO	NE	NO				NO	NE	N	
Other (please specify)										
H.3. Other (please specify)										
ther industrial processes and product use [IPCC Software]									-	
Unspecified mix of HFCs and PFCs	IE	0	IE				16	1138753684241.99	1	
SF6	IE	0	IE				IE I	5992000	18	
NF3	IE	0	IE				81	19990000	18	

Example: F-gases designated as confidential reported, together, under 2.H, stocks

Detailed mapping between the Software and the UNFCCC ETF Reporting Tool

The attached tables reflect the UNFCCC CRT agreed by Parties for reporting under the Paris Agreement, and the corresponding mapping instructions from the *Software*.

Table 3. Detailed mapping between the *Software* and the UNFCCC ETF reporting Tool *Please note that the tables are accessible by clicking the ATTACH icon (paper-clip) on the left-hand side of your screen.*

Notation keys are automatically populated in some cells of the visualized CRT for the IPPU sector. In some cases, these are automatically populated for all users (e.g. recovery of biogenic CO₂ from the mineral industry is automatically populated as "NA" for all users as it is not applicable). In some cases, certain notation keys will be populated depending on user choices (for example, if the user applies Tier 1 for refrigeration and air conditioning, all emissions are reported under commercial refrigeration in the CRT, and other sub-applications (except mobile air conditioning) are reported as "IE".

Table 4 explains the use of notation keys for each table relevant for reporting of GHG emissions from the IPPU sector. If appropriate for national circumstances, the user may change the type of notation key populated prior to generating the JSON file (e.g. if a category labelled as "IE" or "NA" is really not occurring in the country the user may change the notation key to "NO"). Recall that for reporting in the CRTs, Parties should provide the necessary explanations for the use of the notation keys "NE" and "IE". Refer to the <u>UNFCCC Interoperability-CRT Export Quick Start Guide</u> for more information on how to change notation keys and enter notation key explanations.

Note that the information included in Table 4 is in addition to the automatic population of notation keys if a user does not include any information for a category/gas. These rules can be found in the top of the columns for each table of the CRT (see the mapping files attached to this Guidebook for the specific rules for each column header).

			Automa	ion Keys in the IPPU Sector of the CR1
CRT Table	CRT category (ies)	Parameter/G as	tic mappin g	Explanation
2(I)A-H	2.A.1, 2.A.2 2.A.3, 2.A.4 (all)	CO ₂ biogenic recovery /capture	NA	Any CO_2 recovery here is of process-related CO_2 ; so biogenic CO_2 is not applicable. All recovery is reported under CO_2 fossil.
2(I)A-H	2.B.7, 2.C.3 2.C.4, 2.C.7.a 2.D.1, 2.D.2 2.D.3 (all), 2.G.4, 2.H.1, 2.H.2	CO2 biogenic recovery /capture	NA	Any CO ₂ recovery here is of process-related CO ₂ ; so biogenic CO ₂ is not applicable. All recovery is reported under CO ₂ fossil.
2(I)A-H	2.D.3.d. Other -Urea- based catalysts	CH ₄ and N ₂ O (emissions and recovery)	NA	This category is from IPCC <i>Software</i> category 1.A.3.b.vi – Urea-based catalysts, which only estimates CO ₂ emissions. Thus, CH ₄ and N ₂ O emissions and removals are not applicable.
2(I)A-H	2.G.4 2.H.3	AD	NA	AD are automatically reported in the CRT as "NA." Given the large number of possible activities a user may choose to report here, the AD have not been aggregated. The user should describe the nature and quantity of these AD in the documentation box and/or NID.
2(I)A-H	2.H.1 2.H.2	AD	NA	AD are automatically reported in the CRT as "NA" because the user has a choice to report information based on production or consumption. The user may update these pale green cells (both for description and the amount of AD) to reflect the actual reporting.
Table 2(II).B- Hs2	2.F.1.b, 2.F.1.c, 2.F.1.d, 2.F.1.f	Emissions	IE	If in IPCC category 2.F.1, the user applies the Tier 1 method only (i.e. completes worksheet F-gas Emissions), all emissions are reported under CRT category 2.F.1.a commercial refrigeration, and the other sub-applications are reported as "IE". The Tier 1 method does not break consumption down into sub-applications, as shown in the CRT and a decision had to be made into which sub-application emissions would be reported.
Table 2(II).B- Hs2	2.F (all)	AD/ Emissions	NE	The <i>Software</i> automatically inserts an "NE" in cases where the result in a cell is zero or blank AND the gas is listed as in table 7.1 of the 2006 IPCC Guidelines (Volume 3, chapter 7) as a common gas for that application. If the activity and/or gas does not occur in the country, the user should change the "NE" to an "NO".
Table 2(II).B- Hs2	2.F.3, 2.F.4.a, 2.F.4.b, 2.F.6.a, 2.G.2.(all), 2.G.4, 2.H.3	Emissions from manufacturing	IE	If a user reports any emissions from stocks, then emissions from manufacturing are reported as "IE" and included in stocks. Otherwise, "NE" or "NO" is reported.
Table 2(II).B- Hs2	2.G.2.a, 2.G.2.b, 2.G.2.d,	Emissions from disposal	IE	If a user reports any emissions from stocks, then emissions from disposal are reported as "IE" and included in stocks. Otherwise, "NE" or "NO" is reported.

Table 4. Automatic Reporting of Notation Keys in the IPPU Sector of the CRT

	2.G.2.e, 2.G.4, 2.H.3			
Table 2(II).B- Hs2	2.G.2.a.ii	Emissions from disposal	NA	This category is "other prompt emissive applications"; Since prompt emissions do not have disposal, this is automatically reported as "NA".
2(II)B- Hs1 and 2(II)B- Hs2	All	AD and emissions	С	If the user reports any F-gas as confidential, "C" will appear in the reporting table for AD and emissions for that category. All F-gases will be reported as stocks under 2.H.3, in tCO ₂ eq.