

Version 1  
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# ENERGY SECTOR USERS' GUIDEBOOK

## IPCC Inventory Software, version 2.89

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**This Guidebook is prepared by IPCC TFI TSU. It has not been a subject to the formal IPCC review process**

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## Abbreviations

<i>2006 IPCC Guidelines</i>	2006 IPCC Guidelines for National Greenhouse Gas Inventories
<i>2019 Refinement</i>	2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories
AD	activity data
C	carbon
CC	carbon content
ECT	emission control technology
EF	emission factor
GCV	gross calorific value
Gg	gigagram
GHG	greenhouse gas
IPCC	Intergovernmental Panel on Climate Change
IPCC TFI-TSU (or TSU)	Technical Support Unit of the IPCC Task Force on National Greenhouse Gas Inventories
IPPU	Industrial Processes and Product Use
kPa	kilopascal
l	litre
LTO	landing / take-off
m <sup>3</sup>	cubic meters
NCV	net calorific value
NGHGI	national GHG inventory
TFI	IPCC Task Force on National Greenhouse Gas Inventories
TJ	terajoule
<i>Wetlands Supplement</i>	2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands



## 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 Greenhouse 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 factor (EF) selection and input, to GHG estimation and reporting.

*Software* users must be familiar with the 2006 IPCC Guidelines methods and read the *Software's* manual (downloadable from the “Help” menu) before going through this guidebook. This guidebook does not replace guidance provided in the 2006 IPCC Guidelines.

### Scope

The guidebook covers all methodological tiers and approaches provided in the 2006 IPCC Guidelines and the *Wetlands Supplement*<sup>1</sup> to estimate anthropogenic GHG emissions and removals from each inventory category as well as to deal with cross-cutting elements. Elements of the 2019 Refinement<sup>2</sup> are introduced in limited cases, where needed to enable interoperability between the *Software* and the UNFCCC electronic reporting tool for CRT.

### 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<sup>3</sup>. Multiple categories (e.g. electricity generation and non-ferrous metals) are grouped together when the underlying instructions are the same for entering information in the *Software*. Table 1 below provides the definitions of various categories, as well as a hyperlink to the relevant section of the guidebook where further information may be found.

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, emission factors 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 activity data and emission factor 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:

**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-specific<sup>4</sup> methodology, Tier 1 equations can be used to enter AD and Implied Emission Factor(s), 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 1.A.3.d water-borne navigation).

<sup>1</sup> Elements derived from the *Wetlands Supplement* are clearly distinguishable because of the **lilac** colour used to mark those.

<sup>2</sup> Elements derived from the 2019 Refinement are clearly distinguishable because of **magenta** colour used to mark those.

<sup>3</sup> In few instances, denoted by **magenta** colour, from the 2019 Refinement.

<sup>4</sup> User-specific methodologies need anyhow to be accordant with IPCC *good practice* to satisfy the Transparency, Completeness, Consistency, Accuracy and thus Comparability reporting principles.

**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.

### Tips

Stratification<sup>5</sup> of variables<sup>6</sup> 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 a two-way, 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 out<sup>7</sup> while all remaining are reported within a single aggregation<sup>8</sup>, as e.g. *unspecified*<sup>9</sup>.

However, the *Software* allows to enter each combination of variables, e.g. subdivision/fuel/vehicle type/ECT, only once. A way to further disaggregate such a combination across 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*).

### Interoperability with the UNFCCC electronic reporting tool for the Common Reporting Tables (CRT)

The *Software* has been upgraded for the energy sector to be interoperable with the United Nations Framework Convention on Climate Change (UNFCCC) electronic reporting tool for the Common Reporting Tables (CRT) under the Enhanced Transparency Framework of the Paris Agreement.<sup>10</sup> In practice, that means that users of the *Software* can estimate GHG emissions and CO<sub>2</sub> 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 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 electronic reporting tool for CRT.

A separate Guidebook, titled [IPCC Inventory Software: UNFCCC Interoperability- CRT Export Quick Start Guide](#), has been developed to assist users in generating the JSON file for upload to the UNFCCC electronic reporting tool for CRT. Annex I illustrates the mapping of activity data and GHG estimates for categories/gases from the *Software* to the corresponding UNFCCC CRT category/ies.

<sup>5</sup> The larger the number of strata, the more accurate and precise the estimates are.

<sup>6</sup> Stratification is the act of sorting data into distinct groups or layers.

<sup>7</sup> By applying a higher tier method

<sup>8</sup> By applying a lower tier method

<sup>9</sup> This does not apply to variables required by IPCC Tier 1 method.

<sup>10</sup> As requested by Parties in decision 5/CMA.3, paragraphs 19 and 20.

# 1 - Energy Sector

The Energy sector covers all GHG emissions arising from combustion of fuels or as fugitive releases from those. Emissions from the non-energy uses of fuels are generally not included here, but reported under the Industrial Processes and Product Use (IPPU) sector. Where carbonates such as limestone or dolomite are consumed for environmental pollution control (e.g. for flue gas desulphurisation) these emissions are reported in the category of the energy sector where the carbonates are consumed. However, these emissions are calculated in the IPPU sector of the *Software* (see the IPPU Guidebook for further information).

As CO<sub>2</sub> emissions from fuel combustion dominate GHG emissions in many countries, an independent check is required through the “Reference Approach”. It is *good practice* to apply both, a sectoral approach and the reference approach, to estimate a total CO<sub>2</sub> emission from fuel combustion and to compare the results of these two independent estimates. Significant differences indicate possible problems with the AD, calorific values, carbon contents, excluded carbon calculation, etc.

The Reference Approach is a top-down approach and in that respect is relatively independent from the bottom-up approach as described in the Tier 1, Tier 2, and Tier 3 methods. It consists of a methodology for producing a first-order estimate of national GHG emission based on a C mass balance of fuels supplied for energy use [see section on [Reference Approach](#)].

Where not indicated, all references from the *2006 IPCC Guidelines* and its *2019 Refinement* come from Volume 2 [Energy sector]

**Table 1.** lists all categories included in the Energy sector of the *2006 IPCC Guidelines*, as refined by the *2019 Refinement* for those categories relevant for the interoperability with the UNFCCC electronic reporting tool for the Common Reporting Tables

Categories	Definitions	Guidebook
<b>1.A - Fuel Combustion Activities</b>	Emissions from the intentional oxidation of materials within an apparatus that is designed to raise heat and provide it either as heat or as mechanical work to a process or for use away from the apparatus.	
<b>1.A.1 - Energy Industries</b>	Comprises emissions from fuels combusted by the fuel extraction or energy-producing industries	
1.A.1.a - Main Activity Electricity and Heat Production	Sum of emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (formerly known as public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included. Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector (e.g. 1.A.2/1.A.4) where they were generated and not under 1.A.1.a. Autoproducers may be in public or private ownership.	
1.A.1.a.i - Electricity Generation	Comprises emissions from all fuel use for electricity generation from main activity producers except those from combined heat and power plants.	<b>1.A - Stationary Combustion Source Categories</b>
1.A.1.a.ii - Combined Heat and Power Generation (CHP)	Emissions from production of both heat and electrical power from main activity producers for sale to the public, at a single CHP facility.	<b>1.A - Stationary Combustion Source Categories</b>
1.A.1.a.iii - Heat Plants	Production of heat from main activity producers for sale by pipe network.	<b>1.A - Stationary Combustion Source Categories</b>
1.A.1.b - Petroleum Refining	All combustion activities supporting the refining of petroleum products including on-site combustion for the generation of electricity and heat for own use. Does not include evaporative emissions occurring at the refinery; which should be reported separately under 1.B.2.a.	<b>1.A - Stationary Combustion Source Categories</b>
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	Combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. Emissions from own on-site fuel use should be included. Also includes combustion for the generation of electricity and heat for own use in these industries	
1.A.1.c.i - Manufacture of Solid Fuels	Emissions arising from fuel combustion for the production of coke, brown coal briquettes and patent fuel.	<b>1.A - Stationary Combustion Source Categories</b>
1.A.1.c.ii - Other Energy Industries	Combustion emissions arising from the energy-producing industries own (on-site) energy use not mentioned above or for which separate data are not available. This includes the emissions from own-energy use for the production of charcoal, bagasse, saw dust, cotton stalks and carbonizing of biofuels as well as fuel used for coal mining, oil and gas extraction and the processing and upgrading of natural gas. This category also includes emissions from pre-combustion processing for CO <sub>2</sub> capture and storage. Combustion emissions from pipeline transport should be reported under 1.A.3.e.	<b>1.A - Stationary Combustion Source Categories</b>
<b>1.A.2 - Manufacturing Industries and Construction</b>	Emissions from combustion of fuels in industry. Also includes combustion for the generation of electricity and heat for own use in these industries. Emissions from fuel combustion in coke ovens within the iron and steel industry should be reported under 1.A.1.c and not within manufacturing industry. Emissions from the industry sector should be specified by sub-categories that correspond to the International Standard Industrial Classification of all Economic Activities (ISIC). Energy used for transport by industry should not be reported here but under Transport (1.A.3). Emissions arising from off-road and other mobile machinery in industry should, if possible, be broken out as a separate subcategory. For each country, the emissions from the largest fuel-consuming industrial categories ISIC should be reported, as well as those from significant emitters of pollutants. A suggested list of categories is outlined below.	

Categories	Definitions	Guidebook
1.A.2.a - Iron and Steel	ISIC Group 271 <sup>11</sup> and Class 2731	1.A - Stationary Combustion Source Categories
1.A.2.b - Non-Ferrous Metals	ISIC Group 272 and Class 2732	1.A - Stationary Combustion Source Categories
1.A.2.c - Chemicals	ISIC Division 24	1.A - Stationary Combustion Source Categories
1.A.2.d - Pulp, Paper and Print	ISIC Divisions 21 and 22	1.A - Stationary Combustion Source Categories
1.A.2.e - Food Processing, Beverages and Tobacco	ISIC Divisions 15 and 16	1.A - Stationary Combustion Source Categories
1.A.2.f - Non-Metallic Minerals	Includes products such as glass, ceramic, cement, etc.; ISIC Division 26.	1.A - Stationary Combustion Source Categories
1.A.2.g - Transport Equipment	ISIC Divisions 34 and 35	1.A - Stationary Combustion Source Categories
1.A.2.h - Machinery	Includes fabricated metal products, machinery and equipment other than transport equipment; ISIC Divisions 28, 29, 30, 31 and 32.	1.A - Stationary Combustion Source Categories
1.A.2.i - Mining (excluding fuels) and Quarrying	ISIC Divisions 13 and 14	1.A - Stationary Combustion Source Categories
1.A.2.j - Wood and wood products	ISIC Division 20	1.A - Stationary Combustion Source Categories
1.A.2.k - Construction	ISIC Division 45	1.A - Stationary Combustion Source Categories
1.A.2.l - Textile and Leather	ISIC Divisions 17, 18 and 19	1.A - Stationary Combustion Source Categories
1.A.2.m - Non-specified Industry	Any manufacturing industry/construction not included in previous categories, or for which separate data are not available. Includes ISIC Divisions 25, 33, 36 and 37.	1.A - Stationary Combustion Source Categories
<b>1.A.3 - Transport</b>	Emissions from the combustion and evaporation of fuel for all transport activity (excluding military transport), regardless of the sector, specified by sub-categories below. Emissions from fuel sold to any air or marine vessel engaged in international transport (1.A.3.a.i and 1.A.3.d.i) should as far as possible be excluded from the totals and subtotals in this category and should be reported separately.	
1.A.3.a - Civil Aviation	Emissions from international and domestic civil aviation, including take-offs and landings. Comprises civil commercial use of airplanes, including scheduled and charter traffic for passengers and freight, air taxiing, and general aviation. The international/domestic split should be determined based on departure and landing locations for each flight stage and not by the nationality of the airline. Exclude use of fuel at airports for ground transport which is reported under 1.A.3.e Other Transportation. Also exclude fuel for stationary combustion at airports; report this information under the appropriate stationary combustion category.	
1.A.3.a.i - International Aviation (International Bunkers)	Emissions from flights that depart in one country and arrive in a different country. Include take-offs and landings for these flight stages. Emissions from international military aviation can be included as a separate subcategory of international aviation provided that the same definitional distinction is applied, and data are available to support the definition.	1.A.3.a - Civil Aviation

<sup>11</sup> The ISIC references to “Division”, “Group” and “Class” are based on the [International Standard Industrial Classification of All Economic Activities \(ISIC\), Revision 3.1](#), which was the latest available publication at the time of development of the 2006 IPCC Guidelines.

Categories	Definitions	Guidebook
1.A.3.a.ii - Domestic Aviation	Emissions from civil domestic passenger and freight traffic that departs and arrives in the same country (commercial, private, agriculture, etc.), including take-offs and landings for these flight stages. Note that this may include journeys of considerable length between two airports in a country (e.g. San Francisco to Honolulu). Exclude military, which should be reported under 1.A.5.b.	<b>1.A.3.a - Civil Aviation</b>
1.A.3.b - Road Transportation	All combustion and evaporative emissions arising from fuel use in road vehicles, including the use of agricultural vehicles on paved roads.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.i - Cars	Emissions from automobiles so designated in the vehicle registering country primarily for transport of persons and normally having a capacity of 12 persons or fewer.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.i.1 - Passenger cars with 3-way catalysts	Emissions from passenger car vehicles with 3-way catalysts.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.i.2 - Passenger cars without 3-way catalysts	Emissions from passenger car vehicles without 3-way catalysts.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.ii - Light-duty trucks	Emissions from vehicles so designated in the vehicle registering country primarily for transportation of light-weight cargo or which are equipped with special features such as four-wheel drive for off-road operation. The gross vehicle weight normally ranges up to 3500-3900 kg or less.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts	Emissions from light duty trucks with 3-way catalysts.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts	Emissions from light duty trucks without 3-way catalysts.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.iii - Heavy-duty trucks and buses	Emissions from any vehicles so designated in the vehicle registering country. Normally the gross vehicle weight ranges from 3500-3900 kg or more for heavy duty trucks and the buses are rated to carry more than 12 persons.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.iv - Motorcycles	Emissions from any motor vehicle designed to travel with not more than three wheels in contact with the ground and weighing less than 680 kg.	<b>1.A.3.b - Road Transportation</b>
1.A.3.b.v - Evaporative emissions from vehicles	Evaporative emissions from vehicles (e.g. hot soak, running losses) are included here. Emissions from loading fuel into vehicles are excluded.	<b>1.A.3.b.v - Evaporative emissions from vehicles</b>
1.A.3.b.vi - Urea-based catalysts	CO <sub>2</sub> emissions from use of urea-based additives in catalytic converters (non-combustive emissions).	<b>1.A.3.b.vi - Urea-based catalysts</b>
1.A.3.c - Railways	Emissions from railway transport for both freight and passenger traffic routes.	<b>1.A.3.c - Railways</b>
1.A.3.d - Water-borne Navigation	Emissions from fuels used to propel water-borne vessels, including hovercraft and hydrofoils, but excluding fishing vessels. The international/domestic split should be determined on the basis of port of departure and port of arrival, and not by the flag or nationality of the ship.	



Categories	Definitions	Guidebook
1.A.3.d.i - International water-borne navigation (International bunkers)	Emissions from fuels used by vessels of all flags that are engaged in international water-borne navigation. The international navigation may take place at sea, on inland lakes and waterways and in coastal waters. Includes emissions from journeys that depart in one country and arrive in a different country. Exclude consumption by fishing vessels (see Other Sectors - Fishing). Emissions from international military water-borne navigation can be included as a separate sub-category of international water-borne navigation provided that the same definitional distinction is applied, and data are available to support the definition.	1.A.3.d - Water-borne Navigation
1.A.3.d.ii - Domestic Water-borne Navigation	Emissions from fuels used by vessels of all flags that depart and arrive in the same country (exclude fishing, which should be reported under 1.A.4.c.iii, and military, which should be reported under 1.A.5.b). Note that this may include journeys of considerable length between two ports in a country (e.g. San Francisco to Honolulu).	1.A.3.d - Water-borne Navigation
1.A.3.e - Other Transportation	Combustion emissions from all remaining transport activities including pipeline transportation, ground activities in airports and harbours, and off-road activities not otherwise reported under 1.A.4.c Agriculture/Forestry/Fishing/Fish Farms or 1.A.2. Manufacturing Industries and Construction. Military transport should be reported under 1.A.5 (see 1.A.5 Non-specified).	
1.A.3.e.i - Pipeline Transport	Combustion related emissions from the operation of pump stations and maintenance of pipelines. Transport via pipelines includes transport of gases, liquids, slurry and other commodities via pipelines. Distribution of natural or manufactured gas, water or steam from the distributor to final users is excluded and should be reported in 1.A.1.c.ii or 1.A.4.a.	1.A.3.e.i - Pipeline transport
1.A.3.e.ii - Off-road	Combustion emissions from Other Transportation, excluding Pipeline Transport.	1.A.3.e.ii - Off-road transportation
<b>1.A.4 - Other Sectors</b>	Emissions from combustion activities as described below, including combustion for the generation of electricity and heat for own use in these sectors.	
1.A.4.a - Commercial/Institutional	Emissions from fuel combustion in commercial and institutional buildings; all activities included in ISIC Divisions 41, 50, 51, 52, 55, 63-67, 70-75, 80, 85, 90-93 and 99.	1.A - Stationary Combustion Source Categories
1.A.4.b - Residential	All emissions from fuel combustion in households.	1.A - Stationary Combustion Source Categories
1.A.4.c - Agriculture/Forestry/Fishing/Fish Farms	Emissions from fuel combustion in agriculture, forestry, fishing and fishing industries such as fish farms. Activities included in ISIC Divisions 01, 02 and 05. Highway agricultural transportation is excluded.	
1.A.4.c.i - Stationary	Emissions from fuels combusted in pumps, grain drying, horticultural greenhouses and other agriculture, forestry or stationary combustion in the fishing industry.	1.A - Stationary Combustion Source Categories
1.A.4.c.ii - Off-road Vehicles and Other Machinery	Emissions from fuels combusted in traction vehicles on farm land and in forests.	1.A.3.e.ii - Off-road transportation
1.A.4.c.iii - Fishing (mobile combustion)	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country (include international fishing).	1.A.3.d - Water-borne Navigation
<b>1.A.5 - Non-Specified</b>	All remaining emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries that are not engaged in multilateral operations.	

Categories	Definitions	Guidebook
1.A.5.a - Stationary	Emissions from fuel combustion in stationary sources that are not specified elsewhere.	<b>1.A - Stationary Combustion Source Categories</b>
1.A.5.b - Mobile	Emissions from vehicles and other machinery, marine and aviation (not included in 1.A.4.c.ii or elsewhere).	
1.A.5.b.i - Mobile ( <i>aviation component</i> )	All remaining aviation emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in multilateral operations.	<b>1.A.3.a - Civil Aviation</b>
1.A.5.b.ii - Mobile ( <i>water-borne component</i> )	All remaining water-borne emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in multilateral operations.	<b>1.A.3.d - Water-borne Navigation</b>
1.A.5.b.iii - Mobile ( <i>other</i> )	All remaining emissions from mobile sources not included elsewhere.	<b>1.A.3.b - Road Transportation</b> <b>1.A.3.e.ii - Off-road transportation</b>
1.A.5.c - Multilateral Operations	Emissions from fuels used in multilateral operations pursuant to the Charter of the United Nations. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries.	<b>1.A.3.a.i - Civil Aviation</b> <b>1.A.3.d - Water-borne Navigation</b>
<b>1.B - Fugitive emissions from fuels</b>	Includes all intentional and unintentional emissions from the extraction, processing, storage and transport of fuel to the point of final use.	
<b>1.B.1 - Solid Fuels</b>	Includes all intentional and unintentional emissions from the extraction, processing, storage and transport of solid fuel to the point of final use.	
1.B.1.a - Coal mining and handling	Includes all fugitive emissions from coal.	
1.B.1.a.i - Underground mines	Includes all emissions arising from mining, post-mining, abandoned mines and flaring of drained methane.	
1.B.1.a.i.1 - Mining	Includes all seam gas emissions vented to atmosphere from coal mine ventilation air and degasification systems.	<b>1.B.1.a.i - Underground Mines</b>
1.B.1.a.i.2 - Post-mining seam gas emissions	Includes methane and CO <sub>2</sub> emitted after coal has been mined, brought to the surface and subsequently processed, stored and transported.	<b>1.B.1.a.i - Underground Mines</b>
1.B.1.a.i.3 - Abandoned underground mines	Includes methane emissions from abandoned underground mines.	<b>1.B.1.a.i.3 - Abandoned Underground Mines</b>
1.B.1.a.i.4 - Flaring of drained methane or conversion of methane to CO <sub>2</sub>	Methane drained and flared, or ventilation gas converted to CO <sub>2</sub> by an oxidation process should be included here. Methane used for energy production should be included in Volume 2, Energy, Chapter 2 'Stationary Combustion'.	<b>1.B.1.a.i.4 - Flaring or Conversion of drained CH<sub>4</sub> to CO<sub>2</sub></b>
1.B.1.a.ii - Surface mines	Includes all seam gas emissions arising from surface coal mining	
1.B.1.a.ii.1 - Mining	Includes methane and CO <sub>2</sub> emitted during mining from breakage of coal and associated strata and leakage from the pit floor and highwall	<b>1.B.1.a.ii - Surface Mines</b>
1.B.1.a.ii.2 - Post-mining seam gas emissions	Includes methane and CO <sub>2</sub> emitted after coal has been mined, subsequently processed, stored and transported.	<b>1.B.1.a.ii - Surface Mines</b>



Categories	Definitions	Guidebook
1.B.1.a.ii.3- Abandoned surface mines	Includes methane emissions from abandoned surface mines.	1.B.1.a.ii.3 - Abandoned Surface Mines
1.B.1.b - Uncontrolled combustion and burning coal dumps	Includes emissions of CO <sub>2</sub> from uncontrolled combustion due to coal exploitation activities.	1.B.1.b - Uncontrolled combustion and burning coal dumps
1.B.1.c - Fuel transformation	Fugitive emissions arising during the manufacture of secondary and tertiary products from fuels.	1.B.1.c - Fuel Transformation
1.B.1.c.i – Charcoal and biochar production	Fugitive emissions arising during the production of charcoal and biochar.	1.B.1.c.i - Charcoal and Biochar production
1.B.1.c.ii – Coke production	Fugitive emissions arising during the production of coke.	1.B.1.c.ii - Coke production
1.B.1.c.iv – Gasification transformation	Fugitive emissions from the transformation of biomass, coal or natural gas into syngas, composed by H <sub>2</sub> , CO, CO <sub>2</sub> and CH <sub>4</sub> , and, then, into a liquid hydrocarbons fuels.	1.B.1.c.iv - Gasification transformation
1.B.2 - Oil and Natural Gas	Comprises fugitive emissions from all oil and natural gas activities. The primary sources of these emissions may include fugitive equipment leaks, evaporation losses, venting, flaring and accidental releases.	
1.B.2.a - Oil	Comprises emissions from venting, flaring and all other fugitive sources associated with the exploration, production, transmission, upgrading, and refining of crude oil and distribution of crude oil products.	
1.B.2.a.i - Venting	Emissions from venting of associated gas and waste gas/vapour streams at oil facilities.	1.B.2.a.i - Oil, Venting
1.B.2.a.ii - Flaring	Emissions from flaring of natural gas and waste gas/vapour streams at oil facilities.	1.B.2.a.ii - Oil, Flaring
1.B.2.a.iii - All Other	Fugitive emissions at oil facilities from equipment leaks, storage losses, pipeline breaks, well blowouts, land farms, gas migration to the surface around the outside of wellhead casing, surface casing vent bows, biogenic gas formation from tailings ponds and any other gas or vapour releases not specifically accounted for as venting or flaring.	
1.B.2.a.iii.1 - Exploration	Fugitive emissions (excluding venting and flaring) from oil well drilling, drill stem testing, and well completions.	1.B.2.a - Oil, Fugitives
1.B.2.a.iii.2 - Production and Upgrading	Fugitive emissions from oil production (excluding venting and flaring) occur at the oil wellhead or at the oil sands or shale oil mine through to the start of the oil transmission system. This includes fugitive emissions related to well servicing, oil sands or shale oil mining, transport of untreated production (i.e., well effluent, emulsion, oil shale and oilsands) to treating or extraction facilities, activities at extraction and upgrading facilities, associated gas re-injection systems and produced water disposal systems. Fugitive emissions from upgraders are grouped with those from production rather than those from refining since the upgraders are often integrated with extraction facilities and their relative emission contributions are difficult to establish. However, upgraders may also be integrated with refineries, cogeneration plants or other industrial facilities and their relative emission contributions can be difficult to establish in these cases.	1.B.2.a - Oil, Fugitives

Categories	Definitions	Guidebook
1.B.2.a.iii.3 - Transport	Fugitive emissions (excluding venting and flaring) related to the transport of marketable crude oil (including conventional, heavy and synthetic crude oil and bitumen) to upgraders and refineries. The transportation systems may comprise pipelines, marine tankers, tank trucks and rail cars. Evaporation losses from storage, filling and unloading activities and fugitive equipment leaks are the primary sources of these emissions.	1.B.2.a - Oil, Fugitives
1.B.2.a.iii.4 - Refining	Fugitive emissions (excluding venting and flaring) at petroleum refineries. Refineries process crude oils, natural gas liquids and synthetic crude oils to produce final refined products (e.g., primarily fuels and lubricants). Where refineries are integrated with other facilities (for example, upgraders or co-generation plants) their relative emission contributions can be difficult to establish.	1.B.2.a - Oil, Fugitives
1.B.2.a.iii.5 - Distribution of oil products	This comprises fugitive emissions (excluding venting and flaring) from the transport and distribution of refined products, including those at bulk terminals and retail facilities. Evaporation losses from storage, filling and unloading activities and fugitive equipment leaks are the primary sources of these emissions.	1.B.2.a - Oil, Fugitives
1.B.2.a.iii.6 - Other	Fugitive emissions from oil systems (excluding venting and flaring) not otherwise accounted for in the above categories. This includes fugitive emissions from spills and other accidental releases, waste oil treatment facilities and oilfield waste disposal facilities.	1.B.2.a - Oil, Fugitives
1.B.2.b - Natural Gas	Comprises emissions from venting, flaring and all other fugitive sources associated with the exploration, production, processing, transmission, storage and distribution of natural gas (including both associated and non-associated gas).	
1.B.2.b.i - Venting	Emissions from venting of natural gas and waste gas/vapour streams at gas facilities.	1.B.2.b.i - Natural Gas, Venting
1.B.2.b.ii - Flaring	Emissions from flaring of natural gas and waste gas/vapour streams at gas facilities.	1.B.2.b.ii - Natural Gas, Flaring
1.B.2.b.iii - All Other	Fugitive emissions at natural gas facilities from equipment leaks, storage losses, pipeline breaks, well blowouts, gas migration to the surface around the outside of wellhead casing, surface casing vent bows and any other gas or vapour releases not specifically accounted for as venting or flaring.	
1.B.2.b.iii.1 - Exploration	Fugitive emissions (excluding venting and flaring) from gas well drilling, drill stem testing and well completions.	1.B.2.b - Natural Gas, Fugitives
1.B.2.b.iii.2 - Production	Fugitive emissions (excluding venting and flaring) from the gas wellhead through to the inlet of gas processing plants, or, where processing is not required, to the tie-in points on gas transmission systems. This includes fugitive emissions related to well servicing, gas gathering, processing and associated waste water and acid gas disposal activities.	1.B.2.b - Natural Gas, Fugitives
1.B.2.b.iii.3 - Processing	Fugitive emissions (excluding venting and flaring) from gas processing facilities.	1.B.2.b - Natural Gas, Fugitives
1.B.2.b.iii.4 - Transmission and Storage	Fugitive emissions from systems used to transport processed natural gas to market (i.e., to industrial consumers and natural gas distribution systems). Fugitive emissions from natural gas storage systems should also be included in this category. Emissions from natural gas liquids extraction plants on gas transmission systems should be reported as part of natural gas processing (Sector 1.B.2.b.iii.3). Fugitive emissions related to the transmission of natural gas liquids should be reported under Category 1.B.2.a.iii.3.	1.B.2.b - Natural Gas, Fugitives

Categories	Definitions	Guidebook
1.B.2.b.iii.5 - Distribution	Fugitive emissions (excluding venting and flaring) from the distribution of natural gas to end users.	1.B.2.b - Natural Gas, Fugitives
1.B.2.b.iii.6 - Other	Fugitive emissions from natural gas systems (excluding venting and flaring) not otherwise accounted for in the above categories. This may include emissions from well blowouts and pipeline ruptures or dig-ins.	1.B.2.b - Natural Gas, Fugitives
1.B.3 - Other emissions from Energy Production	Emissions from geothermal energy production and other energy production not included in 1.B.1 or 1.B.2.	1.B.3 - Other Emissions from Energy Production
1.C. Carbon dioxide Transport and Storage	CO <sub>2</sub> capture and storage (CCS) involves the capture of CO <sub>2</sub> , its transport to a storage location and its long-term isolation from the atmosphere. Emissions associated with CO <sub>2</sub> transport, injection and storage are covered under category 1.C. Emissions (and reductions) associated with CO <sub>2</sub> capture should be reported under the IPCC sector in which capture takes place (e.g. Stationary Combustion or Industrial Activities).	
1.C.1. – Transport of CO <sub>2</sub>	Fugitive emissions from the systems used to transport captured CO <sub>2</sub> from the source to the injection site. These emissions may comprise fugitive losses due to equipment leaks, venting and releases due to pipeline ruptures or other accidental releases (e.g. temporary storage).	
1.C.1.a. Pipelines	Fugitive emissions from the pipeline system used to transport CO <sub>2</sub> to the injection site.	1.C - Carbon Dioxide Transport and Storage
1.C.1.b. Ships	Fugitive emissions from the ships used to transport CO <sub>2</sub> to the injection site.	1.C - Carbon Dioxide Transport and Storage
1.C.1.c Other (please specify)	Fugitive emissions from other systems used to transport CO <sub>2</sub> to the injection site and temporary storage.	1.C - Carbon Dioxide Transport and Storage
1.C.2. Injection and Storage	Fugitive emissions from activities and equipment at the injection site and those from the end containment once the CO <sub>2</sub> is placed in storage.	
1.C.2.a Injection	Fugitive emissions from activities and equipment at the injection site.	1.C - Carbon Dioxide Transport and Storage
1.C.2.b Storage	Fugitive emissions from the end containment once the CO <sub>2</sub> is placed in storage.	1.C - Carbon Dioxide Transport and Storage
1.C.3. Other	Any other emissions from CCS not reported elsewhere.	1.C - Carbon Dioxide Transport and Storage
Reference Approach	The Reference Approach is a top-down approach, using a country's energy supply data to calculate the emissions of CO <sub>2</sub> from combustion of mainly fossil fuels. The Reference Approach is a straightforward method that can be applied on the basis of relatively easily available energy supply statistics.	Reference Approach

**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 electronic reporting tool for CRT, 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.

## I. - General

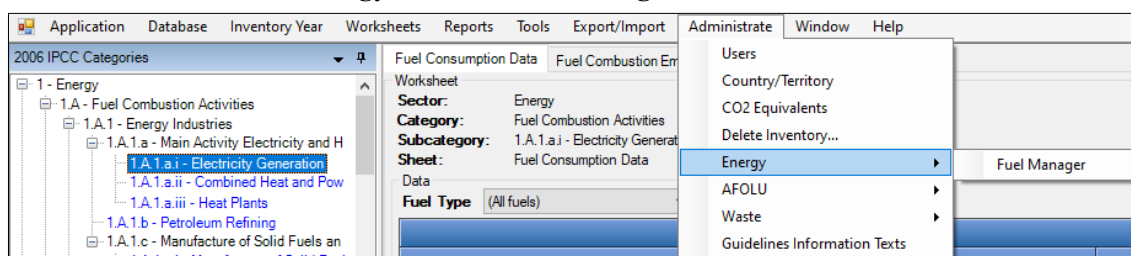
### I.1 - Fuel Manager

Before entering data in the Energy sector worksheets to estimate emissions from 1.A. (Fuel Combustion Activities), the Fuel Manager shall be populated with all relevant data that will be used by the *Software* to estimate GHG emissions.

The Fuel Manager contains data on *carbon content* and *calorific value* for each fuel used in the NGHGI. All IPCC default fuels are listed in it; in addition, the user can enter its own user-specific fuels together with relevant data required by the Fuel Manager.

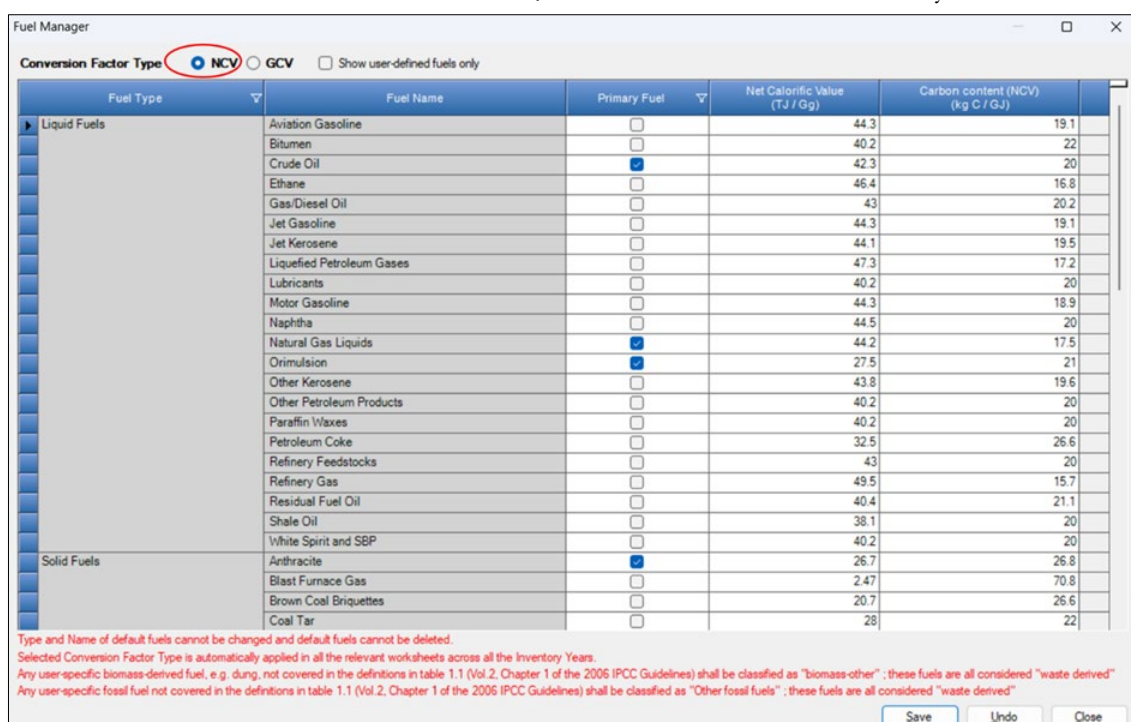
Fuel manager setting is the first step to prepare GHG estimates in 1.A, and it is done as follows:

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



2. On the window's top border, select either *NCV* (Net Calorific Value) or *GCV* (Gross Calorific Value) as the **Conversion Factor Type**. Note that:

- ✓ For each IPCC default fuel, when *NCV* is selected, the **Calorific Value** and the **Carbon Content** are prefilled with IPCC default values, which anyhow 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. For each new (user-specific) fuel entry the following steps apply:
  1. Click on the asterisk in the bottom-most row to add the user-specific fuel.
  2. Select **fuel type** from the drop-down menu.
  3. Enter specific **fuel name**.
  4. Indicate (checkbox) if it is a **primary fuel**<sup>12</sup> or not.
  5. Enter its **calorific value** in **TJ/Gg**, (either *NCV* or *GCV* according to the selection made for the entire Fuel Manager).
  6. Enter **carbon content** in **kg C/GJ**.

<sup>12</sup> 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 Manager

Conversion Factor Type ☐ NCV ☒ GCV ☐ Show user-defined fuels only

Fuel Type	Fuel Name	Primary Fuel	Gross Calorific Value (TJ / Gg)	Carbon content (GCV) (kg C / GJ)
Liquid Fuels	Aviation Gasoline	<input type="checkbox"/>		19.1
	Bitumen	<input type="checkbox"/>		22
	Crude Oil	<input checked="" type="checkbox"/>		20
	Ethane	<input type="checkbox"/>		16.8
	Gas/Diesel Oil	<input type="checkbox"/>		20.2
	Jet Gasoline	<input type="checkbox"/>		19.1
	Jet Kerosene	<input type="checkbox"/>		19.5
	Liquefied Petroleum Gases	<input type="checkbox"/>		17.2
	Lubricants	<input type="checkbox"/>		20
	Motor Gasoline	<input type="checkbox"/>		18.9
	Naphtha	<input type="checkbox"/>		20
	Natural Gas Liquids	<input checked="" type="checkbox"/>		17.5
	Orimulsion	<input checked="" type="checkbox"/>		21
	Other Kerosene	<input type="checkbox"/>		19.6
	Other Petroleum Products	<input type="checkbox"/>		20
	Paraffin Waxes	<input type="checkbox"/>		20
	Petroleum Coke	<input type="checkbox"/>		26.6
	Refinery Feedstocks	<input type="checkbox"/>		20
	Refinery Gas	<input type="checkbox"/>		15.7
	Solid Fuels	Residual Fuel Oil	<input type="checkbox"/>	
Shale Oil		<input type="checkbox"/>		20
White Spirit and SBP		<input type="checkbox"/>		20
Anthracite		<input checked="" type="checkbox"/>		26.8
Blast Furnace Gas		<input type="checkbox"/>		70.8
Brown Coal Briquettes		<input type="checkbox"/>		26.6
Coal Tar		<input type="checkbox"/>		22

Type and Name of default fuels cannot be changed and default fuels cannot be deleted.  
 Selected Conversion Factor Type is automatically applied in all the relevant worksheets across all the Inventory Years.  
 Any user-specific biomass-derived fuel, e.g. dung, not covered in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC Guidelines) shall be classified as "biomass-other"; these fuels are all considered "waste derived"  
 Any user-specific fossil fuel not covered in the definitions in table 1.1 (Vol.2, Chapter 1 of the 2006 IPCC Guidelines) shall be classified as "Other fossil fuels"; these fuels are all considered "waste derived"

Save Undo Close

To single out the user-defined fuels only, the corresponding box on the window's top border shall be marked.

Fuel Manager

Conversion Factor Type ☒ NCV ☐ GCV ☒ Show user-defined fuels only

Fuel Type	Fuel Name	Primary Fuel	Net Calorific Value (TJ / Gg)	Carbon content (NCV) (kg C / GJ)
Other Fossil Fuels	Diesel for off-road	<input type="checkbox"/>	38	17
	Diesel for trains	<input type="checkbox"/>	40	19
	Lignite Power Plants	<input checked="" type="checkbox"/>	12	30
	Natural Gas Power Plants	<input checked="" type="checkbox"/>	45	15
Biomass - other	biomass 1	<input type="checkbox"/>	10	25
		<input checked="" type="checkbox"/>		

**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.



The 2006 IPCC Guidelines provide methodological guidance to estimate anthropogenic GHG emissions and removals according to three methodological tier levels: Tier 1, Tier 2, Tier 3. Where Tier 1 is the common default methodological approach that the IPCC Guidelines provide to all inventory compilers, higher tiers are based on user-specific and multivariable-dependent rates of GHG emissions and CO<sub>2</sub> removals, and likely requires data with a higher spatial and temporal resolution. Tier 2 may apply a different methodological approach, or the Tier 1 methodology approach with user-specific values for parameters and EFs, and may further disaggregate the population of activity data to apply condition-specific values of parameters and EFs<sup>13</sup>. Tier 3 is generally<sup>14</sup> a user-specific methodology that maintain consistency with IPCC *good practice*, although it is designed to better cope with the user-specific statistical population for which GHG emissions/removals are estimated or it is based on the direct monitoring of the source of GHG emissions.

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 and its *Wetlands Supplement*, 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.

Subdivision	Fuel	Total consumption (TJ)	CO2 Emissions (Gg CO2)	CH4 Emissions (Gg CH4)	N2O Emissions (Gg N2O)
Example, Tier 1	Natural Gas (Dry)	4500	269.25	0.0048	0.00048
Example, Tier 2	Natural Gas Power Plants	4500	247.5	0.0045	0.00045
Example, Tier 3	Natural Gas Power Plants	4500	234	0.0025	0.00023
Total		13800	750.78	0.01155	0.00116

Figures show an example of applying three<sup>15</sup> different tiers, and reporting the total

Categories	CO2	CH4	N2O	NOx	CO	MMVOCs	SO2
1 - Energy	121912.205	1326.449	68.209				100.000
1.A - Fuel Combustion Activities	117484.923	1090.805	63.524				100.000
1.A.1 - Energy Industries	15661.745	2.847	0.124				
1.A.1.a - Main Activity Electricity and Heat Production	11599.044	2.853	0.096				
1.A.1.a.i - Electricity Generation	4122.820	2.566	0.030				
1.A.1.a.ii - Combined Heat and Power Generation (CHP)	6185.444	0.115	0.012				
1.A.1.a.iii - Heat Plants	750.780	0.012	0.001				
1.A.1.b - Petroleum Refining	1429.120	0.003	0.002				
1.A.1.c - Manufacture of Solid Fuels and Other Energy Industries	3173.582	0.131	0.025				
1.A.1.c.i - Manufacture of Solid Fuels	3173.582	0.131	0.025				
1.A.1.c.ii - Other Energy Industries							
1.A.2 - Manufacturing Industries and Construction	5435.850	1.114	0.155				
1.A.2.a - Non-Ferrous Metals	2100.590	0.127	0.025				
1.A.2.b - Non-Ferrous Metals							
1.A.2.c - Chemicals	642.450	0.004	0.000				
1.A.2.d - Pulp, Paper and Print							
1.A.2.e - Food Processing, Beverages and Tobacco							
1.A.2.f - Non-Metallic Minerals							
1.A.2.g - Transport Equipment							
1.A.2.h - Machinery	2692.800	0.043	0.005				
1.A.2.i - Mining (excluding fuels) and Quarrying							
1.A.2.j - Wood and wood products							
1.A.2.k - Construction	0.000	0.036	0.125				
1.A.2.l - Textile and Leather							

In doing so the user shall transparently describe in any accompanying inventory report the original methodology and the way it has derived the implied EF.

While, as described above, the user may use a combination of tiers within a single source category, it may also 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 to double count GHG emissions from a source.

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 CO<sub>2</sub> and/or CH<sub>4</sub> and/or N<sub>2</sub>O IEFs<sup>16</sup>, 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.

<sup>13</sup> For example, the Tier 2 approach for estimating CO<sub>2</sub> emissions from civil aviation separately considers CO<sub>2</sub> emissions from landings and take-offs and the cruise phase, whereas the Tier 1 approach estimates CO<sub>2</sub> emissions based on fuel consumption and default EFs.

<sup>14</sup> In some cases, IPCC also provides a Tier 3 methodology, as for instance for CH<sub>4</sub> and N<sub>2</sub>O emissions from Road transportation.

<sup>15</sup> In this example, Tier 1 – default factors, Tier 2 – user-specific NCVs, Tier 3 – technology specific factors

<sup>16</sup> Implied Emission Factors

GHG inventories can 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 Energy sector.

Where the user is interested in calculating GHG estimates at a single level of aggregation, e.g. national, in Column |S| either *unspecified* is to be selected from the dropdown menu or the single univocal name/code is to be entered e.g. the *country name*. Where multiple subdivisions, the univocal name/code for each subdivision will be entered in Column |S|, 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/removals.

Every calculation worksheet<sup>17</sup> includes filters to enable the user to view data entry, by subdivision.

### Example: subdivisions and applying filter

Subdivision	Fuel	Vehicle type	Emission control technology	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit)	Total consumption (TJ)
(All)	Motor Gasoline	5-7 seat	OC	1500	Gg (Auto CF)	44.3	66450
Other Passenger Cars	Motor Gasoline	5 seat	THC/OC	1500	Gg (Auto CF)	44.3	66450
Taxis in Capital	Gas/Diesel Oil	5-7 seat	THC	2000	Gg (Auto CF)	43	86000
Taxis in other cities	Motor Gasoline	5-7 seat	OC	1500	Gg (Auto CF)	44.3	66450
Heavy motor cars	Motor Gasoline	5-7 seat	OC	1500	Gg (Auto CF)	44.3	66450
Total							263200

### Example: viewing filtered results

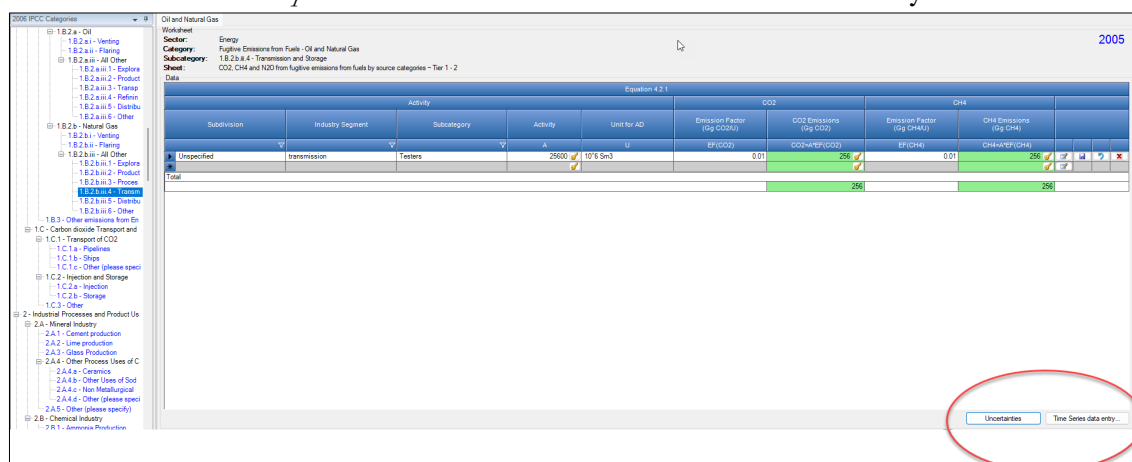
Subdivision	Fuel	Vehicle type	Emission control technology	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	Amount (kg CO2)	CO2 Emissions (kg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (kg CH4)	CH4=CHF (CH4)/10% (kg CO2)	CH4=CHF (CH4)/10% (kg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (kg N2O)	N2O=CHF (N2O)/10% (kg CO2)	N2O=CHF (N2O)/10% (kg N2O)
Taxis in other cities	Gas/Diesel Oil	5-7 seat	THC	86000	74100	6372.6	6372.6	3.9	0.3354	25	1.99665	8	0.5318	0.867	0.867
Taxis in other cities	Motor Gasoline	5-7 seat	OC	66450	69300	4604.985	4604.985	25	1.66125	8	0.5318	8	0.5318	0.867	0.867
Total				152450		10977.586	10977.586	1.99665	1.99665						

<sup>17</sup> Those can also be referred as TABs of the Software

## I.4. - “Uncertainty” and “Time Series data entry”

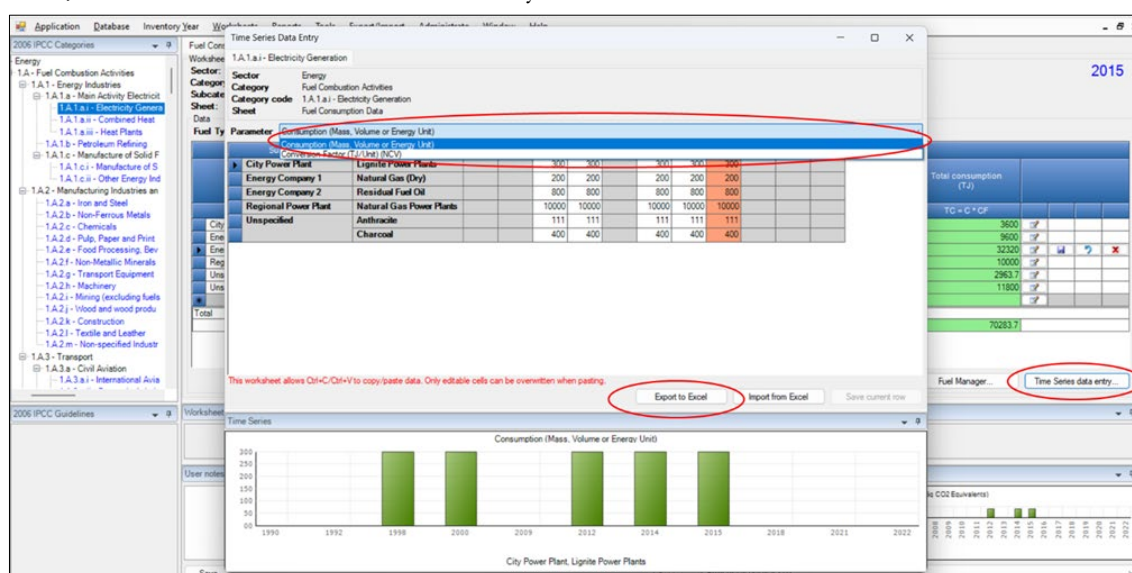
To enter data on *Uncertainties* or to enter *Time Series data*, calculation worksheets have dedicated tabs that can be accessed through buttons placed either at the lower right-hand side or next to the *Fuel type* button. Users are prompted to learn about how to use these functionalities in the *User Manual* of the *Software* (accessible at *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.



To use this functionality then users:

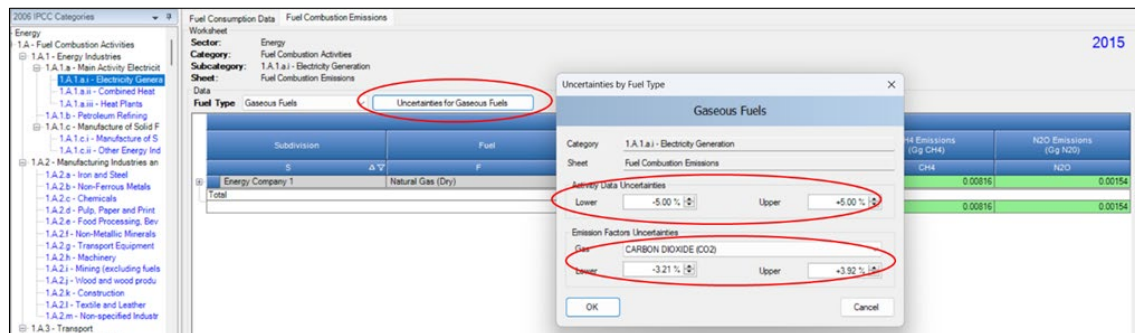
1. select parameters for which the user wants to upload a time series of data from the *Parameters* bar. This list of parameters (e.g. consumption, conversion factors, EFs, etc.) depend on variables contained in the specific worksheet.
2. press the button *Export to Excel*, name the file and export it.
3. open exported file and for the entire time series, or for any fraction of it, enters data or make changes to data already present.
4. once data are compiled, the file is imported back into the *Software* by clicking the button *Import from Excel*.

### Uncertainty:

For 1.A categories, IPCC default uncertainty data for AD and EFs are automatically filled in the *Software*. Further, information on the underlying sources of uncertainty, and the default uncertainty values is available in the *2006 IPCC Guidelines* in the section titled *Uncertainty Assessment* of each source category.

Further, once the user selects a *Fuel type* [this does not apply to the option *All Fuels*] from the dropdown menu, the button *Uncertainties for selected fuels* appears. Clicking the button, a pop-up window opens where users can enter lower and upper ranges of uncertainties for both AD and EF.





Please note that the Uncertainty Analysis has not yet been enhanced in this *Software* version, so this section is going to be revised in the next future.

## 1.A - Stationary Combustion Source Categories (1.A.1, 1.A.2, 1.A.4 and 1.A.5)

Information

In general, emissions of each GHG from stationary combustion sources are calculated by multiplying fuel consumption (AD) by the corresponding EF.

NGHGI Stationary Combustion source categories are shown in [Table 1](#).

GHGs

Stationary combustion source categories emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X	X				

IPCC Equations

- ✓ Tier 1: IPCC Tier 1 [Equations 2.1](#) and [2.2](#)
- ✓ Tier 2: IPCC Tier 1 equations, although with user-specific EFs
- ✓ Tier 3: [Equations 2.3](#), [2.4](#) and [2.5](#)

As explained in section [I.2. 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 the three GHGs using worksheets:

- ✓ **Fuel Manager**: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ **Fuel Consumption Data**: contains for each subdivision the amount of fuel consumed, in the source category, for each fuel.  
*Note that in worksheet **Fuel Combustion Emissions** where data on technology types are available, fuel consumption data are apportioned to the various technology-types, considering the penetration rate of each technology type.*
- ✓ **Fuel Combustion Emissions**: contains for each subdivision, the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs for each fuel, the penetration rate of specific technologies (if known), the CO<sub>2</sub> captured, if any, and calculates associated GHG emissions.

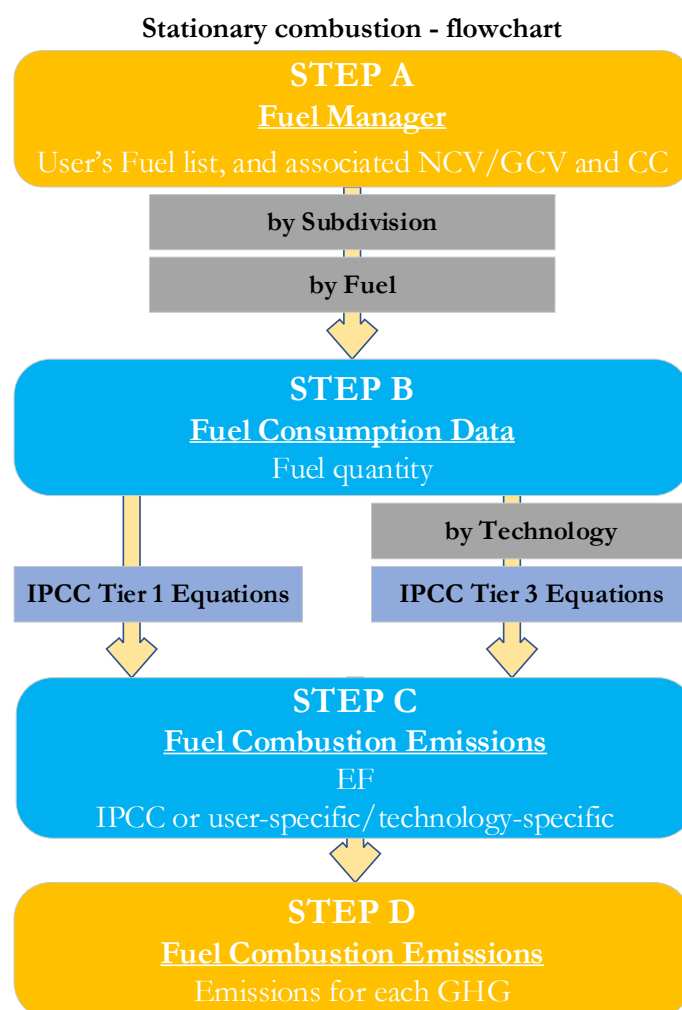
In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

Data compilation of each of 1.A.1, 1.A.2, 1.A.4, and 1.A.5 categories is operated independently, following for each category the entire set of instructions below.

User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 2.1](#) 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-specific<sup>18</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



Thus, for the relevant source-category:

**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

**Step B**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel.

**Step C**, worksheet **Fuel Combustion Emissions**, users collect and enter in each row associated EFs for each GHG. Where technology-specific EFs are available, fuel consumption data are apportioned to the various technology-types, considering the penetration rate of each technology type.

**Step D**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

Activity data input

The *2006 IPCC Guidelines*, [Sections 1.4.1.2](#) and [1.4.1.3](#), contain information on how to collect and use energy statistics data. Further information on the choice of AD for stationary combustion can be found in [Section 2.3.3](#).

<sup>18</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in [Table 1.2](#)). Other units may be entered into the **Fuel Consumption Data** worksheet, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter a user-defined conversion factor (TJ/unit).

Thus, for the relevant source-category:

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the worksheet **Fuel Consumption Data** either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

Example: single subdivision (unspecified)

Subdivision	Fuel	Consumption Unit	Consumption (Mass, Volume or Energy Unit)	Conversion Factor (TJ/unit (NCV))	Total consumption (TJ)
Unspecified	Anthracite	Gg (Auto CF)	111	26.7	2963.7
Unspecified	Charcoal	Gg (Auto CF)	400	29.5	11800
Total					14763.7

Example: multiple subdivisions

Subdivision	Fuel	Consumption Unit	Consumption (Mass, Volume or Energy Unit)	Conversion Factor (TJ/unit (NCV))	Total consumption (TJ)
City Power Plant	Anthracite	Gg (Auto CF)	300	26.7	8010
City Power Plant	Lignite	Gg (Auto CF)	400	11.9	4760
Energy Company "X"	Natural Gas (Dry)	Gg (Auto CF)	200	48	9600
Energy Company "X"	Residual Fuel Oil	Gg (Auto CF)	800	40.4	32320
Unspecified	Charcoal	Gg (Auto CF)	400	29.5	11800
Total					66490

Then, for each subdivision in Column |S| data are entered in worksheet **Fuel Consumption Data** row by row as follows:

- Column |F|: select each fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager.*  
*Note that user shall select “Fuel Type” in the “Fuel Type” bar at the top, to enter data for each fuel one by one.*
- Column |U|: enter unit of fuel consumption data (e.g. Gg, TJ, m<sup>3</sup>). To enter a user-specific unit (e.g. m<sup>3</sup>) select Gg (Manual CF) from the dropdown menu and overwrite Gg with the user-specific unit.
- Column |C|: enter amount of fuel consumed.
- Column |CF|: enter conversion factor to convert the consumption unit to an energy unit (TJ).  
*Note that where Gg of fuel are converted to TJ, 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. m<sup>3</sup>) the user shall enter the relevant conversion factor here.*

## Emission factor input

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel C content, where the fuel C content is expressed in C units of mass per unit of energy (IPCC default values in [Table 1.3](#) are in kg C/GJ).

IPCC default values for EFs are provided in Tables [2.2](#), [2.3](#), [2.4](#), [2.4](#), in kg/TJ.

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel combinations entered in worksheet **Fuel Consumption Data**. Then:

- 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.  
*Note that the drop-down table can be filled: either with a single row of data, this is the case for IPCC default method; or with several rows, one row for each technology type, this is the case for IPCC Tier 3 method.*  
*Note that user shall select “Fuel Type” in the “Fuel Type” bar at the top, to enter data for each fuel one by one.*
- Compile each row as follows:
  - Column |T|: enter technology type. Where the IPCC default method<sup>19</sup> is applied, the notation “unspecified” is selected.

<sup>19</sup> This is the case for Tier 1 and Tier 2.

2. **Column |P|**: enter technology penetration rate (%) associated with each technology type. The technology penetration rate<sup>20</sup> apportions the total fuel consumed in the subdivision among technology types. Where the IPCC default method is applied<sup>21</sup>, the value 100 is automatically entered by the *Software*.

*Note that for each fuel in each subdivision, summing up technology penetration rates of technologies reported shall always result in 100%.*

#### Example: unspecified technology type

Subdivision	Fuel	Total consumption (Tj)	CO2 Emissions (Gg CO2)	CH4 Emissions (Gg CH4)	N2O Emissions (Gg N2O)
Unspecified	Charcoal	11800	1321.6	2.36	0.0472

Type of Technology	Technology penetration (%)	Consumption (Tj)	CO2 Emission Factor (kg CO2/Tj)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/Tj)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/Tj)	N2O Emissions (Gg N2O)
Unspecified	100	11800	112000		1321.6	200	2.36	4	0.0472

#### Example: technology types (Tier 3)

Subdivision	Fuel	Total consumption (Tj)	CO2 Emissions (Gg CO2)	CH4 Emissions (Gg CH4)	N2O Emissions (Gg N2O)
Energy Company 1	Natural Gas (Dry)	9600	529.92	0.00816	0.00154

Type of Technology	Technology penetration (%)	Consumption (Tj)	CO2 Emission Factor (kg CO2/Tj)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/Tj)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/Tj)	N2O Emissions (Gg N2O)
Open Cycle Turbine	40	3840	54100		207.744	0.5	0.00192	0.2	0.00072
Closed Cycle Turbine	10	960	55100		52.896	1.5	0.00144	0.3	0.00028
Unspecified	50	4800	56100		269.28	1	0.0048	0.1	0.00048

3. **Column |EF(CO<sub>2</sub>)|**: select from the drop-down menu the IPCC default value or, for user-specific fuels, the value calculated by the *Software* as the CC multiplied by 44/12; otherwise enter the technology-type-specific value, in kg of CO<sub>2</sub> per Tj.
4. **Column |EF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default value for the given fuel or enter the technology-type-specific value, in kg of CH<sub>4</sub> per Tj.
5. **Column |EF(N<sub>2</sub>O)|**: select from the drop-down menu the IPCC default value for the given fuel or enter the technology-type-specific value, in kg of N<sub>2</sub>O per Tj.


## Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> produced across the process from that fuel used by that technology in that subdivision that has been captured instead of emitted into the atmosphere is to be entered in Gg CO<sub>2</sub> in **Column |Z|** of worksheet **Fuel Combustion Emissions**.

Subdivision	Fuel	Total consumption (Tj)	CO2 Emissions (Gg CO2)	CH4 Emissions (Gg CH4)	N2O Emissions (Gg N2O)
City Power Plant	Anthracite	8010	287.383	0	0

Type of Technology	Technology penetration (%)	Consumption (Tj)	CO2 Emission Factor (kg CO2/Tj)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/Tj)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/Tj)	N2O Emissions (Gg N2O)
Unspecified	100	8010	96200	500	287.383				

*Note that Column |Z| is accessed in worksheet **Fuel Combustion Emissions** by clicking the symbol “” on the left of the row (a drop-down table opens and Column |Z| becomes visible:*

Then, for each GHG, emissions from each source are calculated by the *Software*, in mass unit (Gg). Total emissions from each source of stationary combustion is the sum of all emissions from combustion of all fuels listed in all subdivisions reported in worksheet **Fuel Combustion Emissions**.

<sup>20</sup> Where the penetration rate is calculated based on the specific technology share of the total energy produced with the specific fuel and its per unit of energy fuel consumption.

<sup>21</sup> This is the case for Tier 1 and Tier 2.

2006 IPCC Categories

1 - Energy

1.A - Fuel Combustion Activities

1.A.1 - Electricity Generation

1.A.1.a - Main Activity Electricity and Heat

1.A.1.a.i - Electricity Generation

1.A.1.a.i.i - Combined Heat and Power

1.A.1.a.i.ii - Heat Plants

1.A.1.a.i.iii - Petroleum Refining

1.A.1.c - Manufacture of Solid Fuels and

1.A.1.c.i - Manufacture of Solid Fuel

1.A.2 - Manufacturing Industries and Construction

1.A.2.a - Iron and Steel

1.A.2.b - Non-Ferrous Metals

1.A.2.c - Chemicals

1.A.2.d - Pulp, Paper and Print

1.A.2.e - Food Processing, Beverages and

1.A.2.f - Non-Metallic Minerals

1.A.2.g - Transport Equipment

1.A.2.h - Machinery

1.A.2.i - Mining (excluding fuels) and

1.A.2.j - Other Manufacturing Industries

Fuel Consumption Data

Fuel Combustion Emissions

Worksheet

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.1.a.i - Electricity Generation

Sheet: Fuel Combustion Emissions

Data

Fuel Type (MWh)

Subdivision		Fuel	Total Consumption (TJ)	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
S	Δ V	F	TC	CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O
City Power Plant		Softwood	8070	282.99	0.0001	0.0100
City Power Plant		Lignite	4760	-409.24	0.0047	0.0071
Energy Company "C"		Natural Gas (Dry)	9600	838.56	0.0096	0.0009
Energy Company "C"		Residual Fuel Oil	3200	0	0	0
Unspecified		Charcoal	11800	721.6	2.36	0.047
Unspecified		Natural Gas (Wet)	36000	1544	0.216	0.072
Total			102490	2867.91	2.59637	0.13932

## 1.A.3 - Mobile Combustion Source Categories

### Information

In general, emissions of each GHG from mobile sources is calculated by multiplying fuel consumption (AD) by the corresponding EF.

NGHGI Mobile Combustion source categories are shown in [Table 1](#).

The following sections group sources according to the methodological approaches applied in the *Software*, and corresponding worksheets:

- ✓ **1.A.3.a Civil Aviation** - counts for domestic and international air transport emissions.
- ✓ **1.A.3.b Road Transportation** - includes all types of light-duty vehicles such as automobiles and light trucks, and heavy-duty vehicles such as tractor trailers and buses, and on-road motorcycles (including mopeds, scooters, and three-wheelers). These vehicles operate on many types of gaseous and liquid fuels.
- ✓ **1.A.3.c Railways** – includes diesel railway locomotives only; while for electric locomotives, emissions associated with electricity production are covered under Stationary Combustion.
- ✓ **1.A.3.d Water-borne Navigation** - counts for domestic and international water-borne navigation emissions.
- ✓ **1.A.3.e.i Pipeline transport** – counts combustion related emissions from the operation of pump stations and maintenance of pipelines. Transport via pipelines includes transport of gases, liquids, slurry, and other commodities. Distribution of natural or manufactured gas, water, or steam from the distributor to final users shall instead be reported under 1.A.1.c.ii or 1.A.4.a.
- ✓ **1.A.3.e.ii Off-road transportation** – includes combustion emissions from all remaining transport activities excluding Pipeline Transport. Military transport shall instead be reported under 1.A.5.



## 1.A.3.a - Civil Aviation

## GHGs

Mobile combustion source categories in aviation emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X	X				

## IPCC Equations

1. **Tier 1:** IPCC Tier 1 [Equation 3.6.1](#)
2. **Tier 2:** IPCC Tier 2 [Equations 3.6.2](#), [3.6.3](#), [3.6.4](#) and [3.6.5](#)
3. **Tier 3:** Emissions are estimated based on actual flight traffic data.

As explained in section [1.2. 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. In such a case, it is suggested to report estimates as two subdivisions i.e. *Tier 3-Commercial Scheduled Aviation* and *Tier 3- Other Jet-Fuelled Activities*, recognizing that the *2006 IPCC Guidelines* refer to these two subdivisions at the Tier 3 level (see [section 3.6.1.1](#)).

## Software Worksheets

The *Software* calculates emissions of the three GHGs using worksheets **Fuel Consumption Data** and **Fuel Combustion Emissions** for Tier 1, and worksheets **LTO Fuel consumption and LTO emissions** and **Cruise and total emissions** are to be used for Tier 2. In particular:

- ✓ **Fuel Manager:** contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ **Fuel Consumption Data:** contains, for each subdivision, the amount of fuel consumed, in the source category, for each fuel.
- ✓ **Fuel Combustion Emissions:** for each subdivision, contains the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs for each fuel and calculates associated GHG emissions.
- ✓ **LTO Fuel consumption and LTO emissions – Tier 2:** contains for each subdivision the amount of fuel consumed and estimates associated GHGs emitted during LTO<sup>22</sup> cycles according to each aircraft type and its number of LTOs.
- ✓ **Cruise and total emissions – Tier 2:** contains for each subdivision the amount of fuel consumed and calculates associated GHGs emitted during the cruise mode from all aircrafts entered in worksheet **LTO Fuel consumption and LTO emissions – Tier 2**. This worksheet also sums up total fuel consumption and associated GHG emissions in aviation (either domestic or international).

In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

In the upper part of worksheets **LTO Fuel consumption and LTO emissions – Tier 2** and **Cruise and total emissions – Tier 2**, users select the GHG for which to enter data.

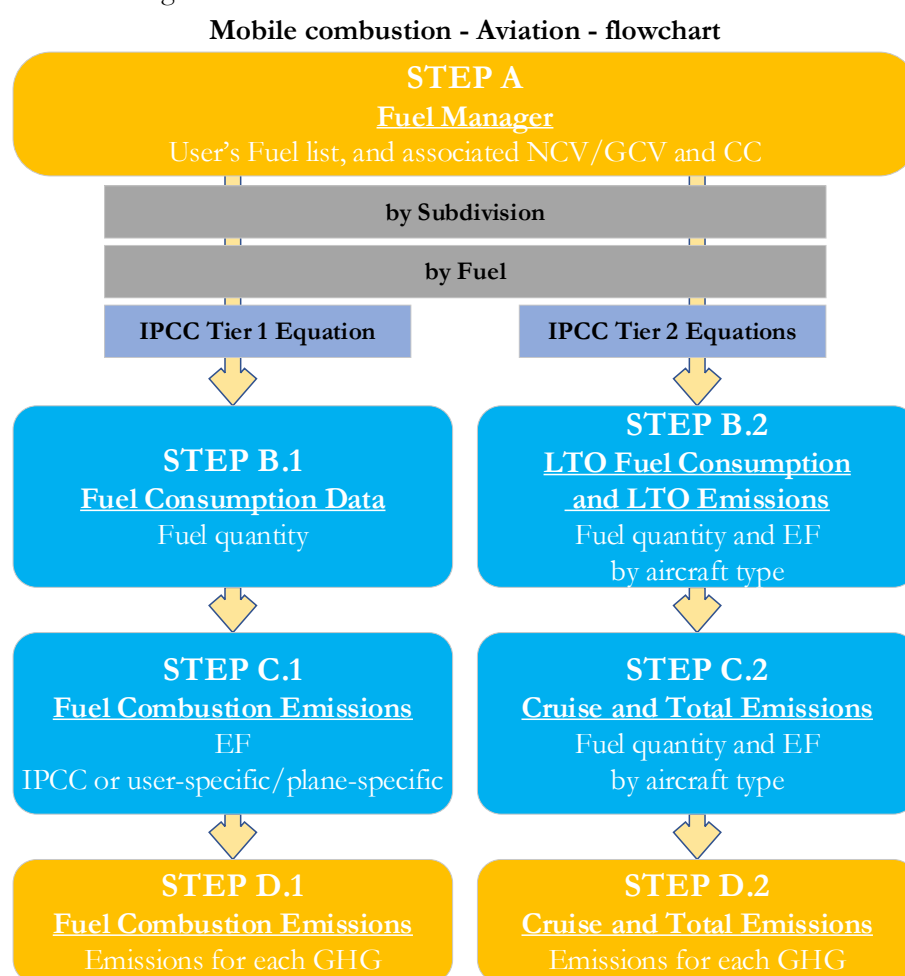
Data compilation for each of the 1.A.3.a subcategories is operated independently, following for each subcategory the entire set of instructions below.

<sup>22</sup> Landing/Take-Off



Consistent with the key category analysis and the decision trees in figures 3.6.1 and 3.6.2, of the 2006 IPCC Guidelines, GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>23</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category (domestic and international), the users apply steps described in the following flowchart:



Thus, for the relevant source-category:

**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

**When Tier 1 Equation is applied:**

**Step B.1**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel.

**Step C.1**, worksheet **Fuel Combustion Emissions**, users collect and enter in each row associated EFs for each GHG.

**Step D.1**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

**When Tier 2 Equations are applied:**

**Step B.2**, in worksheet **LTO Fuel consumption and LTO Emissions – Tier 2**, users collect and enter data on the amount consumed of each fuel for each aircraft type and associated number of LTOs. Further the *Software* calculates fuel consumption (to be used in step C.2) and associated emissions for LTO cycles in mass units (Gg). In addition, for each GHG, LTO emissions are calculated.

**Step C.2, Cruise and Total Emissions – Tier 2** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel combinations entered in the **LTO Fuel consumption and LTO Emissions – Tier 2** worksheet. Users collect and enter total amount of fuel consumed for each subdivision/fuel combination, as well as for the

<sup>23</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

cruise phase associated EFs for each GHG. In addition, the *Software* estimates fuel consumption, in TJ, for cruise mode, as well as associated GHG emissions, in Gg, for each subdivision/fuel combination.

**Step D.2, worksheet *Cruise and Total Emissions – Tier 2***, for each fuel and GHG the *Software* calculates total emissions<sup>24</sup> in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

### Activity data input

The *2006 IPCC Guidelines*, [Sections 1.4.1.2](#) and [1.4.1.3](#), contain information on how to collect and use energy statistics data. [Section 3.5.1.3](#) describes how to disaggregate AD between domestic aviation (described as journeys that arrive and depart in the same country) and international aviation (journeys departing from one country and arriving in another), since emissions from domestic and international aviation are reported separately.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in [Table 1.2](#)). Other units may be entered into the calculation worksheets, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter a user-defined conversion factor (TJ/unit).

**Thus, for the relevant source-category:**

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

*Example: single subdivision (unspecified)*

*Example: multiple subdivisions*

**When Tier 1 Equation is applied:**

For each subdivision in Column |S|, data are entered in worksheet **Fuel Consumption Data** row by row as follows:

- Column |F|: select each fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager.*  
*Note that user shall select “Fuel Type” in the “Fuel Type” bar at the top, to enter data for each fuel one by one.*
- Column |U|: enter unit of fuel consumption data (e.g. Gg, TJ, m<sup>3</sup>). To enter a user-specific unit (e.g. m<sup>3</sup>) select *Gg (Manual CF)* from the dropdown menu and overwrite *Gg* with the user-specific unit.
- Column |C|: enter amount of fuel consumed.
- Column |CF|: enter conversion factor to convert the consumption unit to an energy unit (TJ).  
*Note that where Gg of fuel are converted to TJ, 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. m<sup>3</sup>) the user shall enter the relevant conversion factor here.*

<sup>24</sup> LTO plus Cruise

**When Tier 2 Equations are applied:**

For each subdivision in Column |S| data are entered in worksheets **LTO Fuel consumption** and **LTO Fuel consumption and LTO Emissions – Tier 2** row by row as follows:

1. Column |AT|: select the aircraft type in operation from the drop-down menu or enter user-specific aircraft type(s).
2. Column |F|: select from the drop-down menu the fuel used by the corresponding aircraft type.  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager.*  
*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*
3. Column |A|: enter number of LTO cycles for the corresponding combination of aircraft type/fuel.
4. Column |D|: enter specific fuel consumption for the LTO cycle in kg/LTO.  
*Note that for each default aircraft type default values from table 3.6.9 of the 2006 IPCC Guidelines are automatically compiled by the Software, although the user can overwrite those with user-specific values.*

**Example: LTO consumption**

Subdivision	Aircraft type	Fuel	Number of LTOs	Emission factor for LTO (kg/LTO)	LTO Emissions (Gg)	Fuel consumption per LTO (kg/LTO)	Fuel consumption for LTO (Gg)
Commercial Large	747-200	Jet Kerosene	15000	11370	170550	3600	54000000
Commercial Large	A320	Jet Kerosene	10000	2440	24400	770	7700000
Private Jets	Cessna 525/560	Jet Kerosene	200	1070	2140	340	68000
Private Jets	Dornier 328 Jet	Jet Kerosene	150	870	13050	280	42000
Private Jets	Gulfstream V	Jet Kerosene	300	1890	5670	600	180000
<b>Total</b>			<b>25650</b>		<b>1958615</b>		<b>61990000</b>

Data on subdivision, fuel, number of LTOs and LTO fuel consumption compiled in the **LTO Fuel consumption and LTO Emissions – Tier 2** worksheet is automatically compiled by the *Software* in the worksheet **Cruise and total emissions – Tier 2**. In addition, for each row of data, users enter total fuel consumption in Column |D|, and the *Software* calculates fuel consumption for cruise mode in Column |E| as the difference between total fuel consumption and LTO fuel consumption.  
*Note that for all aircrafts under the subdivision, AD for cruise mode is entered in one row, without dividing by each aircraft type.*

**Example: cruise mode consumption**

Subdivision	Fuel	Number of LTOs	Fuel consumption for LTO (kg)	Conversion factor (T/kg)	Fuel consumption for LTO (T)	Total fuel consumption (T)	Fuel consumption for Cruise (T)	Emission factor for Cruise (kg/T)	Cruise Emissions (Gg)	LTO Emissions (Gg)	Total Emissions (Gg)
Commercial Large	Jet Kero.	25000	61700000	0.00004	2720.97	10000	7279.03	71500	5204505	19495	7154055
Private Jets	Jet Kero.	650	290000	0.00004	12.789	50	37.211	70000	250477	0.9115	351627
<b>Total</b>		<b>25650</b>	<b>61990000</b>		<b>2733.759</b>	<b>10050</b>	<b>7316.241</b>		<b>5230552</b>	<b>1958615</b>	<b>7189165</b>

**Emission factor input**

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel carbon content, where the fuel C content is expressed in C units of mass per unit of energy (IPCC default values for CO<sub>2</sub> in Table 1.3 are in kg/GJ).

IPCC default EFs are provided in tables 3.6.4 and 3.6.5, in kg/TJ.

**When Tier 1 Equation is applied:**

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel combinations entered in worksheet **Fuel Consumption Data**. Then, for each row:

**Example: single subdivision (unspecified)**

Subdivision	Fuel	Total fuel consumption (T)	CO2 Emission Factor (kg CO2/T)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/T)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/T)	N2O Emissions (Gg N2O)
Unspecified	Jet Kerosene	44100	71500		3153.15	0.5	0.02205	2	0.0882
<b>Total</b>		<b>44100</b>			<b>3153.15</b>		<b>0.02205</b>		<b>0.0882</b>

1. Column |EF(CO<sub>2</sub>)|: select from the drop-down menu the IPCC default value or, for user-specific fuels the value calculated by the *Software* as the CC multiplied by 44/12; otherwise enter a user-specific value, in kg of CO<sub>2</sub> per TJ.

2. Column |EF(CH<sub>4</sub>)|: select from the drop-down menu the IPCC default value for the given fuel or enter it, in kg of CH<sub>4</sub> per TJ.
3. Column |EF(N<sub>2</sub>O)|: select from the drop-down menu the IPCC default value for the given fuel or enter it, in kg of N<sub>2</sub>O per TJ

### When Tier 2 Equations are applied:

First, in worksheet **LTO Fuel consumption and LTO emissions – Tier 2**, for each GHG for each row:

1. Column |B| enter EF for LTO cycle, in kg/LTO.

*Note that user shall select “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous oxide (N<sub>2</sub>O)” in the “Gas” bar at the top, to enter the relevant EF to estimate emissions data for each GHG one by one.*

### Example: LTO emissions - methane

Subdivision	Aircraft type	Fuel	Number of LTOs	Emission Factor for LTO (kg/LTO)	LTO Emissions (Gg)	Fuel consumption per LTO (kg/LTO)	Fuel consumption for LTO (kg)
Commercial Large	747-200	Jet Kerosene	10000	0.0273	273	3600	36000000
Commercial Large	A320	Jet Kerosene	10000	0.06	600	770	7700000
Private Jets	Cessna 525/560	Jet Kerosene	200	0.00007	0.014	340	68000
Private Jets	Dornier 328 Jet	Jet Kerosene	150	0.00001	0.0015	280	42000
Private Jets	Gulfstream V	Jet Kerosene	300	0.00001	0.003	600	180000
<b>Total</b>			<b>25600</b>		<b>0.02798</b>		<b>61990000</b>

Second, in worksheet **Cruise and total emissions – Tier 2**, for each GHG for each row:

1. Column |F| enter EF for cruise mode, in kg/TJ. For all aircrafts within a subdivision, the EF for cruise mode should be entered in one row, without dividing by each aircraft type.

*Note that user shall select “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous oxide (N<sub>2</sub>O)” in the “Gas” bar at the top, to enter data for each GHG one by one.*

### Example: cruise and total emissions - CO<sub>2</sub>

Subdivision	Fuel	Number of LTOs	Fuel consumption for LTO (kg)	Conversion Factor (T/kg)	Fuel consumption for LTO (T)	Total fuel consumption (T)	Fuel consumption for Cruise (T)	Emission Factor for Cruise (kg/T)	Cruise Emissions (Gg)	LTO Emissions (Gg)	Total Emissions (Gg)
Commercial Large	Jet Kero.	25000	61700000	0.00004	2720.91	10000	7279.03	71500	520.45065	194.95	715.40065
Private Jets	Jet Kero.	650	290000	0.00004	12.788	50	37.211	70000	2.60477	0.9115	3.51627
<b>Total</b>		<b>25650</b>	<b>61990000</b>		<b>2733.798</b>	<b>10050</b>	<b>7316.241</b>		<b>523.05542</b>	<b>195.8615</b>	<b>718.91692</b>

## Results

Then, for Tier 1, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data in worksheet **Fuel Combustion Emissions**.

While, for Tier 2, for each GHG, emissions from each source category are calculated by the *Software*, in mass unit (Gg), for each row of data in worksheets:

- LTO Fuel consumption and LTO emissions – Tier 2:** LTO emissions are calculated in Column |C| and then reported by the *Software* in Column |H| of worksheet **Cruise and total emissions – Tier 2**.
- Cruise and total emissions – Tier 2:** Cruise emissions are calculated in Column |G|. Column |I| calculates total emissions: LTO *plus* cruise mode.

Thus, for each GHG, total emission from domestic or international aviation is the sum of all emissions from combustion of all fuels by all aircraft types listed in all subdivisions reported in worksheets **Fuel Combustion Emissions** and **Cruise and total emissions – Tier 2**.



**1.A.3.b - Road Transportation****GHGs**

Mobile combustion source categories in road transport emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

**IPCC Equations**

1. **Tier 1 (CO<sub>2</sub>)**: IPCC Tier 1 [Equation 3.2.1](#)
2. **Tier 1 (CH<sub>4</sub>, N<sub>2</sub>O)**: IPCC Tier 1 [Equation 3.2.3](#)
3. **Tier 2 (CO<sub>2</sub>)**: IPCC Tier 1 equation, although with user-specific EFs
4. **Tier 2 (CH<sub>4</sub>, N<sub>2</sub>O)**: IPCC Tier 2 [Equation 3.2.4](#)
5. **Tier 3 (CH<sub>4</sub>, N<sub>2</sub>O)**: IPCC Tier 3 [Equation 3.2.5](#)
6. **Tier 3 (CO<sub>2</sub>)**: no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **I.2. 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**

The *Software* calculates emissions of the three GHGs using worksheets **Fuel Consumption Data** and **Fuel Combustion Emissions**, or for CH<sub>4</sub> and N<sub>2</sub>O at Tier 2 or Tier 3 using worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**. Further, the additional **Fuel Consumption – Validation** worksheet is provided to verify fuel consumption data. In particular:

- ✓ **Fuel Manager**: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ **Fuel Consumption Data**: contains for each subdivision/fuel/vehicle type/emission control (ECT) technology the amount of fuel consumed, in the source category, for each fuel.
- ✓ **Fuel Combustion Emissions**: contains for each subdivision/fuel/vehicle type/ECT the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs and calculates associated GHG emissions.
- ✓ **CH<sub>4</sub> and N<sub>2</sub>O emissions – Tier 3**: contains for each subdivision/fuel/vehicle type/ECT/operating conditions the distance travelled and associated GHG EF as well as the emissions on cold start of the vehicle and calculates associated GHG emissions.
- ✓ **Fuel Consumption – Validation**: estimates fuel use from the distance travelled data based on the types of fuel, road (e.g. urban highway or rural road) and, if known, vehicle type (e.g. car, bus) ([Equation 3.2.6](#)).

In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

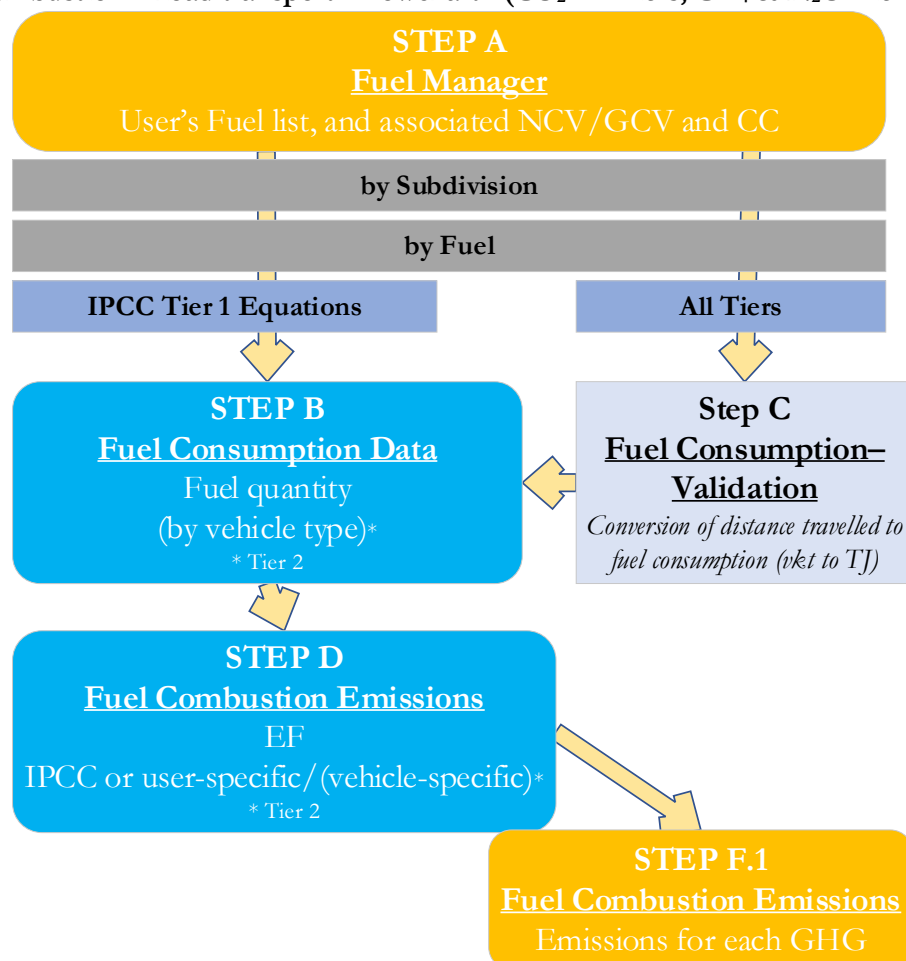
In the upper part of worksheet **CH<sub>4</sub> and N<sub>2</sub>O emissions – Tier 3**, users select the greenhouse *Gas* for which to enter data.

Data compilation of each of the 1.A.3.b subcategories is operated independently, following for each subcategory the entire set of instructions below.

## User's work Flowchart

Consistent with the key category analysis and the decision trees of the 2006 IPCC Guidelines -Figures 3.2.1 - 3.2.2 for CO<sub>2</sub> and Figure 3.2.3 for CH<sub>4</sub> and N<sub>2</sub>O-, GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>25</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowcharts:

Mobile combustion - Road transport – flowchart - (CO<sub>2</sub> All Tiers; CH<sub>4</sub> & N<sub>2</sub>O Tier 1 & Tier 2)

Thus, for the relevant source-category:

**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

When Tier 1 & Tier 2 Equations are applied:

**Step B**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel, for each subdivision/ vehicle type/ECT.

**Step C**, worksheet **Fuel Consumption - Validation**, for each subdivision/vehicle type/road type the *Software* calculates fuel consumption in mass units (Gg) based on the number of vehicles, distance travelled (km) and specific fuel consumption rate per km travelled (l/km). Total fuel consumption calculated in this worksheet can be compared to the total consumption in **Fuel Consumption Data** as a quality check.

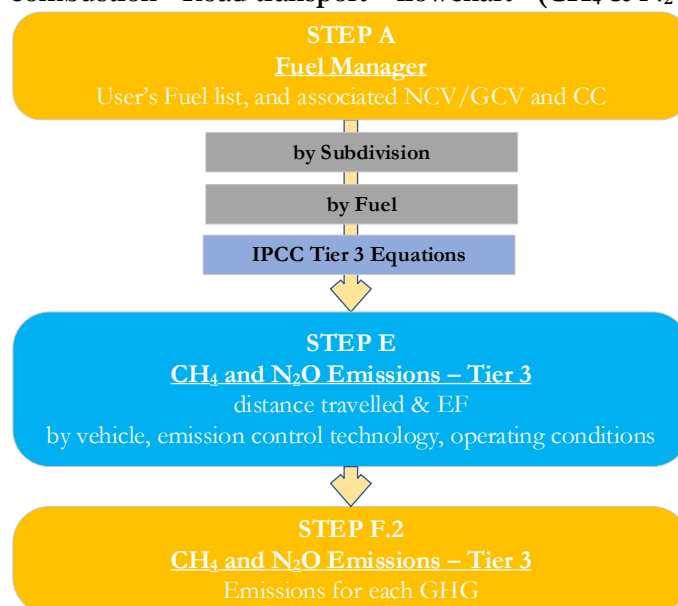
**Step D**, worksheet **Fuel Combustion Emissions**, for each subdivision/fuel/vehicle type/ECT, users collect and enter associated EFs for each GHG.

**Step F.1**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

<sup>25</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two 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 user-specific EF, as the weighted average EF across the two regions.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

### Mobile combustion - Road transport – flowchart - (CH<sub>4</sub> & N<sub>2</sub>O Tier 3)



### When Tier 3 Equation [CH<sub>4</sub> & N<sub>2</sub>O] is applied:

**Step E**, worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each subdivision/fuel/vehicle/ECT/operating conditions, users collect and enter data on the distance travelled -i.e. vehicle kilometres travelled (VKT)- stratified by ECT and by operating conditions. Further, for each combination users collect and enter associated EFs for CH<sub>4</sub> and N<sub>2</sub>O as well as enter CH<sub>4</sub> and N<sub>2</sub>O emissions during warm-up.

**Step F.2**, worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg), based on distance travelled *plus* emissions during warm-up. In addition, for each GHG, total emissions are calculated.

### Activity data input

The 2006 IPCC Guidelines, Sections 1.4.1.2 and 1.4.1.3, contain information on how to collect and apply energy statistics data. Specific guidance on collecting AD for road transportation may be found in Section 3.2.1.3.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in Table 1.2). Other units may be entered into the calculation worksheets, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter a user-defined conversion factor (TJ/unit). In addition, data on distance travelled by vehicles can be converted to fuel consumed in TJ units, where applicable (see **Fuel Consumption – Validation worksheet** below).

### Thus, for the relevant source-category:

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

### Example: single subdivision (unspecified)

Subdivision	Fuel	Vehicle type	Emission control technology	Consumption (Mass, Volume or Energy Units)	Consumption Unit	Conversion Factor (TJ/unit) (NCV)	Total consumption (TJ)
Unspecified	Unspecified	Unspecified	Unspecified	100	Gg (Units CF)	47.3	4730
Total							4730

## Example: multiple subdivisions

Subdivision	Fuel	Vehicle type	Emission control technology	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit (NCV))	Total consumption (TJ)
East	Motor Gasoline	Unspecified	7-seat	1222	Gg (Auto CF)	44.3	54134.6
North	Gas/Diesel Oil	Unspecified	5-seat	1220	Gg (Auto CF)	43	52460
Unspecified	Motor Gasoline	Unspecified	7-seat	1000	Gg (Auto CF)	44.3	44300
<b>Total</b>							<b>150894.6</b>

## When Tier 1 &amp; Tier 2 Equations are applied:

For each subdivision in **Column |S|** data are entered in worksheet **Fuel Consumption Data** row by row as follows:

- Column |F|**: select each fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager*  
*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*
- Column |VT|**: enter vehicle type (e.g. sedan, 2-seat, 5-seat, etc.); where no data are available select *Unspecified* from the dropdown menu.
- Column |ECT|**: enter applicable emission control technology (e.g. three-way catalyst, oxidation catalyst, etc.); where no data are available select *Unspecified* from the dropdown menu. The ECT is relevant for Tier 2 and for CH<sub>4</sub> and N<sub>2</sub>O emissions only; indeed, the ECT does not impact the estimate of CO<sub>2</sub> emissions given that IPCC methods assume that the entire C content of fuels is oxidised to CO<sub>2</sub>.
- Column |C|**: enter amount of fuel consumed by the relevant combination fuel/vehicle type/ECT.
- Column |U|**: enter unit in which fuel consumption data are entered (e.g. Gg, TJ, m<sup>3</sup>). To enter a user-specific unit (e.g. m<sup>3</sup>) select *Gg (Manual CF)* from the dropdown menu and overwrite *Gg* with the user-defined unit.
- Column |CF|**: enter conversion factor to convert the consumption unit to an energy unit (TJ).  
*Note that where Gg of fuel are converted to TJ, the NCV/GCV is sourced from the Fuel Manager and compiled by the Software as a conversion factor; while if the consumption unit is TJ the Software compiles the conversion factor with the value 1. Where other units are applied (e.g. m<sup>3</sup>) the user shall enter the relevant conversion unit here.*

**Fuel consumption data** (TJ) can be validated in comparison to the distance travelled using the **Fuel Consumption – Validation** worksheet, where the following data will be entered for each combination of subdivision/fuel/vehicle type/road type:

## Example: fuel validation

Subdivision	Fuel	Vehicle type	Road type	Number of vehicles	Distance travelled (km)	Consumption (l/km)	Total fuel consumption (l)	Conversion Factor (TJ/l)	Total fuel consumption (TJ)
Taxis	Gas/Diesel Oil	5 seat	Urban	1	100000	0.8	80000	7.5E-07	0.06
<b>Total</b>				<b>1</b>	<b>100000</b>	<b>0.8</b>	<b>80000</b>		<b>0.06</b>

- Column |F|**: select fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager.*  
*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*
- Column |VT|**: enter vehicle type.
- Column |RT|**: enter road type.
- Column |A|**: enter number of vehicles of the relevant type.
- Column |B|**: enter annual average kilometres travelled, per vehicle, by the relevant type of vehicles, in km.
- Column |C|**: enter average fuel consumption rate by the relevant type of vehicles, in l/km.
- Column |E|**: enter conversion factor, in TJ/l.

Thus, the *Software* will calculate in **Column |F|** the fuel consumption, in TJ.

*Note that calculated quantities in this worksheet are not reported. However, the inventory compiler may wish to investigate further if there are significant differences between the fuel used, as calculated in this worksheet, and fuel sold entered in worksheet Fuel Consumption Data.*

When Tier 3 Equation [CH<sub>4</sub> & N<sub>2</sub>O] is applied:

For each subdivision in **Column |S|** data are entered in each row of a unique combination of fuel/vehicle type/ECT/operating conditions, in worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, as follows:

- Column |F|**: select fuel used from the drop-down menu (one row for each fuel).



*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager*

*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*

2. **Column |VT|**: enter vehicle type (e.g. sedan, 2 seat, 5 seat, etc.) using that fuel.
3. **Column |ECT|**: enter applicable emission control technology (e.g. three-way catalyst, oxidation catalyst, etc.) for that combination of fuel/vehicle type.
4. **Column |Operating Conditions|**: enter operating conditions (e.g., urban or rural road type, climate, or other environmental factors) for that combination of fuel/vehicle type/ECT.
5. **Column |A|**: enter total distance travelled in km for that combination of fuel/vehicle type/ECT/operating conditions.

#### Example: CH<sub>4</sub> Tier 3 calculation

Subdivision	Fuel	Vehicle type	Emission control technology	Operating conditions	Distance travelled (km)	CH4 Emission Factor (g/kg)	CH4 Emissions (kg)	CH4 Emissions during warm-up (kg)	CH4 Emissions (Gg)
Taxis	Motor Gasoline	5 seat	TWC-OC	Urban	100000000	0.00004	3900	170	0.00407
<b>Total</b>					<b>100000000</b>		<b>3900</b>		<b>0.00407</b>

### Emission factor input

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel carbon content, where the fuel carbon content is expressed in C units of mass per unit of energy (IPCC default values in [Table 1.3](#) are in kg/GJ).

IPCC default EFs are provided in tables [3.2.1](#), for CO<sub>2</sub>, and [3.2.2](#), for CH<sub>4</sub> and N<sub>2</sub>O, in kg/TJ. Further, in tables [3.2.3](#) and [3.2.5](#) N<sub>2</sub>O and CH<sub>4</sub> EFs for gasoline and diesel vehicles in USA and Europe, respectively, are compiled, and N<sub>2</sub>O and CH<sub>4</sub> EFs for alternative fuels are compiled in [Table 3.2.4](#).

#### When Tier 1 & Tier 2 Equations are applied:

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel/vehicle type/ECT combinations entered in worksheet **Fuel Consumption Data**. Then, for each row:

1. **Column |EF(CO<sub>2</sub>)|**: select from the drop-down menu the IPCC default value or, for user-specific fuels the value calculated by the *Software* as the CC multiplied by 44/12; otherwise enter a user-specific value, kg of CO<sub>2</sub> per TJ.
2. **Column |EF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default value for the given fuel or enter a user-specific value, kg of CH<sub>4</sub> per TJ.
3. **Column |EF(N<sub>2</sub>O)|**: select from the drop-down menu the IPCC default value for the given fuel or enter a user-specific value, kg of N<sub>2</sub>O per TJ.

#### Example: multiple subdivisions

Subdivision	Fuel	Vehicle type	Emission control technology	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	Amount of fuel consumed (kg CO2)	CO2 Emissions (kg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (kg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (kg N2O)
Taxis	Gas Diesel Oil	5 seat	Unspecified	3400	14100	24930	24930	33	11415	33	11415
Taxis	Gas Diesel Oil	7 seat	Unspecified	8600	74100	63735	63735	39	3384	39	3384
Taxis	Motor Gasoline	5 seat	TWC-OC	44300	89300	398385	398385	25	11075	0	0.9944
Unspecified	Liquefied Petroleum Gases	Unspecified	Unspecified	4730	63100	298461	298461	60	28380	60	28380
<b>Total</b>				<b>189430</b>		<b>12290.055</b>			<b>1.87032</b>		<b>0.00491</b>

#### When Tier 3 Equation [CH<sub>4</sub> & N<sub>2</sub>O] is applied:

In worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each GHG for each row:

1. **Column |B|**: enter EF, in kg/km.  
*Note that user shall select "Carbon dioxide (CO<sub>2</sub>)" or "Methane (CH<sub>4</sub>)" or "Nitrous oxide (N<sub>2</sub>O)" in the "Gas" bar at the top, to enter data for each GHG one by one*
2. **Column |D|**: select from drop-down menu *Specified* or *Calculated*.  
  - ✓ When *Specified* is selected, enter in **Column |D|** emissions during warm-up (cold start), in kg.
  - ✓ When *Calculated* is selected, a table opens to allow the user to enter the number of cold starts and the user-specific CH<sub>4</sub> or N<sub>2</sub>O EF per cold start.
3. See [section 3.2.1.1](#) of the 2006 IPCC Guidelines for more information on how to estimate these emissions.  
*Note that user shall select "Methane (CH<sub>4</sub>)" or "Nitrous oxide (N<sub>2</sub>O)" in the "Gas" bar at the top, to enter data for each GHG one by one.*

Example: N<sub>2</sub>O emissions – Tier 3

Worksheet: Fuel Consumption Data, Fuel Combustion Emissions, CH<sub>4</sub> and N<sub>2</sub>O Emissions - Tier 3, Fuel Consumption - Validation

2000

Sector: Energy  
Category: Fuel Combustion Activities  
Subcategory: 1.A.3.b.i.1 - Passenger cars with 3-way catalysts  
Sheet: CH<sub>4</sub> and N<sub>2</sub>O Emissions - Tier 3

Gas: NITROUS OXIDE (N<sub>2</sub>O) Fuel Type: (All fuels)

Equation 3.2.6

Subdivision	Fuel	Vehicle type	Emission control technology	Operating conditions	Distance travelled (km)	N <sub>2</sub> O Emission Factor (kg/km)	N <sub>2</sub> O Emissions (kg)	N <sub>2</sub> O Emissions during warm-up (kg)	N <sub>2</sub> O Emissions (Gg)
Taxis	Motor Gasoline	5 seat	TWC-OC	Urban	100000	0.00003	2600	460	0.00306
Total					100000000		2600		0.00306

Results

Then, for Tier 1 and Tier 2, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data in worksheet **Fuel Combustion Emissions**.

While, for Tier 3, for CH<sub>4</sub> and N<sub>2</sub>O only, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**.

Thus, for each GHG, total emission from each source of road transportation is the sum of all emissions from combustion of all fuels by all vehicle types listed in all subdivisions reported in worksheets **Fuel Combustion Emissions** and **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**.

**1.A.3.b.v - Evaporative emissions from vehicles**

There are no emissions of main GHGs from this source category, thus no calculation worksheets are provided in the *Software*.

Regarding NMVOC emissions from this category, users can enter those in the *Energy sectoral table*. Further, it can enter those also in category 5.B of the *Software* to calculate indirect CO<sub>2</sub> emissions (*A Guidebook for calculating indirect emissions is under development*).

*Example:* NMVOC emissions entered in Table 1 Energy Sectoral Table

Table 1 Energy Sectoral Table		Emissions (Gg)						
Categories		CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	NO <sub>x</sub>	CO	NMVOCs	SO <sub>2</sub>
1.A.2.j - Wood and wood products								
1.A.2.k - Construction		0.000	0.936	0.125				
1.A.2.l - Textile and Leather								
1.A.2.m - Non-specified Industry								
<b>1.A.3 - Transport</b>		95841.912	1056.545	35.999			100.000	
1.A.3.a - Civil Aviation		12534.812	0.389	1.179				
1.A.3.a.i - International Aviation (International Bunkers) (1)								
1.A.3.a.ii - Domestic Aviation		12534.812	0.389	1.179				
1.A.3.b - Road Transportation		63489.742	62.774	16.961			100.000	
1.A.3.b.i - Cars		31920.185	8.867	3.069				
1.A.3.b.i.1 - Passenger cars with 3-way catalysts		18901.905	5.012	1.638				
1.A.3.b.i.2 - Passenger cars without 3-way catalysts		6878.300	0.932	1.148				
1.A.3.b.ii - Light-duty trucks		1346.400	12.000	1.200				
1.A.3.b.ii.1 - Light-duty trucks with 3-way catalysts		1346.400	12.000	1.200				
1.A.3.b.ii.2 - Light-duty trucks without 3-way catalysts								
1.A.3.b.iii - Heavy-duty trucks and buses		19890.000	32.667	12.576				
1.A.3.b.iv - Motorcycles		1105.000	0.442	0.088				
1.A.3.b.v - Evaporative emissions from vehicles							100	
1.A.3.b.vi - Urea-based catalysts		274.267						
1.A.3.c - Railways		3275.468	2.655	9.914				

## GHGs

Emissions from use of urea-based additives in catalytic converters (non-combustive emissions) in road transportation and off-road transportation include only CO<sub>2</sub>:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X						

## IPCC Equations

- Tier 1: IPCC Tier 1 equations [3.2.2](#) (road transportation) and [3.3.4](#) (off-road transportation)
- Tier 2: Same equation as Tier 1, although with user-specific EFs
- Tier 3: no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*

As explained in section [1.2. 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

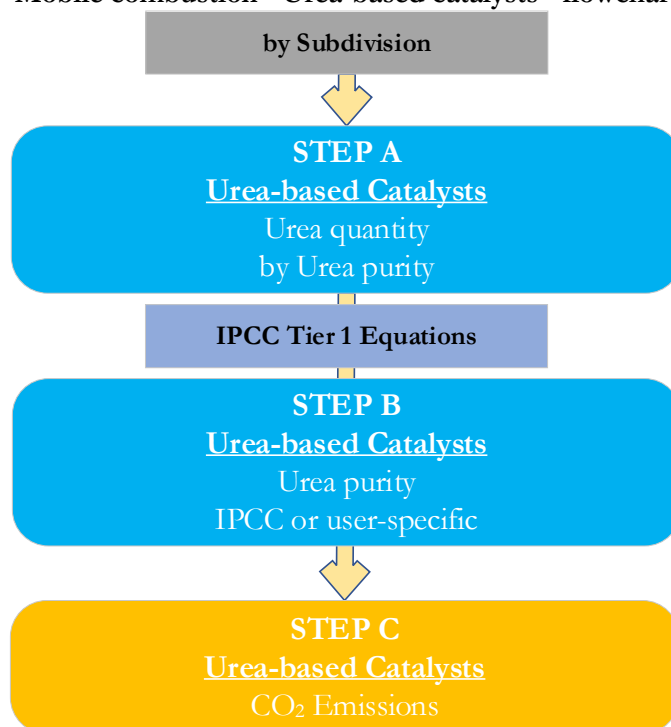
The *Software* calculates CO<sub>2</sub> emissions using worksheets **Urea-based Catalysts**.

*Note that although CO<sub>2</sub> emissions are calculated here, under the energy sector, these emissions are reported in the IPPU sector under category 2.D.4 other (non-energy products from fuels and solvent use) for the purposes of Reporting.*

User's work Flowchart

Consistent with the key category analysis GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>26</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:

**Mobile combustion - Urea-based catalysts - flowchart**

For each subdivision, if any:

**Step A**, worksheet **Urea-based Catalysts**, users collect and enter data on the amount of urea-based additive consumed for use in catalytic converters for both road transport and off-road transportation, in Gg.

**Step B**, worksheet **Urea-based Catalysts**, users collect and enter data on purity (i.e. the mass fraction of urea in the urea-based additive).

**Step C**, worksheet **Urea-based Catalysts**, for each row of data, the *Software* calculates CO<sub>2</sub> emissions in mass units (Gg). In addition, total CO<sub>2</sub> emissions are calculated.

Activity data input

Input of AD for use of urea-based additives in catalytic converters requires the following steps:

**First**, users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|.

**Then**, for each subdivision, Column |A|: enter amount of urea-based additive consumed for use in catalytic converters, in Gg.

Emission factor input

For each subdivision, Column |B|: enter purity values (i.e. the fraction of urea in the urea-based additive).

Results

Then, CO<sub>2</sub> emissions are calculated by the *Software*, in mass unit (Gg), for each row of data and total emission from urea-based catalysts is the sum of all emissions from all urea-based additive consumed for use in catalytic converters listed in all subdivisions reported in worksheet **Urea-based Catalysts**.

*Note that Urea consumption for catalytic converters in vehicles is directly related to the vehicle fuel consumption and technology.*

<sup>26</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

## 1.A.3.c - Railways

## GHGs

Mobile combustion sources in railway transport emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X	X				

## IPCC Equations

1. **Tier 1:** IPCC Tier 1 [Equation 3.4.1](#)
2. **Tier 2 (CO<sub>2</sub>):** Same equation as Tier 1, although with user-specific EFs
3. **Tier 2 (CH<sub>4</sub>, N<sub>2</sub>O):** IPCC Tier 2 [Equations 3.4.2](#), [3.4.4](#) and [3.4.5](#)
4. **Tier 3 (CH<sub>4</sub>, N<sub>2</sub>O):** IPCC Tier 3 [Equation 3.4.3](#)
5. **Tier 3 (CO<sub>2</sub>):** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*

As explained in section [I.2. 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

The *Software* calculates emissions of the three GHGs using worksheets **Fuel Consumption Data** and **Fuel Combustion Emissions**, for Tier 1 and Tier 2 and for CH<sub>4</sub> and N<sub>2</sub>O at Tier 3 using worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**. In particular:

- ✓ **Fuel Manager:** contains data on *carbon content* and *calorific value* of each fuel type used in the NGHGI.
- ✓ **Fuel Consumption Data:** contains for each subdivision/fuel/locomotive type the amount of fuel consumed.
- ✓ **Fuel Combustion Emissions:** contains for each subdivision/fuel/locomotive type the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs and calculates associated GHG emissions.
- ✓ **CH<sub>4</sub> and N<sub>2</sub>O emissions – Tier 3:** contains for each subdivision/fuel/locomotive type, the number of locomotives, the rated power of these as well as the annual average hours of use per locomotive and the load factor, and calculates associated GHG emissions.

In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

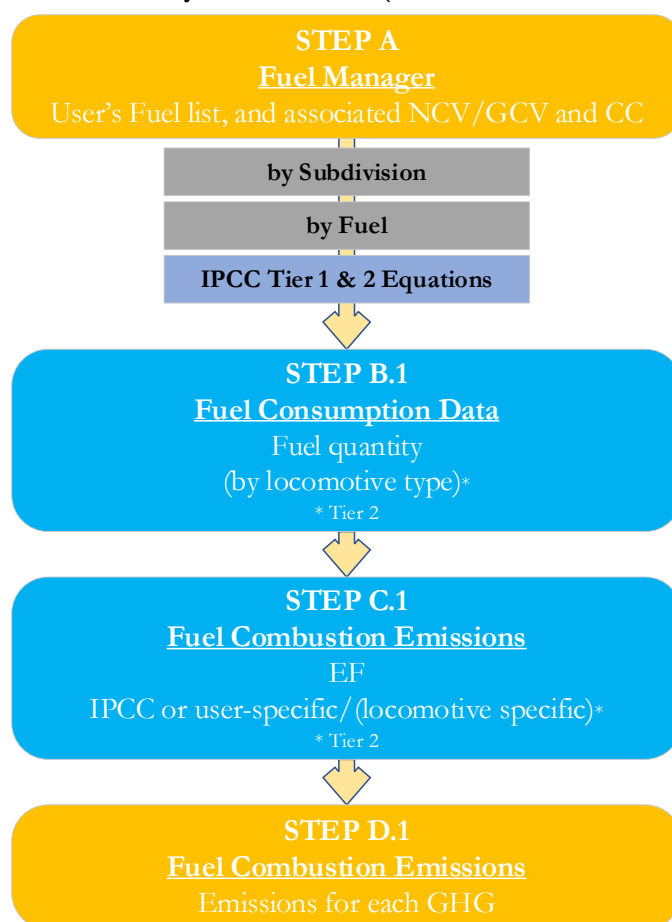
In the upper part of worksheet **CH<sub>4</sub> and N<sub>2</sub>O emissions – Tier 3**, users select the greenhouse *Gas* for which to enter data.



Consistent with the key category analysis and the decision tree in [Figure 3.4.1](#) for CO<sub>2</sub> and [Figure 3.4.2](#) for CH<sub>4</sub> and N<sub>2</sub>O, GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>27</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse the users apply steps described in the following flowcharts:

**Mobile combustion - Railways – flowchart - (CO<sub>2</sub> All Tiers; CH<sub>4</sub> & N<sub>2</sub>O Tier 1 & 2)**



**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

**When Tier 1 & Tier 2 Equations are applied:**

**Step B.1**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel, for each subdivision/locomotive type combination.

**Step C.1**, worksheet **Fuel Combustion Emissions**, for each subdivision/locomotive type/fuel users collect and enter associated EFs for each GHG.

**Step D.1**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

**While for Tier 3 Equation [CH<sub>4</sub> & N<sub>2</sub>O]:**

**Step B.2**, worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each subdivision/locomotive type/fuel type users collect and enter data on number of locomotives, annual average hours of use, average rated power, and typical load factors.

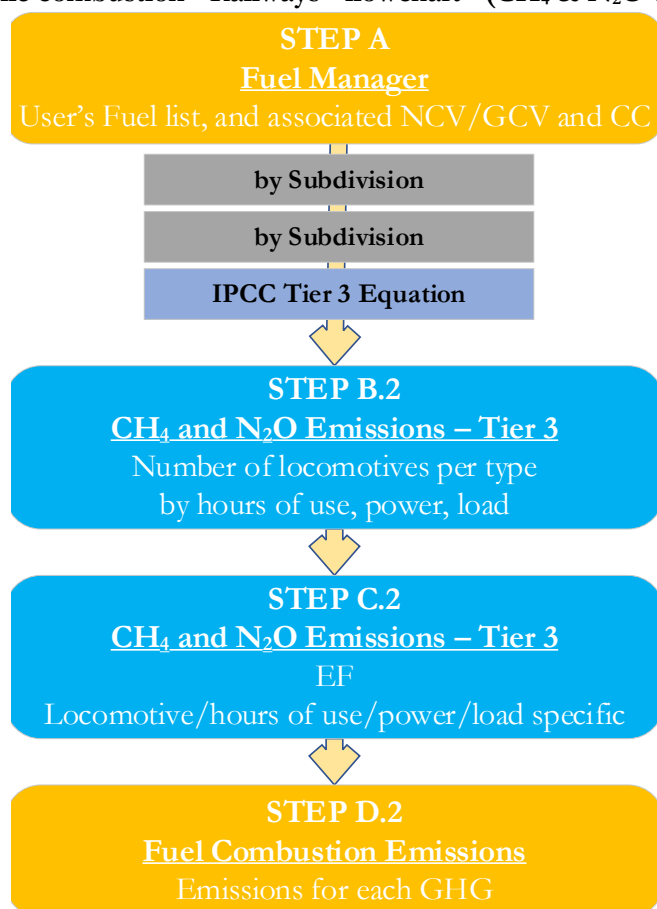
**Step C.2**, worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each subdivision/locomotive/fuel type users collect and enter associated EFs for each GHG.

**Step D.2**, worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

<sup>27</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented by either applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then reported at the level at which corresponding emissions are calculated.

### Mobile combustion - Railways - flowchart - (CH<sub>4</sub> & N<sub>2</sub>O Tier 3)



### Activity data input

The 2006 IPCC Guidelines, Sections 1.4.1.2 and 1.4.1.3, contain information on how to collect and apply energy statistics data. Specific guidance on collecting AD for road transportation may be found in Section 3.2.1.3.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in Table 1.2). Other units may be entered into the calculation worksheets, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter user-defined conversion factor (TJ/unit).

**Thus, for the relevant source-category:**

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; and for each fuel listed in the **Fuel Manager** the *calorific value* (either *NCV* or *GCV*) and the *carbon content* are entered or, for IPCC default fuels, are selected from the dropdown menu.

### Example: multiple subdivisions

2008 IPCC Categories

1.A.2.1 - Non-Metallic Minerals

1.A.2.2 - Transport Equipment

1.A.2.h - Machinery

1.A.2.i - Mining (excluding fuels) and Q

1.A.2.j - Vined and wood products

1.A.2.k - Construction

1.A.2.l - Textile and Leather

1.A.2.m - Non-specified Industry

1.A.3 - Transport

1.A.3.a - Civil Aviation

1.A.3.a.i - International Aviation (Int)

1.A.3.a.ii - Domestic Aviation

1.A.3.b - Road Transportation

1.A.3.b.i - Cars

1.A.3.b.i.1 - Passenger cars with

1.A.3.b.i.2 - Passenger cars with

1.A.3.b.i.3 - Light-duty trucks

1.A.3.b.i.4 - Light-duty trucks w/

1.A.3.b.i.5 - Light-duty trucks w/

1.A.3.b.ii - Heavy-duty trucks and b

1.A.3.b.iii - Motorcycles

1.A.3.b.iv - Exportative emissions fr

Fuel Consumption Data

Fuel Combustion Emissions

CH4 and N2O Emissions - Tier 3

Worksheet:

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.3.c - Railways

Sheet: Fuel Consumption Data

Data

Fuel Type: Liquid Fuels

Equation 3.4.1, 3.4.2, 3.4.4, 3.4.6

Subdivision	Locomotive type	Fuel	Consumption method	Number of locomotives	Average fuel consumption per locomotive per day (liters)	Average number of days of operation per loco	Diesel for locomotive (liters)	Conversion Factor (Gg/l)	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/unit) (NDV)	Total consumption (TJ)						
S	Δ	LT	F	Δ	LN	LFC	LD	LFCy = LN * LFC * LD	LCP	Gg (Manual CF)	U	CF	TC = C * CF					
Unspecified	Railcars	Liquefied Petroleum	Specified							120002	Gg (Manual CF)	5	600010					
Unspecified	Unspecified	Gas Diesel Oil	Eq. 3.4.5	100	863	55	4746500	1	4746500	Gg (Auto CF)	43	204099						
Passenger trains	Railcars	Gas Diesel Oil	Specified							120002	Gg (Auto CF)	43	5160009					
Total													209859510					

2015

**Second**, users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

### When Tier 1 & Tier 2 Equations are applied:

For each subdivision in Column |S|, data are entered in worksheet **Fuel Consumption Data** row by row as follows:

1. Column |LT|: enter locomotive type (e.g. railcars, yard locomotives, etc.).

- Column |F|**: select fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager*  
*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*
- Column |Consumption calculation method|**: select from drop-down menu *Eq. 3.4.5* or *Specified*.  
✓ When *Specified* is selected, enter amount of fuel consumed in **Column |C|**.  
✓ When *Eq. 3.4.5* is selected, enter data required in steps 4-7 below.
- Column |LN|**: enter number of locomotives.
- Column |LFC|**: enter amount of daily average fuel consumption by locomotive, in l/day.
- Column |LD|**: enter average number of days of locomotives' operation per year.
- Column |LCF|**: enter conversion factor for liquid fuels to convert volume units (litres) into mass units (Gg).
- Column |C|**: enter amount of fuel consumed.  
*Note that the amount of fuel consumption would be calculated by the Software if the user selected "Eq. 3.4.5" as a consumption calculation method*
- Column |U|**: enter unit of the fuel consumption data entered (e.g. Gg, TJ). To enter a user-specific unit (e.g. BTUs) select *Gg (Manual CF)* from the dropdown menu and overwrite *Gg* with the user-defined unit.
- Column |CF|**: enter conversion factor to convert the consumption unit to an energy unit (TJ).  
*Note that, where (Gg) of fuel are converted to (TJ), the NCV/GCV is sourced from the Fuel Manager and compiled by the Software as a conversion factor; while if the consumption unit is (TJ) the Software compiles the conversion factor with the value 1. Where other units are applied (e.g. m³) the user shall enter the relevant conversion unit here.*

### When Tier 3 Equation [CH<sub>4</sub> & N<sub>2</sub>O] is applied:

For each subdivision in **Column |S|** data are entered in each row of a unique combination of fuel/locomotive type, in worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, as follows:

- Column |LT|**: enter locomotive type (e.g. railcars, yard locomotive, etc.).
- Column |F|**: select fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager*
- Column |N|**: enter number of locomotives.
- Column |H|**: enter annual average hours of operation for that locomotives type (h).
- Column |P|**: enter average rated power of that type of locomotive in (kW).
- Column |LF|**: enter typical load factor of that type of locomotive (fraction).

### Example: Tier 3 calculation worksheet

The screenshot shows the 'CH<sub>4</sub> and N<sub>2</sub>O Emissions - Tier 3' worksheet. The left sidebar lists IPCC categories, with '1.A.3.c - Railways' selected. The main table is titled 'Equation 3.4.3' and contains columns for Subdivision, Locomotive type, Fuel, Number of locomotives, Annual hours of use, Average rated power, Typical load factor, and emission factors for CH<sub>4</sub> and N<sub>2</sub>O. The data row shows 'North-Central Rail' with 150 railcars, 6000 annual hours, 30 kW average power, and 0.9 load factor, resulting in 97.2 kg CH<sub>4</sub>/TJ and 24.3 kg N<sub>2</sub>O/TJ.

Subdivision	Locomotive type	Fuel	Number of locomotives	Annual hours of use (hours)	Average rated power of locomotive (kW)	Typical load factor of locomotive (Fraction)	CH <sub>4</sub> Emission Factor (kg CH <sub>4</sub> /TJ)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emission Factor (kg N <sub>2</sub> O/TJ)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
North-Central Rail	Railcars	Diesel for trains	150	6000	30	0.9	97.2	14580	24.3	3645
Total			150	6000			97.2	14580	24.3	3645

### Emission factor input

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel carbon content, where the fuel carbon content is expressed in carbon units of mass per unit of energy (IPCC default values in [Table 1.3](#) are in kg/GJ).

IPCC default EFs are provided in [Table 3.4.1](#), and pollutant weighting factors in [Table 3.4.2](#).

### When Tier 1 & Tier 2 Equations are applied:

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/locomotive type/fuel combinations entered in the **Fuel Consumption Data** worksheet. Then, for each row:

- Column |EF(CO<sub>2</sub>)|**: select from the drop-down menu the IPCC default value or, for user-specific fuels, the value calculated by the *Software* as the CC multiplied by 44/12; otherwise enter a user-specific value, in kg of CO<sub>2</sub> per TJ.
- Column |WF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default value or enter the user-specific value for CH<sub>4</sub> Pollutant Weighting Factor, based on the engine type. For more information on the pollutant weighting factors, see [Section 3.4.1.2](#) of the 2006 IPCC Guidelines.
- Column |EF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default value for the given fuel or enter a user-specific value, in kg of CH<sub>4</sub> per TJ.

4. Column |WF(N<sub>2</sub>O)|: select from the drop-down menu the IPCC default value or enter the user-specific value for N<sub>2</sub>O Pollutant Weighting Factor, based on the engine type. For more information on the pollutant weighting factors, see [Section 3.4.1.2](#) of the 2006 IPCC Guidelines.
5. Column |EF(N<sub>2</sub>O)|: select from the drop-down menu the IPCC default value for the given fuel or enter a user-specific value, in kg of N<sub>2</sub>O per TJ.

*Example: single subdivision (unspecified)*

The screenshot shows the 'CH<sub>4</sub> and N<sub>2</sub>O Emissions - Tier 3' worksheet. The left sidebar shows the hierarchy: 2006 IPCC Categories > 1.A.3.b.i - Ca > 1.A.3.b.i - Li > 1.A.3.b.i - U. The main table has columns for Subdivision, Locomotive type, Fuel, Total fuel consumption (TJ), CO<sub>2</sub> Emission Factor (kg CO<sub>2</sub>/TJ), Amount Captured (kg CO<sub>2</sub>), CO<sub>2</sub> Emissions (kg CO<sub>2</sub>), CH<sub>4</sub> Pollutant Weighting Factor, CH<sub>4</sub> Emission Factor (kg CH<sub>4</sub>/TJ), CH<sub>4</sub> Emissions (kg CH<sub>4</sub>), N<sub>2</sub>O Pollutant Weighting Factor, N<sub>2</sub>O Emission Factor (kg N<sub>2</sub>O/TJ), N<sub>2</sub>O Emissions (kg N<sub>2</sub>O), and N<sub>2</sub>O-CWP (N<sub>2</sub>O/10<sup>6</sup>). The data row shows 'Unspecified' for subdivision, 'Unspecified' for locomotive type, 'Gas/Diesel Oil' for fuel, 9481.34 TJ for total fuel consumption, 74100 kg CO<sub>2</sub>/TJ for emission factor, 702.568 kg CO<sub>2</sub> for amount captured, 544.887 kg CO<sub>2</sub> for emissions, 0.8 for CH<sub>4</sub> weighting factor, 4.15 for CH<sub>4</sub> emission factor, 0.03148 for CH<sub>4</sub> emissions, 1 for N<sub>2</sub>O weighting factor, 28.6 for N<sub>2</sub>O emission factor, 0.27117 for N<sub>2</sub>O emissions, and 0.00851 for N<sub>2</sub>O-CWP. The total row shows 15151.3 TJ for total fuel consumption, 1247.455 kg CO<sub>2</sub> for total emissions, 0.04282 for total CH<sub>4</sub> emissions, and 0.27967 for total N<sub>2</sub>O emissions.

*Example: multiple subdivisions*

The screenshot shows the 'CH<sub>4</sub> and N<sub>2</sub>O Emissions - Tier 3' worksheet with multiple subdivisions. The left sidebar shows the hierarchy: 2006 IPCC Categories > 1.A.3.b.i - Ca > 1.A.3.b.i - Li > 1.A.3.b.i - U. The main table has columns for Subdivision, Locomotive type, Fuel, Total fuel consumption (TJ), CO<sub>2</sub> Emission Factor (kg CO<sub>2</sub>/TJ), Amount Captured (kg CO<sub>2</sub>), CO<sub>2</sub> Emissions (kg CO<sub>2</sub>), CH<sub>4</sub> Pollutant Weighting Factor, CH<sub>4</sub> Emission Factor (kg CH<sub>4</sub>/TJ), CH<sub>4</sub> Emissions (kg CH<sub>4</sub>), N<sub>2</sub>O Pollutant Weighting Factor, N<sub>2</sub>O Emission Factor (kg N<sub>2</sub>O/TJ), N<sub>2</sub>O Emissions (kg N<sub>2</sub>O), and N<sub>2</sub>O-CWP (N<sub>2</sub>O/10<sup>6</sup>). The data rows show 'Unspecified' for subdivision, 'Unspecified' for locomotive type, 'Gas/Diesel Oil' for fuel, 9481.34 TJ for total fuel consumption, 74100 kg CO<sub>2</sub>/TJ for emission factor, 702.568 kg CO<sub>2</sub> for amount captured, 544.887 kg CO<sub>2</sub> for emissions, 0.8 for CH<sub>4</sub> weighting factor, 4.15 for CH<sub>4</sub> emission factor, 0.03148 for CH<sub>4</sub> emissions, 1 for N<sub>2</sub>O weighting factor, 28.6 for N<sub>2</sub>O emission factor, 0.27117 for N<sub>2</sub>O emissions, and 0.00851 for N<sub>2</sub>O-CWP. The total row shows 42932.3 TJ for total fuel consumption, 3275.468 kg CO<sub>2</sub> for total emissions, 0.23864 for total CH<sub>4</sub> emissions, and 2.02653 for total N<sub>2</sub>O emissions.

**When Tier 3 Equation [CH<sub>4</sub> & N<sub>2</sub>O] is applied:**

In worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for each GHG for each row:

1. Column |EF(CH<sub>4</sub>)|: enter a value for CH<sub>4</sub> EF, in kg/kWh.
2. Column |EF(N<sub>2</sub>O)|: enter a value for N<sub>2</sub>O EF, in kg/kWh.

## Results

Then, for Tier 1 and Tier 2, in worksheet **Fuel Combustion Emissions**, for each GHG, emissions are calculated by the *Software* in mass unit (Gg).

While, for Tier 3, in worksheet **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**, for CH<sub>4</sub> and N<sub>2</sub>O only, emissions are calculated by the *Software* in mass unit (Gg).

For each GHG, total emission from railway transport is the sum of all emissions from combustion of all fuels by all locomotive types listed in all subdivisions reported in worksheets **Fuel Combustion Emissions** and **CH<sub>4</sub> and N<sub>2</sub>O Emissions – Tier 3**.

## GHGs

Mobile combustion source categories in water-borne navigation emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X	X				

## IPCC Equations

- Tier 1: IPCC Tier 1 [Equation 3.5.1](#)
- Tier 2: IPCC Tier 1 equations, although with user-specific EFs, stratified by fuel type and transportation modes (e.g. ocean-going ships or boats) with engine type (e.g. diesel)
- Tier 3: no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*

As explained in section [1.2. 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 the three GHGs using worksheets:

- ✓ **Fuel Manager**: contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ **Fuel Consumption Data**: contains for each subdivision/fuel/vessel+engine type the amount of fuel consumed, in the source category, for each fuel.
- ✓ **Fuel Combustion Emissions**: contains for each subdivision/fuel/vessel+engine type the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs and calculates associated GHG emissions.

In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

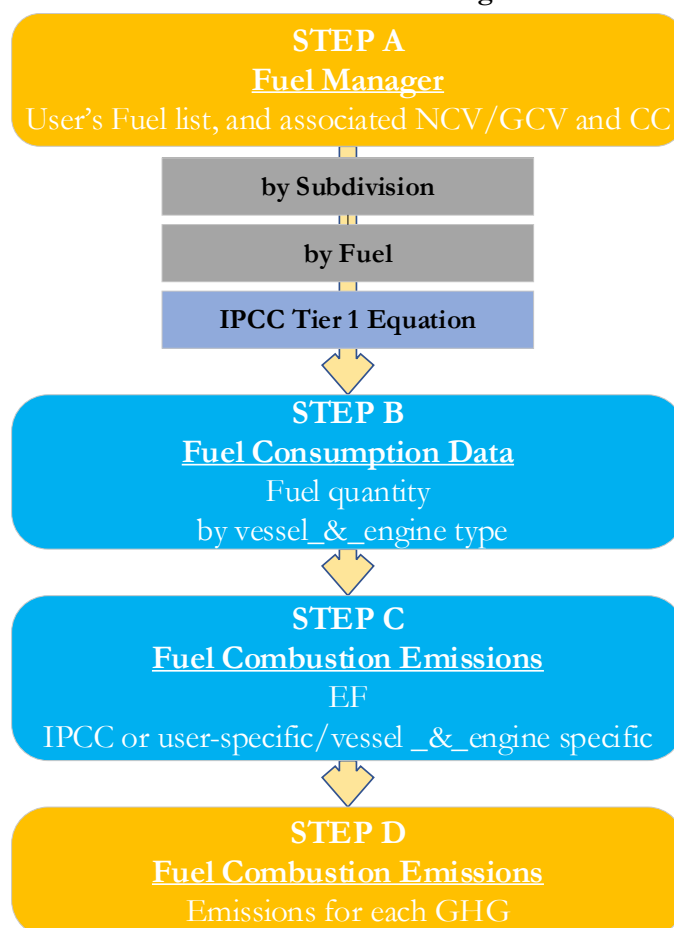
Data compilation of each of 1.A.3.d subcategories is operated independently, following for each subcategory the entire set of instructions below.



User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 3.5.1](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>28</sup> and/or vessel+engine-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:

**Mobile combustion - Water-borne navigation - flowchart**

Thus, for the relevant source-category:

**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

**Step B**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel for each vessel<sup>29</sup>+engine combination<sup>30</sup>.

**Step C**, worksheet **Fuel Combustion Emissions**, users collect and enter in each row associated EFs for each GHG.

**Step D**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

Activity data input

The 2006 IPCC Guidelines, [Sections 1.4.1.2](#) and [1.4.1.3](#), contain information on how to collect and use energy statistics data. [Section 3.5.1.3](#) describes how to disaggregate AD between domestic water-borne navigation (described as journeys that arrive

<sup>28</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

<sup>29</sup> e.g. ocean-going ships, bulk carriers, boats.

<sup>30</sup> e.g. diesel, slow speed, two stroke.



and depart in the same country) and international water-borne navigation (journeys departing from one country and arriving in another), since emissions from domestic and international water-borne navigation are reported separately.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in [Table 1.2](#)). Other units may be entered into the **Fuel Consumption Data** worksheet, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter a user-defined conversion factor (TJ/unit).

**Thus, for the relevant source-category:**

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the worksheet **Fuel Consumption Data** either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

*Example: single subdivision (unspecified)*

Subdivision	Fuel	Vessel / Engine type	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)
S	F	VT	C	U	CF	TJ=C*CF
Unspecified	Gas/Diesel Oil	Unspecified	200	Gg	43	8600
Total						8600

*Example: multiple subdivisions*

Subdivision	Fuel	Vessel and Engine type	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (Gg N2O)
S	F	VT	C	EF(CO2)	Z	EF(CH4)	Z	EF(N2O)	Z
Cargo company	Gas/Diesel Oil	Tankers	12900	74000	400	554.6	10	0.129	3
Cruisers	Gas/Diesel Oil	2 stroke, crosshead engines	12900	74050		955.245	6.9	0.0801	2.1
Cruisers	Gas/Diesel Oil	4 stroke, trunk engines	8600	74150		637.69	7.1	0.06106	1.9
Cruisers	Gas/Diesel Oil	Offshore Vessels	4300	73000		313.9	4	0.0172	2
Unspecified	Residual Fuel Oil	Unspecified	20200	77400		1563.48	7	0.1414	2
Total			58900			4024.915		0.43767	0.13113

Then, for each subdivision in Column |S| data are entered in worksheet **Fuel Consumption Data** row by row as follows:

- Column |F|: select each fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager.*  
*Note that user shall select “Fuel Type” in the “Fuel Type” bar at the top, to enter data for each fuel one by one.*
- Column |VT|: enter data on the vessel type (e.g. ocean-going ships, bulk carriers, boats) and, if known, the engine type (e.g. diesel, two stroke, etc.). The *Software* combines information on vessel and engine type in a single column. If this information is unknown, select *Unspecified* as per Tier 1.
- Column |C|: enter amount of fuel consumed.
- Column |U|: enter unit of fuel consumption data (e.g. Gg, TJ, m<sup>3</sup>). To enter a user-specific unit (e.g. m<sup>3</sup>) select *Gg (Manual CF)* from the dropdown menu and overwrite *Gg* with the user-specific unit.
- Column |CF|: enter conversion factor to convert the consumption unit to an energy unit (TJ)  
*Note that, where (Gg) of fuel are converted to TJ, 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 with the value 1. Where other units are applied (e.g. BTU) the user shall enter the relevant conversion unit here.*

### Emission factor input

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel C content, where the fuel C content is expressed in C units of mass per unit of energy (IPCC default values in [Table 1.3](#) are in kg C/GJ).

IPCC default values for EFs are provided in [Table 3.5.2](#), for CO<sub>2</sub>, and in [Table 3.5.3](#), for CH<sub>4</sub> and N<sub>2</sub>O, in kg/TJ.

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel/vessel+engine type combinations entered in worksheet **Fuel Consumption Data**. Then:

1. **Column |EF(CO<sub>2</sub>)|**: select from the drop-down menu the IPCC default value or, for user-specific fuels, the value calculated by the *Software* as the CC multiplied by 44/12; otherwise enter the vessel+engine type-specific value, in kg of CO<sub>2</sub> per TJ.
2. **Column |EF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default value for the given fuel or enter the vessel+engine type-specific value, in kg CH<sub>4</sub>/TJ.
3. **Column |EF(N<sub>2</sub>O)|**: select from the drop-down menu the IPCC default value for the given fuel or enter the vessel+engine type-specific value, in kg N<sub>2</sub>O/TJ.

Example: single subdivision (unspecified)

Subdivision	Fuel	Vessel and Engine type	Total fuel consumption (TJ)	CO <sub>2</sub> Emission Factor (kg CO <sub>2</sub> /TJ)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emission Factor (kg CH <sub>4</sub> /TJ)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emission Factor (kg N <sub>2</sub> O/TJ)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
Unspecified	Residual Fuel Oil	Unspecified	36764	77400	5	2840	7	0.257	2	0.0735
<b>Total</b>			<b>36764</b>			<b>2840</b>		<b>0.25735</b>		<b>0.07353</b>

Example: multiple subdivisions

Subdivision	Fuel	Vessel and Engine type	Total fuel consumption (TJ)	CO <sub>2</sub> Emission Factor (kg CO <sub>2</sub> /TJ)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emission Factor (kg CH <sub>4</sub> /TJ)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emission Factor (kg N <sub>2</sub> O/TJ)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
Cargo company	Gas/Diesel Oil	Tankers	12900	74000	400	554.6	10	0.129	3	0.0387
Cruisers	Gas/Diesel Oil	2 stroke, crosshead engines	12900	74050		955.245	6.9	0.08901	2.1	0.02709
Cruisers	Gas/Diesel Oil	4 stroke, trunk engines	8600	74150		637.69	7.1	0.06106	1.9	0.01634
Cruisers	Gas/Diesel Oil	Offshore Vessels	4300	73000		313.9	4	0.0172	2	0.0086
Unspecified	Residual Fuel Oil	Unspecified	20200	77400		1563.48	7	0.1414	2	0.0404
<b>Total</b>			<b>58900</b>			<b>4024.915</b>		<b>0.43767</b>		<b>0.13113</b>

## Results

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data and total emission from international or domestic water-borne navigation is the sum of all emissions from combustion of all fuels by all vessel types listed in all subdivisions reported in worksheets **Fuel Combustion Emissions**.

**1.A.3.e.i - Pipeline transport****Information**

Emissions of each GHG from pipeline transport are calculated by multiplying fuel consumption (AD) by the corresponding EF.

**GHGs**

Pipeline transport source emits the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X	X				

**IPCC Equations**

Given that there are no specific equations in the *2006 IPCC Guidelines* for this category, GHG emissions from mobile combustion in the pipeline transport source category are estimated in the *Software* by applying the following IPCC equations provided for road transportation, although no stratification<sup>31</sup> by equipment type is provided:

1. **Tier 1:** no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*
2. **Tier 2:** IPCC Tier 1 equations 3.2.1 for CO<sub>2</sub> emissions and 3.2.3 for CH<sub>4</sub> and N<sub>2</sub>O emissions (taken from road transportation), although with user-specific EFs
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*

As explained in section **I.2. 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**

The *Software* calculates emissions of the three GHGs using worksheets:

- ✓ **Fuel Manager:** contains data on *carbon content* and *calorific value* of each fuel used in the NGHGI.
- ✓ **Fuel Consumption Data:** contains for each subdivision/fuel the amount of fuel consumed, in the source category, for each fuel.
- ✓ **Fuel Combustion Emissions:** contains for each subdivision/fuel the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs, the CO<sub>2</sub> captured, if any, and calculates associated GHG emissions.

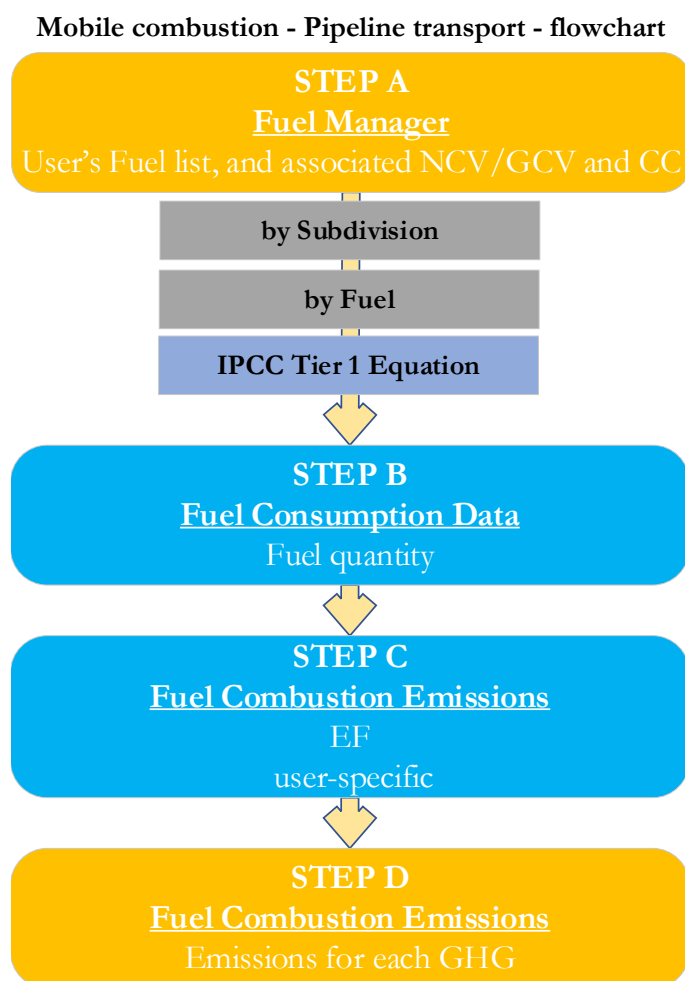
In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

<sup>31</sup> Such stratification can be implemented through the coding of the subdivision name.

User's work Flowchart

GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>32</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

**Then, for each subdivision, if any:**

**Step B**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel.

**Step C**, worksheet **Fuel Combustion Emissions**, for each subdivision/fuel users collect and enter associated EFs for each GHG.

**Step D**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which data are collected.

Activity data input

The 2006 IPCC Guidelines, Sections 1.4.1.2 and 1.4.1.3, contain information on how to collect and apply energy statistics data.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in Table 1.2). Other units may be entered into the calculation worksheets, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter a user-defined conversion factor (TJ/unit).

<sup>32</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.



As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|.

For each subdivision in Column |S|, data are entered in worksheet **Fuel Consumption Data**, row by row, as follows:

1. Column |C|: enter amount of fuel consumed.  
*Note that user shall select “Fuel Type” in the “Fuel Type” bar at the top, to enter data for each fuel one by one.*
2. Column |U|: enter unit of fuel consumption data (e.g. Gg, TJ, m<sup>3</sup>). To enter a user-specific unit (e.g. m<sup>3</sup>) select *Gg (Manual CF)* from the dropdown menu and overwrite *Gg* with the user-specific unit.
3. Column |CF|: enter conversion factor to convert the consumption unit to an energy unit (TJ).  
*Note that, where (Gg) of fuel are converted to TJ, the NCV/GCV is sourced from the Fuel Manager and compiled by the Software as conversion factor; while if the consumption unit is TJ the Software compiles the conversion factor with the value 1. Where other units are applied (e.g. BTU) the user shall enter the relevant conversion unit here.*

### Emission factor input

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel C content, where the fuel C content is expressed in C units of mass per unit of energy (IPCC default values in [Table 1.3](#) are in kg C/GJ).

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel combinations entered in worksheet **Fuel Consumption Data**. Then:

1. Column |EF(CO<sub>2</sub>)|: select from the drop-down menu the IPCC default value or, for user-specific fuels, the value calculated by the Software as the CC multiplied by 44/12; otherwise enter the user-specific value, in kg of CO<sub>2</sub> per TJ.
2. Column |EF(CH<sub>4</sub>)|: enter the user-specific value, in kg CH<sub>4</sub>/TJ.
4. Column |EF(N<sub>2</sub>O)|: enter the user-specific value, in kg N<sub>2</sub>O/TJ.

#### Example: single subdivision (unspecified)

Subdivision	Fuel	Total fuel consumption (TJ)	CO <sub>2</sub> Emission Factor (kg CO <sub>2</sub> /TJ)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emission Factor (kg CH <sub>4</sub> /TJ)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emission Factor (kg N <sub>2</sub> O/TJ)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
Unspecified	Crude Oil	42300	50000		2115	50	2.115	5	0.2115
Total		42300			2115		2.115		0.2115

#### Example: multiple subdivisions

Subdivision	Fuel	Total fuel consumption (TJ)	CO <sub>2</sub> Emission Factor (kg CO <sub>2</sub> /TJ)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emission Factor (kg CH <sub>4</sub> /TJ)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emission Factor (kg N <sub>2</sub> O/TJ)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
East-West Pipeline	Natural Gas Liquids	22100	64200		1418.82	10	0.221	0.6	0.01326
Northern Pipeline	Crude Oil	63450	51000		3235.95	52	3.2954	4.8	0.30456
Unspecified	Crude Oil	42300	50000		2115	50	2.115	5	0.2115
Total		127850			6769.77		5.6354		0.52932

### Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> produced across the process from that fuel used by that technology in that subdivision that has been captured instead of emitted into the atmosphere is to be entered in Gg CO<sub>2</sub> in Column |Z| of **Fuel Combustion Emissions** worksheet.

*Note that Column |Z| is accessed in worksheet **Fuel Combustion Emissions** by clicking the symbol “⌵” on the left of the row (a drop-down table opens and Column |Z| becomes visible:*

Then, for each GHG, emissions from each source are calculated by the *Software*, in mass unit (Gg). Total emission from pipeline transport is the sum of all emissions from combustion of all fuels listed in all subdivisions reported in worksheet **Fuel Combustion Emissions**.

Off-road transportation emissions are also estimated and reported in IPCC categories: 1.A.4.c.ii – Off-road vehicles and other machinery; 1.A.5.b.iii – Mobile (other).

### GHGs

Mobile combustion sources in off-road transport emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X	X				

### IPCC Equations

1. Tier 1: IPCC Tier 1 [Equation 3.3.1](#)
2. Tier 2: IPCC Tier 2 [Equation 3.3.2](#)
3. Tier 3: IPCC Tier 3 [Equation 3.3.3](#)

As explained in section 1.2. 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 the three GHGs using worksheets **Fuel Consumption Data** and **Fuel Combustion Emissions**, for Tier 1 and Tier 2, and using worksheet **Fuel Combustion Emissions – Tier 3** for Tier 3. In particular:

- ✓ **Fuel Manager**: contains information on *carbon content* and *calorific value* of each fuel type used in the NGHGI.
- ✓ **Fuel Consumption Data**: contains for each subdivision/fuel/vehicle/equipment type the amount of fuel consumed.
- ✓ **Fuel Combustion Emissions**: contains for each subdivision/fuel/vehicle/equipment type the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs and calculates associated GHG emissions.
- ✓ **Fuel Combustion Emissions – Tier 3**: contains for each subdivision/fuel/vehicle/equipment type, the number of vehicles/equipment, annual average hours of use, rated power and load factor of vehicle/equipment and calculates associated GHG emissions.

In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

Data compilation of each of subcategories 1.A.3.e.ii, 1.A.4.c.ii, and 1.A.5.b.iii is operated independently, following for each category the entire set of instructions below.

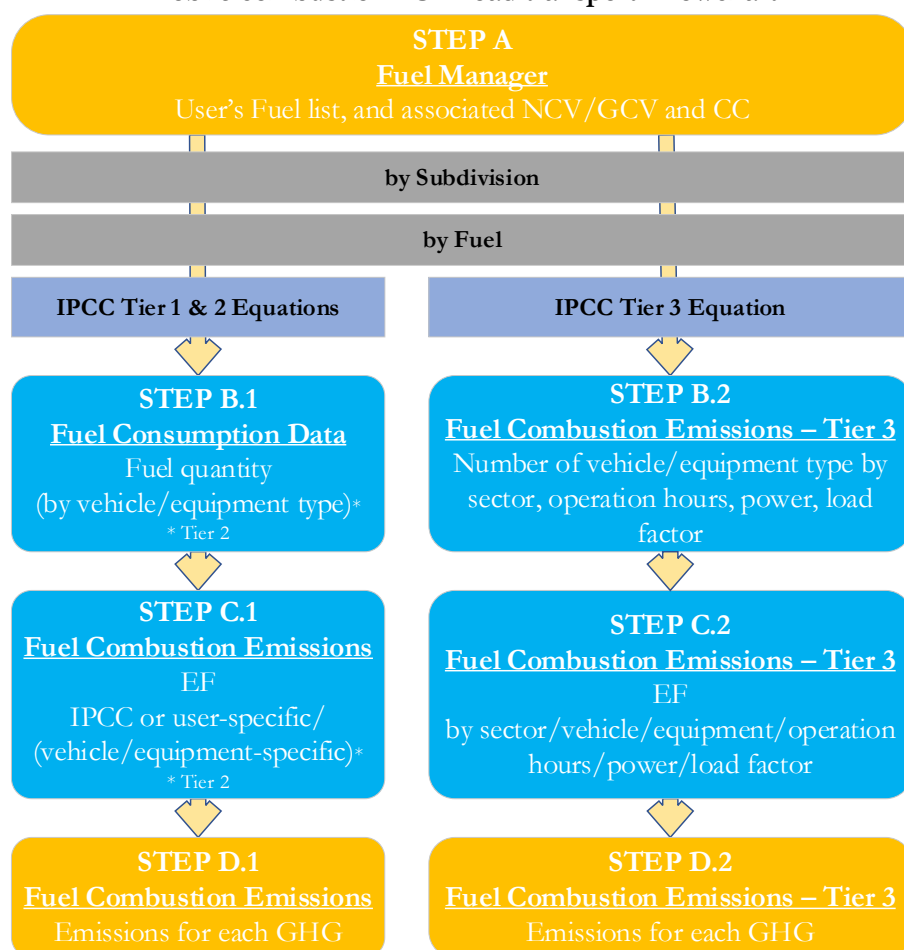


## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 3.3.1](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>33</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse the users apply steps described in the following flowchart:

## Mobile combustion - Off-road transport - flowchart



Thus, for the relevant source-category:

**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

When Tier 1 & Tier 2 Equations are applied:

**Step B.1**, worksheet **Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel, for each subdivision/vehicle or equipment type combination.

**Step C.1**, worksheet **Fuel Combustion Emissions**, for each subdivision/vehicle or equipment type/fuel users collect and enter associated EFs for each GHG.

**Step D.1**, worksheet **Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

While for Tier 3 Equation:

**Step B.2**, worksheet **Fuel Combustion Emissions – Tier 3**, for each subdivision/vehicle or equipment type users collect and enter data on fuel used, number of vehicle or equipment type, annual hours of use, average rated power, typical load factors.

**Step C.2**, worksheet **Fuel Combustion Emissions – Tier 3**, for each subdivision/ vehicle or equipment type/fuel users collect and enter EFs for each GHG.

**Step D.2**, worksheet **Fuel Combustion Emissions – Tier 3**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

<sup>33</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

Where data are available, CO<sub>2</sub> capture can be reported in **Fuel Combustion Emissions** and **Fuel Combustion Emissions – Tier 3** worksheets. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

### Activity data input

The 2006 IPCC Guidelines, Sections 1.4.1.2 and 1.4.1.3, contain information on how to find and apply energy statistics data. Specific guidance on collecting AD for off-road transport may be found in Section 3.3.1.3.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in Table 1.2). Other units may be entered into the calculation worksheets, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter user-defined conversion factor (TJ/unit).

### Thus, for the relevant source-category:

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; and for each fuel listed in the **Fuel Manager** the *calorific value* (either *NCV* or *GCV*) and the *carbon content* are entered or, for IPCC default fuels, are selected from the dropdown menu.

**Second**, users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

#### Example: single subdivision (unspecified)

Subdivision	Source	Fuel	Vehicle / Equipment	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/unit) (NCV)	Total consumption (TJ)
Unspecified	Unspecified	Gas/Diesel Oil	Unspecified	500 Gg (Auto CF)		43	21500
	Unspecified	Motor Gasoline	Unspecified	1000 Gg (Auto CF)		44.3	44300
<b>Total</b>							<b>65800</b>

#### Example: multiple subdivisions

Subdivision	Source	Fuel	Vehicle / Equipment	Consumption (Mass, Volume or Energy Unit)	Consumption Unit	Conversion Factor (TJ/unit) (NCV)	Total consumption (TJ)
North	Off-road - Manufact.	Motor Gasoline	Unspecified	930 Gg (Auto CF)		44.3	41199
South	Off-road - Commerci.	Other Kerosene	Unspecified	930 Gg (Auto CF)		43.8	40734
Unspecified	Off-road - Manufact.	Aviation Gasoline	Unspecified	930 Gg (Auto CF)		44.3	41199
	Off-road - Manufact.	CS liquid fuel	Unspecified	556 Gg (Auto CF)		44	24464
	Off-road - Manufact.	Gas/Diesel Oil	Unspecified	999 Gg (Auto CF)		43	42957
	Off-road - Manufact.	Liquefied Petroleum.	Unspecified	410 Gg (Auto CF)		47.3	19393
	Off-road - Residential	Jet Gasoline	Unspecified	930 Gg (Auto CF)		44.3	41199
	Off-road - Residential	Liquefied Petroleum.	Unspecified	930 Gg (Auto CF)		47.3	43989
	Unspecified	Ethane	Unspecified	930 Gg (Auto CF)		46.4	43152
	Unspecified	Liquefied Petroleum.	Unspecified	930 Gg (Auto CF)		47.3	43989
	Unspecified	Motor Gasoline	Unspecified	930 Gg (Auto CF)		44.3	41199
West	Off-road - Commerci.	Motor Gasoline	Unspecified	930 Gg (Auto CF)		44.3	41199

### When Tier 1 & Tier 2 Equations are applied:

For each subdivision in Column |S|, data are entered in worksheet **Fuel Consumption Data** row by row as follows:

- Column |SRC|: select from the drop-down menu the reporting category in UNFCCC CRTs. In case the *Software* is not used for reporting under the UNFCCC, users may select *Unspecified* from the drop-down menu.  
*Note that this step is relevant for IPCC category 1.A.3.e.ii - Off-road transportation only*<sup>34</sup>.
- Column |F|: select fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager*
- Column |VE|: users collect and enter data on vehicle and equipment types (e.g. tractors, snowmobiles, compression-ignition engines, 2-stroke engines, etc.).
- Column |C|: enter amount of fuel consumed.
- Column |U|: enter unit of the fuel consumption data entered (e.g. Gg, TJ). To enter a user-specific unit (e.g. BTU's) select *Gg (Manual CF)* from the dropdown menu and overwrite *Gg* with the user-defined unit.
- Column |CF|: enter conversion factor to convert the consumption unit to an energy unit (TJ)

<sup>34</sup> It does not apply to the other 2 IPCC categories that contains calculation worksheets for off-road transportation.

*Note that, where (Gg) of fuel are converted to (TJ), the NCV/GCV is sourced from the Fuel Manager and compiled by the Software as a conversion factor; while if the consumption unit is (TJ) the Software compiles the conversion factor with the value 1. Where other units are applied (e.g. m<sup>3</sup>) the user shall enter relevant conversion unit here.*

### When Tier 3 Equation is applied:

1. **Column |SRC|**: select from the drop-down menu the reporting category in UNFCCC CRTs. In case the *Software* is not used for reporting under the UNFCCC, users may select *Unspecified* from the drop-down menu.  
*Note that this step is relevant for IPCC category 1.A.3.e.ii - Off-road transportation only<sup>35</sup>.*
2. **Column |VE|**: users collect and enter data on vehicle and equipment types (e.g. tractors, snowmobiles, compression-ignition engines, 2-stroke engines, etc.);
3. **Column |F|**: select fuel used from the drop-down menu (one row for each fuel).  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager*
4. **Column |N|**: enter number of vehicles or equipment types.
5. **Column |H|**: enter annual average hours of operation per vehicle or equipment type.
6. **Column |P|**: enter average rated power per vehicle or equipment type, in kW.
7. **Column |LF|**: enter typical load factor of vehicle or equipment type (fraction).

### Example: Tier 3 calculation worksheet

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2006 IPCC Categories

1.A.2 i - Textile and Leather

1.A.2 m - Non-specified Industry

1.A.3 - Transport

1.A.3 a - Civil Aviation

1.A.3 a i - International Aviation

1.A.3 a ii - Domestic Aviation

1.A.3 b - Road Transportation

1.A.3 b i - Cars

1.A.3 b i.1 - Passenger car

1.A.3 b i.2 - Passenger car

1.A.3 b ii - Light-duty trucks

1.A.3 b i.1 - Light-duty truck

1.A.3 b i.2 - Light-duty truck

1.A.3 b iii - Heavy-duty trucks

1.A.3 b iv - Motorcycles

1.A.3 b v - Evaporative emission

1.A.3 b vi - User-based category

1.A.3 c - Railways

1.A.3 d - Water-borne navigation

1.A.3 d i - International water-borne

1.A.3 d ii - Domestic Water-borne

1.A.3 e - Other Transportation

1.A.3 e i - Pipeline Transport

Fuel Consumption Data

Fuel Combustion Emissions

Fuel Combustion Emissions - Tier 3

Worksheet

Sector:

Energy

Category:

Fuel Combustion Activities

Subcategory:

1.A.2 a - Off-road

Sheet:

CO2, CH4 and N2O Emissions - Tier 3

Data

Fuel Type

(All fuels)

Equation 3.3.3

		CO2				CH4		N2O										
Subdivision	Source	Vehicle type	Fuel	Source population	Annual average hours of use of vehicle (hours)	Average rated power of vehicle (kW)	Typical load factor of vehicle (Fraction)	CO2 Emission Factor (kg CO2/kWh)	Amount Captured (Gg CO2)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/kWh)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/kWh)	N2O Emissions (Gg N2O)				
S	Δ T	SRC	Δ T	LT	Δ T	F	Δ T	N	H	P	LF	EF(CO2)	Z	CO2-4H/HP/LP/EF (CO2)/1016*Z	EF(CH4)	CH4-4H/HP/LP/EF (CH4)/1016	EF(N2O)	N2O-4H/HP/LP/EF (N2O)/1016
Forestry	Unspecified	Chain saw	Motor Gasoline	1000	3000	1.3	0.9	70000	245700	250	877.6	1	3.61					
Industry	Unspecified	Forklifts	Motor Gasoline	100	2000	5	0.8	71000	56800	130	104	4	3.2					
Total				1100	5000				302500		9816		6.71					

2000

### Emission factor input

IPCC default EFs for CO<sub>2</sub> are calculated assuming 100% oxidation to CO<sub>2</sub> of fuel carbon content, where the fuel C content is expressed in C units of mass per unit of energy (IPCC default values in [Table 1.3](#) are in kg/GJ).

IPCC default EFs are provided in [Table 3.3.1](#).

### When Tier 1 & Tier 2 Equations are applied:

The **Fuel Combustion Emissions** worksheet is prefilled by the *Software* with a number of rows corresponding to the number of subdivision/fuel/vehicle or equipment type combinations entered in the **Fuel Consumption Data** worksheet. Then, for each row:

1. **Column |EF(CO<sub>2</sub>)|**: select from the drop-down menu the IPCC default value or, for user-specific fuels, the value calculated by the *Software* as the CC multiplied by 44/12; otherwise enter a user-specific value, in kg of CO<sub>2</sub>/TJ.
2. **Column |EF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default EF values for the given fuel and sector in which the off-road source is used (e.g. agriculture or household) or enter it, in kg of CH<sub>4</sub>/TJ.
3. **Column |EF(N<sub>2</sub>O)|**: select from the drop-down menu the IPCC default EF values for the given fuel and sector in which the off-road source is used or enter it, in kg of N<sub>2</sub>O/TJ.

*Note that any combination of subdivision/fuel/vehicle/equipment is allowed, including singling out one or more specific technologies or sectors and reporting all remaining together under the notation "unspecified".*

### Example: multiple subdivisions

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2006 IPCC Categories

1.A.2.i - Textile and Leather

1.A.2.m - Non-specified Industry

1.A.3 - Transport

1.A.3.a - Civil Aviation

1.A.3.a.i - International Aviation

1.A.3.a.ii - Domestic Aviation

1.A.3.b - Road Transportation

1.A.3.b.i - Cars

1.A.3.b.i.1 - Passenger cars

1.A.3.b.i.2 - Passenger cars

1.A.3.b.ii - Light-duty trucks

1.A.3.b.ii.1 - Light-duty trucks

1.A.3.b.ii.2 - Light-duty trucks

1.A.3.b.iii - Heavy-duty trucks

1.A.3.b.iv - Motorcycles

1.A.3.b.v - Explosive emission

1.A.3.b.vi - Un-road based costly

1.A.3.c - Railways

1.A.3.d - Waterborne Navigation

1.A.3.d.i - International water

1.A.3.d.ii - Domestic water

1.A.3.e - Other Transportation

Fuel Consumption Data

Fuel Combustion Emissions

Fuel Combustion Emissions - Tier 3

Worksheet

Sector:

Energy

Category:

Fuel Combustion Activities

Subcategory:

1.A.3.a - Off-road

Sheet:

Fuel Combustion Emissions

Data

Fuel Type

Liquid Fuels

Uncertainties for Liquid Fuels

Equation 3.3.1, 3.3.2

		Fuel consumption		Amount		CH4		N2O		
Subdivision	Source	Fuel	Vehicle / Equipment	Total fuel consumption (TJ)	CO2 Emission Factor (kg CO2/TJ)	CO2 Emissions (Gg CO2)	CH4 Emission Factor (kg CH4/TJ)	CH4 Emissions (Gg CH4)	N2O Emission Factor (kg N2O/TJ)	N2O Emissions (Gg N2O)
S	A	TRC	A	VE	C	Z	EF(CH4)	CH4	EF(N2O)	N2O
					EF(CO2)	CO2	CH4	CH4	EF(N2O)	N2O
Forklifts	Unspecified	Gas Diesel Oil	2-stroke engine	12900	73500	948.15	7	0.0903	8	0.1032
Resorts	Unspecified	Motor Gasoline	Snowmobiles	5000	69300	346.5	170	0.85	0.4	0.302
Unspecified	Unspecified	Gas Diesel Oil	Unspecified	21500	73200	1569.5	2	0.943	10	0.215
Unspecified	Unspecified	Motor Gasoline	Unspecified	44300	69300	3069.99	50	2.215	2	0.0888
Total				83700		5934.14		3.1983		0.4088

2000

<sup>35</sup> It does not apply to the other 2 IPCC categories that contains calculation worksheets for off-road transportation.

### When Tier 3 Equation [CO<sub>2</sub>, CH<sub>4</sub> & N<sub>2</sub>O] is applied:

In worksheet **Fuel Combustion Emissions – Tier 3**, for each row:

1. Column |EF(CO<sub>2</sub>)|: enter EF for CO<sub>2</sub>, in kg/kWh;
2. Column |EF(CH<sub>4</sub>)|: enter EF for CH<sub>4</sub>, in kg/kWh;
3. Column |EF(N<sub>2</sub>O)|: enter EF for N<sub>2</sub>O, in kg/kWh.

*Example: Tier 3 calculation*

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2005 IPCC Categories

1.A.2.i - Textile and Leather

1.A.2.m - Non-specified Industry

1.A.3 - Transport

1.A.3.a - Civil Aviation

1.A.3.a.i - International Aviation

1.A.3.a.ii - Domestic Aviation

1.A.3.b - Road Transportation

1.A.3.b.i - Cars

1.A.3.b.i.1 - Passenger cars

1.A.3.b.i.2 - Passenger cars

1.A.3.b.ii - Light-duty trucks

1.A.3.b.ii.1 - Light-duty trucks

1.A.3.b.ii.2 - Light-duty trucks

1.A.3.b.iii - Heavy-duty trucks

1.A.3.b.iv - Motorcycles

1.A.3.b.v - Evaporative emissions

1.A.3.b.vi - Uses-based category

1.A.3.c - Railways

1.A.3.d - Water-borne Navigation

1.A.3.d.i - International water-borne

1.A.3.d.ii - Domestic Water-borne

1.A.3.e - Other Transportation

1.A.3.e.i - Pipeline Transport

1.A.3.e.ii - Other

Fuel Consumption Data

Fuel Combustion Emissions

Fuel Combustion Emissions - Tier 3

Worksheet

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.3.a.i - Off-road

Sheet: CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O Emissions - Tier 3

Data

Fuel Type (All fuels)

Equation 3.3.3

		CO <sub>2</sub>				CH <sub>4</sub>		N <sub>2</sub> O							
Subdivision	Source	Vehicle type	Fuel	Source population	Annual average hours of use of vehicle (hours)	Average rated power of vehicle (kW)	Typical load factor of vehicle (Fraction)	CO <sub>2</sub> Emission Factor (kg CO <sub>2</sub> /kWh)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emission Factor (kg CH <sub>4</sub> /kWh)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emission Factor (kg N <sub>2</sub> O/kWh)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)	
S	Δ	Δ	Δ	N	H	P	LF	EF(CO <sub>2</sub> )	Z	CO <sub>2</sub> = H * P * LF * EF(CO <sub>2</sub> )	EF(CH <sub>4</sub> )	CH <sub>4</sub> = H * P * LF * EF(CH <sub>4</sub> )	EF(N <sub>2</sub> O)	N <sub>2</sub> O = H * P * LF * EF(N <sub>2</sub> O)	
Forestry	Unspecified	Chainsaw	Motor Gasoline	1000	3000	1.3	0.9	70000		245700	250	877.5	1	3.51	
Industry	Unspecified	Forklifts	Motor Gasoline	100	2000	5	0.8	71000		56800	130	104	4	3.2	
Total											302500		981.5		6.71

2000

## Results

Then, for Tier 1 and Tier 2 in worksheet **Fuel Combustion Emissions** and for Tier 3 in worksheet **Fuel Combustion Emissions – Tier 3**, for each GHG, emissions are calculated by the *Software* in mass unit (Gg).

Thus, for each GHG, total emission from each off-road transportation source is the sum of all emissions from combustion of all fuels by all vehicle and equipment types listed in all subdivisions reported in worksheets **Fuel Combustion Emissions** and **Fuel Combustion Emissions – Tier 3**.

## 1.B - Fugitive emissions from fuels

### Information

Fugitive emissions from fuels are released due to fugitive equipment leaks, evaporation losses, venting, flaring and accidental releases. In general, emissions are calculated based on the amount of fuel produced, transported, stored, or distributed and the corresponding EF.

NGHGI Fugitive Emissions source categories are shown in [Table 1](#).



## 1.B.1. Solid Fuels

### Information

Hereafter, the use of the *Software* to estimate emissions associated with coal production is illustrated. The following sections are separated, as emissions from various activities/categories are estimated via different methods and correspondingly using different worksheets of the *Software*:

- ✓ **1.B.1.a.i Underground Mines & 1.B.1.a.i.2 Post-mining** - calculates fugitive emissions during underground mining/post-mining operations.
- ✓ **1.B.1.a.i.3 Underground Abandoned Mines** - calculates fugitive emissions from abandoned underground mines.
- ✓ **1.B.1.a.i.4 - Flaring or Conversion of drained CH<sub>4</sub> to CO<sub>2</sub>** - calculates emissions from methane drained and flared, or ventilation gas converted to CO<sub>2</sub> by an oxidation process.
- ✓ **1.B.1.a.ii Surface Mining** - calculates fugitive emissions during surface mining/post-mining operations.
- ✓ **1.B.1.b Uncontrolled combustion and burning coal dumps** - calculates emissions of CO<sub>2</sub> from uncontrolled combustion.
- ✓ **1.B.1.c.i Charcoal and Biochar production** – calculates fugitive emissions during the production of charcoal and biochar.
- ✓ **1.B.1.c.ii Coke production** – calculates fugitive emissions during the production of coke.
- ✓ **1.B.1.c.iv Gasification transformation** – calculates fugitive emissions from the transformation of biomass, coal or natural gas into syngas, composed by H<sub>2</sub>, CO, CO<sub>2</sub> and CH<sub>4</sub>, and, then, into liquid hydrocarbons fuels.



**1.B.1.a.i Underground Mines - 1.B.1.a.i.2 Post-mining**

Fugitive emissions from underground mining arise from both ventilation and degasification systems. These emissions are normally emitted at a small number of centralised locations and can be considered as point sources. Those are amenable to standard measurement methods.

**GHGs**

Underground mining source categories consist of mining and post-mining activities and emit the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>					

**IPCC Equations**

CH<sub>4</sub> emissions from underground mining and post-mining source categories are estimated by applying the following IPCC equations:

1. **Tier 1:** IPCC Tier 1 Equations [4.1.3](#) (underground mining) and [4.1.4](#) (post mining)
2. **Tier 2:** Tier 1 equations, although with user-specific (e.g. basin-specific) EFs
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section [I.2. 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.

CO<sub>2</sub> emissions from underground mining are estimated by applying the following IPCC equation from the *2019 Refinement*:

1. **Tier 1:** IPCC Tier 1 Equation [4.1.3A](#)
2. **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

There are no equations for CO<sub>2</sub> emissions from post-mining in the *2006 IPCC Guidelines* or the *2019 Refinement*. A generic worksheet is provided to enable calculation of fugitive CO<sub>2</sub> emissions from post mining activities.

**Software Worksheets**

The *Software* calculates emissions of the two GHGs using worksheets:

- ✓ **Coal production from underground mines:** contains for each subdivision the production volumes.
- ✓ **Emissions from underground mines:** contains for each subdivision the CO<sub>2</sub> and CH<sub>4</sub> EFs and corresponding conversion factors, CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered, and calculates associated GHG emissions.

In the upper part of worksheet **Emissions from underground mines**, users select the GHG for which to enter data.

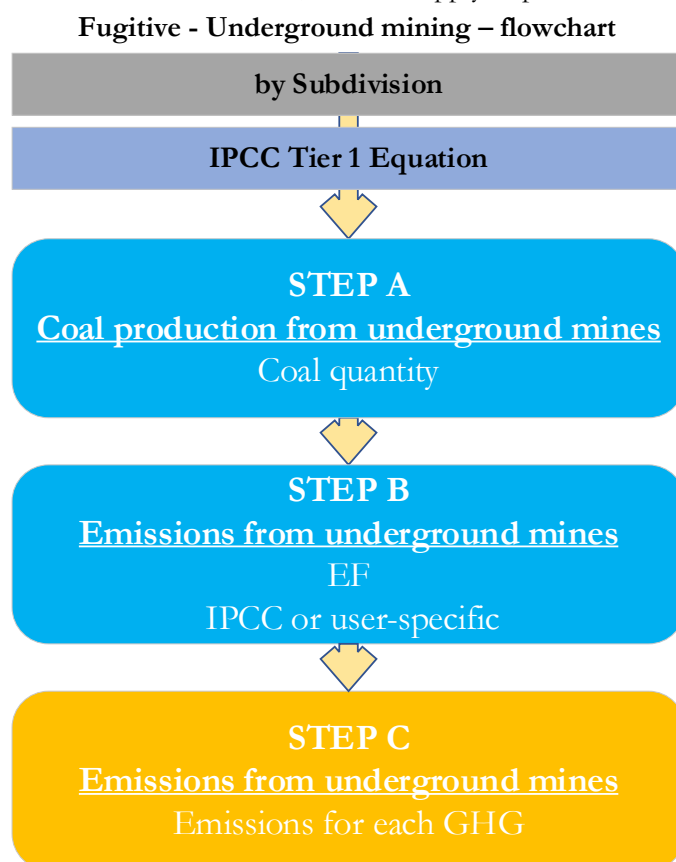
Data compilation of each subcategory is operated following the entire set of instructions below.

*Note that activity data input in worksheet **Coal production from underground mines** in one of the subcategories (1.B.1.a.i Underground Mines and 1.B.1.a.i.2 Post-mining) is automatically filled by the Software in the corresponding worksheet **Coal production from underground mines** in the other subcategory.*

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.1.1](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>36</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



Thus, for the relevant source-category, for each subdivision, if any:

**Step A**, worksheet **Coal production from underground mines**, users collect and enter data on the amount of raw coal produced from underground coal mines.

**Step B**, worksheet **Emissions from underground mines**, users collect and enter in each row associated EFs for each GHG.

**Step C**, worksheet **Emissions from underground mines**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery can be reported in **Emissions from underground mines** worksheet. The CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is entered at the level at which corresponding emissions are calculated.

## Activity data input

The 2006 IPCC Guidelines, [Section 4.1.3.3](#), contain information on collecting AD for underground coal mines.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|.

Thus, for the relevant source-category:

For each subdivision in Column |S|, data are entered in worksheet **Coal production from underground mines**, row by row, as follows:

1. Column |CP|: enter annual amount of raw coal produced, in tonnes.

*Note that once a user adds underground coal production data into one of the two source categories (either mining or post-mining seam emissions), the coal production for each subdivision is automatically pre-filled in the other source category. A change to the AD in one source category will also change the AD in the other.*

<sup>36</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

## Examples: multiple subdivisions

Subdivision	Amount of Coal Produced (tonne)	CH4 Emissions (Gg CH4)
Longwall mining	250000	9.75
Unspecified	150000	13.50
Western mines	300000	42.25
<b>Total</b>	<b>700000</b>	<b>6.75</b>

## Emission factor input

IPCC default EFs are provided in [Section 4.1.3.2](#) in m<sup>3</sup> per tonne of coal produced.

The **Emissions from underground mines** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of subdivisions entered in worksheet **Coal production from underground mines**. Then:

- Column [EF]:** select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in m<sup>3</sup> per tonne of coal produced.  
*Note that user shall select "Carbon dioxide (CO<sub>2</sub>)" or "Methane (CH<sub>4</sub>)" in the "Gas" bar at the top, to enter data for each GHG one by one.*
- Column [CF]:** select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value. The Conversion Factors represent the density of the corresponding GHG, in Gg GHG per m<sup>3</sup> of gas emitted. The default density of CH<sub>4</sub>, 0.67\*10<sup>-6</sup>, is sourced from the *2006 IPCC Guidelines* while the default CO<sub>2</sub> density, 1.84\*10<sup>-6</sup>, is sourced from the *2019 Refinement*.

Example: single subdivision, CH<sub>4</sub>

Subdivision	Amount of Coal Produced (tonne)	CH4 Emission Factor (m <sup>3</sup> /tonne)	CH4 Emissions (m <sup>3</sup> )	Conversion Factor (Gg CH4/m <sup>3</sup> )	CH4 Emissions (Gg CH4)
Unspecified	250000	10	2500000	0.00000067	0.675
<b>Total</b>	<b>250000</b>		<b>2500000</b>		<b>0.675</b>

Example: multiple subdivisions, CH<sub>4</sub>

Subdivision	Amount of Coal Produced (tonne)	CH4 Emission Factor (m <sup>3</sup> /tonne)	CH4 Emissions (m <sup>3</sup> )	Conversion Factor (Gg CH4/m <sup>3</sup> )	CH4 Emissions (Gg CH4)
Longwall mining	250000	10	2500000	0.00000067	9.75
Unspecified	150000	18	2700000	0.00000067	13.50
Western mines	300000	25	7500000	0.00000067	42.25
<b>Total</b>	<b>700000</b>		<b>12700000</b>		<b>65.08</b>

## Results

To estimate the total CO<sub>2</sub> and total CH<sub>4</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> and of CH<sub>4</sub> released from that subdivision that has been instead captured or recovered, respectively, are to be entered in Gg CO<sub>2</sub> in Column [Z] and/or Gg CH<sub>4</sub> in Column [R] of worksheet **Emissions from underground mines**.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions in each subcategory are reported in worksheet **Emissions from underground mines**.

**1.B.1.a.i.3 Abandoned Underground Mines**

This category estimates emissions from underground coal mines after extraction activities have been ended. Methodologies do not yet exist for abandoned or decommissioned surface mines, and therefore are not included in this chapter.

**GHGs**

Underground abandoned coal mines source category emits the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>					

**IPCC Equations**

CH<sub>4</sub> emissions from underground abandoned coal mines source category are estimated by applying the following IPCC equations:

1. **Tier 1:** IPCC Tier 1 [Equations 4.1.9, 4.1.10](#)
2. **Tier 2:** IPCC Tier 2 [Equations 4.1.11, 4.1.12](#) country-/basin-specific approach
3. **Tier 3:** IPCC Tier 3 [Equation 4.1.13](#) mine-specific approach

There are no equations for CO<sub>2</sub> emissions in the *2006 IPCC Guidelines*. A generic worksheet is thus provided to enable calculation of fugitive CO<sub>2</sub> emissions from Abandoned Underground Mines.

1. **Tier 1:** no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*.
2. **Tier 2:** 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 **1.2. 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**

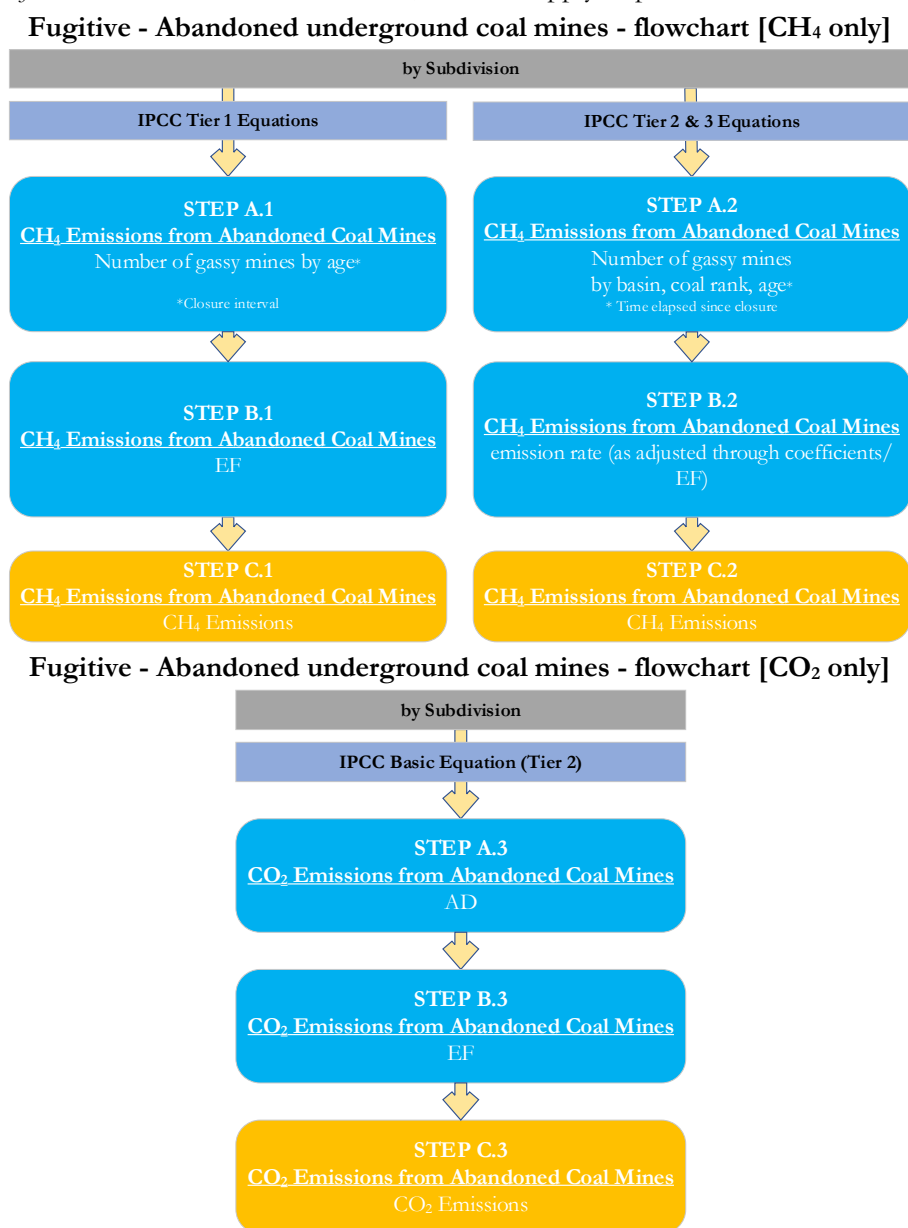
The *Software* calculates emissions of the two GHGs using worksheets.

- ✓ **CH<sub>4</sub> Emissions from Abandoned Coal Mines:** calculates Tier 1 emissions for each subdivision based on closure interval, number of abandoned mines, fraction of gassy mines, emission and conversion factors and CH<sub>4</sub> recovered for each subdivision.
- ✓ **CH<sub>4</sub> Emissions from Abandoned Coal Mines – Tier 2 & 3:** calculates Tier 2 and Tier 3 emissions for each subdivision and region/basin based on coal rank, number of abandoned mines, fraction of gassy mines, average emission rate prior to abandonment, coefficients A & B, years elapsed since abandonment, emission and conversion factors and CH<sub>4</sub> recovered.
- ✓ **CO<sub>2</sub> Emissions from Abandoned Coal Mines:** calculates associated CO<sub>2</sub> emissions for each subdivision based on AD and EF entered.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.1.3](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>37</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



For each subdivision, if any:

**When Tier 1 Equation is applied [CH<sub>4</sub> only]**

**Step A.1**, in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines**, users collect and enter data on the closure interval, number of mines, fraction of gassy mines.

**Step B.1**, in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines**, users collect and enter in each row associated EFs.

**Step C.1**, in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines**, for each row of data, the *Software* calculates the emissions in mass units (Gg). In addition, total emissions are calculated.

**When Tier 2 & Tier 3 Equations are applied [CH<sub>4</sub> only]**

**Step A.2**, in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines – Tier 2&3**, users collect and enter data on the region/basin, coal rank, number of mines, fraction of gassy mines.

**Step B.2**, in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines – Tier 2&3**, users collect and enter in each row associated average emission rate, coefficients A & B, years elapsed, emission and conversion factors.

<sup>37</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

**Step C.2**, in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines**, for each row of data, the *Software* calculates the emissions in mass units (Gg). In addition, total emissions are calculated.

### When IPCC Basic Equation applied [CO<sub>2</sub> only]

**Step A.3**, in worksheet **CO<sub>2</sub> Emissions from Abandoned Coal Mines**, users collect and enter data on the source and activity data.

**Step B.3**, in worksheet **CO<sub>2</sub> Emissions from Abandoned Coal Mines**, users collect and enter in each row the associated EF.

**Step C.3**, in worksheet **CO<sub>2</sub> Emissions from Abandoned Coal Mines**, for each row of data, the *Software* calculates the emissions in mass units (Gg). In addition, total emissions are calculated.

### Activity data input

The 2006 IPCC Guidelines, [Section 4.1.5.3](#), contain information on collecting AD for underground abandoned coal mines

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S|, [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then:

### When Tier 1 Equation is applied for CH<sub>4</sub> emissions:

For each subdivision in Column |S|, data are entered in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines**, row by row, as follows:

- Column |CI|: select closure interval of mines (i.e. the period during which the mine was abandoned), or enter a user-specific value.  
*Note that the closure intervals found in Table 4.1.6 of the 2006 IPCC Guidelines end in inventory year 2016. For inventory years after 2016, a country may consult Table 4.1.6 (Updated) of the 2019 Refinement. This table includes the time series for inventory year 1990 to 2050, with the information provided for all years between 1990 and 2016 the same as that in Table 4.1.6 of the 2006 IPCC Guidelines.*
- Column |N|: enter the number of abandoned mines remaining unflooded in that subdivision during that time interval. If no information is available on the flooded status, assume 100% remain unflooded.
- Column |G|: enter the fraction of gassy coal mines among those abandoned. IPCC default values can be found in [Table 4.1.5](#) of the 2006 IPCC Guidelines.

### Example: multiple subdivisions – Tier 1

Subdivision	Closure Interval	Number of abandoned mines	Fraction of Gassy Coal Mines	Emission Factor	Conversion Factor	Methane Emissions	Methane recovered	Methane emissions to be reported
S	ΔT	N	G	EF	CF	E=ΔT*EF*CF	R	E=E-E.R
New mines	1951 - 1975	77	1	400000	0.00000067	21.04872		21.04872
Old mines	1926 - 1950	100	0.9	1000000	0.00000067	60.3		60.3
Unspecified	2001 - 2025	10	1	713000	0.00000067	4.7771		4.7771
<b>Total</b>		<b>187</b>				<b>86.12582</b>		<b>86.12582</b>

### When Tier 2&3 Equations are applied for CH<sub>4</sub> emissions:

For each subdivision in Column |S|, data are entered in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines – Tier 2 & 3**, row by row, as follows:

*Note that for Tier 3, all information below shall be mine-specific:*

- Column |CR|: select coal rank.
- Column |N|: enter the number of abandoned mines remaining unflooded in that subdivision during that time interval. If no information is available on the flooded status, assume 100% remain unflooded.
- Column |G|: enter the fraction of gassy coal mines.

### To estimate CO<sub>2</sub> emissions:

For each subdivision in Column |S| and source Column |SRC|, data are entered in worksheet **CO<sub>2</sub> Emissions from Abandoned Coal Mines**, row by row, as follows:

- Column |AD|: enter the activity value.
- Column |U|: specify measurement unit for the activity.

### Emission factor input

IPCC default emission factors for the designated time intervals of mine closure are provided in [Table 4.1.6](#).

IPCC default active mine emissions prior to abandonment are provided in [Table 4.1.8](#), in million m<sup>3</sup> per year, and default coefficients are provided in [Table 4.1.9](#).

### When Tier 1 Equation is applied for CH<sub>4</sub> emissions:

For each row of data entered in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines**, data are entered row by row, as follows:



1. **Column |EF|**: CH<sub>4</sub> EF in m<sup>3</sup>/year is automatically populated by the *Software* based on the closure interval selected. Users can retain that value, or enter a user-specific value.
2. **Column |CF|**: conversion factor (density of CH<sub>4</sub> 6.7\*10<sup>-7</sup>) in Gg CH<sub>4</sub>/m<sup>3</sup> is automatically populated by the *Software*.

### When Tier 2&3 Equations are applied for CH<sub>4</sub> emissions:

For each row of data entered in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines – Tier 2 & 3**, data are entered as follows:

1. **Column |ER|**: enter the average emission rate before abandonment in m<sup>3</sup>/year.
2. **Column |A|**: enter value of coefficient A.
3. **Column |b|**: enter value of coefficient b.  
*Note that default coefficients “A” and “b” are automatically populated when a coal rank for anthracite, bituminous or sub-bituminous is selected. These default values can be retained for the Tier 2 method, or a user-specific (e.g. basin-specific) value is entered. Mine-specific information are entered for Tier 3.*
4. **Column |T|**: enter number of years elapsed since abandonment and the inventory year.
5. **Column |EF|**: the *Software* calculates the EF based on [Equation 4.1.12](#).
6. **Column |CF|**: conversion factor (density of methane 6.7\*10<sup>-7</sup>) in Gg CH<sub>4</sub>/m<sup>3</sup> is automatically populated by the *Software*.

### Example: multiple subdivisions – Tier 2 & 3

Subdivision	Region / Basin	Coal rank	Number of abandoned mines	Fraction of Gassy Coal Mines	Average emission rate before abandonment	Coefficient A	Coefficient b	Years elapsed since abandonment	Emission Factor	Conversion Factor	Methane emissions	Methane recovery	Methane emissions to be reported
S	B	CR	N	G	ER	A	b	T	EF = (1+A/T)^b	CF	E = N*G*ER*EF*CF	R	ER-E-R
East	Mine#1	Anthracite	25	0.75	1300000	1.72	-0.58	15	0.14848	0.0000	2.42494	2.1	0.32494
Unspecified	oklahoma	Anthracite	100	0.03	1300000	1.72	-0.58	10	0.18585	0.0000	0.48562	0.05	0.43562
Total			125								2.91056		0.76056

### To estimate CO<sub>2</sub> emissions:

For each row of data entered in worksheet **CO<sub>2</sub> Emissions from Abandoned Coal Mines**, data are entered row by row, as follows:

1. **Column |EF|**: enter the user-specific value, in Gg CO<sub>2</sub>/U, with U being the measurement unit entered in **Column |U|**.

### Example: single subdivision – CO<sub>2</sub>

Subdivision	Source	Activity	Activity unit	Emission Factor	Amount Captured	Emissions (Gg)
S	SR	A	U	EF	Z	E = A*EF - Z
Unspecified	Abandoned surface mines	100	t	0.05	1	5
	Active abandoned	1001	t	0.05	2	48.05
Total						53.05

## Results

Then, for Tier 1 in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines** and for Tier 2 and Tier 3 in worksheet **CH<sub>4</sub> Emissions from Abandoned Coal Mines – Tier 2 & 3**, CH<sub>4</sub> emissions are calculated by the *Software* in mass unit (Gg). While in worksheet for **CO<sub>2</sub> Emissions from Abandoned Coal Mines**, CO<sub>2</sub> emissions are calculated by the *Software* in mass unit (Gg). When the users apply a hybrid of tiers, total emissions from the source category of abandoned coal mines are those included in all three worksheets.

**1.B.1.a.i.4 Flaring of drained methane or conversion of methane to CO<sub>2</sub>**

When the methane is simply combusted in active or abandoned mines with no energy recovery, as in flaring or catalytic oxidation to CO<sub>2</sub>, the corresponding CO<sub>2</sub> production shall be added to the total GHG emissions from coal mining activities. During flaring and oxidation, not all CH<sub>4</sub> is converted to CO<sub>2</sub>; unburned methane is also included in total GHG emissions.

**GHGs**

Flaring of drained methane or conversion of methane to CO<sub>2</sub> emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>					

**IPCC Equations**

1. **Tier 1:** IPCC Tier 1 [Equation 4.1.5](#).
2. **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs.
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **1.2. 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**

The *Software* calculates emissions of the two GHGs using worksheet:

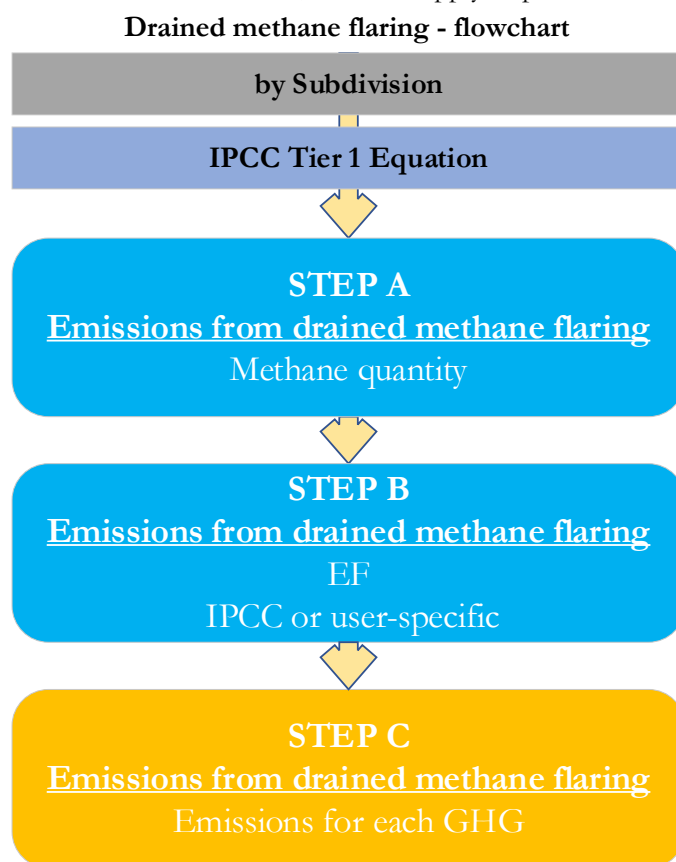
- ✓ **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized:** calculates emissions for each subdivision based on the volume of combusted methane, a CH<sub>4</sub> or CO<sub>2</sub> conversion factor, combustion efficiency factor and stoichiometric mass factor.

In the upper part of **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized** worksheet, users select the GHG for which to enter data.

User's work Flowchart

GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>38</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



For each subdivision, if any:

**Step A**, worksheet **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized**, users collect and enter data on the volume of combusted methane.

**Step B**, worksheet **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized**, users collect and enter in each row, for each GHG, associated conversion factor, combustion efficiency factor and stoichiometric mass factor.

**Step C**, worksheet **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Activity data input

The 2006 IPCC Guidelines, [Section 4.1.3.3](#), contain information on collecting AD for flaring of drained methane or conversion of methane to CO<sub>2</sub>.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then:

For each subdivision in Column |S|, data are entered in worksheet **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized**, row by row, as follows:

1. Column |C| enter volume of methane combusted, in m<sup>3</sup>.

Emission factor input

IPCC default EFs are provided in [Section 4.1.3.2](#) in m<sup>3</sup> per tonne of coal produced.

For each row of data entered in worksheet **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized**, data are entered as follows:

<sup>38</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

1. **Column |CF|**: the CH<sub>4</sub> and CO<sub>2</sub> conversion factors, in Gg GHG/m<sup>3</sup> are automatically populated by the *Software*. Users can retain these values, or enter user-specific values.
2. **Column |CE|**: the CH<sub>4</sub> and CO<sub>2</sub> combustion efficiency factors are automatically populated by the *Software*. Users can retain these values, or enter user-specific values.

*Note that 0.98 represents the default combustion efficiency of natural gas that is flared. Country or basin-specific information may be input here.*

3. **Column |MF|**:
  - ✓ for CO<sub>2</sub>, the stoichiometric mass factor, which is the mass ratio of CO<sub>2</sub> produced from full combustion of unit mass of methane is equal to 2.75.
  - ✓ for CH<sub>4</sub>, the stoichiometric mass factor is set automatically to “1”, and shall not be changed given it refers to the unburnt fraction.

*Note that user needs to select the corresponding GHG from the “Gas” tab as shown on the screenshot below.*

*Example: multiple subdivisions*

Subdivision	Volume of Methane combusted (m3)	CO2 Conversion Factor (Gg CH4/m3)	CO2 Combustion efficiency factor	CO2 Stoichiometric Mass Factor	CO2 Emissions (Gg)
Unspecified	3000000	0	0.98	2.75	5.41695
Unspecified 2	1000000	0	0.98	2.75	1.80565
<b>Total</b>	<b>4000000</b>				<b>7.2226</b>

## Results

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions in each subcategory are reported in worksheet **CO<sub>2</sub> emissions and unburnt CH<sub>4</sub> emissions from drained methane flared or catalytically oxidized**.

**1.B.1.a.ii Surface Mines (1.B.1.a.ii.1 Mining & 1.B.1.a.ii.2 Post-mining seam gas emissions)**

These categories include all seam gas emissions arising from mining and post-mining activities at surface mines.

This section covers emissions in active surface mines, as per IPCC categories 1.B.1.a.ii.1 and 1.B.1.a.ii.2, while the next section covers emissions from abandoned surface mines.

**GHGs**

Surface mining source categories consist of surface mining and post-mining activities and emit the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X	X					

**IPCC Equations**

CH<sub>4</sub> emissions from surface mining and post-mining source categories are estimated by applying the following IPCC equations:

1. **Tier 1:** Equations 4.1.7 (surface mining) and 4.1.8 (post-mining)
2. **Tier 2:** Tier 1 equations, although with user-specific (e.g. basin-specific) EFs
3. **Tier 3:** no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines.

As explained in section 1.2. 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.

CO<sub>2</sub> emissions from surface post mining are estimated by applying the following IPCC equations:

1. **Tier 1:** Equations 4.1.7A (mining)
2. **Tier 2:**
  - ✓ (mining) Tier 1 equation, although with user-specific (e.g. basin-specific) EFs
  - ✓ (post-mining) IPCC basic equation with user-specific EF
3. **Tier 3:** no IPCC Tier 3 Equation provided in the 2006 IPCC Guidelines.

**Software Worksheets**

The *Software* calculates emissions of the two GHGs using worksheets:

- ✓ **Coal production from surface mines:** contains for each subdivision the production volumes.
- ✓ **Emissions from surface mines:** contains for each subdivision the CO<sub>2</sub> and CH<sub>4</sub> EFs and corresponding conversion factors and calculates associated GHG emissions.

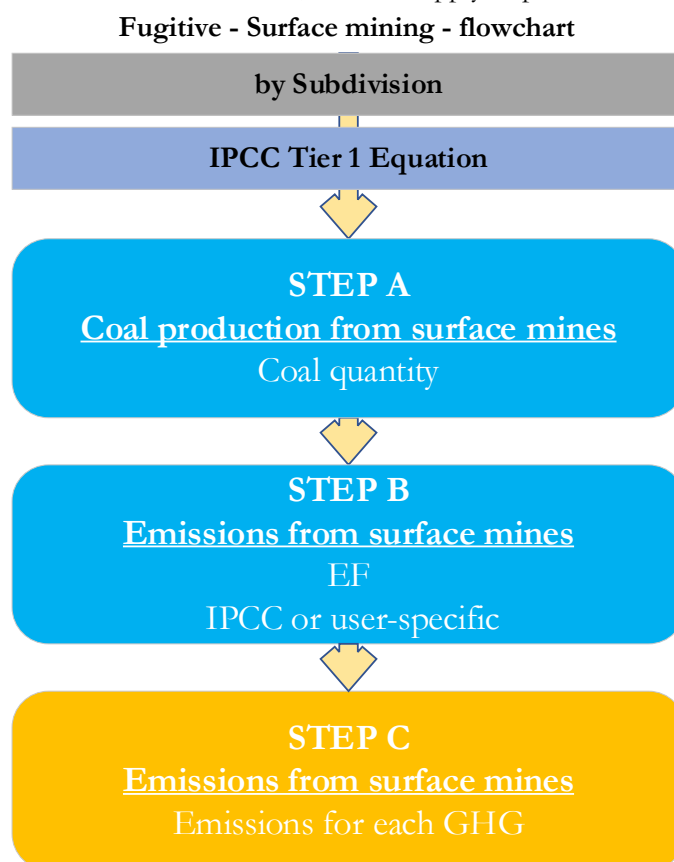
In the upper part of **Emissions from surface mines** worksheet, users select the GHG for which to enter data.

Data compilation of each subcategory is operated following the entire set of instructions below.

*Note that activity data input in worksheet **Coal production from surface mines** in one of the subcategories (1.B.1.a.ii Surface Mines and 1.B.1.a.ii.2 Post-mining) is automatically filled by the Software in the corresponding worksheet **Coal production from surface mines** in the other subcategory.*

Consistent with the key category analysis and the decision tree in [Figure 4.1.2](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>39</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A**, worksheet **Coal production from surface mines**, users collect and enter data on the amount of coal produced from surface coal mines.

**Step B**, worksheet **Emissions from surface mines**, users collect and enter in each row associated EFs for each GHG.

**Step C**, worksheet **Emissions from surface mines**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

### Activity data input

The *2006 IPCC Guidelines*, [Section 4.1.3.3](#) and [Section 4.1.4.3](#), contain information on collecting AD for surface coal mines.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|.

**Thus, for the relevant source-category:**

For each subdivision in Column |S|, data are entered in worksheet **Coal production from surface mines**, row by row, as follows:

1. Column |CP|: enter annual amount of raw coal produced, in tonne.

*Note that once a user adds surface coal production data into one of the two source categories (either mining or post-mining seam emissions), the coal production for each subdivision is automatically pre-filled in the other source category. A change to the AD in one source category will also change the AD in the other.*

*Example: single subdivision*

Subdivision	Equation 4.1.7	Amount of Coal Produced (tonnes)
Unspecified	CP	2000000
Total		2000000

<sup>39</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.



**Emission factor input**

IPCC default EFs are provided in [Section 4.1.4.2](#), for CH<sub>4</sub>, [Section 4.1.4.2](#), for CO<sub>2</sub>, in m<sup>3</sup> per tonne of coal produced.

The **Emissions from surface mines** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of subdivisions entered in worksheet **Coal production from surface mines**. Then:

1. **Column |EF|**: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in m<sup>3</sup> per tonne of coal produced.  
*Note that user shall select "Carbon dioxide (CO<sub>2</sub>)" or "Methane (CH<sub>4</sub>)" in the "Gas" bar at the top, to enter data for each GHG one by one.*
2. **Column |CF|**: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value. The Conversion Factors represent the density of the corresponding GHG, in Gg GHG per m<sup>3</sup> of gas emitted. The default density of CH<sub>4</sub>,  $0.67 \times 10^{-6}$ , is sourced from the *2006 IPCC Guidelines* while the default CO<sub>2</sub> density,  $1.84 \times 10^{-6}$ , is sourced from the *2019 Refinement*.

*Example: single subdivision, CH<sub>4</sub> emissions*

Subdivision	Amount of Coal Produced (tonnes)	CH <sub>4</sub> Emission Factor (m <sup>3</sup> /tonne)	CH <sub>4</sub> Emissions (m <sup>3</sup> )	Conversion Factor (Gg CH <sub>4</sub> /m <sup>3</sup> )	Methane recovered (Gg CH <sub>4</sub> )	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )
S	CP	EF	E(m <sup>3</sup> )=CP*EF	CF	R	E(Gg)=E(m <sup>3</sup> )/CF-R
Unspecified	200000	1.2	240000	0.00000067	0.5	1.108
Total	200000		240000			1.108

**Results**

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions in each subcategory are reported in worksheet **Emissions from surface mines**.

This section describes calculation of emissions from **abandoned surface mines**. After closure, emissions from abandoned surface mines may include the following: the standing highwall; leakage from the pit floor; low temperature oxidation and uncontrolled combustion.

This category has been added to facilitate interoperability with the UNFCCC CRT, where other emissions from surface mines can be reported.

### GHGs

Emissions from abandoned surface mines includes the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>					

### IPCC Equations

The *2019 Refinement* qualitatively discusses this category in Appendix 4.A.1.1. 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 fugitive GHG emissions from Abandoned Surface Mines.

1. **Tier 1**: no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*.
2. **Tier 2**: 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 **I.2. 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

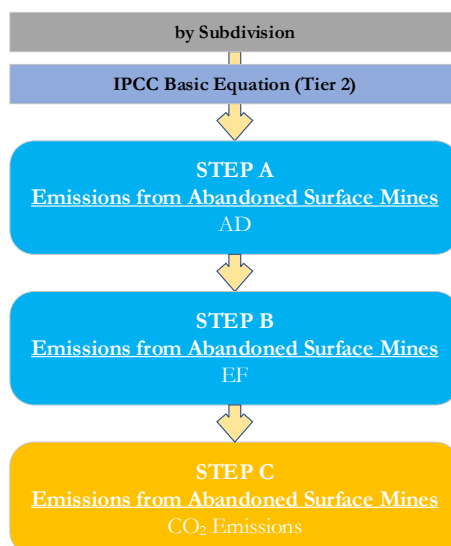
The *Software* allows to calculate emissions of the two GHGs using the following worksheet:

- ✓ **Emissions from abandoned surface mines**: calculates GHG emissions for each subdivision based on user-defined AD and EF.

In the upper part of **Emissions from abandoned surface mines** worksheet, users select the GHG for which to enter data.

### User's work Flowchart

Fugitive - Abandoned surface mines - flowchart



**Step A**, in worksheet **Emissions from Abandoned Surface Mines**, users collect and enter data on the source and activity data.

**Step B**, in worksheet **Emissions from Abandoned Surface Mines**, users collect and enter in each row the associated EF.

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

### Activity data input

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then:

For each subdivision in Column |S|, data are entered in worksheet **Emissions from abandoned surface mines**, row by row, as follows:

1. Column |SRC|: describe the type of activity emitting GHG emissions from this category (e.g. abandoned surface mines).

2. Column |AD|: enter AD (quantity).
3. Column |U|: enter the unit of the AD.

### Emission factor input

For each row of data entered in worksheet **Emissions from abandoned surface mines**, data are entered as follows:

1. Column |EF|: enter the user-specific CH<sub>4</sub> or CO<sub>2</sub> EF in Gg CO<sub>2</sub>/U, with U being the measurement unit entered in Column |U|;

*Example: single subdivision*

Subdivision	Source	Activity	Activity unit	CO2 Emission Factor (Gg/U)	Amount Captured (Gg CO2)	CO2 Emissions (Gg)
Unspecified	Abandoned surface mines	1000020	MT	0.6	100	599912
Total						599912

### Results

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions are reported in worksheet **Emissions from abandoned surface mines**.

**1.B.1.b Uncontrolled combustion and burning coal dumps**

This category covers uncontrolled combustion only due to coal exploration activities. While emissions from this source may be significant for an individual coal mine, it is unclear as to how significant these emissions may be for an individual country. In some countries where such fires are widespread, the emissions may be very significant. There are no clear methods available at present to systematically measure or precisely estimate the activity data, though where countries have data on amounts of coal burned, the CO<sub>2</sub> are estimated based on the carbon content of the coal and reported in this subcategory 1.B.1.b. Care needs to be taken to avoid double counting with fugitive CH<sub>4</sub> and low oxidation CO<sub>2</sub> emissions.

**GHGs**

Uncontrolled combustion and burning of coal dumps emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

**IPCC Equations**

Given that there are no specific equations in the *2006 IPCC Guidelines* for this category, GHG emissions from the uncontrolled combustion source category are estimated in the *Software* by applying the following IPCC equations provided for stationary combustion:

- Tier 1:** no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*.
- Tier 2:** IPCC Tier 1 equations [2.1](#) and [2.2](#), although with user-specific EFs
- Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.  
*Note that since Tier 3 of IPCC equation 2.4 is NOT applicable to this category (by definition the category is "uncontrolled" combustion), the user shall compile "unspecified" in Column [T] - Technology type - and must input "100" in the next Column [P] - Technology penetration -.*

As explained in section [1.2. 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.

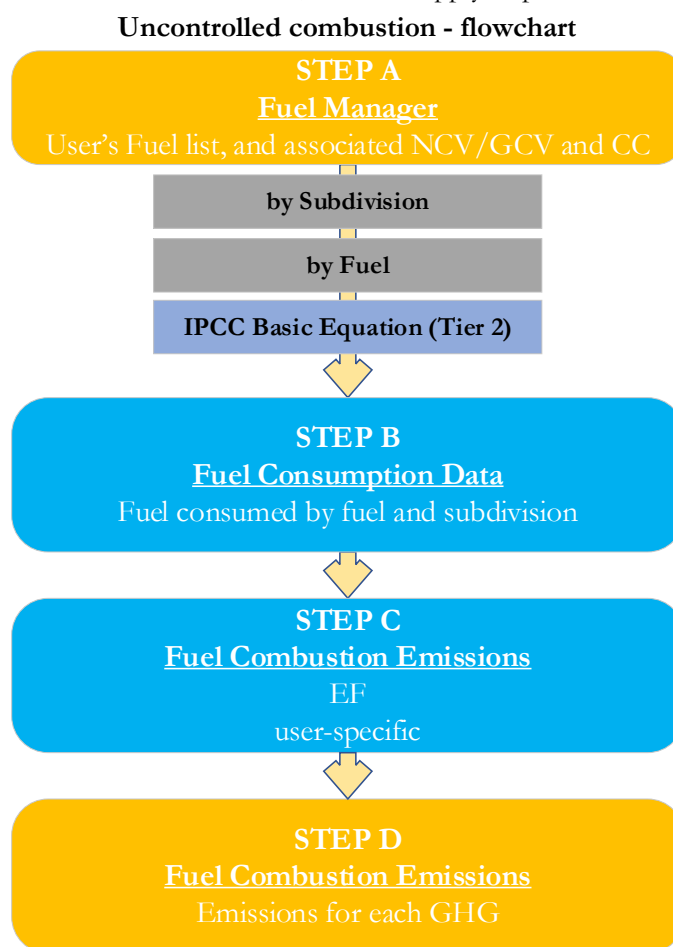
**Software Worksheets**

The *Software* calculates emissions of the three GHGs using worksheets:

- ✓ **Fuel Manager:** contains information on the *carbon content* and the *calorific value* of each solid fuel type used in the NGHGI. Although, for this category is not good practice to apply IPCC defaults given the assumption of full oxidation to CO<sub>2</sub> does not apply.
- ✓ **Fuel Consumption Data:** contains for each solid fuel type the amount subject to uncontrolled combustion.
- ✓ **Fuel Combustion Emissions:** contains for each subdivision and solid fuel type the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs and calculates associated GHG emissions.

In the upper part of each worksheet, users select the *Fuel type* for which to enter data. The *All Fuels* option is selected to visualize all fuels entered, with no *Fuel type* limitation.

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant source category: its name and the *calorific value* and the *carbon content* of each fuel.

**Then, for each subdivision, if any:**

**Step B, worksheet Fuel Consumption Data**, users collect and enter data on the amount consumed of each fuel.

**Step C, worksheet Fuel Combustion Emissions**, users collect and enter in each row associated EFs for each GHG.

**Step D, worksheet Fuel Combustion Emissions**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

#### Activity data input

The *2006 IPCC Guidelines*, [Sections 1.4.1.2](#) and [1.4.1.3](#), contain information on how to collect and apply energy statistics data. Due to the nature of this category, uncontrolled combustion, the information may not be in official statistics and efforts may need to be made to collect information on the amount of uncontrolled combustion.

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ. Other units may be entered into the **Fuel Consumption Data** worksheet, e.g. British Thermal Units (BTUs). However, when alternative units are used, the column for GCV/NCV becomes blank and the user shall enter a user-defined conversion factor (TJ/unit).

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the worksheet **Fuel Consumption Data** either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

## Example: multiple subdivisions

Subdivision	Fuel	Consumption Unit	Consumption (Mass, Volume or Energy Unit)	Conversion Factor (TJ/Gg)	Total consumption (TJ)
Central region	Anthracite	TJ	10000	1	10000
Unspecified	Brown Coal Briquettes	Gg (Auto CF)	3000	20.7	62100
<b>Total</b>					<b>72100</b>

Then, for each subdivision in Column |S|, data are entered in worksheet **Fuel Consumption Data** row by row as follows:

- Column |F|: select each solid fuel subject to uncontrolled combustion from the drop-down menu, one row for each fuel.  
*Note that fuels shown in the dropdown menu are those listed in the Fuel Manager.*  
*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*
- Column |U|: enter the unit in which fuel consumption data are available (e.g. Gg, TJ). To enter a user-specific unit (e.g. m<sup>3</sup>) select **Gg (Manual CF)** from the dropdown menu and overwrite Gg with the user-defined unit.
- Column |C|: enter amount of fuel consumed.
- Column |CF|: enter conversion factor to convert the consumption unit to energy units (TJ).  
*Note that where Gg of fuel are converted to TJ, 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. m<sup>3</sup>) the user shall enter the relevant conversion factor here.*

## Emission factor input

The **Fuel Combustion Emissions** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of subdivision/fuel combinations entered in worksheet **Fuel Consumption Data**. Then:

- 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.  
*Note that the drop-down table will be filled with a single row of data as technology type is not applicable.*  
*Note that user shall select "Fuel Type" in the "Fuel Type" bar at the top, to enter data for each fuel one by one.*
- Compile each row as follows:
  - Column |T|: given that Tier 3 of IPCC Equation 2.4 is not applicable to this category, the user shall select *Unspecified* from the drop-down menu.

## Example: Tier 2

Subdivision	Fuel	Total consumption (TJ)	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
Unspecified	Anthracite	2670	262 461	0 0267	0 02937
Unspecified	Lignite	1190	125 19	0 0119	0 0119
<b>Total</b>		<b>1190</b>	<b>125 19</b>	<b>0 0119</b>	<b>0 0119</b>

- Column |P|: given that Tier 3 of IPCC Equation 2.4 is not applicable to this category, the user shall leave the pre-filled, by the *Software*, value of 100.
- Column |EF(CO<sub>2</sub>)|: enter user-specific value.
- Column |EF(CH<sub>4</sub>)|: There are no IPCC default values for this category; enter value, if available.  
*Note that the unit to be used is kg CH<sub>4</sub>/TJ.*
- Column |EF(N<sub>2</sub>O)|: There are no IPCC default values for this category; enter value, if available.  
*Note that the unit to be used is kg N<sub>2</sub>O/TJ.*

## Results

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data and total emissions from each source of uncontrolled combustion and burning coal dumps is the sum of all emissions from all subdivisions reported in worksheet **Fuel Combustion Emissions**.



**1.B.1.c Fuel Transformation**

The category 1.B.1.c Solid Fuel Transformation is included in the *2006 IPCC Guidelines*<sup>40</sup>, but no specific equations are provided. To facilitate interoperability with the UNFCCC CRT Reporting tool, the corresponding category **1.B.1.c Fuel Transformation** of the *2019 Refinement* has been included in the *Software*.

Specifically, instructions are provided for the worksheets in the *Software* to calculate fugitive emissions from charcoal and biochar production, coke production and gasification transformation:

- ✓ **1.B.1.c.i Charcoal and Biochar production**
- ✓ **1.B.1.c.ii Coke production**
- ✓ **1.B.1.c.iv Gasification transformation**

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<sup>40</sup> It includes fugitive emissions arising during the manufacture of secondary and tertiary products from solid fuels.

**1.B.1.c.i Charcoal and Biochar production**

This section describes calculation of fugitive emissions arising from **charcoal and biochar production**. Charcoal is produced by the carbonization of wood, through thermal decomposition in the absence of oxygen at a temperature above 300°C. The carbonization of wood produces charcoal<sup>41</sup> as well as direct greenhouse gases (CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O). Emissions of biogenic CO<sub>2</sub> from charcoal production are reported here as an information item, and are covered under Agriculture, Forestry and Other Land Use (AFOLU). Fugitive emissions of CH<sub>4</sub> and N<sub>2</sub>O are reported here.

**GHGs**

**Charcoal and biochar production** emit the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

**IPCC Equations**

1. **Tier 1:** IPCC Tier 1 [Equation 4.3.1\(New\)](#).
2. **Tier 2:** IPCC Tier 1 Equation with user-specific EFs
3. **Tier 3:** IPCC Tier 1 Equation with emission-stage-specific EFs and thus detailed AD

As explained in section **1.2. 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**

The *Software* calculates emissions of the three GHGs using worksheet:

- ✓ **Emissions from Charcoal and Biochar production:** contains AD and EF, CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered, if any, and calculates associated GHG emissions.

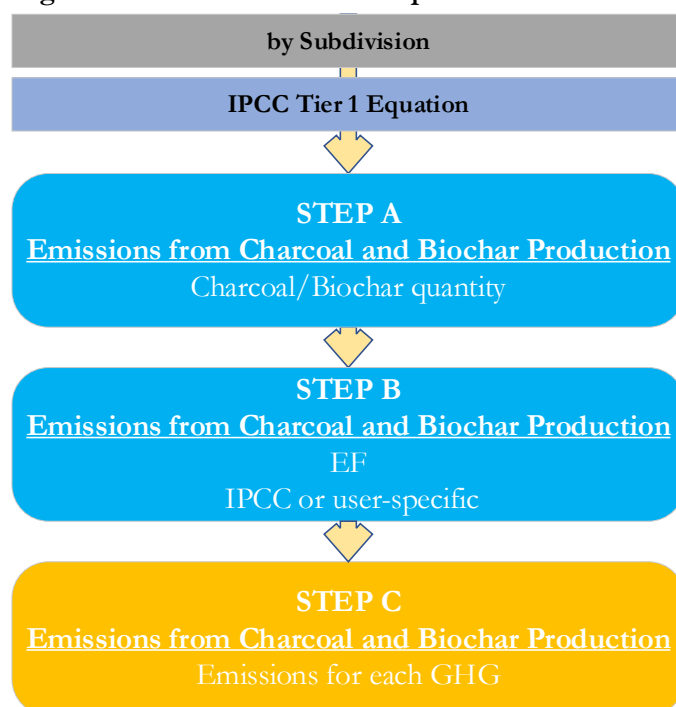
<sup>41</sup> Biochar is charcoal applied to soil.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.3.1 \(New\)](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>42</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:

## Fugitive – Charcoal and biochar production - flowchart



**Step A**, in worksheet **Emissions from Charcoal and Biochar production**, users collect and enter in the *Software* the amount of charcoal or biochar produced, by each subdivision. Data can be entered as a single total for each product or stratified, where information is available, in subdivisions.

**Step B**, in worksheet **Emissions from Charcoal and Biochar production**, for each subdivision, users enter CO<sub>2</sub>, CH<sub>4</sub> or N<sub>2</sub>O EFs. For this category, the user may also select and estimate nitrogen oxides (NO<sub>x</sub>) and carbon monoxide (CO) emissions.

**Step C**, in worksheet **Emissions from Charcoal and Biochar production**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery can be reported in **Emissions from Charcoal and Biochar production** worksheet. CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery are only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is known. The CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is then entered at the level at which corresponding emissions are calculated.

## Activity data input

The *2019 Refinement*, [Section 4.3.2](#), contain information on how to find data on charcoal and biochar production.

Input of AD for this category requires the following steps:

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Further, for each subdivision, there is a separate row for charcoal and one for biochar.

Then, for each subdivision in Column |S|, data are entered in worksheet **Emissions from Charcoal and Biochar production**, row by row, as follows:

1. Column |SRC| enter source of solid fuel transformation (biochar or charcoal production);
2. Column |A| enter AD for each source of solid fuel transformation

*Note that once AD are entered for one gas, the same AD apply for all three GHGs (see multiple subdivisions below)*

<sup>42</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

## Example: single subdivision (unspecified)

Worksheet: Emissions from Charcoal and Biochar production

Sector: Energy  
Category: Fuel transformation  
Subcategory: 1.B.1.c.i - Charcoal and Biochar production  
Sheet: Emissions from Charcoal and Biochar production

Data  
Gas: CARBON DIOXIDE (CO<sub>2</sub>)

Equation 4.3.1 (New)

Subdivision	Source	Activity Data (kg)	CO <sub>2</sub> Emission Factor (g/kg)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg)
S	SRC	AD	EF	Z	E = (A * EF * 10 <sup>-9</sup> ) - Z
Unspecified	Biochar Production	5000000000	4300	0	21500
	Charcoal Production	5000000000	1570	0	7850
Total					29350

## Example: multiple subdivisions

Worksheet: Emissions from Charcoal and Biochar production

Sector: Energy  
Category: Fuel transformation  
Subcategory: 1.B.1.c.i - Charcoal and Biochar production  
Sheet: Emissions from Charcoal and Biochar production

Data  
Gas: CARBON DIOXIDE (CO<sub>2</sub>)

Equation 4.3.1 (New)

Subdivision	Source	Activity Data (kg)	CO <sub>2</sub> Emission Factor (g/kg)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg)
S	SRC	AD	EF	Z	E = (A * EF * 10 <sup>-9</sup> ) - Z
Northeastern	Charcoal Production	120000	1570	0	0.1884
Unspecified	Biochar Production	5000000000	4300	0	21500
	Charcoal Production	5000000000	1570	0	7850
Total					29350.1884

## Emission factor input

IPCC default charcoal and biochar production EFs in [Section 4.3.3](#) of the *2019 Refinement*, in g/kg.

For each row of data entered in worksheet **Emissions from Charcoal and Biochar production**, data are entered as follows:

1. Column |EF|: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value;

*Note that user shall select "Carbon dioxide (CO<sub>2</sub>)" or "Methane (CH<sub>4</sub>)" or "Nitrous oxide (N<sub>2</sub>O)" in the "Gas" bar at the top, to enter data for each GHG one by one.*

*Note that the Software can calculate also NO<sub>x</sub> and CO emissions where those gases are selected, and the relevant EF is entered.*

Example: single subdivision, CH<sub>4</sub> emissions

Worksheet: Emissions from Charcoal and Biochar production

Sector: Energy  
Category: Fuel transformation  
Subcategory: 1.B.1.c.i - Charcoal and Biochar production  
Sheet: Emissions from Charcoal and Biochar production

Data  
Gas: METHANE (CH<sub>4</sub>)

Equation 4.3.1 (New)

Subdivision	Source	Activity (kg)	CH <sub>4</sub> Emission Factor (g/kg)	Methane recovered (Gg CH <sub>4</sub> )	CH <sub>4</sub> Emissions (Gg)
S	SRC	A	EF	R	E = (A * EF * 10 <sup>-9</sup> ) - R
Unspecified	Biochar Production	6333333	41	0	0.25967
	Charcoal Production	120000000	40	1	3.8
Total					4.05967

## Results

To estimate the total CO<sub>2</sub> and total CH<sub>4</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> and of CH<sub>4</sub> released from that subdivision that has been instead captured or recovered, respectively, are to be entered in Gg CO<sub>2</sub> in Column |Z| and/or in Gg CH<sub>4</sub> in Column |R| of worksheet **Emissions from Charcoal and Biochar production**.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions in each subcategory are reported in worksheet **Emissions from Charcoal and Biochar production**.

**1.B.1.c.ii Coke production**

This section describes calculation of emissions from **coke production**. While emissions from the carbonisation process and from combustion are reported in category **1.A.1.c**, fugitive emissions are reported in this category. For a detailed description of processing stages and associated GHG emissions see [Table 4.3.4\(New\)](#).

**GHGs**

**Coke production** emits the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

*Note that inventory compilers who are using a carbon mass balance approach to estimate emissions from iron and steel production, and are including fugitive emissions in that balance, shall not estimate CO<sub>2</sub> fugitive emissions from coke production to avoid double counting.*

**IPCC Equations****I. Fugitive emissions from coke production**

- Tier 1:** IPCC Tier 1 [Equation 4.3.2\(New\)](#). IPCC defaults are not available for CO<sub>2</sub> and N<sub>2</sub>O.
- Tier 2:** IPCC Tier 1 Equation with user-specific EFs.
- Tier 3:** IPCC Tier 1 Equation with emission-stage-specific EFs, and thus detailed AD.

**II. Emissions from coke oven gas flaring**

- Tier 1:** IPCC Tier 1 [Equation 4.3.3\(New\)](#) for CO<sub>2</sub> emissions and [Equation 4.3.4\(New\)](#) for CH<sub>4</sub> and N<sub>2</sub>O emissions.
- Tier 2 (CO<sub>2</sub> only):** IPCC Tier 1 Equation with user-specific EFs.
- Tier 3:** IPCC Tier 1 Equation with facility-specific measurement data with or without a carbon balance of remaining carbon sources.

As explained in section **1.2. 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**

The *Software* calculates emissions of the three GHGs using worksheets:

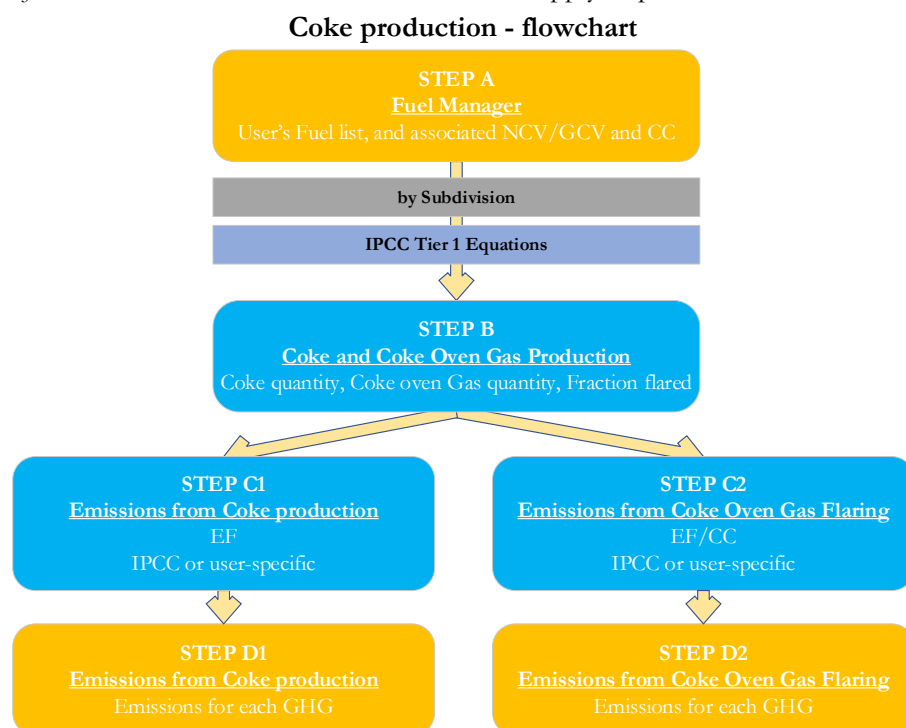
- ✓ **Fuel Manager:** contains information on the *carbon content* and the *calorific value* for coke oven gas.
- ✓ **Coke and Coke Oven Gas production:** contains for each subdivision the total amount of coke and coke oven gas produced.
- ✓ **Emissions from Coke production:** contains for each subdivision the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs and calculates associated emissions from coke production.
- ✓ **Emissions from Coke Oven Gas flaring:** contains for each subdivision the relevant CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O EFs, CO<sub>2</sub> captured and CH<sub>4</sub> recovered, if any, and calculates associated emissions from flaring of coke oven gas.

In the upper part of **Emissions from Coke production** and **Emissions from Coke Oven Gas flaring** worksheets, users select the GHG for which to enter data.

## User's work Flowchart

Consistent with the key category analysis and the decision trees in [Figure 4.3.3 \(New\)](#) (fugitive emissions from coke production) and [Figure 4.3.4 \(New\)](#) and [Figure 4.3.5 \(New\)](#) (flaring of coke oven gas), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>43</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A, Fuel Manager**, users collect and enter data on each fuel used in the relevant 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.

Then, for each subdivision, if any:

**Step B**, worksheet **Coke and Coke Oven Gas production**, users collect and enter data on the amount of coke produced, as well as the coke oven gas produced per unit of coke produced and the fraction of that coke oven gas that is flared.

**Step C1**, worksheet **Emissions from Coke production**, users collect and enter in each row associated EFs for each GHG.

**Step C2**, worksheet **Emissions from Coke Oven Gas flaring**, users collect and enter in each row associated EFs for each GHG.

**Step D1**, worksheet **Emissions from Coke production**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

**Step D2**, worksheet **Emissions from Coke Oven Gas flaring**, for each row of data and GHG, the *Software* calculates emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery can be reported in each worksheet. CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery are only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is known. The CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered may then be assigned to a specific subdivision.

## Activity data input

The *2019 Refinement*, [Section 4.3.2](#), contain information on how to find data on the quantities of coke produced. Unlike data entry for stationary combustion, these AD are to be entered in the *Software* in mass units (tonnes).

As a **Starting step**, users enter in the **Fuel Manager** all user-specific fuels to be reported in the NGHGI; 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**, users compile the worksheet **Coke and Coke Oven Gas production** either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|:

<sup>43</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.



## Example: single subdivision (unspecified)

Subdivision	Coke produced (tonnes)	Coke oven gas produced per unit of coke (Nm³/tonne)	Conversion Factor (kg/m³ COG)	Net Calorific Value (TJ/Gg)	Coke oven gas produced (GJ)	Coke oven gas flared (Fraction)
S	A	B	C = A * B	D	NCV	F
Unspecified	10000000	100	1000000000	0.589	38.7	0.02
Total	10000000	100	1000000000	0.589	38.7	0.02

## Example: multiple subdivisions

Subdivision	Coke produced (tonnes)	Coke oven gas produced per unit of coke (Nm³/tonne)	Conversion Factor (kg/m³ COG)	Net Calorific Value (TJ/Gg)	Coke oven gas produced (GJ)	Coke oven gas flared (Fraction)
S	A	B	C = A * B	D	NCV	F
Region A	1000	100	100000	0.589	38	0.02
Region B	1000	100	100000	0.589	38	0.02
Unspecified	10000000	100	1000000000	0.589	38.7	0.02
Total	10002000	100	1000000000	0.589	38.7	0.02

Then, for each subdivision in Column |S| data are entered in worksheet **Coke and Coke Oven Gas production** row by row as follows:

- Column |A| enter AD on coke produced, in tonnes.
- Column |B| enter AD on coke oven gas produced per unit of coke, in Nm³/tonne.
- Column |D| enter conversion factor to convert the calculated amount of coke oven gas produced to mass (kg),
- Column |NCV| enter NCV to convert the calculated amount of coke oven gas produced to energy units (GJ).  
*Note that the NCV entered in the Fuel Manager will be available as the dropdown option.*
- Column |F| input the fraction of the calculated amount of coke oven gas produced that is flared.  
*Note that AD on coke produced, coke oven gas produced, and coke oven gas flared are automatically pre-filled in worksheets **Emissions from Coke production** and **Emissions from Coke Oven Gas flaring**.*

## Emission factor input

IPCC default EFs for fugitive emissions from coke production are provided in [Section 4.3.2](#) while those for flaring of coke oven gas are provided in [Section 4.3.2](#); both of the 2019 Refinement.

The **Emissions from Coke Production** worksheet and the **Emissions from Coke Oven Gas flaring** worksheet are pre-filled by the *Software* with a number of rows corresponding to the number of subdivisions entered in worksheet **Coke and Coke Oven Gas production**.

Then, for each row, in worksheet **Emissions from Coke Production** data are entered as follows:

- Column |EF|: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in kg per tonne of coal produced.  
*Note that 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.*

Then, for each row, in worksheet **Emissions from Coke Oven Gas flaring** data are entered as follows:

- Column |CC| or Column |EF|: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in kg C per GJ (for carbon content) or kg/GJ (for EF).  
*Note that for CH₄ and N₂O an EF is entered used while for CO₂ the carbon content is entered.*

## Example: single subdivision- CH₄

Subdivision	Coke oven gas produced (GJ)	Coke oven gas flared (Fraction)	CH₄ Emission Factor (kg/GJ)	Methane recovered (Gg CH₄)	CH₄ Emissions (Gg)
S	A	B	EF	R	E = (A * B * EF * 10⁻⁶) - R
Unspecified	22794300	0.02	0.18	0.02	0.06206
Total	22794300	0.02	0.18	0.02	0.06206

To estimate the total CO<sub>2</sub> and total CH<sub>4</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> and of CH<sub>4</sub> released from that subdivision that has been instead captured or recovered, respectively, are to be entered in Gg CO<sub>2</sub> in Column |Z| and/or Gg CH<sub>4</sub> in Column |R| of **Emissions from Coke production** and **Emissions from Coke Oven Gas flaring** worksheets.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions in each subcategory are reported in worksheets **Emissions from Coke production** and **Emissions from Coke Oven Gas flaring**. The sum of emissions calculated in the two worksheets gives the total emissions from the category.

**1.B.1.c.iv Gasification transformation**

**Gasification transformation** processes are related to the transformation of biomass, coal or natural gas into syngas, composed of H<sub>2</sub>, CO, CO<sub>2</sub> and CH<sub>4</sub>, and, then, into a liquid hydrocarbons fuel. These processes are called biomass to gaseous (BtG), biomass to liquid (BtL), coal to liquid (CtL) and gas to liquid (GtL); as shown in [Figure 4.3.6 \(New\)](#).

**GHGs**

**Gasification transformation** include fugitive emissions from gas to liquids, coal to liquids and from other gasification processes, and emits the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

**IPCC Equations**✓ **Fugitive emissions from Gas to Liquids and from Coal to Liquids**

1. **Tier 1:** IPCC Tier 1 [Equation 4.3.5 \(New\)](#).
2. **Tier 2:** IPCC Tier 1 Equation with user-specific EFs
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2019 Refinement*, although it refers to a mass balance method.

✓ **Fugitive emissions from other gasification**

1. **Tier 1:** no IPCC Tier 1 Equation provided in the *2019 Refinement*.
2. **Tier 2:** IPCC basic equation, based on user provided AD and EFs, has been implemented in the *Software* to enable reporting of other user-specific gasification activities in addition to gas to liquids and coal to liquids.
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2019 Refinement*.

As explained in section [1.2. 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 the three GHGs using worksheets:

- ✓ **Emissions from Gas to Liquids:** calculates emissions for each subdivision based on the type of feedstock consumed.
- ✓ **Emissions from Coal to Liquids:** calculates emissions for each subdivision based on the gasification process (Syngas, Syngas/H<sub>2</sub>, Synthetic Natural Gas) and the amount of syngas produced.
- ✓ **Emissions from Other Gasification:** calculates emissions for each subdivision based on the user-defined input on the amount of activity driving the gasification process (e.g. feedstock consumption or production).

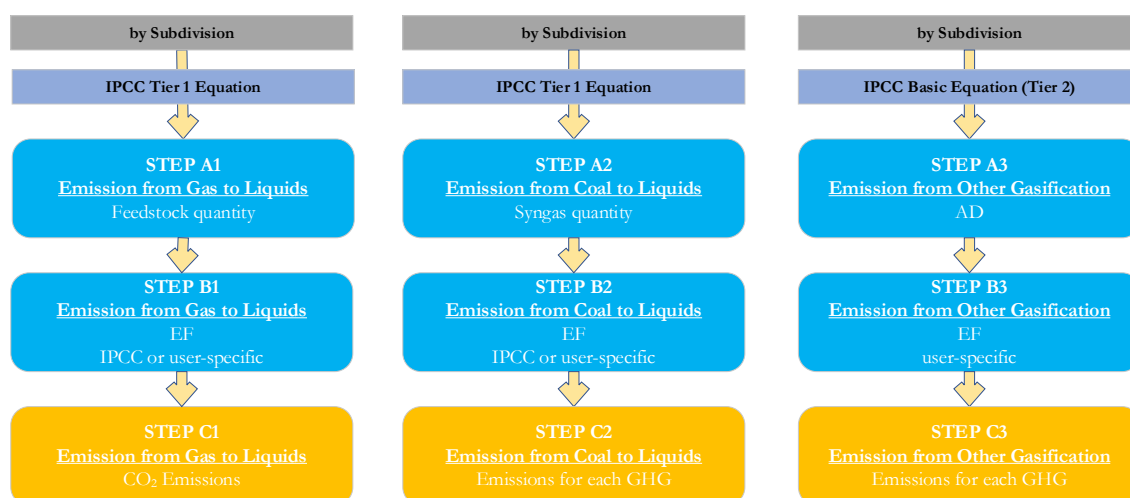
In the upper part of each worksheet, users select the GHG for which to enter data.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.3.7 \(New\)](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>44</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:

## Fugitive - Gasification transformation - flowchart



**Step A**, in each worksheet, enter amount of feedstock consumed or product produced, by each subdivision.

**Step B**, in each worksheet, enter CO<sub>2</sub>, CH<sub>4</sub> or N<sub>2</sub>O EFs.

**Step C**, in each worksheet the *Software* calculates the emissions in Gg.

Where data are available, CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery can be reported in the relevant worksheet. CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery are only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is known. The CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered may then be assigned to a specific subdivision.

## Activity data input

The *2019 Refinement*, [Section 4.3.2](#), contain information on gas to liquids and coal to liquids and may be useful when collecting AD for other gasification processes.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in [Column |S|](#) [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in [Column |S|](#).

**Thus, for the relevant source-category:**

For each subdivision in [Column |S|](#), data are entered in the relevant worksheet, row by row, as follows:

- [Column |i|](#): enter type of Feedstock produced (for gas to liquids) or gasification process (for coal to liquids)
- [Column |AD|](#): enter feedstock, in worksheet **Emissions from Gas to Liquids**, or amount of syngas produced, in worksheet **Emissions from Coal to Liquids**, in Tj. While for **Emissions from other gasification** the AD are entered in the unit collected, and the unit is to be entered in [Column |U|](#).

## Example: single subdivision (unspecified)

The screenshot shows the 'Emissions from Gas to Liquids' worksheet. The left sidebar lists categories under '1.B.1 - Solid Fuels', with '1.B.1.c.iv - Gasification transformation' selected. The main area displays a table with columns: Subdivision, Type of Feedstock, Amount of Feedstock (Tj), CO2 Emission Factor (kg Tj), Amount Captured (Gg CO2), and CO2 Emissions (Gg). The formula bar shows the equation:  $E = (A \times EF \times 10^{-6}) - Z$ . The table contains one row for 'Unspecified' with values: Natural Gas, 1000, 12730, 2, and a calculated CO2 Emissions of 10.73. A 'Total' row at the bottom shows a CO2 Emissions of 10.73.

<sup>44</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

## Example: multiple subdivisions

The screenshot shows the IPCC Inventory Software interface for the year 2015. The left sidebar lists categories, with '1.B.1.c.iv - Gasification transformation' selected. The main window displays a worksheet for 'Emissions from Gas to Liquids' with the 'Gas' set to 'CARBON DIOXIDE (CO2)'. The table below shows data for three subdivisions (Tier 1, Tier 2, and Total) with columns for Subdivision, Type of Feedstock, Amount of Feedstock (TJ), CO2 Emission Factor (kg/TJ), Amount Captured (Gg CO2), and CO2 Emissions (Gg). The formula for CO2 emissions is  $E = (A \cdot EF \cdot 10^{-6}) - Z$ .

Subdivision	Type of Feedstock	Amount of Feedstock (TJ)	CO2 Emission Factor (kg/TJ)	Amount Captured (Gg CO2)	CO2 Emissions (Gg)
Tier 1	Natural Gas	1000	12730	2	10.73
Tier 2	Natural Gas	2500	12730	0	31.825
Total					42.555

## Emission factor input

IPCC default EFs are provided in [Table 4.3.10 \(NEW\)](#) of the *2019 Refinement*, in kg/TJ (for coal to liquids) and [Table 4.3.11 \(NEW\)](#) (for gas to liquids).

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

1. **Column |EF|**: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value;

*Note that user shall select “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous Oxide (N<sub>2</sub>O)” in the “Gas” bar at the top, to enter data for each GHG one by one.*

Example: single subdivision- CH<sub>4</sub>

The screenshot shows the IPCC Inventory Software interface for the year 2015. The left sidebar lists categories, with '1.B.1.c.iv - Gasification transformation' selected. The main window displays a worksheet for 'Emissions from Gas to Liquids' with the 'Gas' set to 'METHANE (CH4)'. The table below shows data for three subdivisions (Unspecified, Syngas, and Total) with columns for Subdivision, Gasification process, Amount of Syngas produced (TJ), CH4 Emission Factor (kg/TJ), Methane recovered (Gg CH4), and CH4 Emissions (Gg). The formula for CH4 emissions is  $E = (A \cdot EF \cdot 10^{-6}) - R$ .

Subdivision	Gasification process	Amount of Syngas produced (TJ)	CH4 Emission Factor (kg/TJ)	Methane recovered (Gg CH4)	CH4 Emissions (Gg)
Unspecified	Syngas	10000	6.1	0.01	0.051
	Syngas / H2	10000	6.1	0	0.061
	Synthetic Natural Gas	10000	6.1	0	0.061
Total					0.173

## Results

To estimate the total CO<sub>2</sub> and total CH<sub>4</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> and of CH<sub>4</sub> released from that subdivision that has been instead captured or recovered, respectively, are to be entered in Gg CO<sub>2</sub> in **Column |Z|** and/or in Gg CH<sub>4</sub> in **Column |R|** of the relevant worksheet.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions in each subcategory are reported in the relevant worksheet. The sum of emissions calculated in the three worksheets gives the total emissions from the category.

### 1.B.2.a Oil

Hereafter, the use of the *Software* to estimate fugitive emissions associated with all infrastructure required to produce, collect, process, or refine and deliver oil to market is illustrated. The following sections are separated, as emissions from various activities/categories are estimated via different approaches and correspondingly using different worksheets of the *Software*:

- ✓ **1.B.2.a.i Oil - Venting** - calculates emissions from venting at oil facilities.
- ✓ **1.B.2.a.ii Oil - Flaring** - calculates emissions from flaring of natural gas and waste gas/vapour streams at oil facilities.
- ✓ **1.B.2.a Oil - Fugitives (1.B.2.a.iii.1-1.B.2.a.iii.6)** – calculates fugitive emissions from all activities at oil facilities that are not associated with venting and flaring, as follows:
  - Exploration - fugitive emissions from oil well drilling, drill stem testing, and well completion.
  - Production and Upgrading - fugitive emissions from well servicing, oil sands or shale oil mining, transport of untreated production to treating or extraction facilities.
  - Transport - fugitive emissions related to the transport of marketable crude oil to upgraders and refineries.
  - Refining - fugitive emissions at petroleum refineries.
  - Distribution of oil products - fugitive emissions from the transport and distribution of refined products, including those at bulk terminals and retail facilities.
  - Other - fugitive emissions from oil systems not otherwise accounted for in the above categories.

This category excludes the following activities, which are covered in other parts of this Guidebook or in other sectors of the *Software*:

- Combustion-related activities at oil facilities are covered under **Stationary Combustion Source Categories** of this Guidebook.
- Fugitive CO<sub>2</sub> emissions from carbon capture and storage activities, including release of CO<sub>2</sub> during enhanced oil recovery activities, are included in **1.C - Carbon Dioxide Transport and Storage**.



**1.B.2.a.i Oil - Venting**

Emissions from venting of associated gas and waste gas/vapour streams at oil facilities.

**GHGs**

Venting at oil facilities emits the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

N<sub>2</sub>O is included here for completeness and recognizing that some categories may have N<sub>2</sub>O emissions. However, there are no default N<sub>2</sub>O EFs provided in the *2006 IPCC Guidelines* for venting from oil facilities.

Note that this category includes only venting activities (i.e. intentional releases of gas). GHG emissions from flaring of associated gas are covered in **Oil - Flaring**. Fugitive releases of CH<sub>4</sub> and CO<sub>2</sub> are calculated in section on **Oil – Fugitives**

**IPCC Equations**

1. **Tier 1:** IPCC Tier 1 [Equation 4.2.1](#)
2. **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs, or alternative IPCC Tier 2 [Equation 4.2.3](#)
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **1.2. 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**

The *Software* calculates emissions of the three GHGs using worksheets:

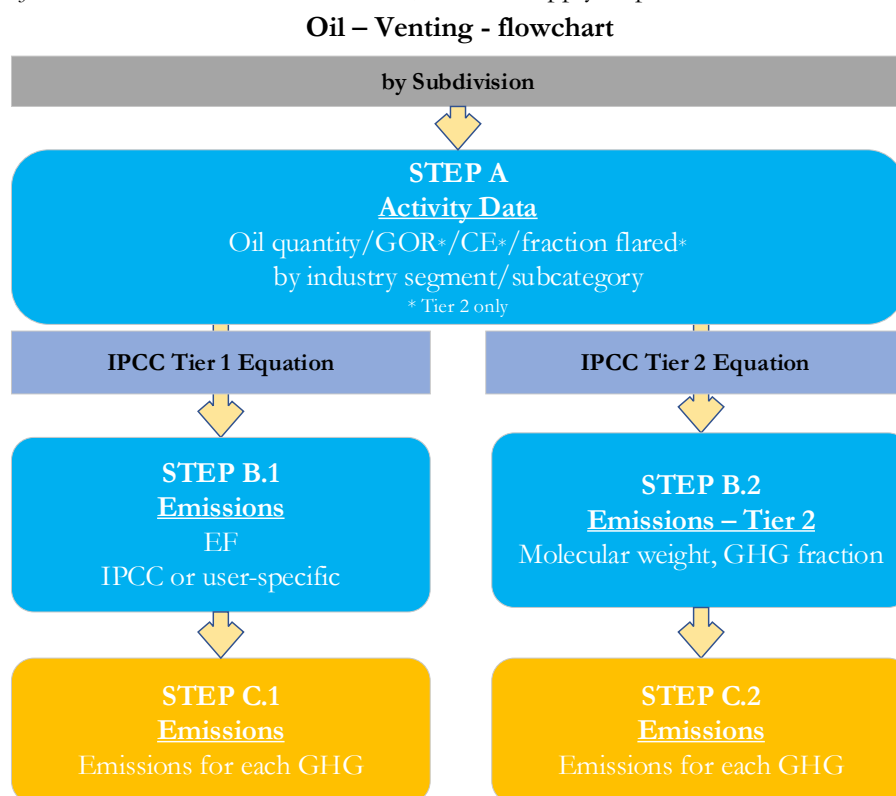
- ✓ **Activity Data:** contains for each subdivision/industry segment/subcategory the annual amount of oil production, and if Tier 2 is selected, the user enters the gas-to-oil ratio, gas conservation efficiency factor, and fraction of waste gas flared.
- ✓ **Emissions:** contains for each subdivision/industry segment/subcategory the EFs and calculates associated GHG emissions following the default method (using Equation 4.2.1). If user-specific EFs are applied, this would be considered a Tier 2 method.
- ✓ **Emissions – Tier 2:** contains for each industry segment/subcategory the molecular weight and associated gas fraction of the GHG of interest and calculates associated GHG emissions for Tier 2 using the alternative Tier 2 method.

In the upper part of **Emissions** and **Emissions – Tier 2** worksheets, users select the GHG for which to enter data.

User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.2.2](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>45</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



Thus, for each subdivision, if any:

**Step A**, worksheet **Activity Data**, users input the annual amount of oil production or activity by industry segment/subcategory. Data can be input as a single total or stratified (e.g. regions/companies, etc.).

**When Tier 1 Equation is applied**

**Step B.1**, worksheet **Emissions**, users input in the *Software* the EFs. The user shall select in the drop-down menu at the top “Gas” bar the corresponding GHG, “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous Oxide (N<sub>2</sub>O)”.

**Step C.1**, worksheet **Emissions**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

**When Tier 2 Equation is applied**

**Step B.2**, worksheet **Emissions – Tier 2**, for each subdivision/industry segment/subcategory users input in the *Software* molecular weight and fraction of associated gas that is composed of the GHG that is being estimated.

**Step C.2**, worksheet **Emissions – Tier 2**, for each row of data and GHG, the *Software* calculates the emissions in mass units (Gg). In addition, for each GHG, total emissions are calculated.

Where data are available, CO<sub>2</sub> capture can be reported in worksheets **Emissions** and **Emissions – Tier 2**. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

Activity data input

The 2006 IPCC Guidelines, [Section 4.2.2.4](#), including [Tables 4.2.6 & 4.2.7](#) for the Tier 1 method, provide information on the minimum data needs and where to find and how to apply statistics data.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then, for each subdivision in Column |S|, data are entered in worksheet **Activity Data**, row by row, as follows:

<sup>45</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

1. **Column |I|**: select from the drop-down menu or enter the corresponding industry segment. Default industry segments are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.
2. **Column |SC|**: select from the drop-down menu or enter the subcategory corresponding to the industry segment selected. Default subcategories are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.
3. **Column |Calculation Method|**: select the approach to prepare estimates: *Default* or *Tier 2*. Based on the selection in this column, data are transferred by the *Software* to the relevant worksheet **Emissions** or **Emissions – Tier 2**.  
*Note that a Tier 2 estimate can be calculated using either a user-specific EF in the Default equation, or the alternative Tier 2 equation based on the mass balance approach. Where a user-specific EF is applied, select “Default” here.*

#### Example: selection of Calculation method

Application Database Inventory real-time Monitoring Worksheet Tools Reports Worksheet Window Help

2006 IPCC Categories

1.A.5.b.iii - Mobile (Other)

1.A.5.c - Multilateral Operations

B - Fugitive emissions from fuels

1.B.1 - Solid Fuels

1.B.1.a - Coal mining and handling

1.B.1.a.i - Underground mines

1.B.1.a.i.1 - Mining

1.B.1.a.i.2 - Post-mining seam gas emis

1.B.1.a.i.3 - Abandoned underground mi

1.B.1.a.i.4 - Flaring of drained methane o

1.B.1.a.ii - Surface mines

1.B.1.a.ii.1 - Mining

1.B.1.a.ii.2 - Post-mining seam gas emis

1.B.1.a.ii.3 - Abandoned surface mines

1.B.1.b - Uncontrolled combustion and burning c

1.B.1.c - Fuel transformation

1.B.1.c.i - Charcoal and Biochar production

1.B.1.c.ii - Coke production

1.B.1.c.iv - Gasification transformation

1.B.2 - Oil and Natural Gas

1.B.2.a - Oil

1.B.2.a.ii - Venting

1.B.2.a.iii - Flaring

Worksheet notes

Activity Data

Worksheet

Emissions

Emissions - Tier 2

Energy

Fugitive Emissions from Fuels - Oil

1.B.2.a.i - Venting

Activity Data

Data

Equation 4.2.1, 4.2.3

Subdivision	Industry Segment	Subcategory	Calculation method	Oil production (10 <sup>3</sup> m <sup>3</sup> )	Average gas-to-oil ratio (m <sup>3</sup> /m <sup>3</sup> )	Gas conservation efficiency factor	Fraction of waste gas flared	Total gas vented (10 <sup>3</sup> m <sup>3</sup> )
S	I	SC	AD	GOR	CE	X	V=Q*GOR*(1-CE)/(1-X)	
Unspecified	Oil Production	Conventional Oil	Default	200000				
Unspecified	Oil Production	Default Weighted Total	Tier 2	200000	15	0.99	0.98	60
Unspecified	Oil Production	Default Weighted Total	Default	200000				
Unspecified	Oil Production	Heavy Oil / Cold Bit.	Default	200000				
Unspecified	Oil Production	Thermal Oil Production	Default	200000				
Unspecified	Oil Transport	Loading of Off-shore	Default	200000				
Unspecified	Oil Transport	Tanker Trucks and	Default	200000				
Unspecified	Well	All	Tier 2	200000	0.5	0.99	0.8	200
Unspecified	Well	All	Tier 2	200000	0.5	0.97	0.88	360
Unspecified	Well Drilling	All	Tier 2	200000	0.5	0.98	0.6	800
Total								

2015

4. **Column |AD|**: enter total amount of oil production, in 10<sup>3</sup> m<sup>3</sup>
- When **Tier 2** is selected in step 3:
5. **Column |GOR|**: enter average gas-to-oil ratio in m<sup>3</sup>/m<sup>3</sup>, noting the value shall be referenced at 15°C and 101.325 kPa.
6. **Column |CE|**: enter gas conservation efficiency factor.
7. **Column |X|**: enter fraction of waste gas flared.
8. **Column |V|**: *Software* calculates the amount of total gas vented, in 10<sup>3</sup> m<sup>3</sup>.

#### Emission factor input

IPCC default EFs are provided in [Tables 4.2.4 & 4.2.5](#) of the 2006 IPCC Guidelines. Where a range of factors is provided in the Tables, the mid-point has been selected for the dropdown. Users can overwrite this value, as necessary.

*Note that this category includes all venting at oil facilities, from exploration through to distribution. When using the default EFs for well drilling, well testing and well servicing, be sure not to double count emissions between oil venting and oil flaring.*

#### When Tier 1 Equation is applied:

The **Emissions** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of combinations of subdivision/industry segment/subcategory entered in worksheet **Activity Data**, for which *Default* method is selected. Then:

1. **Column |EF|**: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in Gg per 1,000 m<sup>3</sup> of oil.  
*Note that user shall select “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous Oxide (N<sub>2</sub>O)” in the “Gas” bar at the top, to enter data for each GHG one by one.*

#### Example: Emissions, CO<sub>2</sub>

Subdivision	Industry Segment	Subcategory	Activity Data (10 <sup>3</sup> m <sup>3</sup> )	CO <sub>2</sub> Emission Factor (Gg/10 <sup>3</sup> m <sup>3</sup> )	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )
S	I	SC	AD	EF	Z	E = A * EF - Z
Unspecified	Oil Production	Conventional Oil	200000	0.000095	1	18
Unspecified	Oil Production	Default Weighted Total	200000	0.0018	2	358
Unspecified	Oil Production	Heavy Oil / Cold Bitum.	200000	0.0053	3	1057
Unspecified	Oil Production	Thermal Oil Production	200000	0.00022	4	40
Unspecified	Oil Transport	Loading of Off-shore P.	200000	0.000023	0	0.46
Unspecified	Oil Transport	Tanker Trucks and Rai.	200000	0.000023	0	0.46
Total			1200000			1473.92

#### When Tier 2 Equation is applied:

The **Emissions – Tier 2** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of combinations of subdivision/industry segment/subcategory entered in worksheet **Activity Data**, for which *Tier 2* method is selected. Then:

1. **Column |M|**: *Software* pre-fills the molecular weight of the corresponding GHG (16.043 for CH<sub>4</sub>, 44.011 for CO<sub>2</sub> and 44.013 for N<sub>2</sub>O).

2. **Column |Y|**: enter fraction of associated gas that is composed of the GHG of interest.

*Note that the selection of GHG shall be done from the bar "Gas".*

*Example: Emissions – Tier 2, CH<sub>4</sub>*

Subdivision	Industry Segment	Subcategory	Total gas vented (10 <sup>3</sup> m <sup>3</sup> )	Molecular weight	Fraction of the associated gas that is composed of CH <sub>4</sub>	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )
Unspecified	Oil Production	Default Weighted Tot.	60	16.043	0.5	0.02036
Unspecified	Well	All	200	16.043	0.3	0.04072
Unspecified	Well	All	360	16.043	0.29	0.07085
Unspecified	Well Drilling	All	800	16.043	0.3	0.16287
<b>Total</b>			<b>1420</b>			<b>0.29479</b>

## Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> released from that subdivision that has been instead captured is to be entered in Gg CO<sub>2</sub> in **Column |Z|** of worksheets **Emissions** and **Emissions – Tier 2**.

Then, for Tier 1 in worksheet **Emissions** and for Tier 2 in worksheet **Emissions – Tier 2**, for each GHG, emissions are calculated by the *Software* in mass unit (Gg).

Thus, for each GHG, total emission is the sum of all emissions from all subdivisions reported in worksheets **Emissions** and **Emissions – Tier 2**.

**1.B.2.a.ii Oil - Flaring**

Emissions from flaring of natural gas and waste gas/vapour streams at oil facilities

**GHGs**

Flaring at oil facilities emits the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

Note that this category includes only GHG emissions from flaring of associated gas are covered. Estimation of emissions from intentional releases of gas are described above in **Oil - Venting**. Fugitive releases of CH<sub>4</sub> and CO<sub>2</sub> are described in the section on **Oil – Fugitives**

**IPCC Equations**

- ✓ **Tier 1:** IPCC Tier 1 [Equation 4.2.1](#)
- ✓ **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs, or alternative IPCC Tier 2 Equations [4.2.4](#) for CH<sub>4</sub>, [4.2.5](#) for CO<sub>2</sub>, [4.2.8](#) for N<sub>2</sub>O
- ✓ **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **I.2. 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 the three GHGs using worksheets:

- ✓ **Activity Data:** contains, for each subdivision/industry segment/subcategory, annual amount of oil production, and if Tier 2 is selected, gas-to-oil ratio, gas conservation efficiency factor, and fraction of waste gas flared.
- ✓ **Emissions:** contains, for each subdivision/industry segment/subcategory, EFs, and CO<sub>2</sub> captured and calculates associated GHG emissions.
- ✓ **CH<sub>4</sub> Emissions – Tier 2:** contains, for each subdivision/industry segment/subcategory: flaring destruction efficiency, molecular weight, CH<sub>4</sub> fraction in flared gas, and calculates associated emissions for Tier 2.
- ✓ **CO<sub>2</sub> Emissions – Tier 2:** contains, for each subdivision/industry segment/subcategory, molecular weight, fraction of non-CO<sub>2</sub> carbon in waste gas stream that is converted to soot, fractions of flared gas composed of CO<sub>2</sub>, CH<sub>4</sub> and NMVOCs, number of moles of carbon per mole of compound, CO<sub>2</sub> captured, if any, and calculates associated CO<sub>2</sub> emissions for Tier 2.
- ✓ **N<sub>2</sub>O Emissions – Tier 2:** contains, for each subdivision/industry segment/subcategory, N<sub>2</sub>O EFs and calculates associated N<sub>2</sub>O emissions for Tier 2.

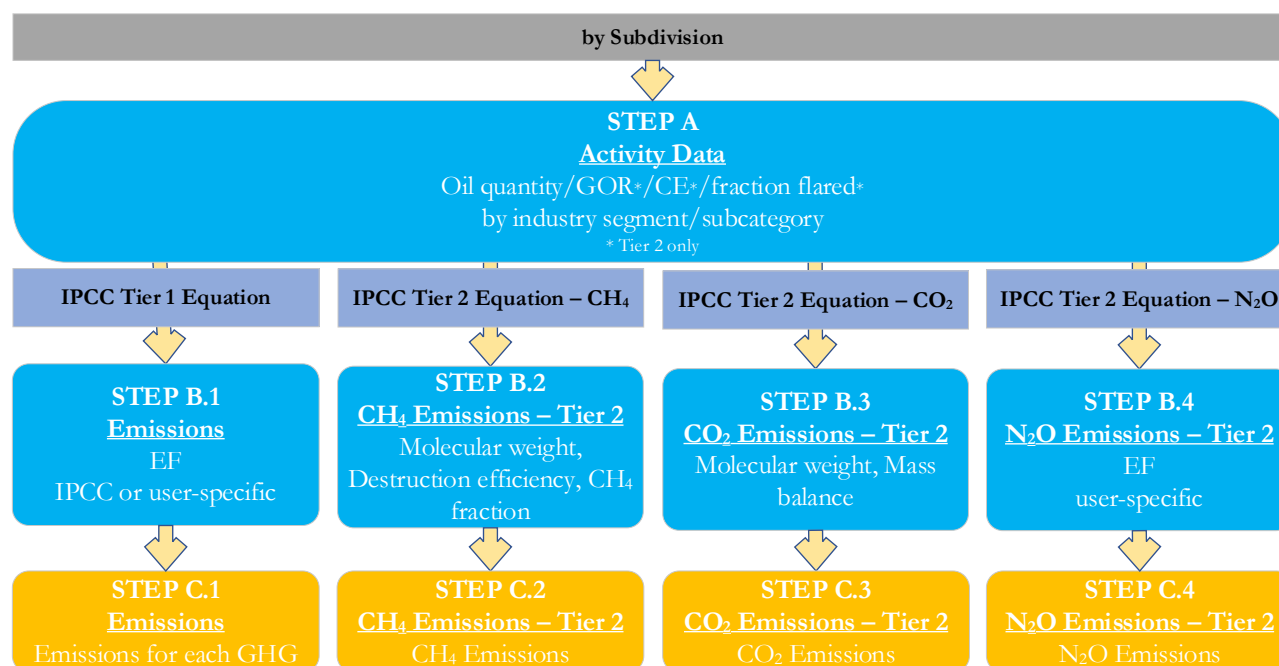
In the upper part of **Emissions** worksheet, users select the GHG for which to enter data.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.2.2](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>46</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:

## Oil – Flaring - flowchart



**Step A**, worksheet **Activity Data**, users input the annual amount of oil production by subdivision/industry segment/subcategory. Data can be input as a single total or stratified in subdivisions (e.g. regions/companies, etc.).

## When Tier 1 Equation is applied

**Step B.1**, worksheet **Emissions**, users input in the software the EFs for all GHGs. The user shall select in the drop-down menu at the top “Gas” bar the corresponding GHG, “Carbon dioxide (CO<sub>2</sub>)”, “Methane (CH<sub>4</sub>)” or “Nitrous Oxide (N<sub>2</sub>O)”.

**Step C.1**, worksheet **Emissions**, the software estimates GHG emissions for each subdivision/industry segment/subcategory.

## When Tier 2 Equations are applied

**Step B.2**, worksheet **CH<sub>4</sub> Emissions – Tier 2**, for each subdivision/industry segment/subcategory users input in the software flaring destruction efficiency, molecular weight and fraction of associated gas.

**Step B.3**, worksheet **CO<sub>2</sub> Emissions – Tier 2**, for each subdivision/industry segment/subcategory users input in the software molecular weight, fraction of the non-CO<sub>2</sub> carbon in the input waste gas stream that is converted to soot, fractions of associated gas composed of CO<sub>2</sub>, CH<sub>4</sub> and NMVOCs, and the number of moles of carbon per mole of compound.

**Step B.4**, worksheet **N<sub>2</sub>O Emissions – Tier 2**, for each subdivision/industry segment/subcategory users input in the software EFs for N<sub>2</sub>O.

**Step C.**, worksheets in steps B.2.-B.4, the *Software* calculates corresponding GHG emissions for each subdivision/industry segment/subcategory.

Where data are available, CO<sub>2</sub> capture can be reported in worksheets **Emissions** and **CO<sub>2</sub> Emissions – Tier 2**. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

## Activity data input

The 2006 IPCC Guidelines, [Section 4.2.2.4](#), including [Tables 4.2.6 & 4.2.7](#) for the Tier 1 method, provide information on the minimum data needs and where to find and how to apply statistics data.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then, for each subdivision in Column |S|, data are entered in worksheet **Activity Data**, row by row, as follows:

<sup>46</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.



1. **Column |I|**: select from the drop-down menu or enter the corresponding industry segment. Default industry segments are listed in [Table 4.2.2](#) of the *2006 IPCC Guidelines*.
2. **Column |SC|**: select from the drop-down menu or enter the subcategory corresponding to the industry segment selected. Default subcategories are listed in [Table 4.2.2](#) of the *2006 IPCC Guidelines*.
3. **Column |Calculation Method|**: select the approach to prepare estimates: *Default* or *Tier 2*. Based on the selection in this column, data are transferred by the *Software* to the relevant worksheet **Emissions** or **Emissions – Tier 2**.  
*Note that a Tier 2 estimate can be calculated using either a user-specific EF in the Default equation, or the alternative Tier 2 equation based on the mass balance approach. Where a user-specific EF is applied, select “Default” here.*

#### Example: selection of Calculation method

Subdivision	Industry Segment	Subcategory	Calculation method	Oil production (10 <sup>3</sup> m <sup>3</sup> )	Average gas-to-oil ratio (m <sup>3</sup> /m <sup>3</sup> )	Gas conservation efficiency factor	Fraction of waste gas flared	Total gas flared (10 <sup>3</sup> m <sup>3</sup> )
Region1	Well Drilling	All	Default	555				
Unspecified	Well Drilling	All	Default	56000				
Unspecified	Well Testing	All	Tier 2	5000000	0.6	0.98	0.7	42000
Total				5056555				42000

4. **Column |AD|**: enter total amount of oil production, in 10<sup>3</sup> m<sup>3</sup>.

#### When Tier 2 is selected in step 3:

5. **Column |GOR|**: enter average gas-to-oil ratio in m<sup>3</sup>/m<sup>3</sup>, noting the value shall be referenced at 15°C and 101.325 kPa.
6. **Column |CE|**: enter gas conservation efficiency factor.
7. **Column |X|**: enter fraction of waste gas flared.
8. **Column |F|**: *Software* calculates the amount of total gas flared, in 10<sup>3</sup> m<sup>3</sup>.

#### Emission factor input

IPCC default EFs are provided in [Tables 4.2.4 & 4.2.5](#) of the *2006 IPCC Guidelines*. Where a range of factors is provided in the Tables, the mid-point has been selected for the dropdown. Users can overwrite this value, as necessary.

*Note that this category includes all flaring at oil facilities, from exploration through to distribution. When using the default EFs for well drilling, well testing and well servicing, be sure not to double count emissions between oil venting and oil flaring.*

#### When Tier 1 Equation is applied:

The **Emissions** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of combinations of subdivision/industry segment/subcategory entered in worksheet **Activity Data**, for which *Default* method is selected. Then:

1. **Column |EF|**: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in Gg per 1,000 m<sup>3</sup> of oil.  
*Note that user shall select “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous Oxide (N<sub>2</sub>O)” in the “Gas” bar at the top, to enter data for each GHG one by one.*

#### Example: Emissions, N<sub>2</sub>O

Subdivision	Industry Segment	Subcategory	Activity (10 <sup>3</sup> m <sup>3</sup> )	N <sub>2</sub> O Emission Factor (Gg/10 <sup>3</sup> m <sup>3</sup> )	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
Unspecified	Well Testing	All	1000	0.00000064	0.0000064
Total			1000		0.0000064

#### When Tier 2 Equation is applied:

The **CH<sub>4</sub> Emissions – Tier 2** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of combinations of subdivision/industry segment/subcategory entered in worksheet **Activity Data**, for which *Tier 2* method is selected. Then:

1. **Column |FE|**: enter flaring destruction efficiency. In the absence of user-specific information typically a value of 0.995 is assumed for flares at refineries and a value of 0.98 is assumed for those used at production and processing facilities.
2. **Column |M|**: enter molecular weight of the corresponding GHG (16.043 for CH<sub>4</sub>);
3. **Column |Y|**: enter fraction of associated gas that is composed of CH<sub>4</sub>.

Example: CH<sub>4</sub> Emissions – Tier 2

Subdivision	Industry Segment	Subcategory	Total gas flared (10 <sup>3</sup> m <sup>3</sup> )	Flaring destruction efficiency	Molecular weight	Fraction of the associated gas that is composed of CH <sub>4</sub>	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )
S	I	SC	F	FE	M	Y	$E = F \cdot (1 - FE) \cdot M \cdot Y \cdot 10^{-6}$
East	Well Servicing	All	5	0.98	16.043	0.1	0.00001
Total			5				0.00001

The **CO<sub>2</sub> Emissions – Tier 2** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of combinations of subdivision/industry segment/subcategory entered in worksheet **Activity Data**, for which the *Tier 2* method is selected. Then:

1. **Column |M|**: *Software* pre-fills the molecular weight of the corresponding GHG (44.011 for CO<sub>2</sub>).
2. **Column |X|**: enter fraction of the non-CO<sub>2</sub> carbon in the input waste gas stream that is converted to soot.
3. **Column |Y1|**: enter fraction of associated gas that is composed of CO<sub>2</sub>.
4. **Column |Y2|**: enter fraction of associated gas that is composed of CH<sub>4</sub>.
5. **Column |Y3|**: enter fraction of associated gas that is composed of NMVOC.
6. **Column |N2|**: *Software* pre-fills the number of moles of carbon per mole of CH<sub>4</sub>.
7. **Column |N3|**: input the number of moles of carbon per mole of NMVOC. Default values in the *2006 IPCC Guidelines* range from 2.1 to 2.7 for the NMVOC fraction in natural gas and 4.6 for the NMVOC fraction of crude oil vapours.

Example: CO<sub>2</sub> Emissions – Tier 2

Subdivision	Industry Segment	Subcategory	Total gas flared (10 <sup>3</sup> m <sup>3</sup> )	Molecular weight	Fraction of non-CO <sub>2</sub> carbon of waste gas converted to soot	Fraction of the associated gas that is composed of CO <sub>2</sub>	Fraction of the associated gas that is composed of CH <sub>4</sub>	Fraction of the associated gas that is composed of NMVOC	Number of moles of carbon for mole of CH <sub>4</sub>	Number of moles of carbon for mole of NMVOC	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )
S	I	SC	F	M	X	Y1	Y2	Y3	N2	N3	Z	$E = F \cdot M \cdot (Y1 + (Y2 \cdot N2 + Y3 \cdot N3) \cdot (1 - X)) \cdot 10^{-6} - Z$
East	Well Servicing	All	5	44.011	0.2	0.3	0.1	0.5	1	2		0.01098
Total			5									0.01098

The **N<sub>2</sub>O Emissions – Tier 2** worksheet is pre-filled by the *Software* with a number of rows corresponding to the number of combinations of subdivision/industry segment/subcategory entered in worksheet **Activity Data**, for which the *Tier 2* method is selected. The total gas flared for each combination from worksheet **Activity Data** also is automatically pre-filled.

Example: N<sub>2</sub>O Emissions – Tier 2

Subdivision	Industry Segment	Subcategory	Total gas flared (10 <sup>3</sup> m <sup>3</sup> )	N <sub>2</sub> O Emission Factor (Gg/10 <sup>3</sup> m <sup>3</sup> )	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
S	I	SC	F	EF	$E = F \cdot EF$
East	Well Servicing	All	5	0.001	0.005
Total			5		0.005

## Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> released from that subdivision that has been instead captured is to be entered in Gg CO<sub>2</sub> in **Column |Z|** of worksheets **Emissions** and **CO<sub>2</sub> Emissions – Tier 2**.

Then, for Tier 1 in worksheet **Emissions** and for Tier 2 in worksheets **CH<sub>4</sub> Emissions – Tier 2**, **CO<sub>2</sub> Emissions – Tier 2** and **N<sub>2</sub>O Emissions – Tier 2**, for each GHG, emissions are calculated by the *Software* in mass unit (Gg).

Thus, for each GHG, total emission is the sum of all emissions from all subdivisions reported in worksheets **Emissions** and **CH<sub>4</sub> Emissions – Tier 2**, **CO<sub>2</sub> Emissions – Tier 2** and **N<sub>2</sub>O Emissions – Tier 2**.

**1.B.2.a Oil – Fugitives (1.B.2.a.iii.1 to 1.B.2.a.iii.6)**

This section provides instructions to use the IPCC Software to estimate fugitive emissions (i.e. unintentional releases) from:

- 1.B.2.a.iii.1 Oil Exploration,
- 1.B.2.a.iii.2 Production and Upgrading,
- 1.B.2.a.iii.3 Transport,
- 1.B.2.a.iii.4 Refining,
- 1.B.2.a.iii.5 Distribution of oil products
- 1.B.2.a.iii.6 Other, segments of oil industry.

The guide below is provided as an example for the segment **Oil Production and Upgrading**, although the same calculation worksheet, and thus instructions, apply to all other segments.

**GHGs**

Oil industry emits the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

N<sub>2</sub>O is included here for completeness and recognizing that some categories may have N<sub>2</sub>O emissions. However, there are no default N<sub>2</sub>O EFs provided in the *2006 IPCC Guidelines* for fugitive emissions from the oil industry.

**IPCC Equations**

- ✓ **Tier 1:** IPCC Tier 1 Equations [4.2.1](#) and [4.2.2](#)
- ✓ **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs.
- ✓ **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **1.2. 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**

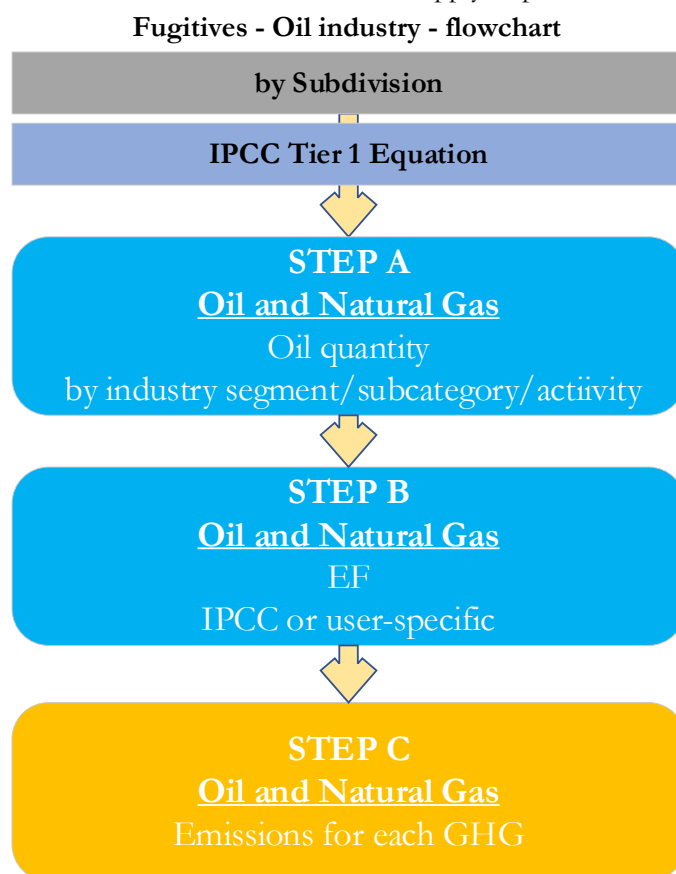
The *Software* calculates emissions of the three GHGs using worksheet:

- ✓ **Oil and Natural Gas:** contains, for each subdivision/industry segment/subcategory, total oil production, EFs for each GHG, and CO<sub>2</sub> captured, and calculates associated emissions.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.2.2](#) and [Figure 4.2.3](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>47</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A**, in the **Oil and Natural Gas** worksheet, users input the total activity (e.g. annual amount of oil production) by subdivision/industry segment/subcategory. Data can be input as a single total or stratified in subdivisions (e.g. regions/companies, etc.).

**Step B**, in the **Oil and Natural Gas** worksheet, users input in the software the EFs for all GHGs, either IPCC defaults or user-specific values.

**Step C**, in the same **Oil and Natural Gas** worksheet, software estimates GHG emissions for each subdivision/industry segment/subcategory.

Where data are available, CO<sub>2</sub> capture can be reported in worksheet **Oil and Natural Gas**. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

## Activity data input

The 2006 IPCC Guidelines, [Section 4.2.2.4](#), including [Tables 4.2.6 & 4.2.7](#) for the Tier 1 method, provide information on the minimum data needs and where to find and how to apply statistics data. It is important to remember that this category includes only fugitive emissions. GHG emissions from oil venting are covered in [Oil - Venting](#) and GHG emissions from flaring are covered in [Oil - Flaring](#).

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in [Column |S|](#) [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in [Column |S|](#). Then, for each subdivision in [Column |S|](#), data are entered in worksheet **Oil and Natural Gas**, row by row, as follows:

1. [Column |I|](#): select from the drop-down menu or enter the corresponding industry segment. Default industry segments are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.
2. [Column |SC|](#): select from the drop-down menu or enter the subcategory corresponding to the industry segment selected. Default subcategories are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.

<sup>47</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

3. **Column |AT|**: select from the drop-down menu or enter the activity type.
4. **Column |AD|**: enter AD, corresponding to the activity type selected in **Column |AT|**, e.g. total amount of annual oil production.
5. **Column |U|**: enter AD unit. The AD unit for which the IPCC default EFs were developed are contained in [Tables 4.2.4 & 4.2.5](#).

### Emission factor input

IPCC default EFs are provided in [Tables 4.2.4 & 4.2.5](#) of the *2006 IPCC Guidelines*. Where a range of factors is provided in the Tables, the mid-point has been selected for the dropdown. Users can overwrite this value, as necessary.

For each row of data entered in worksheet **Oil and Natural Gas**, data are entered as follows:

1. **Column |EF(CO<sub>2</sub>)|**: select from the drop-down menu the IPCC default CO<sub>2</sub> EF or enter a user-specific value; in Gg CO<sub>2</sub>/U.  
*Note that U is the unit of the corresponding AD entered in Column |U|.*
2. **Column |EF(CH<sub>4</sub>)|**: select from the drop-down menu the IPCC default CH<sub>4</sub> EF or enter a user-specific value; in Gg CH<sub>4</sub>/U.  
*Note that U is the unit of the corresponding AD entered in Column |U|.*
3. **Column |EF(N<sub>2</sub>O)|**: select from the drop-down menu the IPCC default N<sub>2</sub>O EF or enter a user-specific value; in Gg N<sub>2</sub>O/U.  
*Note that U is the unit of the corresponding AD entered in Column |U|.*

### Example: oil production and upgrading

Application

Database

Inventory Year

Worksheets

Reports

Tools

Export/Import

Administrative

Window

Help

2006 IPCC Categories

1.B.1.a.i - Underground mine

1.B.1.a.i.1 - Mining

1.B.1.a.i.2 - Post-mining s

1.B.1.a.i.3 - Abandoned u

1.B.1.a.i.4 - Flaring of dsi

1.B.1.a.ii - Surface mines

1.B.1.a.ii.1 - Mining

1.B.1.a.ii.2 - Post-mining

1.B.1.a.ii.3 - Abandoned s

1.B.1.b - Uncontrolled combustio

1.B.1.c - Fuel transformation

1.B.1.c.i - Charcoal and Bio

1.B.1.c.ii - Coke production

1.B.1.c.iii - Gasification transf

1.B.2.a - Oil and Natural Gas

1.B.2.a.i - Oil

1.B.2.a.i.1 - Venting

1.B.2.a.i.2 - Flaring

1.B.2.a.ii - All Other

Oil and Natural Gas

Worksheet

Sector:

Energy

Category:

Fugitive Emissions from Fuels - Oil and Natural Gas

Subcategory:

1.B.2.a.ii.2 - Production and Upgrading

Sheet:

CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O from fugitive emissions from fuels by source categories

Equation 4.2.1

Activity						CO <sub>2</sub>		CH <sub>4</sub>		N <sub>2</sub> O			
Subdivision	Industry Segment	Subcategory	Activity Type	Activity	Unit for AD	Emission Factor (Gg CO <sub>2</sub> /U)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	Emission Factor (Gg CH <sub>4</sub> /U)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	Emission Factor (Gg N <sub>2</sub> O/U)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)	
S	A	I	SC	AT	A	U	EF(CO <sub>2</sub> )	Z	CO <sub>2</sub> = A * EF(CO <sub>2</sub> )	EF(CH <sub>4</sub> )	CH <sub>4</sub> = A * EF(CH <sub>4</sub> )	EF(N <sub>2</sub> O)	N <sub>2</sub> O = A * EF(N <sub>2</sub> O)
Central production, Oil Production	Oil Production	Conventional Oil	Total oil production	5000	10 <sup>3</sup> m <sup>3</sup>	0.000130095	0.65028	0.00180075	9.00375	0.00013	0.95	17	
Central production, Oil Production	Oil Production	Thermal Oil Produ.	Unspecified	9000	10 <sup>3</sup> m <sup>3</sup>	0.000029	0.261	0.00018	1.62	0.00019	1.71	17	
Total								0.91128		10.62375		2.36	

2000

### Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> released from that subdivision that has been instead captured is to be entered in Gg CO<sub>2</sub> in **Column |Z|** of **Oil and Natural Gas** worksheet.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions are reported in worksheet **Oil and Natural Gas**.



### 1.B.2.b Natural Gas

Hereafter, the use of the *Software* to estimate fugitive emissions associated with all infrastructure required to produce, collect, process, or refine and deliver natural gas to market is illustrated. The following sections are separated, as emissions from various activities/categories are estimated via different approaches and correspondingly using different worksheets of the *Software*:

- ✓ **21.B.2.b.i Natural Gas – Venting** - Emissions from venting of natural gas and waste gas/vapour streams at gas facilities
- ✓ **1.B.2.b.ii Natural Gas – Flaring** - Emissions from flaring of natural gas and waste gas/vapour streams at gas facilities
- ✓ **1.B.2.b Natural Gas – Fugitives** – this section provides an example of calculation for all activities at gas facilities that are not related to venting and flaring, as it follows
  - Exploration - fugitive emissions from gas well drilling, drill stem testing and well completions
  - Production - fugitive emissions related to well servicing, gas gathering, processing and associated waste water and acid gas disposal activities
  - Processing - fugitive emissions from gas processing facilities
  - Transmission and Storage - fugitive emissions systems used to transport processed natural gas to market and from storage systems
  - Distribution - fugitive emissions from the distribution of natural gas to end users
  - Other - fugitive emissions from natural gas systems not otherwise accounted for in the above categories

This category excludes the following activities, which are covered in other parts of this Guidebook or in other sectors of the *Software*:

- ✓ Combustion-related activities at natural gas facilities are covered under **Stationary Combustion Source Categories** of this Guidebook.
- ✓ Fugitive CO<sub>2</sub> emissions from carbon capture and storage activities are explained under **1.C - Carbon Dioxide Transport and Storage**.



**1.B.2.b.i Natural Gas – Venting**

GHG emissions from venting of natural gas and waste gas/vapour streams at gas facilities.

Venting at natural gas facilities emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

N<sub>2</sub>O is included here for completeness and recognizing that some categories may have N<sub>2</sub>O emissions. However, there are no default N<sub>2</sub>O EFs provided in the *2006 IPCC Guidelines* for venting from natural gas facilities.

Note that this category includes only venting activities (i.e. intentional releases of gas). GHG emissions from flaring of associated gas are covered in **Natural Gas – Flaring**. Fugitive releases of CH<sub>4</sub> and CO<sub>2</sub> are calculated in section on **Natural Gas – Fugitives**.

**IPCC Equations**

- ✓ **Tier 1:** IPCC Tier 1 [Equation 4.2.1](#)
- ✓ **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs.
- ✓ **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **1.2. 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**

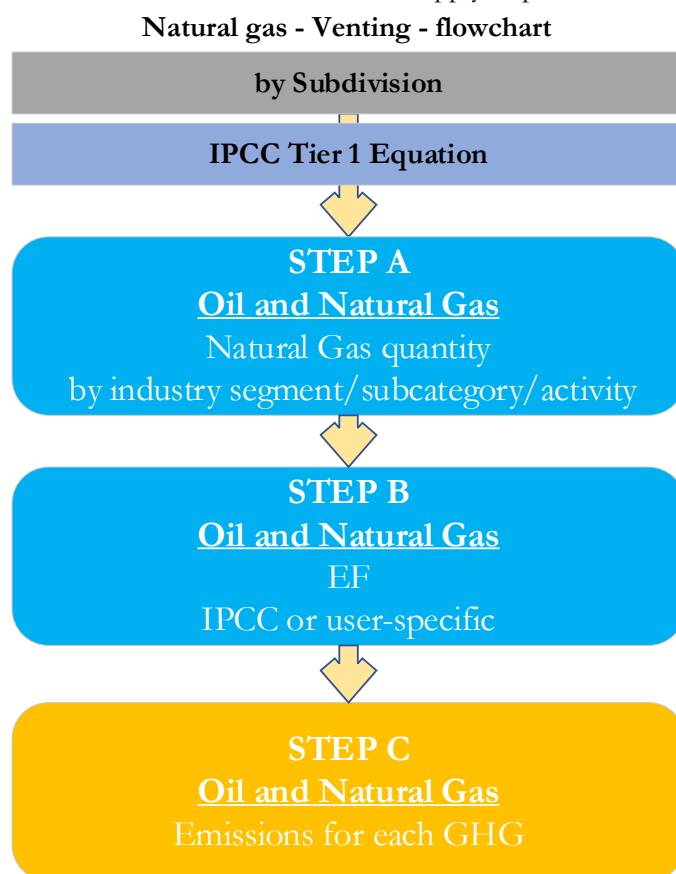
The *Software* calculates emissions of the three GHGs using worksheet:

- ✓ **Oil and Natural Gas:** contains, for each subdivision/industry segment/subcategory, volume of activity, EF for each GHG, CO<sub>2</sub> captured, if any, and calculates associated GHG emissions.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.2.1](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>48</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A**, in the **Oil and Natural Gas** worksheet, users input the annual amount of natural gas activity (e.g. marketable gas production) by subdivision/industry segment/subcategory/activity type. Data can be input as a single total or stratified in subdivisions (e.g. regions/companies, etc.).

**Step B**, in the **Oil and Natural Gas** worksheet, users input in the software the EFs for all GHGs, either IPCC defaults, user-specific or facility/equipment-specific values.

**Step C**, in the same worksheet, the *Software* estimates GHG emissions for each subdivision/industry segment/subcategory/activity type.

Where data are available, CO<sub>2</sub> capture can be reported in **Oil and Natural Gas** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

## Activity data input

The 2006 IPCC Guidelines, [Section 4.2.2.4](#), including [Tables 4.2.6 & 4.2.7](#) for the Tier 1 method, provide information on the minimum data needs and where to find and how to apply statistics data.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then, for each subdivision in Column |S|, data are entered in worksheet **Oil and Natural Gas**, row by row, as follows:

1. Column |I|: select from the drop-down menu or enter the corresponding industry segment. Default industry segments are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.
2. Column |SC|: select from the drop-down menu or enter the subcategory corresponding to the industry segment selected. Default subcategories are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.

<sup>48</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

3. Column |AT|: select from the drop-down menu or enter the activity type corresponding to the industry segment subcategory selected.
4. Column |AD|: enter AD, corresponding to the type selected in Column |AT|, e.g. total marketable gas production or raw gas feed;
5. Column |U|: enter Unit of AD entered in Column |AD|. The AD units for which the IPCC default EFs were developed are contained in [Tables 4.2.4 & 4.2.5](#).

### Emission factor input

IPCC default EFs are provided in [Tables 4.2.4 & 4.2.5](#) of the 2006 IPCC Guidelines. Where a range of factors is provided in the Tables, the mid-point has been selected for the dropdown. Users can overwrite this value, as necessary.

*Note that this category includes all venting at gas facilities, from exploration through to distribution. When using the default EFs for well drilling, well testing and well servicing, be sure not to double count emissions between oil venting and oil flaring.*

1. Column |EF(CO<sub>2</sub>)|: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in Gg CO<sub>2</sub>/U (IPCC defaults are available for some AT).
2. Column |EF(CH<sub>4</sub>)|: enter a user-specific CH<sub>4</sub> EF, in Gg CH<sub>4</sub>/U (IPCC defaults are available for some AT).
3. Column |EF(N<sub>2</sub>O)|: input the N<sub>2</sub>O EF in Gg N<sub>2</sub>O/U.

Example: all tiers

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrative Window Help

2000 IPCC Categories

Oil and Natural Gas

Worksheet

Sector: Energy

Category: Fugitive Emissions from Fuels - Oil and Natural Gas

Subcategory: 1.B.2.b - Venting

Sheet: CO2, CH4 and N2O from fugitive emissions from fuels by source categories

Equation 4.2.1

Activity

CO2

CH4

N2O

Subdivision

Industry Segment

Subcategory

Activity Type

Activity

Unit for AD

Emission Factor (Gg CO2/U)

Amount Captured (Gg CO2)

CO2 Emissions (Gg CO2)

Emission Factor (Gg CH4/U)

CH4 Emissions (Gg CH4)

Emission Factor (Gg N2O/U)

N2O Emissions (Gg N2O)

S

I

SC

AT

A

U

EF(CO2)

Z

CO2 = A \* EF(CO2) - Z

EF(CH4)

CH4 = A \* EF(CH4)

EF(N2O)

N2O = A \* EF(N2O)

Southern Region

Gas Transmission

Transmission

Marketable gas

1500

10<sup>6</sup> m<sup>3</sup>

0.0000031

0.00465

0.00004

0.006

0.0005

0.75

Total

0.00465

0.006

0.75

### Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> released from that subdivision that has been instead captured is to be entered in Gg CO<sub>2</sub> in Column |Z| of worksheet **Oil and Natural Gas**.

Then, GHG emissions are calculated in units of mass (Gg) in **Oil and Natural Gas** worksheet.

**1.B.2.b.ii Natural Gas – Flaring**

GHG emissions from flaring of natural gas and waste gas/vapour streams at gas facilities.

**GHGs**

Flaring at natural gas facilities emit the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

Note that this category includes only flaring activities. GHG emissions from venting of natural gas are covered in **1.B.2.b.i Natural Gas – Venting**. Fugitive releases of CH<sub>4</sub> and CO<sub>2</sub> are calculated in section on **1.B.2.b Natural Gas – Fugitives**

**IPCC Equations**

- ✓ **Tier 1:** IPCC Tier 1 [Equation 4.2.1](#)
- ✓ **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs.
- ✓ **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **1.2. 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**

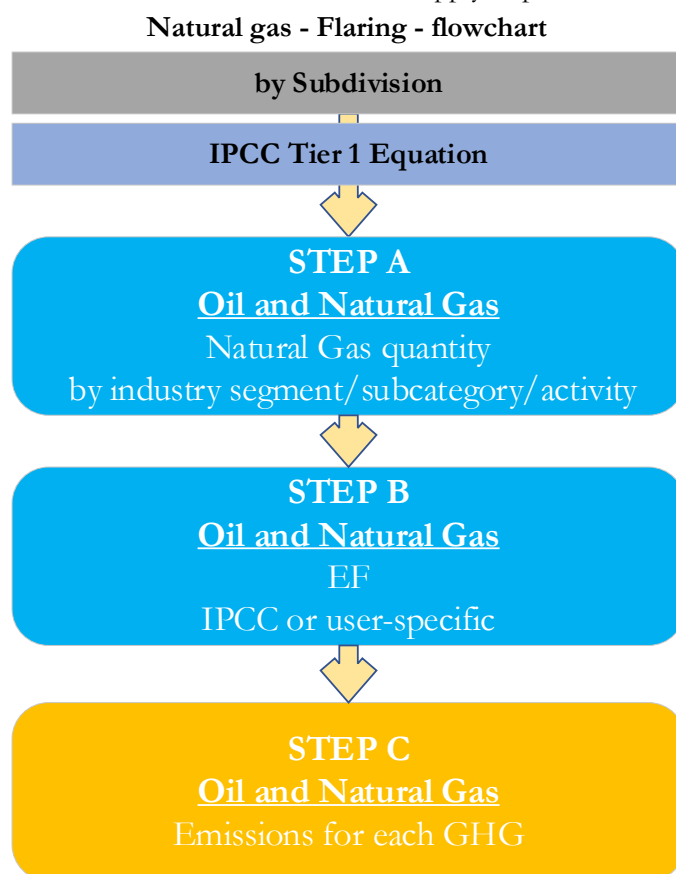
The *Software* calculates emissions of the three GHGs using worksheet:

- ✓ **Oil and Natural Gas:** contains for each subdivision/industry segment/subcategory, volume of activity, EF for each GHG, CO<sub>2</sub> captured, if any, and calculates associated GHG emissions.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.2.1](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>49</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A**, in the **Oil and Natural Gas** worksheet, users input the annual amount of natural gas activity (e.g. gas production) by subdivision/industry segment/subcategory/activity type. Data can be input as a single total or stratified in subdivisions (e.g. regions/companies, etc.).

**Step B**, in the **Oil and Natural Gas** worksheet, users input in the software the EFs for all GHGs, either IPCC defaults, user-specific or facility/equipment-specific values.

**Step C**, in the same worksheet, software estimates GHG emissions for each subdivision/industry segment/subcategory/activity type.

Where data are available, CO<sub>2</sub> capture can be reported in **Oil and Natural Gas** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

## Activity data input

The 2006 IPCC Guidelines, [Section 4.2.2.4](#), including [Tables 4.2.6 & 4.2.7](#) for the Tier 1 method, provide information on the minimum data needs and where to find and how to apply statistics data.

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in [Column |S|](#) [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in [Column |S|](#). Then, for each subdivision in [Column |S|](#), data are entered in worksheet **Oil and Natural Gas**, row by row, as follows:

1. [Column |I|](#): select from the drop-down menu or enter the corresponding industry segment. Default industry segments are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.
2. [Column |SC|](#): select from the drop-down menu or enter the subcategory corresponding to the industry segment selected. Default subcategories are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.

<sup>49</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

3. Column |AT|: select from the drop-down menu or enter the activity type corresponding to the industry segment subcategory selected.
4. Column |AD|: enter total AD, corresponding to the activity type selected in Column |AT|, e.g. raw gas feed.
5. Column |U|: enter Unit of AD entered in Column |AD|, IPCC defaults are available that correspond with the default AT.

### Emission factor input

IPCC default EFs are provided in [Tables 4.2.4 & 4.2.5](#) of the *2006 IPCC Guidelines*. Where a range of factors is provided in the Tables, the mid-point has been selected for the dropdown. Users can overwrite this value, as necessary.

*Note that this category includes all flaring at gas facilities, from exploration through to distribution. When using the default EFs for well drilling, well testing and well servicing, be sure not to double count emissions between oil venting and oil flaring.*

1. Column |EF(CO<sub>2</sub>)|: select from the drop-down menu the IPCC default value for the given GHG or enter a user-specific value, in Gg CO<sub>2</sub>/U (IPCC defaults are available for some AT).  
*Note that U is the unit of the corresponding AD entered in Column |U|;*
2. Column |EF(CH<sub>4</sub>)|: enter a user-specific CH<sub>4</sub> EF, in Gg CH<sub>4</sub>/U (IPCC defaults are available for some AT).  
*Note that U is the unit of the corresponding AD entered in Column |U|;*
3. Column |EF(N<sub>2</sub>O)|: input the N<sub>2</sub>O EF in Gg N<sub>2</sub>O/U (IPCC defaults are available for some AT)  
*Note that U is the unit of the corresponding AD entered in Column |U|;*

Example: Flaring

Subdivision	Industry Segment	Subcategory	Activity Type	Activity	Unit for AD	Emission Factor (Gg CO <sub>2</sub> /U)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	Emission Factor (Gg CH <sub>4</sub> /U)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	Emission Factor (Gg N <sub>2</sub> O/U)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
S	I	SC	AT	A	U	EF(CO <sub>2</sub> )	Z	CO <sub>2</sub> = A * EF (CO <sub>2</sub> ) - Z	EF(CH <sub>4</sub> )	CH <sub>4</sub> = A * EF (CH <sub>4</sub> )	EF(N <sub>2</sub> O)	N <sub>2</sub> O = A * EF (N <sub>2</sub> O)
Southern Region	Gas Processing	Sweet Gas Plants	Raw gas feed	1000	10 <sup>6</sup> m <sup>3</sup>	0.0018		1.8	0.0000012	0.0012	0.00000025	0.000025
Total								1.8		0.0012		0.000025

### Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> released from that subdivision that has been instead captured is to be entered in Gg CO<sub>2</sub> in Column |Z| of worksheet **Oil and Natural Gas**.

Then, GHG emissions are calculated in units of mass (Gg) in **Oil and Natural Gas** worksheet.



**1.B.2.b Natural Gas – Fugitives**

This section provides instructions to calculate fugitive GHG emissions (i.e. unintentional released) from:

- 1.B.2.b.iii.1 Natural Gas Exploration,
- 1.B.2.b.iii.2 Production,
- 1.B.2.b.iii.3 Processing,
- 1.B.2.b.iii.4 Transmission and Storage,
- 1.B.2.b.iii.5 Distribution,
- 1.B.2.b.iii.6 Other, segments of natural gas industry.

The guide below is provided as an example for the segment **Transmission and Storage**, although same calculation worksheet, and thus instructions, apply to all other segments.

**GHGs**

Natural gas industry emits the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

N<sub>2</sub>O is included here for completeness and recognizing that some categories may have N<sub>2</sub>O emissions. However, there are no default N<sub>2</sub>O EFs provided in the *2006 IPCC Guidelines* for fugitive emissions from natural gas facilities.

**IPCC Equations**

- ✓ **Tier 1:** IPCC Tier 1 Equations [4.2.1](#) and [4.2.2](#)
- ✓ **Tier 2:** Tier 1 equation, although with user-specific (e.g. basin-specific) EFs.
- ✓ **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*.

As explained in section **1.2. 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**

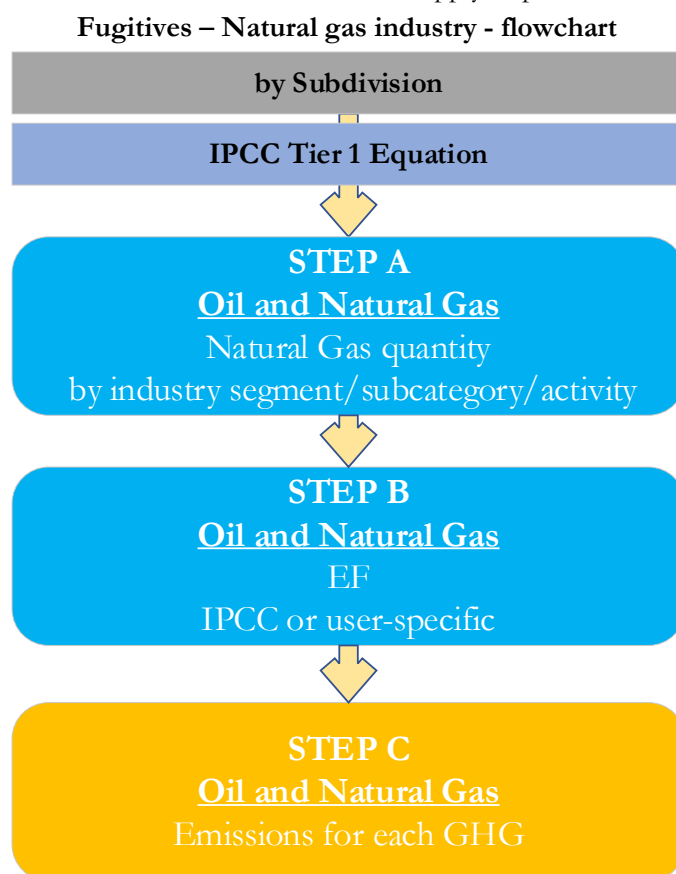
The *Software* calculates emissions of the three GHGs using worksheet:

- ✓ **Oil and Natural Gas:** contains, for each subdivision/industry segment/subcategory, AD, e.g. marketable CH<sub>4</sub>, EF for each GHG, and CO<sub>2</sub> captured, if any, and calculates associated emissions.

## User's work Flowchart

Consistent with the key category analysis and the decision tree in [Figure 4.2.1](#), GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>50</sup> and/or technology-specific EFs

To ease the use of the *Software* as well as to avoid its misuse, the users apply steps described in the following flowchart:



**Step A**, in **Oil and Natural Gas** worksheet, users input the annual amount of natural gas activity (transmission or storage) by subdivision/industry segment/subcategory/activity type. Data can be input as a single total or stratified in subdivisions (e.g. regions/companies, etc.).

**Step B**, in **Oil and Natural Gas** worksheet, users input in the software the EFs for all GHGs, either IPCC defaults or user-specific values.

**Step C**, in **Oil and Natural Gas** worksheet, software estimates GHG emissions for each subdivision/industry segment/subcategory/activity type.

Where data are available, CO<sub>2</sub> capture can be reported in **Oil and Natural Gas** worksheet. CO<sub>2</sub> capture is only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured is known. The CO<sub>2</sub> captured is then entered at the level at which corresponding emissions are calculated.

## Activity data input

The 2006 IPCC Guidelines, [Section 4.2.2.4](#), including [Tables 4.2.6 & 4.2.7](#) for the Tier 1 method, provide information on the minimum data needs and where to find and how to apply statistics data. It is important to remember that this category includes only fugitive emissions. GHG emissions from natural gas venting are covered in [Natural Gas – Venting](#) and GHG emissions from flaring are covered in [Natural Gas – Flaring](#).

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in [Column |S|](#) [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in [Column |S|](#). Then, for each subdivision in [Column |S|](#), data are entered in worksheet **Oil and Natural Gas**, row by row, as follows:

1. [Column |I|](#): select from the drop-down menu or enter the corresponding industry segment. Default industry segments are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines;
2. [Column |SC|](#): select from the drop-down menu or enter the subcategory corresponding to the industry segment selected. Default subcategories are listed in [Table 4.2.2](#) of the 2006 IPCC Guidelines.

<sup>50</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

3. Column |AT|: select from the drop-down menu or enter the activity type;
4. Column |AD|: enter AD, corresponding to the type selected in Column |AT|, e.g. total amount of annual gas production.
5. Column |U|: enter Unit of AD entered in Column |AD|. The AD units for which the IPCC default EFs were developed are contained in [Tables 4.2.4 & 4.2.5](#).

### Emission factor input

Input of EFs for natural gas transmission and storage is to be performed in the same worksheet **Oil and Natural Gas**. Information on selection of EFs for fugitive emissions from gas systems may be found in [Section 4.2.2.3](#) of the *2006 IPCC Guidelines*. The IPCC defaults available in the dropdown menu are from [Tables 4.2.4 and 4.2.5](#) of this section and were developed separately for developed countries (Table 4.2.4) and developing countries and economies in transition (Table 4.2.5). Be sure to select the appropriate value for the country circumstances. Where a range of factors is provided in the Tables, the mid-point has been selected for the dropdown. The user may overwrite this value, as necessary.

1. Column |EF(CO<sub>2</sub>)|: select from the drop-down menu the IPCC default CO<sub>2</sub> EF or enter a user-specific value; in Gg CO<sub>2</sub>/U (IPCC defaults are available for some AT).  
*Note that U is the unit of the corresponding AD entered in Column |U|*
2. Column |EF(CH<sub>4</sub>)|: select from the drop-down menu the IPCC default CH<sub>4</sub> EF or enter a user-specific value; in Gg CH<sub>4</sub>/U (IPCC defaults are available for some AT).  
*Note that U is the unit of the corresponding AD entered in Column |U|*
3. Column |EF(N<sub>2</sub>O)|: select from the drop-down menu the IPCC default N<sub>2</sub>O EF or enter a user-specific value; in Gg N<sub>2</sub>O/U (IPCC defaults are available for some AT).  
*Note that U is the unit of the corresponding AD entered in Column |U|*

### Example: natural gas transmission and storage

Equation 4.2.1							CO <sub>2</sub>		CH <sub>4</sub>		N <sub>2</sub> O	
Subdivision	Industry Segment	Subcategory	Activity Type	Activity	Unit for AD	Emission Factor (Gg CO <sub>2</sub> /U)	Amount Captured (Gg CO <sub>2</sub> )	CO <sub>2</sub> Emissions (Gg CO <sub>2</sub> )	Emission Factor (Gg CH <sub>4</sub> /U)	CH <sub>4</sub> Emissions (Gg CH <sub>4</sub> )	Emission Factor (Gg N <sub>2</sub> O/U)	N <sub>2</sub> O Emissions (Gg N <sub>2</sub> O)
Northern Region	Gas Transmission	Storage	Marketable gas	100	10 <sup>6</sup> m <sup>3</sup>	0.00000011		0.00001	0.000025	0.00025	1E-06	0.0001
Southern Region	Gas Transmission	Transmission	Unspecified	1500	10 <sup>6</sup> Sm <sup>3</sup>	0.00000088		0.00132	0.000273	0.4095	0.0002	0.3
Total								0.00133		0.412		0.3001

### Results

To estimate the total CO<sub>2</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> released from that subdivision that has been instead captured is to be entered in Gg CO<sub>2</sub> in Column |Z| of **Oil and Natural Gas** worksheet.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions are reported in worksheet **Oil and Natural Gas**.

### 1.B.3 Other Emissions from Energy Production

This section describes calculation of emissions from geothermal energy production and other energy production that is not included in categories 1.B.1 or 1.B.2.

#### GHGs

Other emissions from energy production include the following fugitive GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>	<b>X</b>	<b>X</b>				

#### 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 fugitive GHG emissions from Energy production.

1. Tier 1: no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*.
2. Tier 2: 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 [1.2. 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

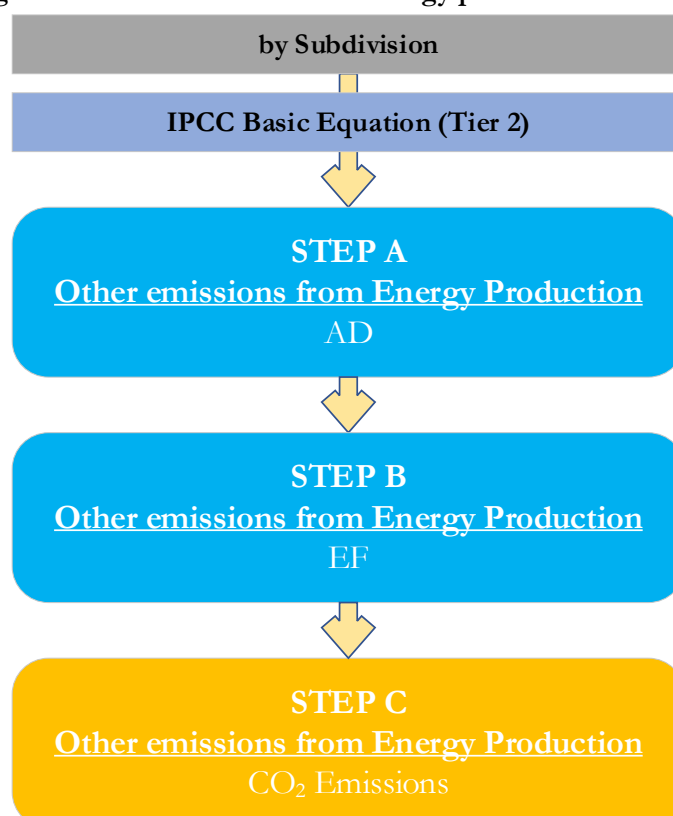
The *Software* calculates emissions of the three GHGs using worksheet:

- ✓ **Other emissions from Energy Production**: contains AD, EF for each GHG, CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered, and calculates associated emissions.

In the upper part of **Other emissions from Energy Production** worksheet, users select the GHG for which to enter data.

#### User's work Flowchart

Fugitive – Other emissions from energy production - flowchart



**Step A**, in **Other emissions from Energy Production** worksheet, users collect and enter data on the source and activity data.

**Step B**, in **Other emissions from Energy Production** worksheet, users collect and enter in each row the associated EF.

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

Where data are available, CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery can be reported in **Other emissions from Energy Production** worksheet. CO<sub>2</sub> capture and/or CH<sub>4</sub> recovery are only expected to be reported when applying a Tier 3 method, and information on the amount of CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is known. The CO<sub>2</sub> captured and/or CH<sub>4</sub> recovered is then entered at the level at which corresponding emissions are calculated.

**Activity data input**

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|.

For each subdivision in Column |S|, data are entered in worksheet **Other emissions from Energy Production**, row by row, as follows:

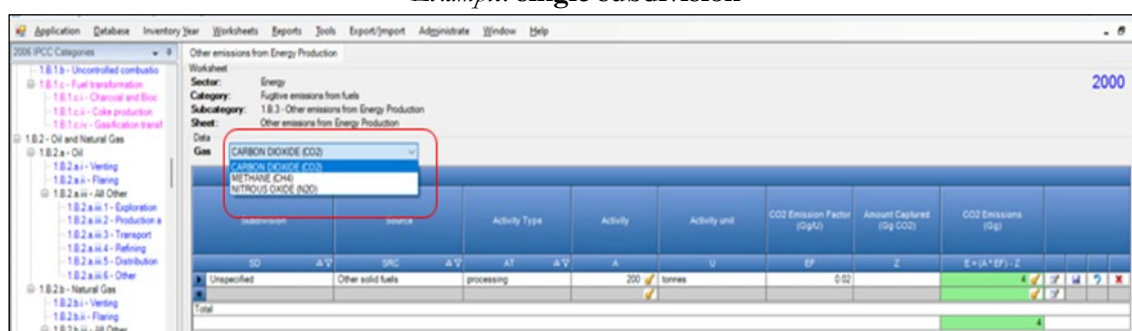
1. Column |SRC|: describe the type of activity emitting GHG emissions from this category (e.g. geothermal energy production).
2. Column |AT|: enter the activity type corresponding to the source selected.
3. Column |AD|: enter AD (quantity).
4. Column |U|: enter Unit of the AD.

**Emission factor input**

For each row of data entered in worksheet **Other emissions from Energy Production**, data are entered as follows:

1. Column |EF|: enter CH<sub>4</sub> or CO<sub>2</sub> or N<sub>2</sub>O EF;  
*Note that user shall select “Carbon dioxide (CO<sub>2</sub>)” or “Methane (CH<sub>4</sub>)” or “Nitrous Oxide (N<sub>2</sub>O)” in the “Gas” bar at the top, to enter data for each GHG one by one.*

*Example: single subdivision*

**Results**

To estimate the total CO<sub>2</sub> and total CH<sub>4</sub> emitted into the atmosphere, the amount of CO<sub>2</sub> and of CH<sub>4</sub> released from that subdivision that has been instead captured or recovered, respectively, are to be entered in Gg CO<sub>2</sub> in Column |Z| and/or Gg CH<sub>4</sub> in Column |R| of worksheet **Other emissions from Energy Production**.

Then, for each GHG, emissions are calculated by the *Software*, in mass unit (Gg), for each row of data, and total emission from all subdivisions are reported in worksheet **Other emissions from Energy Production**.

## 1.C - Carbon Dioxide Transport and Storage

This section provides instructions to calculate CO<sub>2</sub> emissions from:

- ✓ **1.C.1. - Transport of CO<sub>2</sub>:**
  - **1.C.1.a - Pipeline**
  - **1.C.1.b - Ships**
  - **1.C.1.c - Other**
- ✓ **1.C.2. - Injection & Storage:**
  - **1.C.2.a - Injection**
  - **1.C.2.b - Storage**

Emissions estimation methods are not provided for any other type of storage option such as ocean storage or conversion of CO<sub>2</sub> into inert inorganic carbonates.

Emissions resulting from fossil fuels used for capture, compression, transport, and injection of CO<sub>2</sub> are not addressed here. Those emissions are covered by the appropriate stationary or mobile energy use categories described in this Guidebook.

Carbon dioxide transported, injected, and stored can have been originated from combustion/oxidation of fossil fuels as well as of organic matter.



**1.C.1. - Transport of CO<sub>2</sub>**

Pipelines and ships are considered the most likely means of large-scale CO<sub>2</sub> transport. The upstream systems boundary is the outlet of the compression/conditioning plant in the capture and compression system. The downstream systems boundary is the downstream end of a transport pipeline, or a ship offloading facility. Fugitive emissions from compressor stations located along the pipeline system are part of this category.

**GHGs**

Carbon dioxide transport emits the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>						

**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 fugitive CO<sub>2</sub> emissions from CO<sub>2</sub> transport. However, in [Box 5.1](#) the *2006 IPCC Guidelines* provide an outline of the derivation of a default fugitive CO<sub>2</sub> EF for pipeline CO<sub>2</sub> transport. Thus, for

- ✓ CO<sub>2</sub> transport in pipelines:
  - **Tier 1:** IPCC Tier 1 [Equation 4.2.1](#) is provided in the *Software*, and the default CO<sub>2</sub> EF from [Box 5.1](#)
  - **Tier 2:** Same equation as Tier 1, although with user-specific values
  - **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*  
*Note that when intermediate storage sites are needed along the transport route, emissions are estimated like CO<sub>2</sub> transport (when the storage is a tank) or geologic storage (when a natural formation).*
- ✓ CO<sub>2</sub> transport by ship:
  - **Tier 1:** no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*
  - **Tier 2:** IPCC Tier 1 [Equation 4.2.1](#) although with user-specific values
  - **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*

As explained in section [I.2. 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 Worksheet**

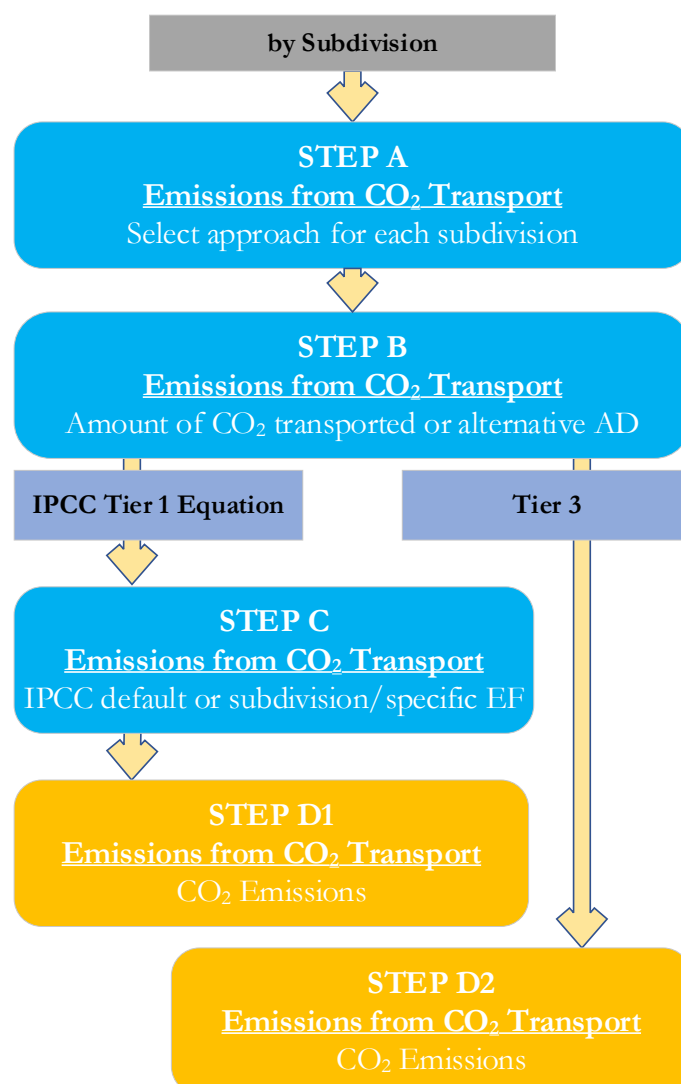
CO<sub>2</sub> emissions from transport of CO<sub>2</sub> are estimated using three worksheets, one for each subcategory -1.C.1.a, 1.C.1.b, 1.C.1.c-, that are similar in structure but differ for the means of transport: pipelines, ships, or others.

Data compilation of each of those subcategories is operated independently, following for each subcategory the entire set of instructions below.

## User's work Flowchart

GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>51</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



For each subcategory, and for each subdivision in the subcategory, if any:

**Step A**, worksheet **Emissions from CO<sub>2</sub> Transport**, users select whether to calculate the annual CO<sub>2</sub> emissions (this is the case for Tier 1 and Tier 2 estimates), and in such case the next step is **B**, or enter the value of annual fugitive CO<sub>2</sub> emissions as estimated through a user-specific model, and in such case next step is **D.2**.

Emissions from CO2 Transport							
Worksheet							
Sector: Energy							
Category: CO2 Transport, Injection and Storage							
Subcategory: 1.C.1.a - Pipelines							
Sheet: Emissions from CO2 Transport							
Data							
Subdivision	Annual mass of CO2 transported (Gg)	Activity Type	Activity	Activity unit	CO2 Emission Factor (Gg / U)	Annual mass of fugitive CO2 emissions to the atmosphere or sea bed (Gg)	
SD	AM	AT	A	U	EF	E = AD * EF or specified	
Pipeline A	1000	Pipeline length	800	km	0.00014	Calculated	0.112
Pipeline B	400					Specified	0.4
Total							0.512

**Step B**, worksheet **Emissions from CO<sub>2</sub> Transport**, users collect and enter the annual mass of CO<sub>2</sub> transported and an activity type (e.g. pipeline length).

<sup>51</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

**Step C**, worksheet **Emissions from CO<sub>2</sub> Transport**, users collect and enter in each row the associated CO<sub>2</sub> EF.

**Step D1**, worksheet **Emissions from CO<sub>2</sub> Transport**, for each row of data, the *Software* calculates fugitive CO<sub>2</sub> emissions in mass units (Gg). In addition, total emissions are calculated.

**Step D2**, worksheet **Emissions from CO<sub>2</sub> Transport**, users collect and enter annual mass of fugitive CO<sub>2</sub> emissions.

### Activity data input

Sections 5.4.1 and 5.4.2 of the 2006 IPCC Guidelines provide information on the collection of AD for transport of CO<sub>2</sub> in units of mass (Gg).

Users compile the calculation worksheets either with a single row of data for the entire category, with its univocal name/code entered in Column |S| [e.g. “country name” or “unspecified” as selected from the dropdown menu], or with subnational aggregations, and for each of those the univocal name/code entered in Column |S|. Then:

**First**, users select the approach to apply to report annual CO<sub>2</sub> emissions i.e. either *Calculated* or *Specified*, where *Specified* means that the amount of annual fugitive CO<sub>2</sub> emissions is entered (see [Results](#)).

**Second**, for each subdivision in Column |S|, data are entered in worksheet **Emissions from CO<sub>2</sub> Transport**, as follows:

1. Column |AM|: enter annual mass of transported CO<sub>2</sub>, in Gg.

*Note that this information is not used by the Software to calculate the annual CO<sub>2</sub> emissions from CO<sub>2</sub> transport in pipelines or in ships; however, given that this information is needed for interoperability with UNFCCC CRTs it shall always be input by users wishing to use the UNFCCC electronic reporting tool.*

Where the approach *Specified* is selected, AD are not needed; otherwise where the approach *Calculated* is selected:

2. Column |AT|: select<sup>52</sup> from the dropdown menu *Pipeline length* activity type, or enter a user-specific Activity Type.<sup>53</sup>
3. Column |AD|: enter AD.
4. Column |U|: select from dropdown menu *km*, or enter unit of AD.

### Emission factor input

Where the approach *Calculated* is selected, for each row:

- ✓ Column |EF|: select the IPCC default EF from the drop-down menu or enter a user specific EF, in Gg/U.

Otherwise no EF is entered, and users enter annual amount of fugitive CO<sub>2</sub> emissions from CO<sub>2</sub> transport in Column |E|.

### Results

Fugitive CO<sub>2</sub> emissions are either calculated by the *Software*, or specified, in mass unit (Gg), for each row of data, and total fugitive emissions from transport of CO<sub>2</sub> are the sum of all emissions listed in all subdivisions reported in worksheet **Emissions from CO<sub>2</sub> Transport**.

<sup>52</sup> Note that this applies to subcategory 1.C.1.a – Pipeline only.

<sup>53</sup> The user-specific AD can be the annual mass of transported CO<sub>2</sub>. In such a case this information is to be entered in this column and the value of annual mass of transported CO<sub>2</sub> is to be entered in Column |AD|.

**1.C.2. Injection & Storage**

The injection system comprises surface facilities at the injection site, e.g. storage facilities, any distribution manifold at the end of the transport pipeline, distribution pipelines to wells, additional compression facilities, measurement and control systems, wellhead(s) and the injection wells.

Geological storage of carbon dioxide may take place onshore or offshore, in: deep saline formations; depleted or partially depleted oil fields; depleted or partially depleted natural gas fields; and coal seams.

For both injection and storage, the only emissions pathways that need to be considered in category 1.C.2 are CO<sub>2</sub> leakage.

**GHGs**

Carbon dioxide injection and storage emits the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
<b>X</b>						

The *Software* calculates fugitive CO<sub>2</sub> emissions in a single worksheet for Tier 2

**IPCC Equations**

Given that there are no specific equations in the *2006 IPCC Guidelines* for this category, fugitive CO<sub>2</sub> emissions from CO<sub>2</sub> injection and storage are calculated in the *Software* with the IPCC basic equation for fugitive emissions:

1. **Tier 1:** no IPCC Tier 1 Equation provided in the *2006 IPCC Guidelines*
2. **Tier 2:** IPCC Tier 1 [Equation 4.2.1](#) (taken from fugitive emissions from oil and gas systems) although with user-specific values
3. **Tier 3:** no IPCC Tier 3 Equation provided in the *2006 IPCC Guidelines*

As explained in section **1.2. 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.

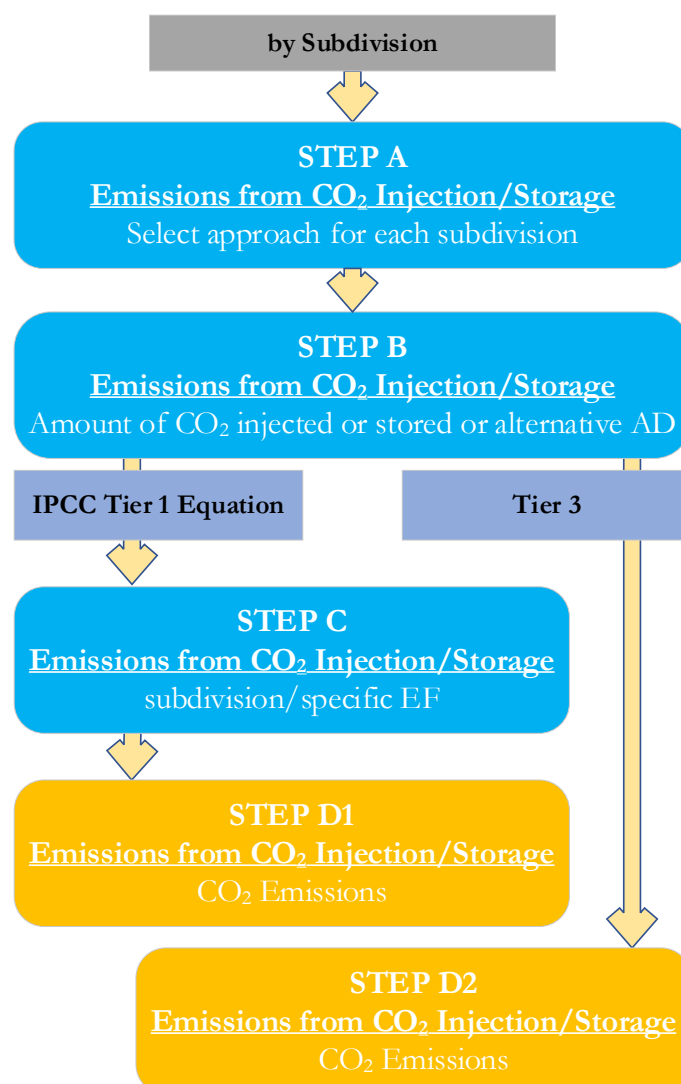
**Software Worksheet**

CO<sub>2</sub> emissions from CO<sub>2</sub> injection and storage are estimated using two worksheets, one for each subcategory 1.C.2.a and 1.C.2.b, that are similar in structure but differ for the activity: injection *vs* storage.

Data compilation of each of those subcategories is operated independently, following for each subcategory the entire set of instructions below.

GHG estimates are calculated using a single methodological tier or applying a combination of tiers according to the availability of AD and of user-specific<sup>54</sup> and/or technology-specific EFs.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



For each subcategory, and for each subdivision in the subcategory, if any:

**Step A**, worksheet **Emissions from CO<sub>2</sub> Injection/Storage**, users select whether to calculate the annual CO<sub>2</sub> emissions -this is the case for Tier 2 estimates-, and in such case next step is **B**, or enter the value of annual fugitive CO<sub>2</sub> emissions as estimated through a user-specific model, and in such case next step is **D.2**.

Subdivision	Annual mass of CO <sub>2</sub> injected (Gg)	Activity Type	Activity Data	Activity Data Unit	CO <sub>2</sub> Emission Factor (Gg / U)	Annual mass of fugitive CO <sub>2</sub> emissions to the atmosphere or sea bed (Gg)	E = AD * EF or specified
Unspecified	140					Specified	140
Southern	120	Annual mass of CO <sub>2</sub> in...	120	Gg	0.36	Calculated	43.2
Total							183.2

**Step B**, worksheet **Emissions from CO<sub>2</sub> Injection/Storage**, users collect and enter the annual mass of CO<sub>2</sub> injected/stored and an activity type.

**Step C**, worksheet **Emissions from CO<sub>2</sub> Injection/Storage**, users collect and enter in each row the associated CO<sub>2</sub> EF.

<sup>54</sup> Where the inventory of the source-category is stratified by subdivisions instead of a single aggregate, subdivision-specific EFs can be applied to prepare estimates at Tier 2. For instance, Region A and Region B are two subdivisions of country's X estimates, a Tier 2 methodological approach can be implemented either by applying different region-specific EFs or by applying to both regions the user-specific EF, as the weighted average EF across the two regions.

**Step D1**, worksheet **Emissions from CO<sub>2</sub> Injection/Storage**, for each row of data, the *Software* calculates the emissions in mass units (Gg). In addition, total emissions are calculated.

**Step D2**, worksheet **Emissions from CO<sub>2</sub> Injection/Storage**, users collect and enter the annual mass of fugitive CO<sub>2</sub> emissions.

### Activity data input

Section 5.7.2 provide information on the collection of AD for CO<sub>2</sub> injection/storage.

**First**, users select the approach to apply to report annual CO<sub>2</sub> emissions i.e. either *Calculated* or *Specified*, where *Specified* means that the amount of annual fugitive CO<sub>2</sub> emissions is entered (see [Results](#)).

**Second**, for each subdivision in Column |S|, data are entered in worksheet **Emissions from CO<sub>2</sub> Injection/Storage**, as follows:

1. Column |AM|: enter annual mass of CO<sub>2</sub> injected/stored, in Gg.

*Note that this information is not used by the Software to calculate the annual CO<sub>2</sub> emissions from CO<sub>2</sub> injected/stored; however, given that this information is needed for interoperability with UNFCCC CRTs it shall always be input by users wishing to use the UNFCCC electronic reporting tool for CRT.*

Where the approach *Specified* is selected, AD are not needed; otherwise where the approach *Calculated* is selected:

2. Column |AT|: enter a user-specific Activity Type.<sup>55</sup>
3. Column |AD|: enter AD.
4. Column |U|: enter unit of AD.

### Emission factor input

Where the approach *Calculated* is selected, enter user-specific CO<sub>2</sub> EF in Column |EF|, in Gg/U. Otherwise no EF is entered, and users enter annual amount of fugitive CO<sub>2</sub> emissions from CO<sub>2</sub> injection/storage in Column |E|.

### Results

Fugitive CO<sub>2</sub> emissions are either calculated by the *Software*, or specified, in mass unit (Gg), for each row of data, and total fugitive emissions from CO<sub>2</sub> injection/storage are the sum of all emissions listed in all subdivisions reported in worksheet **Emissions from CO<sub>2</sub> Injection/Storage**.

<sup>55</sup> The user-specific AD can be the annual mass of transported CO<sub>2</sub>. In such a case this information is to be entered in this column and the value of annual mass of transported CO<sub>2</sub> is to be entered in Column |AD|.



The Reference Approach is designed to calculate the emissions of CO<sub>2</sub> from fuel combustion, starting from high level energy supply data. This approach does not distinguish between different source categories within the energy sector and only estimates total emissions from source category 1.A Fuel Combustion.

## GHGs

The reference approach estimates the following GHGs:

CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	HFCs	PFCs	SF <sub>6</sub>	NF <sub>3</sub>
X						

The *Software* prepares Reference Approach estimates of CO<sub>2</sub> within the two worksheets and provides an additional worksheet for comparison of the results of the Reference and Sectoral Approaches. The Reference Approach worksheets may be found under “Tools” on the main ribbon.

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrative Window Help

Reference Approach Data Estimating Excluded Carbon Comparison

Sector  
Category  
Category code  
Sheet

Energy  
Fuel combustion activities  
1.A  
1 of 1 (CO2 from energy sources - Reference Approach)

Reference Approach  
Uncertainty Analysis  
Key Category Analysis

2005

Fuel Types	Unit	Step 1					Step 2		Step 3		Step 4		Step 5	
		A Production	B Imports	C Exports	D International Bunkers	E Stock change	F Apparent Consumption	G Conversion Factor (TJ/Unit)	H Apparent Consumption (TJ)	I Carbon content (t C/TJ)	J Total Carbon (Gg C)	K Excluded Carbon (Gg C)	L Net Carbon Emissions (Gg C)	M Fraction of Carbon Oxidized
							F=A+B-C-D-E	H=F*G		J=H*I/1000	1)	L=J-K		N=L*M
(1) Liquid Fuels: 25 item(s)								25332.5		453.74245		406.88761		826.6356
(2) Solid Fuels: 16 item(s)								8261.2		233.70052		227.26105		203.927
(3) Gaseous Fuels: 1 item(s)								142		2.142		1.971		
(4) Other Fossil Fuels: 3 item(s)								9489.8		262.8464		262.8464		1337.13
(5) Peat: 2 item(s)								2105.23		40.95293		40.95293		146.8336
(6) Biomass: 1 item(s)								279		5.211		5.211		1
Total								46780.28		1038.69492		973.129682		3072.64

## IPCC Equations

1. IPCC [Equation 6.1](#) calculates the CO<sub>2</sub> emissions
2. IPCC equations [6.2](#) and [6.3](#) estimate the apparent consumption of primary fuel and secondary fuel, respectively
3. [Equation 6.4](#) estimates the amount of excluded carbon

## Software Worksheets

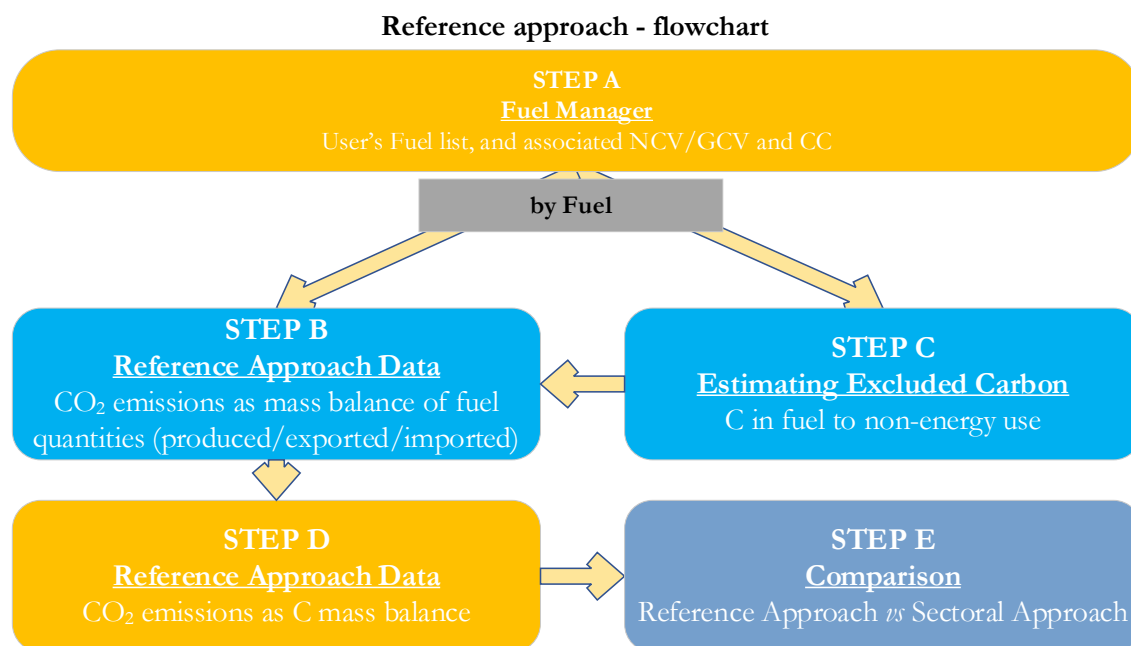
The *Software* calculates CO<sub>2</sub> emissions from Stationary combustion source categories for the top-down reference approach using worksheets:

- ✓ **Fuel Manager:** contains information on the *carbon content* and the *calorific value* of each fuel type applied to the NGHGI.
- ✓ **Reference Approach Data:** contains for each fuel type the amount produced, imported, exported, and used for international bunkers, as well as stock changes for that fuel. This worksheet also contains for each fuel the *calorific value* and *carbon content* (filled in automatically from the **Fuel Manager**), the excluded carbon, and the fraction oxidized. From this information the worksheet calculates actual CO<sub>2</sub> emissions.
- ✓ **Estimating Excluded Carbon:** contains for specific fuels the amount of the total estimated quantity of carbon which does not lead to fuel combustion emissions, and using *calorific value* and *carbon content* data, calculates the amount of carbon that shall be excluded from the emissions.
- ✓ **Comparison:** provides summary information on total estimated AD and CO<sub>2</sub> emissions from the Reference and Sectoral approaches, and performs a comparison between the two methods results.

User's work Flowchart

To estimate emissions under the Reference approach, the user utilizes the four worksheets of the *Software* referred above.

To ease the use of the *Software* as well as to avoid its misuse, for each source category, the users apply steps described in the following flowchart:



**Step A**, in the **Fuel Manager**, users collect and input in the *Software* information on each fuel type used in the relevant source category: the *calorific value* and the *carbon content*.

**Step B**, in worksheet **Reference Approach Data**, users input the supply of each fuel (production, import, export, international bunker, stock change), *calorific value* and *carbon content* (being filled automatically from the **Fuel Manager**) and fraction of carbon oxidized. The *Software* then estimates CO<sub>2</sub> emissions for each fuel.

**Step C**, in worksheet **Estimating Excluded Carbon**, users input estimated quantities for specific fuels that do not lead to fuel combustion emissions, *calorific value* and *carbon content* (being filled automatically from the **Fuel Manager**). The *Software* estimates the amount of carbon that shall be excluded from the calculations. This amount goes automatically to the worksheet **Reference Approach Data** into the Column |K|.

**Step D**, in worksheet **Reference Approach Data**, the *Software* estimates CO<sub>2</sub> emissions for each fuel based on the information from **Step B** and **C**.

**Step E**, in worksheet **Comparison**, the *Software* provides results of CO<sub>2</sub> estimations under the Reference and Sectoral approaches and performs a comparison between the two approaches by each fuel, fuel type and total for the NGHGI.

Activity data input

The 2006 IPCC Guidelines, [Sections 1.4.1.2](#) and [1.4.1.3](#), contain information on how to collect and apply energy statistics data. Further information on collecting information on apparent consumption of primary fuel and secondary fuels is provided in [Section 6.4](#).

Fuel consumption data in mass or volume units shall first be converted into the energy content of these fuels in Terajoule units (TJ). The GCV/NCV are used to convert Gg of fuels into TJ (IPCC default values for NCV are in [Table 1.2](#)) Other units may be entered (e.g. British Thermal Units (BTUs)). However, when alternative units are used, the Column |Conversion Factor| becomes blank and the user shall enter user-defined conversion factor (TJ/unit).

Input of AD for the Reference Approach requires the following steps:

- i. **Fuel Manager**: input all fuel types used and the associated *calorific value* and *carbon content*. All fuels entered in the Fuel Manager are considered in the Reference Approach.
- ii. **Reference Approach Data** worksheet:

For each fuel, enter the following information:

1. Column |Unit|: select or enter manually the measurement unit used (e.g. Gg, TJ, m<sup>3</sup>).  
*Note that worksheet rows for each fuel type are closed by default, "+" sign at the left side of the row shall be clicked to expand to the full fuel list.*
2. Column |A|: input the amount of production of the certain fuel.  
*Note that production amount is to be entered only for primary fuels, not secondary. Fuels are designated as primary or second in the Fuel Manager.*

3. Column |B|: input the amount of imported fuel.
4. Column |C|: input the amount of exported fuel.
5. Column |D|: input the amount of fuel used for international bunkers.
6. Column |E|: input the amount of stock change.  
*Note that an increase in stocks is a positive stock change which withdraws supply from consumption. A stock reduction is a negative stock change which, when subtracted in the equation, causes an increase in apparent consumption*
7. Column |F|: the *Software* estimates the amount of apparent consumption of the fuel.
8. Column |G|: conversion factor in (TJ/Unit) is filled automatically from the **Fuel Manager**.  
*Note that where Gg of fuel are converted to TJ, the NCV/GCV is sourced from the Fuel Manager and compiled by the Software as a 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. m<sup>3</sup>) the user shall enter relevant conversion unit here*
9. Column |K|: this column will be automatically filled by information entered in the next worksheet (**Estimating Excluded Carbon**).

*Example:* reference approach data

Reference Approach Data		Estimating Excluded Carbon		Comparison	Allocation of CO2 from NEU											
Sector	Energy															
Category	Fuel combustion activities															
Category code	1.A															
Sheet	CO2 from energy sources - Reference Approach															
		Step 1					Step 2		Step 3		Step 4			Step 5		
		Production (Unit)	Imports (Unit)	Exports (Unit)	International Bunkers (Unit)	Stock change (Unit)	Apparent Consumption (Unit)	Conversion Factor (TJ/Unit)	Apparent Consumption (TJ)	Carbon content (t/CJ)	Total Carbon (Gg C)	Excluded Carbon (Gg C)	Net Carbon Emissions (Gg C)	Fraction of Carbon Oxidised	Actual Emissions (Gg C)	
Fuel Types		Unit	A	B	C	D	E	F=H+E-C-D-E	G	H=H*G	I	J=H/I*1000	K	L=J-K	M	
Liquid Fuels: 23 item(s)										3686643		72642.9668		71007.547	24188	
Solid Fuels: 17 item(s)										852041.78		26571.4639		22609.21891	7875	
Primary Fuels	Anthracite	Gg	100	7030	50		20	7060	26.7	188502	26.8	5051.8536		5051.8536	0.95	17559
	Coking Coal	Gg	100	3740	50		-20	3810	28.2	107442	25.8	2772.0036		2772.0036	0.95	965
	coke oven gas	Gg						0	345	0	22	0		0	0.95	442
	Lignite	Gg	100	3840	50		20	3870	11.9	46053	27.6	1271.0628		1271.0628	0.95	442
	Oil Shale / Tar Sands	Gg	100	1570	50		-20	1640	8.9	14596	29.1	424.7436		424.7436	0.95	147
Other Bituminous Coal	Other Bituminous Coal	Gg	100	7260	50	30	20	7260	25.8	187308	25.8	4832.5464		4832.5464	0.95	1683
	Sub-Bituminous Coal	Gg	100	3690	50		20	3730	18.9	70497	26.2	1847.0214		1847.0214	0.95	643
	Blast Furnace Gas	Gg		1000	11	25	0	964	2.47	2381.08	70.8	168.50346	1.74876	166.8317	0.95	58
	Brown Coal Briquettes	Gg		1880	50		20	1810	20.7	37467	26.6	996.6222		996.6222	0.95	347
	Coal Tar	Gg		1300	50		20	1230	28	34440	22	757.68	12.32	745.36	0.95	255
Secondary Fuels	Coke Oven Coke / Lignite...	Gg		1170	50		20	1100	28.2	31020	29.2	905.784	16.4688	889.3152	0.95	305
	Coke Oven Gas	Gg		100	1	11		88	37.2	3273.6	12.2	39.93792	4.5384	35.39952	0.95	12
	country specific solids	Gg		100	3			88	30	2640	60	158.4	18	140.4	0.94	14
	Gas Coke	Gg		2430	50		-20	2410	28.2	67680	29.2	1976.296		1976.296	0.95	68
	Gas Works Gas	Gg		203	10			191	73.1	13917	12.1	8.43987	5.61924	83.80033	0.95	25
Oxygen Steel Furnace Gas	Oxygen Steel Furnace Gas	Gg	100	10	10		0	7.06	635.4	49.6	31.51584	4.55229	26.96355	0.95	68	
	Patent Fuel	Gg		2480	50		-20	2450	20.7	50715	26.6	1349.019		1349.019	0.95	469
Isosol Fuels: 3 item(s)										1092024		16706.0592		16706.0592	0.95	557
Other Fossil Fuels: 4 item(s)										523689		13649.065		13639.463	469	
Total: 1 item(s)										0		0		0		
Isosol - solid: 6 item(s)										685		19.4209		9.74039		
Isosol - liquid: 4 item(s)										569		11.8809		7.30666		
Isosol - gas: 3 item(s)										940		14.006		9.50024		
Isosol - other: 1 item(s)										49		1.3377		1.02102		
										Fossil: 6154397.78		124294.55739		123962.75211	4233	

iii. **Estimating Excluded Carbon** worksheet:

For each fuel in the Column |Fuel Types|, enter the following information:

1. Column |A|: enter the estimated quantity of the fuel not used for combustion purposes (e.g. natural gas used as a feedstock for ammonia production, or coking coal used in the iron and steel industry).
2. Column |Unit|: select or enter manually the measurement unit used (e.g. Gg, TJ, m<sup>3</sup>).
3. Column |B|: conversion factor in TJ/Unit is filled automatically from the **Fuel Manager**.

*Example: estimating excluded carbon*

G	A	B	C	D	E
Fuel	Estimated Quantities	Unit	Conversion Factor [TJ/Gg]	Estimated Quantities [TJ]	Carbon content [G C/G]
				$C = A \times B$	$E = C \times D / 1000$
Bitumen		Gg	40.2	0	22
Ethane	15	Gg	46.4	696	11.6328
Gas/Olefin Oil	900	Gg	43	38700	781.74
Liquefied Petroleum Gases	100	Gg	47.3	4730	81.356
Lubricants	50	Gg	40.2	2010	40.2
Naphtha	30	Gg	44.5	1335	26.7
Natural Gas Liquids	25	Gg	44.2	1105	19.3375
Other Kerosene	35	Gg	43.8	1533	30.4463
Paraffin Waxes		Gg	40.2	0	20
Petroleum Coke		Gg	32.5	0	26.6
Refinery Gas		Gg	49.5	0	15.7
White Spirit and SBP		Gg	40.2	0	20
Crude Tar		Gg	28	0	22
Coke Oven Coke / Lignite Coke		Gg	28.2	0	29.2
Natural Gas (Dry)		m3		0	15.3
Natural Gas Power Plants	80	Gg	45	3600	54

### Emission factor input

Input of EFs for the Reference Approach requires the following steps:

i. **Reference Approach Data** worksheet:

For each fuel, enter following information:

1. Column |I|: carbon content is filled automatically from the **Fuel Manager** in t C/TJ.

2. Column |M|: enter fraction of oxidized carbon.

*Note if no information on this factor is available, the value "1" shall be entered to proceed with calculations*

- ii. In the **Estimating Excluded Carbon** worksheet, Column |D| is filled automatically from the **Fuel Manager** in t C/TJ.

## Results

CO<sub>2</sub> emissions are estimated in mass units (Gg) by the *Software* in the **Reference Approach Data** worksheet in Column |N| by fuel, fuel type, and total.

Worksheet **Comparison** also presents the results for the Reference Approach, as well as main AD (apparent consumption). This worksheet also summarizes the main AD and CO<sub>2</sub> emissions calculated under the Sectoral Approach, by fuel type. In the Columns |Difference|, the *Software* provides the comparative difference between the Reference and Sectoral approaches in terms of energy consumption and CO<sub>2</sub> emissions.

The 2006 IPCC Guidelines, [Section 6.8](#), provide possible reasons for a gap between the two approaches, which is generally expected to be less than 5%. For higher percent differences, reporting programs typically require users to provide a clear explanation and justification.

### Example: comparison

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help									
Reference Approach Data Estimating Excluded Carbon Comparison									
Sector Energy									
Category Fuel combustion activities									
Category code 1.A									
Sheet 1 of 1 - Comparison of CO <sub>2</sub> Emissions from Fuel Combustion									
Fuel Types	Reference Approach				Sectoral Approach		Difference		
	Apparent Consumption (TJ)	Excluded consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstocks) (TJ)	CO <sub>2</sub> Emissions (Gg)	Energy Consumption (TJ)	CO <sub>2</sub> Emissions (Gg)	Energy Consumption (%)	CO <sub>2</sub> Emissions (%)	
1 Liquid Fuels: 24 item(s)	1836856.9	50109	1786747.9	122971.9115	1836848.5495	111537.3019	-2.727532953	10.2518255119	
2 Solid Fuels: 12 item(s)	103386.2	0	103386.2	9587.5242848	102183.7	6885.06871	1.176802170	39.2509601374	
3 Gaseous Fuels: 2 item(s)	213806	3600	210206	11631.947679	212000	11565.844	-0.846226415	0.57154219787	
4 Other Fossil Fuels: 3 item(s)	0	0	0	0	0	0	0	0	
5 Peat: 1 item(s)	0	0	0	0	0	0	0	0	
Total	2154049.1	53709	2100340.1	144191.3834	2151032.2495	129988.2146	-2.356642933	10.5265050432	

Application Database Inventory Year Worksheets Reports Tools Export/Import Administrate Window Help									
Reference Approach Data Estimating Excluded Carbon Comparison									
Sector Energy									
Category Fuel combustion activities									
Category code 1.A									
Sheet 1 of 1 - Comparison of CO <sub>2</sub> Emissions from Fuel Combustion									
Fuel Types	Reference Approach				Sectoral Approach		Difference		
	Apparent Consumption (TJ)	Excluded consumption (TJ)	Apparent Consumption (excluding non-energy use and feedstocks) (TJ)	CO <sub>2</sub> Emissions (Gg)	Energy Consumption (TJ)	CO <sub>2</sub> Emissions (Gg)	Energy Consumption (%)	CO <sub>2</sub> Emissions (%)	
1 Liquid Fuels: 24 item(s)	1836856.9	50109	1786747.9	122971.9115	1836848.5495	111537.3019	-2.727532953	10.2518255119	
2 Solid Fuels: 12 item(s)	103386.2	0	103386.2	9587.5242848	102183.7	6885.06871	1.176802170	39.2509601374	
Primary Fuels	12976.2	0	12976.2	1198.62024	12963.7	1274.33171	0.09642	-5.94127	
Anthracite	0	0	0	0	0	0	0	0	
Coking Coal	0	0	0	0	0	0	0	0	
Lignite	19040	0	19040	1811.23712	17850	1702.85	6.66667	6.36504	
Lignite Power Plants	3600	0	3600	372.24	3600	258	0	44.27907	
Oil Shale / Tar Sands	0	0	0	0	0	0	0	0	
Other Bituminous Coal	0	0	0	0	0	0	0	0	
Sub-Bituminous Coal	5670	0	5670	512.01612	5670	544.887	0	-6.0326	
Brown Coal Briquettes	62100	0	62100	5693.4108	62100	3105	0	83.36267	
Coal Tar	0	0	0	0	0	0	0	0	
Coke Oven Coke / Lignite	0	0	0	0	0	0	0	0	
Gas Coke	0	0	0	0	0	0	0	0	
Patent Fuel	0	0	0	0	0	0	0	0	
Secondary Fuels	62100	0	62100	5693.4108	62100	3105	0	83.36267	
Total	103386.2	0	103386.2	9587.5242848	102183.7	6885.06871	1.176802170	39.2509601374	
3 Gaseous Fuels: 2 item(s)	213806	3600	210206	11631.947679	212000	11565.844	-0.846226415	0.57154219787	
Primary Fuels	171011	0	171011	9497.77993	171000	9287.844	0.00643	2.26033	
Natural Gas (Dry)	42795	3600	39195	2134.16775	41000	2278	-4.40244	-6.31397	
Natural Gas Power Plants	0	0	0	0	0	0	0	0	
Total	213806	3600	210206	11631.947679	212000	11565.844	-0.846226415	0.57154219787	

## Next Steps

This Guidebook is to be considered a work-in-progress given it will be periodically revised by IPCC TFI-TSU with the aim to increase the amount of information, in particular with real case examples, as well as to correct the information provided for any error and/or any further enhancement of the *Software*.

Users are therefore required to check periodically the version of the Guidebook published on the TFI website at <https://www.ipcc-nggip.iges.or.jp/software/index.html>.



## Annex I: Mapping between the IPCC Inventory Software and the UNFCCC CRT Reporting Tool

The *Software* enables users to calculate national GHG emissions in accordance with 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 [volume 1, chapter 8](#) 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 UNFCCC electronic reporting tool. 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 subsequently, through a separate UNFCCC platform, be uploaded and further processed through the UNFCCC electronic reporting tool to transfer to UNFCCC their national GHG inventory, as compiled in the CRTs and as required under the Paris Agreement.

Preparing a JSON file that can be imported into the UNFCCC electronic reporting tool required a cell-by-cell mapping of the CRT to document where each of the 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 fuels (Table A.1.1) and categories/gases (Table A.1.2) between the IPCC reporting categories and the CRT.

Table A.1.1 includes the list of the fuels included in [Table 1.1 Definitions of Fuel Types Used in the 2006 IPCC Guidelines](#) and the corresponding fuel to which that fuel is mapped in the CRT. For example, reporting of “Gasoline” in the CRT includes the following consumption of fuels from the *Software*: aviation gasoline, jet gasoline and motor gasoline.



Table A.1 1. Mapping of fuels between the 2006 IPCC Guidelines and the UNFCCC Common Reporting Tables

2006 IPCC Guidelines Fuel Name	CRT Reference Approach Fuel Name
<b>Liquid Fuels</b>	
Aviation Gasoline	Gasoline
Jet Gasoline	
Motor Gasoline	
Bitumen	Bitumen
Crude Oil	Crude Oil
Ethane	Ethane
Gas/diesel oil	Gas/diesel oil
Jet Kerosene	Jet Kerosene
Liquefied Petroleum Gases	Liquefied petroleum gases (LPG)
Lubricants	Lubricants
Naphtha	Naphtha
Natural Gas Liquids	Natural Gas Liquids
Orimulsion	Orimulsion
Other Kerosene	Other Kerosene
Other Petroleum Products	Other oil
Paraffin Waxes	
Refinery Gas	
White Spirit and SBP	
Petroleum Coke	
Refinery Feedstocks	Refinery Feedstocks
Residual Fuel oil	Residual fuel oil
Shale oil	Shale oil
<i>Country specific fuels</i>	Other liquid fossil ( <i>please specify</i> )
<b>Solid Fuels</b>	
Anthracite	Anthracite
Brown Coal Briquettes	Brown coal briquettes and patent fuel
Patent Fuel	
Coal Tar	Coal tar
Coke Oven Gas / Lignite Coke	Coke oven/gas coke
Gas Coke	
Coking coal	Coking coal
Lignite	Lignite
Oil Shale / Tar Sands	Oil shale and tar sand
Other Bituminous Coal	Other bituminous coal
Sub-Bituminous Coal	Sub-bituminous coal
Blast Furnace Gas	Other solid fossil ( <i>please specify</i> )
Gas Works Gas	
Oxygen Steel Furnace Gas	
<i>Country specific fuels</i>	

2006 IPCC Guidelines Fuel Name	CRT Reference Approach Fuel Name
Gaseous Fuels	
Natural Gas (dry)	Natural gas (dry)
Country specific fuels possible	Other gaseous fuels ( <i>please specify</i> )
Other Fossil Fuels	
Municipal Wastes (non-biomass fraction)	Waste (non-biomass fraction)
Industrial Wastes	Other fossil fuels
Waste Oils	
Country specific fuels possible	
Peat	
Peat	Peat
Biomass	
Biodiesels	Liquid biomass
Biogasoline	
Other Liquid Biofuels	
Charcoal	Solid biomass
Other Primary Solid Biomass	
Sulphite lyes (Black Liquor)	
Wood / Wood Waste	
Landfill Gas	Gas biomass
Sludge Gas	
Other Biogas	
Municipal Wastes (biomass fraction)	Other non-fossil fuels (biogenic waste)

## CRT visualization tables in the IPCC Inventory Software

To allow the user to properly understand, and keep for internal use, thus enhancing transparency, the results of conversion of IPCC category GHG estimates into UNFCCC NGHGI categories the mapping between the *Software* and the CRT are visualized in the *Software*.

To generate the visualization tables, select from the ribbon “Export/Import” and then “UNFCCC CRT” so you generate the tables. For complete guidance on how to do this, refer to the [IPCC Inventory Software -UNFCCC Interoperability – CRT Export Quick Start Guide](#). The result of the generated tables is presented below.

The screenshot shows the IPCC Inventory Software interface. The 'Export/Import' menu is open, and 'UNFCCC CRT' is selected. The main window displays 'TABLE 1.A(a) SECTORAL BACKGROUND DATA FOR ENERGY' with a detailed table of greenhouse gas emissions and sinks.

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA		IMPLIED EMISSION FACTORS			EMISSIONS			AMOUNT CAPTURED	CO2			Information
	Consumption (TJ)	NCV/GCV	CO2 (t/TJ)	CH4 (kg/TJ)	N2O (kg/TJ)	CO2 (kt)	CH4 (kt)	N2O (kt)	CO2 (kt)	Method	EF	Method	
1.A. Fuel combustion	14219053.902					35615903.45208	6923.96804	6675.74148	-1481.5				
Liquid fuels	9239844					14714820.08353	3019.41161	628.01039	-406.5				
Solid fuels	1623147.902					128898.48225	1201.23886	2262.65711	-304				
Gaseous fuels (6)	1459855					437842.07095	739.34966	763.56175	-135				
Other fossil fuels (7)	1647431.4					20309215.76087	1423.7529	2205.3674	-150				
Peat (8)	247944.8					25127.05448	7.64838	0.46836	-114				
Biomass (3)	4004030.4					229051.93089	532.46564	615.67649	-372				
1.A.1. Energy industries	2871306.202					191326.14711	52.38066	13.0768	-414.5				
Liquid fuels	558037					39713.6929	1.78022	0.30695	-95.5				
Solid fuels	219538.002					19634.36533	0.38098	0.28458	-59				
Gaseous fuels (6)	241080					13494.588	0.71628	6.03755	-30				
Other fossil fuels (7)	1124454					104541.6112	33.74742	4.51766	-37				
Peat (8)	141560.8					13941.88965	1.12196	0.21909	-29				
Biomass (3)	586626.4					48097.9448	14.6338	1.71098	-164				
1.A.1.a. Public electricity and heat production (9)	965707.8					44914.0246	14.77648	4.51542	-190				
Liquid fuels	248919					17979.0529	0.6604	0.14462	-30				
Solid fuels	127580					11443.7477	0.16022	0.17216	-20				
Gaseous fuels (6)	73440					4109.954	0.07344	2.73845	-10				
Other fossil fuels (7)	92304					9808.3632	2.76912	0.36922	-15				
Peat (8)	14932.8					1572.8768	0.99084	0.0224	-10				
Biomass (3)	408532					34928.898	10.12247	1.06858	-105				
1.A.1.a.i. Electricity generation	463979					13189.6963	10.9216	1.36275	-140				
Liquid fuels	79793	NCV				8622.0113	0.17725	0.03782	-20	CS	D, M	CS, T1, T3	
Solid fuels	40350	NCV				3792.165	0.05325	0.06698	-15	CS	D, M	CS, T1, T3	

**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 electronic reporting tool for CRT, 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.

The mapping tables have been developed to enhance transparency of the relationship between the categories in the *Software* and the UNFCCC reporting tool for CRT. 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 limited cases (e.g. for some short-lived climate forcer emissions in the sector summary tables, the reference approach, and some additional background information) data are mapped from the IPCC background or sectoral reporting tables, or in the case of the Reference Approach, from the “Tools” tab in the *Software*.

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
2. The tab in that worksheet that contains the relevant information
3. The fuel (or gas) of interest
4. The column that contains the relevant information, 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 total liquid fuel consumption for electricity generation 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 electronic reporting tool for CRT, upon import of the JSON file.

**Example: How to read mapping between the *Software* and the UNFCCC CRT**

Example: How to read mapping between the software and the UNFCCC CRT

UNFCCC  
CRT

1.A.1.a.i. Electricity generation  
Liquid fuels

IPCC 1.A.1.a.i. <Fuel Consumption Data> SUM by fuel type (Liquid Fuels) Column TC

05 IPCC Categories

- 1 - Energy
  - 1.A - Fuel Combustion Activities
    - 1.A.1 - Energy Industries
      - 1.A.1.a - Main Activity: Electricity and Heat
        - 1.A.1.a.i - Electricity Generation

1.A.2 - Manufacturing Industries and Construction

- 1.A.2.a - Iron and Steel
- 1.A.2.b - Non-Ferrous Metals
- 1.A.2.c - Chemicals
- 1.A.2.d - Pulp, Paper and Print
- 1.A.2.e - Food Processing, Beverages and Other Non-Metallic Minerals
- 1.A.2.f - Transport Equipment
- 1.A.2.g - Machinery
- 1.A.2.h - Mining (excluding fuels) and Quarrying
- 1.A.2.i - Wood and wood products
- 1.A.2.j - Construction

2 Fuel Consumption Data Fuel Combustion Emissions

Worksheet

Sector: Energy

Category: Fuel Combustion Activities

Subcategory: 1.A.1.a.i - Electricity Generation

Sheet: Fuel Consumption Data

Data

3 Fuel Type Liquid Fuels

Equation 2.4

Subdivision	Fuel	Consumption Unit	Consumption (Mass, Volume or Energy Unit)	Conversion Factor (TJ/Unit) (NCV)	Total consumption (TJ)
S	F	U	C	CF	TC = C * CF
Unspecified	Crude Oil	Gg (Auto CF)	500	42.3	21150
Unspecified	Gas/Diesel Oil	Gg (Auto CF)	1	43	43
Unspecified	Liquefied Petroleum Gases	Gg (Auto CF)	500	47.3	23650
Unspecified	Orimulsion	Gg (Auto CF)	500	27.5	13750
Unspecified	Residual Fuel Oil	Gg (Auto CF)	500	40.4	20200
Total					78793

IPCC  
Inventory  
Software

The example above is a simple illustration. In some cases, multiple worksheets and even multiple categories may map to a single cell in the CRT. This would be illustrated by reference to the two key instructions “PLUS” or “AND” to denote consideration of multiple data elements from the *Software*.

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 information pertains to an additional IPCC category.
- ✓ The sign **"MINUS"** indicates an additional element for mapping in the cell, which information pertains to a different IPCC category and it is to be subtracted.
- ✓ The sign **"EXCEPT"** indicates an element for mapping to be excluded because this element (e.g. fuel or IPCC category) is already included elsewhere.
- ✓ The signs **"MULTIPLY"** and **"DIVIDE"** and **"SUBTRACT"** indicate the corresponding mathematical operation to be applied to information sourced from the *Software*.
- ✓ The sign **"ISNOT"** means  $\neq$ .

In addition to these common instructions, the user will notice one additional marking in the tables; a red “T1”. T1 is designated in cases where it is not logical to simply sum up the underlying activity data. This happens when a user uses more than one tier to estimate GHG emissions for a particular category, and those tiers do not use the same activity data in their respective calculation. For example, this occurs in category 1.A.2.g.vii Off-road vehicles and other machinery, where the Tier 1 and Tier 2 methods rely on TJ of fuel consumption, whereas the Tier 3 method relies on the source population and average annual hours

of use. To add these two different types of activity data would not yield a meaningful value. In these cases, to ensure an accurate calculation of the implied emission factor, the user is encouraged to overwrite the value for activity data in the visualization table to a value that reflects the activity across the entire country. This can typically be done by inserting the total national activity data that would be calculated had the user applied Tier 1 across the entire country. In the visualization tables in the *Software* the user will be able to recognize those cells designated as “T1” by their green shading.

**Table A.1.2. Detailed mapping between the Software and the CRT 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*.

**Please note that the tables are accessible by clicking the ATTACH icon (paper-clip) on the left-hand side of your screen.**