CHAPTER 1

INTRODUCTION

Authors

Bofeng Cai (China) and Deborah A. Ottinger (USA)

Contents

Equation

Figures

Tables

1 INTRODUCTION

Users are expected to go to Mapping Tables in Annex 5, before reading this chapter. This is required to correctly understand both the refinements made and how the elements in this chapter relate to the corresponding chapter in the 2006 IPCC Guidelines.

1.1 INTRODUCTION

This volume, Industrial Processes and Product Use (IPPU), covers greenhouse gas emissions occurring from industrial processes, from the use of greenhouse gases in products, and from non-energy uses of fossil fuel carbon. The former section 'Solvent and Other Product Use' in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* has been incorporated in this volume.

Greenhouse gas emissions are produced from a wide variety of industrial activities. The main emission sources are releases from industrial processes that chemically or physically transform materials. (Examples include the blast furnace in the iron and steel industry, ammonia and other chemical products manufactured from fossil fuels used as chemical feedstock, the cement industry, aluminium production, and HCFC-22 production). During these processes, many different greenhouse gases, including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and other fluorinated compounds such as trifluoromethyl sulphur pentafluoride (SF_5CF_3) can be produced and emitted.

In addition, greenhouse gases often are used in products such as refrigerators, foams or aerosol cans. For example, HFCs are used as alternatives to ozone depleting substances (ODS) in various types of product applications. Similarly, sulphur hexafluoride (SF_6) and N_2O are used in a number of products used in industry (e.g., SF_6 used in electrical equipment, N_2O used as a propellant in aerosol products primarily in food industry) or by end-consumers (e.g., SF_6 used in running-shoes, N_2O used during anaesthesia). A notable feature of these product uses is that, in almost all cases, significant time can elapse between the manufacture of the product and the release of the greenhouse gas. The delay can vary from a few weeks (e.g., for aerosol cans) to several decades as in the case of rigid foams. (See Section 1.5 and Chapters 7 and 8 for discussions of the methodological issues associated with this delay.) In some applications (e.g., refrigeration) a fraction of the greenhouse gases used in the products can be recovered at the end of product's life and either recycled or destroyed. In addition, HFCs, PFCs, SF_6, NF_3, and several other fluorinated greenhouse gases may be used in and/or emitted by processes such as electronics manufacturing. Other fluorinated greenhouse gases[1] that are used in such processes, that are not covered by Annexes A through E of the Montreal Protocol, and that have had their global warming potentials (GWPs) listed in IPCC Assessment Reports include, for example:

- halogenated ethers and perfluoropolyethers used for temperature control, device testing, cleaning substrate surfaces and other parts, and soldering during electronics manufacturing and other processes. (e.g., HFE-449s1, HFE-569sf2, and PFPMIE)[2] (see Table 6.5 of this volume for a more complete list);
- fluoroketones;
- and other halocarbons not covered by Annexes A through E of the Montreal Protocol including, for example CF_3I, CH_2Br_2, $CHCl_3$, CH_3Cl, CH_2Cl_2.

This volume of the *2019 Refinement* also provides estimation methods for halogenated greenhouse gases which are not covered by Annexes A through E of the Montreal Protocol and for which GWP values were not available from an IPCC Assessment Report at the time the *2019 Refinement* was developed. Examples of such GHGs include:

- c-C_4F_8O;
- perfluorotripropylamine, perfluoromethylmorpholine, 3-ethoxy-1,1,1,2,3,4,4,5,5,6,6,6-dodecafluoro-2-trifluoromethyl-hexane, and other fluorinated liquids used for temperature control, device testing, cleaning

[1] Some of these compounds are liquid at room temperature but enter the atmosphere through evaporation, particularly when used at high temperatures, as many of them are.

[2] The first two compounds are hydrofluoroethers marketed under the Novec™ Engineered Fluid tradename by 3M™. The last compound, PFPMIE, is marketed under the Galden™ tradename by Solvay.

substrate surfaces and other parts, and soldering during electronics manufacturing and other processes (see Table 6.5 for a more complete list)[3];

- fluoronitriles.

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

This chapter presents:

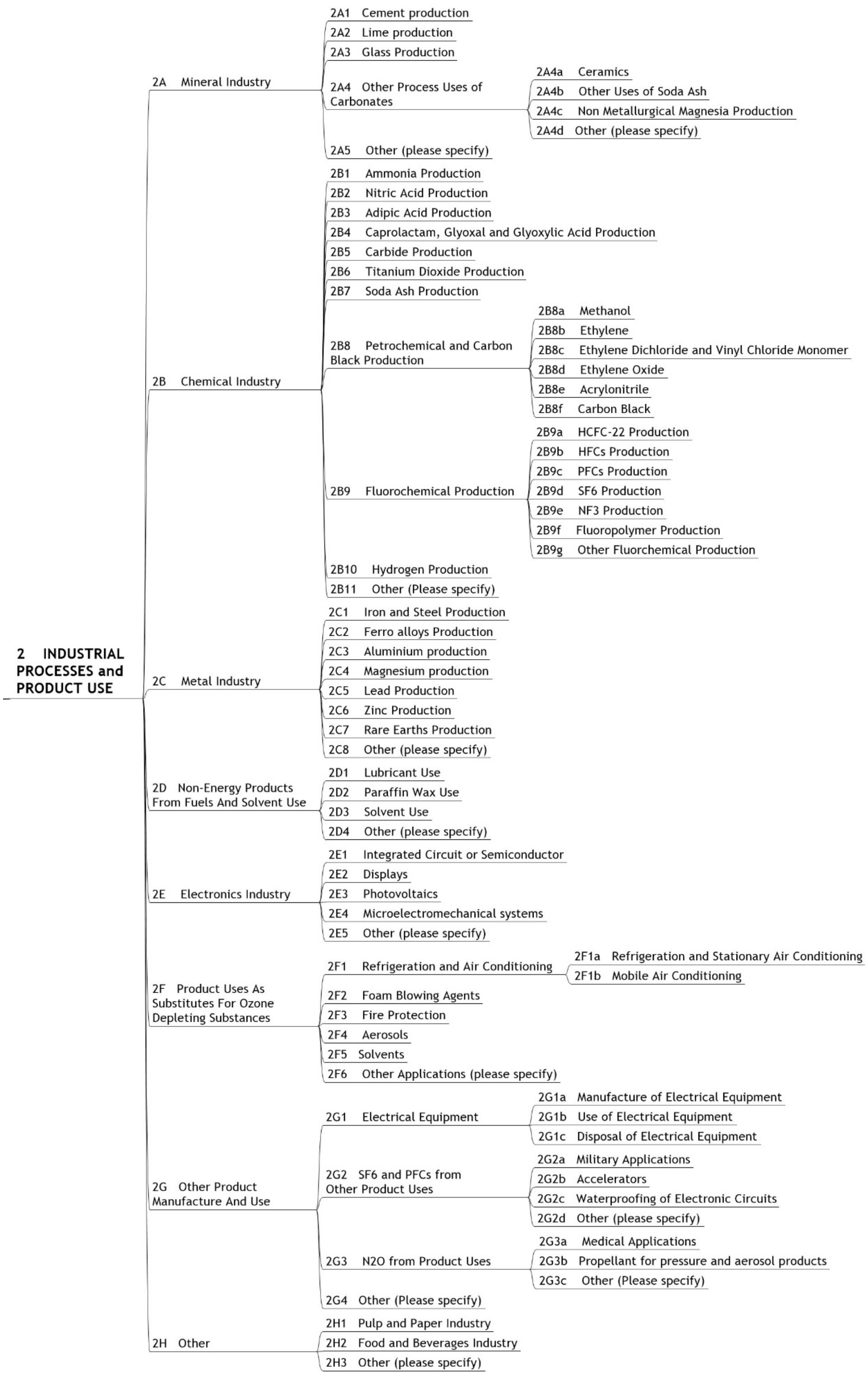
- the definition and structure of the treatment of industrial processes and product use (1.1);
- a number of general or cross-cutting issues (1.2), among which are the definition of industrial process and fuel combustion emissions (1.2.1) and sources of international data (1.2.5);
- the nature of non-energy uses of fossil fuels (1.3);
- the completeness and allocation of CO_2 from non-energy use of fuels (1.4); and
- the choice between the mass-balance and emission-factor approaches (1.5) with specific relevance to the fluorinated gases covered in Chapters 7 and 8 of this volume.

SECTOR CLASSIFICATION AND STRUCTURE

Figure 1.1 sets out the structure and classification codes for each category and subcategory for the IPPU Sector. In the *2019 Refinement*, Figure 1.1 has been updated by (1) adding subcategories for Hydrogen Production (2B10), Rare Earths Production (2C7), Micro electrical mechanical Systems (2E4), and Waterproofing of Electronic Circuits (2G2c) to reflect the addition of new guidance for these subcategories; (2) adding several subcategories under Fluorochemical Production to reflect the broad range of fluorochemical products, (3) updating the name of the Electronics subcategory previously called “TFT Flat Panel Display” to the more comprehensive “Display,” and (4) removing the subcategory “Heat Transfer Fluid” from the Electronics category, because the fluorinated liquids previously covered by this subcategory may be used in any of the Electronics sub-sectors (Semiconductors, Displays, Photovoltaics, or microelectromechanical systems (MEMS)), may be used for applications other than heat transfer (including for testing, soldering, and cleaning), and are identifiable through their chemical contents, which are reported based on the columns of Table 1.1 (see note 10 to Table 1.1).

[3] The first two compounds are marketed under the Fluorinert™ trade name, along with other fully fluorinated compounds such as alkanes, other tertiary amines and aminoethers. The last compound is marketed under the Novec Engineered Fluid™ tradename.

Figure 1.1 (Updated) Industrial Processes and Product Use categories



1.2 GENERAL AND CROSS-CUTTING ISSUES

1.2.1 Definition of industrial process, fuel combustion and fuel transformation emissions

Allocating emissions from the use of fossil fuel between the Energy and IPPU Sectors can be complex. The feedstock and reductant uses of fuels frequently produce gases that may be combusted to provide energy for the process. Equally part of the feedstock may be combusted directly for heat (Sector 1A) or transformed into other energy products (Sector 1B). This can lead to uncertainty and ambiguity in reporting. To help to overcome this problem, these *Guidelines* introduce practical guidance on when to allocate CO_2 emissions released from combustion of fuel to the subcategory fuel combustion within the energy source category or to the industrial process source category. The rule is given in Box 1.1.

Further guidance for specific source categories is also presented in the *2019 Refinement* (including the revised guidance on coke production and new guidance for hydrogen production), to include cross-references to the relevant methodology sections of the Energy Volume, and to present *good practice* for reporting allocations.

The problems encountered when allocating CO_2 emissions to fuel combustion, fuel transformation or industrial processes are particularly prominent when by-product fuels or waste gases are transferred from the manufacturing site and combusted elsewhere in quite different activities. This fact has formed the principle for the guidance given in Box 1.1, which provides a definition for fuel combustion and a criterion for deciding whether emissions from by-product fuels should be reported in the IPPU Sector or in an Energy Sector source category. Section 1.3 provides background information on the nature of non-energy uses of fossil fuels, accounting for feedstock and reductant uses of fossil fuels and on the links with the fossil fuel use in the Energy Sector.

1.2.2 Capture and abatement

No refinement.

1.2.3 Precursors

No refinement.

1.2.4 Indirect N_2O

No refinement.

1.2.5 International data sources

Good national data are to be preferred and used wherever available. In cases where data availability is a problem, inventory compilers may consult international data sources for proxy data for IPPU estimates. Sources include:

- United Nations (UN) industrial production statistics which are available in hard copy in the 'Industrial Commodity Statistics Yearbook' (UN, 2004) from 1991 onwards and as CD-ROM with statistics from 1950 onwards; data (in physical units) are given by commodity and country for all years and almost all commodities relevant for emission inventories.

- Organisation for Economic Co-operation and Development (OECD) publishes production data in monetary units (value of production) for the OECD countries (http://www.oecd.org/statsportal/0,2639,en_2825_293564_1_1_1_1_1,00.html) but data for the most recent years are not available. OECD also sells a publication with additional data (http://www.oecd.org/document/63/0,2340,en_2825_499554_1935935_1_1_1_1,00.html), but according to the web site the most recent data are for 2001. National account data can be also accessed, for a charge, for the years up to 2002. Most useful is perhaps the STAN (Industry Structural Analysis) database of the OECD (again only available via subscription at http://hermia.sourceoecd.org/vl=4126925/cl=58/nw=1/rpsv/cw/vhosts/oecdstats/16081307/v265n1/contp1-1.htm), this contains monetary production data, for years up to 2002, for major industries. Note, however, that the monetary value reflects not only the production quantity but also the price of the product - which may fluctuate from one year to another - so the data should be used with care.

- Eurostat publishes PRODCOM data (Eurostat, 2005) for many European countries.
- Statistics on production of a large number of commodities and capacity of individual plants are provided by the commodity and country by the U.S. Geological Survey as part of the International Minerals Statistics and Information (USGS, 2005).

TABLE 1.1 (UPDATED)
INDUSTRIAL PROCESSES AND PRODUCT USE CATEGORIES AND THEIR POSSIBLE EMISSIONS

2 Industrial Processes and Product Use (Note 1, 2)	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3	Other halogenated compounds (Note3)
2A Mineral Industry								
2A1: Cement Production	X	*						
2A2: Lime Production	X	*						
2A3: Glass Production	X	*						
2A4: Other Process Uses of Carbonates								
2A4a: Ceramics	X	*						
2A4b: Other Uses of Soda Ash	X	*						
2A4c: Non Metallurgical Magnesia Production	X	*						
2A4d: Other	X	*						
2A5: Other	X	*	*					
2B Chemical Industry								
2B1: Ammonia Production	X	*	*					
2B2: Nitric Acid Production	*	*	X					
2B3: Adipic Acid Production	*	*	X					
2B4: Caprolactam, Glyoxal and Glyoxylic Acid Production	*	*	X					
2B5: Carbide Production	X	X	*					
2B6: Titanium Dioxide Production	X	*	*					
2B7: Soda Ash Production	X	*	*					
2B8: Petrochemical and Carbon Black Production								
2B8a: Methanol	X	X	*					
2B8b: Ethylene	X	X	*					
2B8c: Ethylene Dichloride and Vinyl Chloride Monomer	X	X	*					
2B8d: Ethylene Oxide	X	X	*					
2B8e: Acrylonitrile	X	X	*					
2B8f: Carbon Black	X	X	*					
2B9: Fluorochemical Production (Note 4)								
2B9a: HCFC-22 Production				X	X			X
2B9b: HFC Production				X	X			*
2B9c: PFC Production				X	X			*
2B9d: SF6 Production						X		
2B9e: NF3 Production			X		X		X	
2B9f: Fluoropolymer Production				X	X			X
2B9g: Other Fluorochemical Production (Note 5)				X	X	X	X	X
2B10: Hydrogen	X	*	*					
2B11: Other	*	*	*	*	*	*		*
2C Metal Industry								
2C1: Iron and Steel Production	X	X	*					
2C2: Ferroalloys Production	X	X	*					
2C3: Aluminium Production	X	*			X			
2C4: Magnesium Production (Note 6)	X			X	X	X		X
2C5: Lead Production	X							
2C6: Zinc Production	X							
2C7: Rare Earths Production	X				X			
2C8: Other	*	*	*	*	*	*		*
2D Non-Energy Products from Fuels and Solvent Use (Note 7)								
2D1: Lubricant Use	X							
2D2: Paraffin Wax Use	X	*	*					
2D3: Solvent Use (Note 8)								
2D4: Other (Note 9)	*	*	*					
2E Electronics Industry								
2E1: Integrated Circuit or Semiconductor (Note 10)	*		X	X	X	X	X	X
2E2: Display (Note 10)			X	X	X	X	X	X
2E3: Photovoltaics (Note 10)			X	X	X	X	X	X
2E4: MEMS (Note 10)			X	X	X	X	X	X
2E5: Other	*	*	*	*	*	*		*

TABLE 1.1 (UPDATED) (CONTINUED)
INDUSTRIAL PROCESSES AND PRODUCT USE CATEGORIES AND THEIR POSSIBLE EMISSIONS

2 Industrial Processes and Product Use (Note 1, 2)	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	NF_3	Other halogenated compounds (Note3)
2F Product Uses as Substitutes for Ozone Depleting Substances								
2F1: Refrigeration and Air Conditioning								
2F1a: Refrigeration and Stationary Air Conditioning	*			X	X			*
2F1b: Mobile Air Conditioning	*			X	X			*
2F2: Foam Blowing Agents	*			X	*			*
2F3: Fire Protection	*			X	X			*
2F4: Aerosols				X	X			*
2F5: Solvents (Note 11)				X	X			*
2F6: Other Applications	*	*	*	X	X			*
2G Other Product Manufacture and Use								
2G1: Electrical Equipment								
2G1a: Manufacture of Electrical Equipment (Note 12)					X	X		X
2G1b: Use of Electrical Equipment (Note 12)					X	X		X
2G1c: Disposal of Electrical Equipment (Note 12)					X	X		X
2G2: SF_6 and PFCs from Other Product Uses								
2G2a: Military Applications(Note 13)					X	X		X
2G2b: Accelerators (Note 14)					*	X		X
2G2c: Waterproofing of Electronic Circuits				X	X			
2G2d: Other(Note 15)				X	X	X		
2G3: N_2O from Product Uses								
2G3a: Medical Applications			X					
2G3b: Propellant for Pressure and Aerosol Products			X					
2G3c: Other			X					
2G4: Other	*	*		*				*
2H Other								
2H1: Pulp and Paper Industry (Note 16)	*	*						
2H2: Food and Beverages Industry (Note 16)	*	*						
2H3: Other	*	*	*					

1) 'X' denotes gases for which methodological guidance is provided in this volume.
2) '*' denotes gases for which emissions may occur but for which no methodological guidance is provided in this volume.
3) For precursors (NOx, CO, NMVOC, SO_2 and NH_3) see Table 7.1 in Chapter 7 of Volume 1.
4) The Tier 2 and 3 methodologies are applicable to any fluorinated greenhouse gas, including those specifically listed in the columns above and other fluorinated compounds. In these tiers all estimates are based on measurements, either measured losses from the process or measured emissions, and accommodate process-specific releases. For the Tier 1 methodology, default emission factors (for the product and/or by-products) are provided specifically for production of HCFC-22, SF_6 and NF_3. For the production of HFCs, PFCs, and other fluorochemicals, a Tier 1 default emission factor based on a wide range of fluorochemical products and processes is provided. In addition, a representative combination of emitted HFCs and PFCs is provided for situations when the inventory compiler does not know the chemical identities of the emitted gases.
5) The 'Other halogenated gases' include but are not limited to fluorinated ethers, perfluoropolyethers, fluoroketones, fluorinated alcohols, SF_5CF_3, and perfluoroamines.
6) Small amounts of CO_2 used as a diluent for SF_6 and emitted during magnesium processing is considered insignificant and is usually counted elsewhere. The 'other halogenated gases' here mainly comprise fluorinated ketones.
7) Emissions from feedstock uses in petrochemical industry should be addressed in 2B8 (Petrochemical and Carbon Black Production). Emissions from some product uses should be allocated to each industry source category (e.g., CO_2 from carbon anodes and electrodes → 2C (Metal Industry)).
8) Only NMVOC emissions and no direct greenhouse gases are relevant to this category. Therefore no methodological guidance is provided in this volume. For guidance on NMVOC, see Chapter 7, Volume 1.
9) Emissions from Asphalt Production, Paving of Roads and Roofing are included here. For details, see Section 5.4 of this volume.
10) The 'Other halogenated compounds' may include, for example, c-C_4F_8O, as well as hydrofluoroethers, perfluoropolyethers, perfluoroamines, and perfluoroalkyl morpholines used for temperature control, device testing, cleaning substrate surfaces and other parts, and soldering during electronics manufacturing. Specific compounds to be reported here include (but are not limited to) those listed in Table 6.5 of Volume 3, such as HFE-449s1 (3M™ Novec™ HFE-7100), HFE-569sf2, (3MTM Novec™ HFE-7200), perfluorotripropylamine (PTPA, 3M™ Fluorinert™ FC-3283/FC-8270), perfluoroisopropylmorpholine (3M™ Fluorinert™ FC-770), and various PFPMIE fractions marketed by Solvay™ under the Galden™ trademark, such as HT-55 through HT-270. See Volume 3, Chapter 6 for more potentially emitted compounds.
11) Emissions from use of fluorinated gases as solvent should be reported here. Emissions from aerosols containing solvents should be reported under Category 2F4 rather than under this category. Emissions from other solvent use should be reported under 2D3.
12) 'Other halogenated gases' may include fluoroketones and fluoronitriles.
13) 'Other halogenated gases' may include, for example, hydrofluoroethers, perfluoropolyethers, perfluoroamines, and perfluoroalkyl morpholines used for temperature control and other applications. Specific compounds to be reported here include (but are not limited to) those listed in Table 6.5 of Volume 3.
14) 'Other halogenated gases' may include fluoroketones and fluoronitriles.
15) Appendix 1 of this volume includes a basis for future methodological development for estimating fluorinated GHG emissions from the textile, carpet, leather, and paper industries. Gases that are believed to be emitted from these industries include HFCs, PFCs, SF_6, and potentially other fluorinated GHGs.

16) No specific section on these categories is provided in this volume, but methodological guidance on CO_2 emissions from use of carbonates from these industries is provided in Chapter 2, Section 2.5 of this volume.

1.3 NATURE OF NON-ENERGY USES OF FUELS

As explained in Section 1.1 some CO_2 emissions from fossil fuels arise from uses that are not primarily for energy purposes and, in this section, the principles are described which have guided their estimation and reporting. The methods used to estimate emissions are described in the specific IPPU source category chapters (Chapters 3, 4 and 5). This section provides important and additional background information for the use of data relating to non-energy use and the links between these data and the fossil fuel use.

Non-energy use is widespread, diverse and the correct reporting of its emissions is conceptually difficult. It is *good practice* to ensure that all fossil fuels supplied for non-energy purposes can be linked to uses covered by the inventory and the reported emissions are consistent with the carbon supplied. Accordingly, Section 1.4 provides guidance for assessing consistency and completeness of carbon emissions from feedstock use of fuels by (a) checking that feedstock requirements of processes included in the inventory are in balance with the feedstock supply as recorded in national energy statistics, (b) checking that total reported bottom-up calculated CO_2 emissions from feedstock sources at different subcategory levels are complete and consistent, (c) documenting and reporting how these emissions are allocated in the inventory.

Note that in the *2019 Refinement*, new methods are presented to reflect the use of bio-fuels and biomass in non-energy applications, for example as feedstock in the production of hydrogen (see Section 3.11). These IPPU processes may generate methane or nitrous oxide for inclusion within the national inventory total, and also generate IPPU bio-CO_2 emissions as a memo item to the national inventory. The principles outlined in this section, whilst primarily developed to account for fossil carbon across the Energy and IPPU sectors, equally can be applied to reconcile inventory NEU and energy use data for biofuels against national commodity balance data.

1.3.1 Types of uses

Some primary fuels (coal, natural gas) and secondary fuels derived from coal and crude oil may be used for non-fuel purposes. These are commonly referred to as non-energy use of fuels although their use may involve combustion of part of the hydrocarbon content for heat-raising.

Three categories of non-energy use can be distinguished depending on its use:

1. *Feedstock*: Feedstocks are fossil fuels that are used as raw materials in chemical conversion processes in order to produce primarily organic chemicals and, to a lesser extent, inorganic chemicals (especially ammonia) and their derivatives (OECD/IEA/Eurostat, 2004). In most cases, part of the carbon remains embodied in the product manufactured. The use of hydrocarbon feedstocks in chemical conversion processes is almost entirely confined to the chemical and petrochemical industries.

2. *Reductant*: Carbon is used as reducing agent for the production of various metals (Chapter 4) and inorganic products (Sections 3.6 – 3.8). It is either used directly as reducing agent or indirectly via the intermediate production of electrodes used for electrolysis. In most cases, only very small amounts of carbon are embodied in the product manufactured, while the major part is oxidised during the reduction process.

3. *Non-energy product*: Apart from fuels, refineries and also coke ovens produce some non-energy products which are used directly (i.e., without chemical conversion) for their physical or diluent properties or which are sold to the chemical industry as chemical intermediate. Lubricants and greases are used in engines for their lubricating properties; paraffin waxes are used as candles, for paper coating etc.; bitumen on roofs and roads for its waterproofing and wear qualities. Refineries also produce white spirits, which are used for their solvent properties.

This chapter discusses emissions that result from the first use of the hydrocarbons belonging to these three categories. Table 1.2 shows the types of hydrocarbons used in the three categories and the main applications. The list of fuel types and processes is illustrative and not exhaustive as some lesser uses of refinery or coke oven products are omitted. For example, refinery olefins are not shown because only a minor portion of the olefins used for the manufacture of intermediate products is produced in refineries.

This section focuses on the issues surrounding the reporting of industrial process and fuel combustion emissions from the use of fossil fuels as feedstocks and reductants (the first and second categories in Table 1.2). The relatively simpler issues affecting estimation of emissions from the first uses of non-energy products (the third category in Table 1.2) are presented with the methods in Chapter 5.

In addition to the emissions from the first use of hydrocarbons, products made from feedstocks (methanol, ethylene, carbon black) and their derivatives may lead to additional emissions after manufacture and sale. For example, the conversion of ethylene to ethylene oxide leads to substantial industrial process CO_2 emissions (Section 3.9).

Emissions from subsequent uses of 'used' non-energy products (post-consumer waste) are not included in this volume on IPPU Sector but are covered under the Energy and Waste Sectors depending on whether the treatment occurs with or without energy recovery or in the form of wastewater treatment.

TABLE 1.2 (UPDATED)
TYPES OF USE AND EXAMPLES OF FUELS USED FOR NON-ENERGY APPLICATIONS

Type of use	Example of fuel types	Product/process	Chapter
Feedstock	natural gas, oils, coal	ammonia	3.2
	natural gas, oils, coal, biofuels, biomass	hydrogen	3.11
	naphtha, natural gas, ethane, propane, butane, gas oil, fuel oils	methanol, olefins (ethylene, propylene), carbon black	3.9
Reductant	petroleum coke	carbides	3.6
	coal, petroleum coke	titanium dioxide	3.7
	metallurgical cokes, pulverised coal, natural gas	iron and steel (primary)	4.2
	metallurgical cokes	ferroalloys	4.3
	petroleum coke, pitch (anodes)	aluminium 1	4.4
	petroleum coke, pitch (anodes)	Rare Earths Production	4.8
	metallurgical coke, coal	lead	4.6
	metallurgical coke, coal	zinc	4.7
Non-energy product	lubricants	lubricating properties	5.2
	paraffin waxes	misc. (e.g., candles, coating)	5.3
	bitumen (asphalt)	road paving and roofing	5.4
	white spirit2, some aromatics	as solvent (paint, dry cleaning)	5.5

[1.] Also used in secondary steel production (in electric arc furnaces) (see Chapter 4.2).

[2.] Also known as mineral turpentine, petroleum spirits, industrial spirit ('SBP').

1.3.2 Accounting for feedstock and reductant uses of fossil fuels and their CO_2 emissions

No refinement.

1.3.3 Emissions from refinery processes

Refineries manufacture petroleum products for fuel and for non-energy uses, and in doing so produce hydrogen and other gases, intermediate products and basic chemicals. The CO_2 emissions from fuel consumed by the refinery for this activity are reported as Energy Sector emissions. This principle is maintained in the *Guidelines* even when some fuel use in the refinery is to support manufacture of chemicals for sale (for example, propylene or aromatics). In the *2019 Refinement*, this principle is re-iterated within the new guidance presented for hydrogen production, which is a new IPPU source category; the emissions from hydrogen production within a refinery as an intermediate product are primarily to support Energy sector activities, with emissions to be reported in the Energy sector.

The manufacture of basic chemicals in refineries is a normal occurrence usually through the treatment of by-products of mainstream manufacture and they may be used in other refinery processes or transferred to adjoining petrochemical works. However, in some circumstances the demand for basic chemicals may cause the refinery to adjust production processes to increase supply of the chemical and sell directly into the market. Despite this activity the fuel use to support all processes is still considered as refinery fuel and the emissions as Energy Sector emissions. It is important to recognise that the production for sale of basic chemicals in refineries is considered a secondary activity distinct from the manufacture of chemicals in adjoining or co-located petrochemical works. This is consistent with the separate statistical classification of the two economic activities.

1.4 QC OF COMPLETENESS AND ALLOCATION OF CO_2 FROM NON-ENERGY USES

1.4.1 Introduction

No refinement.

1.4.2 Scope of methods

No refinement.

1.4.3 Quality control of completeness

The *CO_2 completeness check* (Section 1.4.3.1) starts from energy balance data and is designed to check that all significant emissions of CO_2 from the first non-energy uses of fossil fuels are reported somewhere in the inventory, without double counting. The emissions are the sum of CO_2 emissions from (a) fuels used as feedstock in the chemical industry, (b) fuels used as reductant in the metal industry, (c) fuel products oxidised during use (partly or fully; direct emissions or emissions of carbon containing non-CO_2 gases (Non-methane volatile organic compound (NMVOC), carbon monoxide (CO) and CH_4) oxidised in the atmosphere).

Subsequent CO_2 emissions may occur in the waste phase if the waste oils or waste products are incinerated. However, the amount of fossil-carbon containing products disposed of annually as waste is not equal to the amount used annually for first uses because fossil-carbon containing products may be imported or exported or they may be used for several years before they are discarded. The complications which arise from external trade hold equally for emissions resulting from the use of products made from feedstocks and their derivatives. Since derivative products may also be imported or exported the emissions from their use (e.g., from ethylene oxide or acrylonitrile production) cannot be linked directly to the first non-energy use of fossil fuels. For these reasons the *CO_2 completeness check* is limited to the first non-energy uses of fossil carbon which lead to emissions and does not include CO_2 emissions from waste incineration. Other non-energy sources of fossil CO_2 are flaring, venting and other fugitive emissions in the Category 1B and are also excluded from this completeness checking method.

The *feedstock balance check* (Section 1.4.3.2) is simpler in concept and starts from non-energy statistics for feedstock/reductant supplies and compares them with the reported (or implied) requirements for feedstock by the various IPPU processes. This check identifies discrepancies between the two sets of data that may indicate omitted processes or feedstock use classified as fuel combustion.

1.4.3.1 CO_2 COMPLETENESS CHECK

The principle of this method is based on comparisons of reported CO_2 emissions with potential CO_2 emissions from the fuel for non-energy uses and consists of three steps:

1. CO_2-equivalent carbon contents are calculated for the non-energy use of fossil fuels as reported in national energy statistics (including the coke and other solid fuel inputs into blast furnaces).
2. Total CO_2 emissions reported per IPPU subcategory are related to (main) fuels used for non-energy purposes. This should include emissions from by-product fuels transferred from the IPPU Sector and reported elsewhere in the Energy Sector.
3. Total reported fossil IPPU CO_2 emissions are compared with a top-down estimate of potential CO_2 of the carbon content of the feedstocks used. The comparison is made by calculating the actual CO_2 released as a fraction of the total potential CO_2 in the input fuels. The fractions may then be compared with values observed for different industries (see below, ‘Step 3: Actions arising from the comparison’). In case of significant discrepancies, likely causes of differences should be listed, taking into account the accuracy of the allocation of sources to individual fuels.

Step 1: Feedstock amount and CO_2-equivalent carbon content

The amount of feedstock and non-energy use entered in Table 1.3 is the final consumption of each fuel for 'non-energy' purposes as reported in the national energy statistics. The quantities should be expressed in, or converted to, Terajoules (TJ) using the net calorific (lower heating) values (see Chapter 1 of Volume 2 for IPCC default values). Next the potential CO_2-eq. emissions associated with the carbon contents can be calculated using country-specific or IPCC default carbon content values (see Chapter 1 of Volume 2 for IPCC default values).

If a country accounts separately for the production of by-product gases from chemical production processes in their energy statistics, these should also be added in the top row of fuel amounts associated with feedstock emissions of CO_2 and the corresponding amount of CO_2-eq. calculated using country-specific carbon content values.

Step 2: Allocating source category CO_2 emissions to one or more feedstock fuels

The CO_2 emissions reported in the IPPU Sector that arise mainly from the metal and chemical industries, should be allocated to the corresponding fuel types used as input for the process. Emissions resulting from the non-energy use of fossil fuels reported elsewhere should be included here too. Guidance for this allocation is provided in Table 1.3, where for each subcategory the most common feedstock fuel is marked as a bolded box. Other fuels that are known to be used as feedstock for these sources are indicated with a regular box. In most cases these boxes are the only allocations to be checked for the country-specific application. If no specific information is available, all CO_2 emissions may be assigned to the bold box. Where country-specific information shows that several fuels are used as feedstock, either the specific fractions for each fuel can be used or each may be given an equal share of the source total.

Step 3: Actions arising from the comparison

The fraction of potential CO_2 actually released may be calculated per fuel type or per group of fuels, and can be assessed for their level, trend and interannual variation. The values of the fractions may be compared with values inferred from the information provided for the methodological tiers for the source categories or from literature (e.g., Neelis *et al.*, 2005).

Small differences or changes may be expected due to process-specific technological or operational differences. Major differences can arise from large differences in technologies or, when comparing with other countries' data or literature, from the use of a different definition of feedstocks (for details see Section 1.3). A third explanation of discrepancies may be due to errors in the presumed allocation of source category emissions to specific fuel types used as feedstock in the process.

TABLE 1.3 (UPDATED) VERIFICATION OF COMPLETENESS OF REPORTED CO_2 FROM NON-ENERGY USE OF FOSSIL FUELS

NOTES			Activity a)	CO_2 Emissions a)	IEF CO_2	Unit	Solids Coal	Coke	Coal tars	Coal oils	BF/OF gas	(CO gas) b)	Total solids
1	Year:_________					Unit	Coal	Coke	Coal tars	Coal oils	BF/OF gas	(CO gas) b)	Total solids
2	A: Declared NEU (from commodity balance)					TJ							
3	B: Carbon Content					kg C/GJ							
	C: Total supplied for feedstock/non-energy	[C = A * B / 1000]				Gg C							
4	**D: Total supplied for feedstock/non-energy**	**[D = C * 44/12]**				Gg CO_2-eq.							
5	**E: Implied carbon fraction oxidised**	**[E = F / D * 100]**				%							
6	**F: Total fossil IPPU CO_2 reported**					Gg CO_2							
	2 INDUSTRIAL PROCESSES					Gg CO_2							
7	**2A: Mineral Industry**					Gg CO_2							
	(Please specify the subcategory.)					Gg CO_2							
7	**2B: Chemical Industry**					Gg CO_2							
	2B1: Ammonia Production					Gg CO_2							
	2B5: Carbide Production					Gg CO_2							
	2B6: Titanium Dioxide Production					Gg CO_2							
	2B8: Petrochemical and Carbon Black Production					Gg CO_2							
	2B8a: Methanol					Gg CO_2							
	2B8b: Ethylene					Gg CO_2							
	2B8f: Carbon Black					Gg CO_2							
	2B10: Hydrogen					Gg CO_2							
	2B11: Other					Gg CO_2							
7	**2C: Metal Industry**					Gg CO_2							
	2C1: Iron and Steel Production					Gg CO_2							
	2C2: Ferroalloys Production					Gg CO_2							
	2C3: Aluminium Production					Gg CO_2							
	2C5: Lead Production					Gg CO_2							
	2C6: Zinc Production					Gg CO_2							
	2C7: Rare Earths Production					Gg CO_2							
	2C8: Other					Gg CO_2							
7	**2D: Non-Energy Products from Fuels and Solvent Use**					Gg CO_2							
	2D1: Lubricant Use					Gg CO_2							
	2D2: Paraffin Wax Use					Gg CO_2							
	2D3: Solvent Use					Gg CO_2							
	2D4: Other					Gg CO_2							
7	**2H: Other**					Gg CO_2							
	2H1: Pulp and Paper Industry					Gg CO_2							
	2H2: Food and Beverage Industry					Gg CO_2							
	2F3: Other					Gg CO_2							
	EXCEPTIONS REPORTED ELSEWHERE					Gg CO_2							
7	**1A FUEL COMBUSTION ACTIVITIES**					Gg CO_2							
	1A1a: Main Activity Electricity and Heat Production					Gg CO_2							
	1A1b: Petroleum Refining					Gg CO_2							
	1A1c: Manufacture of Solid Fuels and Other Energy Industries					Gg CO_2							
	1A2: Manufacturing Industries and Construction					Gg CO_2							

a) Same Activity Data and emissions as in sectoral background table (also for Activity Data NE, NO, C, and for emissions NE, NO, IE, where applicable).
b) To be included only if coke production is reported as part of integrated iron and steel production.
1: To be specified per year
2: Cf. Auxiliary worksheet for CO2-Reference Approach to subtract the NEU from total apparent consumption
3: IPCC default or country-specific values
4: So-called potential emissions, i.e., carbon embodied in the feedstock/non-energy fuels expressed in CO_2-eq.
5: Ratio of CO_2 emissions (direct emissions as well as atmospheric inputs of CO_2 from other carbon (non-CO_2)) at some aggregation level (by detailed fuel type or by major fuel type) to total potential CO_2 in feedstock NEU fuels consumed
6: Sum of subcategories below including IPPU sources allocated to Fuel Combustion Activities 1A (due to transfer of by-product fuels to another source category (and 1B, 4C when appropriate))
7: Sum of subcategories of that category

TABLE 1.3 (UPDATED) (CONTINUED) VERIFICATION OF COMPLETENESS OF REPORTED CO_2 FROM NON-ENERGY USE OF FOSSIL FUELS

NOTES							Liquids												Gas	
1	Year:_________					Unit	Naphtha	Gas oil	Fuel Oil	Ethane	LPG b)	Petcoke	Other	Chem. gas	Lubricants	Waxes	Bitumen	Total liquids	Nat Gas	Total gas
2	A: Declared NEU (from commodity balance)					TJ														
3	B: Carbon Content					kg C/GJ														
	C: Total supplied for feedstock/non-energy	[C = A * B / 1000]				Gg C														
4	**D: Total supplied for feedstock/non-energy**	**[D = C * 44/12]**				Gg CO_2-eq.														
5	**E: Implied carbon fraction oxidised**	**[E = F / D * 100]**				%														
			Activity a)	CO_2 Emissions a)	IEF CO_2															
6	**F: Total fossil IPPU CO_2 reported**					Gg CO_2														
	2 INDUSTRIAL PROCESSES					Gg CO_2														
7	**2A: Mineral Industry**					Gg CO_2														
	(Please specify the subcategory.)					Gg CO_2														
7	**2B: Chemical Industry**					Gg CO_2														
	2B1: Ammonia Production					Gg CO_2														
	2B5: Carbide Production					Gg CO_2														
	2B6: Titanium Dioxide Production					Gg CO_2														
	2B8: Petrochemical and Carbon Black Production					Gg CO_2														
	2B8a: Methanol					Gg CO_2														
	2B8b: Ethylene					Gg CO_2														
	2B8f: Carbon Black					Gg CO_2														
	2B10: Hydrogen					Gg CO_2														
	2B11: Other					Gg CO_2														
7	**2C: Metal Industry**					Gg CO_2														
	2C1: Iron and Steel Production					Gg CO_2														
	2C2: Ferroalloys Production					Gg CO_2														
	2C3: Aluminium Production					Gg CO_2														
	2C5: Lead Production					Gg CO_2														
	2C6: Zinc Production					Gg CO_2														
	2C7: Rare Earths Production					Gg CO_2														
	2C8: Other					Gg CO_2														
7	**2D: Non-Energy Products from Fuels and Solvent Use**					Gg CO_2														
	2D1: Lubricant Use					Gg CO_2														
	2D2: Paraffin Wax Use					Gg CO_2														
	2D3: Solvent Use					Gg CO_2														
	2D4: Other					Gg CO_2														
7	**2H: Other**					Gg CO_2														
	2H1: Pulp and Paper Industry					Gg CO_2														
	2H2: Food and Beverage Industry					Gg CO_2														
	2F3: Other					Gg CO_2														
	EXCEPTIONS REPORTED ELSEWHERE					Gg CO_2														
7	**1A FUEL COMBUSTION ACTIVITIES**					Gg CO_2														
	1A1a: Main Activity Electricity and Heat Production					Gg CO_2														
	1A1b: Petroleum Refining					Gg CO_2														
	1A1c: Manufacture of Solid Fuels and Other Energy Industries					Gg CO_2														
	1A2: Manufacturing Industries and Construction					Gg CO_2														

Note: In the tabular part, bolded boxes mark the main fuels as feedstock or reductant for the processes at the left hand side. Regular boxes mark other known feedstock/reductant for the processes at the left hand side.

1.4.3.2 FEEDSTOCK BALANCE CHECK

The principle of the *feedstock balance check* method is to compare the supply of feedstock/reductants as reported in national fuel statistics with the requirements for the feedstocks by each of the processes using them. A significant difference between the supply and the requirements of a feedstock leads to several suggested actions intended to identify omission of feedstock uses from the inventory or uses of fuel as feedstock that have been reported as fuel consumption or conversion.

Unlike the *CO_2 completeness check* the *feedstock balance check* is conducted at the level of fuel quantities and not CO_2 emissions. The method seeks confirmation that all feedstock carbon has been satisfactorily attributed to source categories identified in the inventory.

The workings of the method are explained below and readily set out in a worksheet (Table 1.5a). A list of feedstock fuels to be considered is presented in Table 1.4.

TABLE 1.4 (UPDATED)
LIST OF FUELS THAT CAN BE USED AS CHEMICAL FEEDSTOCK OR REDUCTANT

Solids	Liquids		Gases	Other fuels
coal	refinery gas	naphtha	natural gas	other fuel
metallurgical coke*	Ethane	kerosene		waste (fossil carbon)
petroleum coke*	propane	gas oil		Biofuels / biomass
coal tars and oils*	butane	fuel oil		
	LPG	waste oils		

* Includes uses as electrodes.

Step 1: Feedstock supply

Figures for supply of each feedstock/reductant are taken from national fuel statistics presented in commodity or energy balances. They will be shown as non-energy use or feedstock use according to the country's particular conventions and reductants as inputs to a transformation process. The quantities should be expressed in, or converted to, Terajoules (TJ) using net calorific (lower heating) values (see Chapter 1 of Volume 2 for IPCC default values).

The definitional basis for feedstock reporting differs between countries and this consideration is fully discussed in Sections 1.2.1 and 1.3.2. Some care is therefore needed to identify and use the correct hydrocarbon input figures that will correspond with a process's gross hydrocarbon requirements for the feedstock or reductant (including inputs not or only partly labelled as non-energy use in energy statistics). The total hydrocarbon process input attributed to feedstock/reductant use is required for the *feedstock balance check* described here, because the Specific Feedstock Consumption (SFC) figures of each process, as given in the table, include the fuel requirement. The SFC is the amount (expressed in TJ/Gg) of feedstock/reductant required per tonne of product produced.

Step 2: Feedstock requirements

The feedstock requirements of each process will include fuels taken directly or indirectly from the feedstock. Where the necessary data are available from industry sources they can then be entered into the 'requirements' part of the worksheet. Where the data are not available the requirements should be calculated from the production figures for the processes and where necessary, using expert judgement based on the emissions estimation used for the process(es). The figure for the process requirement is likely to be identical to the quantity supplied (taken from energy statistics) *only when* the latter has been obtained from industry sources.

When requirements are calculated from production using the spreadsheet the production figures are those relevant to the process for the given feedstock. If two or more feedstocks supply a single process then the corresponding production figures should be used for each feedstock.

Table 1.5b provides SFC factors linking production figures to feedstock requirements. The factors are the specific feedstock requirements of the process and include fuel use of the feedstock. The factors provided in Table 1.5b have been derived from the methods described in this volume of these *Guidelines* and may be considered as default values. It is *good practice* to use national factors if they are demonstrably more relevant than the default factors given here.

If R_{ij} represents the feedstock requirements of process *i* for feedstock *j*, then the total requirement for feedstock *j* (R_j), can be expressed as:

EQUATION 1.1
TOTAL FEEDSTOCK REQUIREMENT

$$R_j = \sum_i R_{ij} = \sum_i \left(SFC_{ij} \bullet P_{ij} \right)$$

Where:

R_j = total requirement for feedstock *j*, TJ

R_{ij} = feedstock requirements of process *i* for feedstock *j*, TJ

SFC_{ij} = Specific Feedstock Consumption of feedstock *j* in process *i*, TJ/Gg

P_{ij} = production from process *i* using feedstock *j*, Gg

The R_j is then compared with the figure for the supply of feedstock *j*. The difference appears in the Table 1.5a. The implementation procedure for this check is set out in the flowchart in Figure 1.3.

Step 3: Actions arising from the comparison

It is suggested that if the difference observed exceeds 10 percent of the feedstock supply action should be taken to check the data and, if the difference is confirmed, it should be investigated. The 10 percent threshold is necessarily arbitrary and chosen to reflect the likely overall inherent uncertainties in the data.

It is considered *good practice* to focus the investigation on differences in which feedstock supply significantly exceeds the apparent requirements because this suggests that:

- Processes and therefore sources of emissions may have been omitted; or
- The specific energy requirements used in the method are too low. The specific energy requirements should then be adjusted to reflect the national situation.

When the calculated requirements exceed the apparent feedstock supply it suggests that:

- Uses of feedstock fuels are reported elsewhere as fuel combustion or fuel conversion uses.
- A ‘net’ definition of feedstock supply may have been used in the energy statistics instead of a ‘gross’ definition (see the reference to ethylene and other chemicals in Section 1.3.2).
- Feedstock requirements, obtained directly from industry sources, are overstated through the inclusion of fuels entering the plant (or more generally, the source category) which are not used in the process and therefore not for feedstock use. The inclusion of non-feedstock fuels should not occur when the feedstock requirements are derived from production data.

Where significant discrepancies remain the likely causes of differences should be listed, taking into account the accuracy of the calculation with default Specific Feedstock Consumption values per source category/feedstock combination.

TABLE 1.5A (Updated) COMPARISON OF FEEDSTOCK SUPPLY WITH REQUIREMENTS IMPLIED BY PRODUCTION

YEAR		Feedstock or Reductant (TJ)	Process SFC (TJ/kt)	Production (Gg [=kt])
	Feedstock Quantity delivered			
	Difference			
Chemicals	Ammonia prodn		↑	
	Silicon carbide			
	Calcium carbide			
	Ethylene		Values	
	Methanol		from	
	Carbon black		Table 1.5b	
	Hydrogen			
	Other			
Metals	Iron and steel			
	Ferroalloys			
	Aluminium			
	Zinc			
	Lead			
	Rare Earths		↓	
	Other			

Table 1.5a is a reduced form of the full table in which the tabular part is replicated as many times as there are types of feedstock or reductant. In each of the replications the ‘Feedstock or Reductant’ heading in column 1 is replaced by the name of the fuel. The corresponding SFC values are then entered in column 2. The default SFC values are given in Table 1.5b below.

An Excel workbook is provided in the *2006 IPCC Guidelines* CDROM containing the full table, the default values and the formulae to carry out automatically the requirements calculation.

TABLE 1.5B (Updated) SPECIFIC FEEDSTOCK CONSUMPTION (TJ/Gg) FOR FEEDSTOCK/REDUCTANTS

		Coal	Met coke	Pet Coke	Coal tars and oils	Ref gas	Ethane	Propane	Butane	LPG	Naphtha	Kerosene	Gas oil	Fuel oil	Waste oils	Natural gas
Chemicals	Ammonia prodn													42(l)		37(o)
	Silicon carbide			36(e)												
	Calcium carbide			17(f)												
	Ethylene						59(j)	100(k)	104(k)	102(k)	137(k)					
	Methanol	72(a)												37(m)		34(p)
	Carbon black				60(h)									60(n)		12(q)
	Hydrogen prodn	215 (r)								165 (r)	165 (r)					165 (r)
	Other															
Metals	Iron and steel		14(b)													
	Ferroalloys															
	Aluminium			12(g)	3(i)											
	Zinc		21(c)													
	Lead		7(d)													
	Rare Earths			4 (s)	1 (s)											
	Other															

NOTES **(a) Methanol:** From Section 3.9.2.2; Table 3.13 Consult table for precise value according to process used.

(b) Iron and Steel: From Section 4.2.2.3:"Coke is consumed at a rate of about 475 kg/tonne of iron (or hot metal) produced." so coke requirement is 0.475 x cv(coke) 28.5 = 3.54 GJ/t iron.

(c) Zinc: From Section 4.7.1 (pyrometallurgical process only) taken from Sjardin(2003) Coke consumption is 0.74t coke/t zinc. That is: 0.74 x 28.5 GJ/t or 21 GJ coke / t zinc.

(d) Lead: taken from Sjardin(2003) Coke consumption is 0.26t coke/t lead. That is: 0.26 x 28.5 GJ/t or 7 GJ coke / t lead

(e) Silicon carbide: From Section 3.6.2.2: ". . . This implies a typical emission factor of 2.3 tonnes CO_2/tonne petroleum coke used (IPCC, 1996), or 2.62 tonnes CO_2/tonne carbide produced.
Or 2.62/2.3 t coke per t carbide; = 1.14 t coke/t carbide. That is; 1.14 x 32 = 36 GJ per tonne of SiC.

(f) Calcium carbide: From: Section 3.6.2.2 "1750 kg limestone (or 950 kg CaO), 640 kg of petroleum coke and 20 kg carbon electrodes are required to produce 1 tonne of carbide."
So coke requirement is:Prodn x (640-20) x CV(coke) per tonne of CaC_2. or .620 x 32.5 = 20.15 GJ/tonne CaC_2

(g) Aluminium: From Section 4.4.2.2; Table 4.11 average of two processes 1.65t CO_2/t alu. = 0.45tC/t alu. Assume anodes contain 84% coke and 16% pitch. (Sjardin 2003). Assume coke is 92% C and pitch 93% C. Assume CV calcined coke is 30MJ.kg and NCV for pitch 35.6MJ/kg. Then coke requirement is 12.3 GJ/t alu and pitch requirement 2.8 GJ/t alu.

(h) Carbon black: Assumed identical to fuel oil.

(i) Aluminium: See note for pet coke.

(j) Ethylene: From Section 3.9.2.3; Table 3.25 Ethane requirement is: NCV(Ethane)x1/yield matrix value. That is:47.5 x 1/0.803 = 59.15

(k) Ethylene: See ethane for sources and method.

(l) Ammonia: From 3.2.2.2; Table 3.1;Partial oxidation assumed

(m) Methanol: From Section 3.9.2.2; Table 3.13. Consult table for precise value according to process used.

(n) Carbon Black: Based on Voll et al and BREF LVIC Table 4.13

(o) Ammonia: From Section 3.2.2.2; Table 3.1

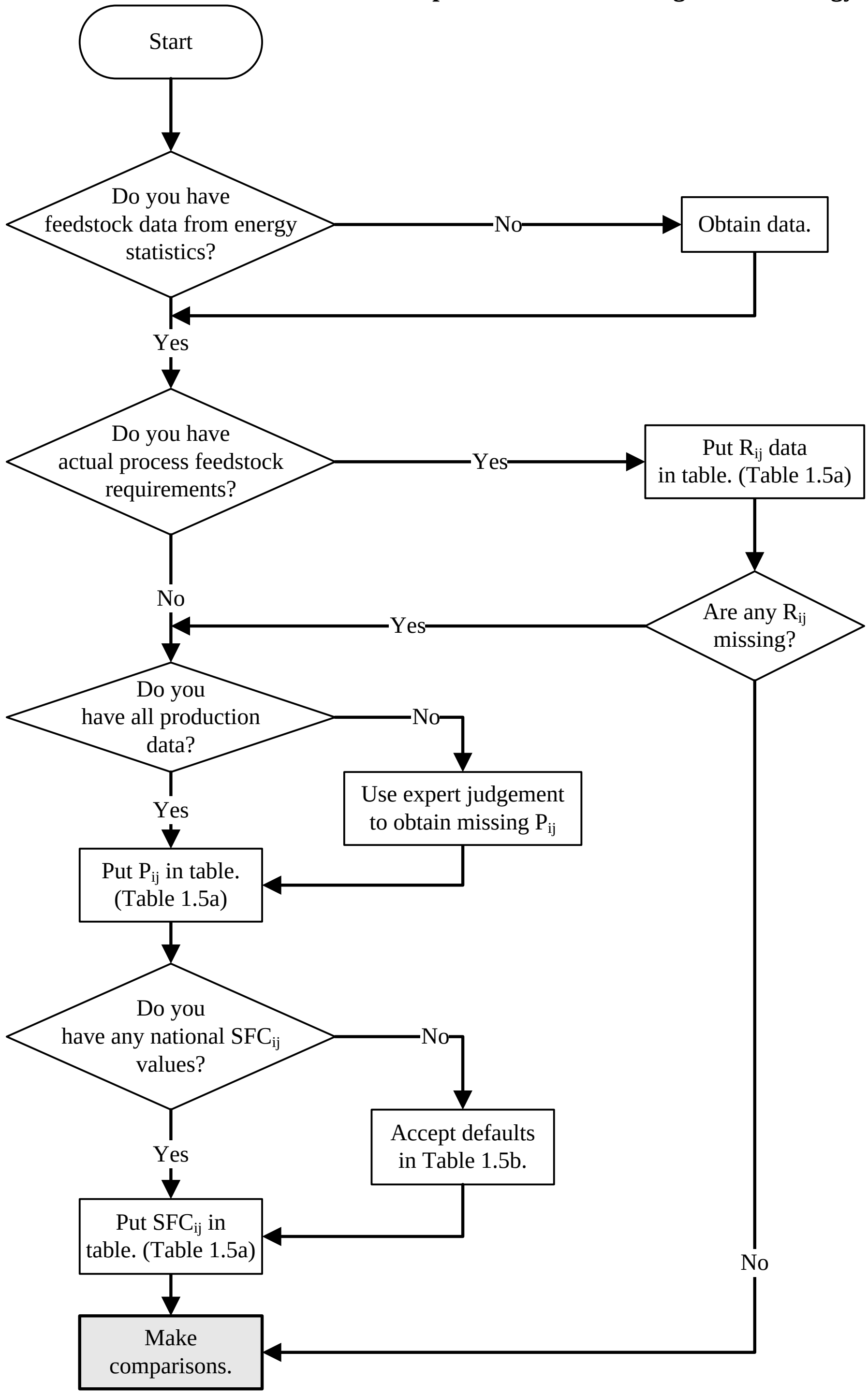
(p) Methanol: From Section 3.9.2.2; Table 3.13;Consult table for precise value according to process used.

(q) Carbon black: Based on Voll et al and BREF LVIC Table 4.13

(r) Hydrogen: From Section 3.11.2.2; Table 3.30 Consult table for precise value according to process used.

(s) Rare Earths: From Section 4.8.2.2; Table 4.26 indicates average emissions of 0.15 tC / t RE produced, which is one third that of Aluminium production.
Applying the same assumptions as for Aluminium in item (g) above derives the values for RE production for coke and pitch.

Figure 1.3 Flowchart for verification of completeness of accounting for non-energy uses of fuels



Note:
R_{ij} = feedstock requirements of process i for feedstock j, TJ
SFC_{ij} = Specific Feedstock Consumption of feedstock j in process i, TJ/Gg
P_{ij} = production from process i using feedstock j, Gg

1.4.4 Reporting and documentation of allocation and QC of completeness

It is *good practice* to review, summarise and document the completeness checks, if performed, for non-energy uses of fuels and fugitive emissions from fuel manufacture. This involves identifying the uses within the IPPU Sector, Fuel Combustion Activities (Category 1A) and Fuel Transformation activities (Category 1B) in the Energy Sector, as discussed in this section.

Different national methods exist for accounting for feedstock use of fuels in energy statistics and there is a possibility, in exceptional cases, of reporting part of the CO_2 in the Energy Sector (see Sections 1.2.1 and 1.3.2). Consequently, it is *good practice* to show in the inventory report:

- Where and how *non-energy* use of fuels has been accounted for in the inventory (whether in the Energy Sector or the Industrial Processes and Product Use Sector.) (Section 1.4.4.1).
- Where and how carbon emissions, other than CO_2, have been accounted for in the inventory. These arise from non-combustion and non-biogenic processes involving fossil carbon such as solvent use.
- Results of *completeness checks* performed, when applicable. Details on the QC activities on completeness should be kept as internal documentation (Section 1.4.4.2), in accordance with the guidance on QA/QC (see Chapter 6 of Volume 1).

The first bullet point refers to the allocation of corresponding emissions, in the IPPU Sector or, possibly, also in the Fuel Combustion Activities (Category 1A) in the Energy Sector, and to the definition of 'non-energy' or 'feedstock' used in the national energy statistics. Depending on the definition of the source categories, the contribution of feedstock and non-energy use CO_2 emissions varies from less than a percent up to about 5 percent of national total fossil fuel related CO_2 emissions.

The description of the completeness check should explain any allocation of a particular source to several sectors. In particular, how adjustments have been made to industrial process emissions should be explained in cases where fuel by-products (off-gases or process vent gas) are transferred to another source category in the IPPU Sector or in the Energy Sector.

1.4.4.1 ALLOCATION OF CO_2 FROM NON-ENERGY USE

Table 1.6 can be used to document and report the following information, summarising the subcategories in which the sectoral CO_2 emissions (other than those from fuel combustion) from the fossil fuels used are reported. The amounts of each fuel type consumed for non-combustion purposes (which correspond to excluded carbon in the CO_2 Reference Approach) should be recorded as internal documentation. This relates to:

- The division between *manufacturing process emissions* reported in the IPPU Sector and *fuel combustion emissions* reported in the Energy Sector.
- The allocation of CO_2 emissions from the *direct use* of 'fuels' for their physical properties and from the *use* of chemical products in the IPPU Sector. The emissions from the *waste disposal* of these products (e.g., incineration) are dealt with in the Waste Sector.

In the allocation reporting table (Table1.6) the 'Primary NEU fuel type' and 'Other NEU fuel types' should be entered for each category. The same CO_2 emissions reported in the IPPU sectoral background table are entered into the IPPU emissions column (or the notation keys NE, NO, IE, where applicable). Then CO_2 emissions related to the use of fossil fuels for non-energy purposes reported in source categories other than IPPU are added to the appropriate 1A subcategories. These are labelled in the IPPU source categories as (partly) included elsewhere in the IPPU reporting with a reference to where they are reported. Thus the table includes all emissions from the IPPU Sector wherever they are reported and so documents the complete reporting of these emissions in the IPPU and Energy Sectors.

The inclusion of the Energy Sector improves transparency of complete CO_2 emissions reporting as regards the emissions from waste gases and other gases such as blast furnace gas produced from industrial processes but used for fuel combustion in other economic sectors and thus reported in the Energy Sector.

1.4.4.2 COMPLETENESS OF CO_2 FROM NON-ENERGY USE

In addition to the summary of the review of the allocation and completeness of emissions from non-energy uses of fossil fuels it is *good practice* to document:

- A description of the emission calculation methods used, in the respective source category sections of the report. This should include the reason for any departure of allocations compared to the suggested IPCC source classification, if applicable.
- The results of the *CO_2 completeness check* if used, for at least the base year (where data permit) and the last reported year, presented in a table such as Table 1.3, as internal documentation.
- If the *feedstock balance check* for completeness was also used, a table showing the difference between the inferred estimate of feedstock consumption and the reported feedstock deliveries; at minimum for the base year (where data permit) and the two most recent years (i.e., as in Table 1.5a) as internal documentation.
- An explanation of significant unexpected discrepancies, if any, in level or trend. This should include the main cause of these differences.
- Conclusions from the comparison in terms of whether significant CO_2 emissions seem to be missing, and if so, in which part of the inventory they occur, and an estimate of the sizes of the omissions.
- A summary of bio-CO_2 emissions from the use of bio-fuels and biomass feedstocks that are reported as memo items to the national inventory.

TABLE 1.6 (UPDATED)
ALLOCATION OF CO_2 FROM NON-ENERGY USE OF FOSSILS FUELS: IPPU AND OTHER SECTORS

Category		Reported in year: ……..				Notes
		Primary NEU fuel (1)	Other NEU fuel(s) (1)	Emissions Amount Reported in IPPU Sector CO_2 (2) (Gg)	In case reported elsewhere: Sub-category in 1A where these emissions are (partly) reported	
2 Industrial Processes and Product Use						
2A Mineral Industry						
(Please specify the sub-category)		(coal, ..)				4
2B Chemical Industry						
2B1	Ammonia Production	natural gas	oil, coal			
2B5	Carbide Production	pet coke	oil			
2B6	Titanium Dioxide Production	coal				
2B8	Petrochemical and Carbon Black Production					
2B8a	Methanol	natural gas	coal, oil			5
2B8b	Ethylene	naphtha	gas oil; butane, ethane, propane, LPG			5
2B8f	Carbon Black	natural gas	oil, coke oven gas			
2B10	Hydrogen	natural gas	LPG, naphtha, coal, methanol			6
2B11	Other					
2C Metal Industry						
2C1	Iron and Steel Production	coke	coal, pet coke (carbon electrode)			7
2C2	Ferroalloys Production	(carbon electrode)	coke, coal			8
2C3	Aluminium Production	(carbon electrode)	coke, coal			8
2C5	Lead Production	coke				
2C6	Zinc Production	coke				
2C7	Rare Earths Production	(carbon electrode)	coke, coal			8
2C8	Other	(carbon electrode)	coke, coal			
2D Non-Energy Products from Fuels and Solvent Use						
2D1	Lubricant Use	lubricants	greases			
2D2	Paraffin Wax Use	waxes				
2D3	Solvent Use	(mineral turpentine)	coal tars and oils			9
2D4	Other					10
2H Other						
2H1	Pulp and Paper Industry					
2H2	Food and Beverages Industry	coke				
2H3	Other					
1 ENERGY						
1A Fuel Combustion Activities				**Reported in Sector 1A (3)**		
1A1a	Main Activity Electricity and Heat Production	(BF gas)	(chemical off-gases)			11
1A1b	Petroleum Refining					
1A1c	Manufacture of Solid Fuels and Other Energy Industries	BF gas				
1A2	Manufacturing Industries and Construction	(BF gas)	(lubricants, chemical off-gases))			

(1) The columns ‘Primary NEU fuel’ and ‘Other NEU fuel’ should be completed with the actual fuel types used.

(2) These are the same emissions reported in the sectoral background table (also the same emissions notation keys NE, NO, IE, where applicable). If (partly) reported elsewhere, a reference to that other source category should be added in the next column.

(3) Report here only the CO_2 emissions from combustion of waste gases produced from industrial processes but used for fuel combustion in other economic sectors and reported in the Energy sector.(e.g. from combustion of blast furnace gas or chemical off-gases transferred offsite to another source category).

(4) For example powdered anthracite coal may be used in Glass Production (2A3).

(5) In cases where the production of off-gases (i.e. byproduct gases) is fully accounted for in the energy statistics, the combustion of these gases may be used to calculate and report CO_2 emissions from the feedstock losses. Part of these off-gases may be combusted off-site (i.e. in a sector other than the petrochemical industry) and should thus be accounted for separately as fuel combustion in the Energy Sector.

(6) In some cases the emissions from feedstock use to produce hydrogen will be accounted for within other source categories, including petroleum refining (1A1b) and ammonia production (2B1).

(7) Part of the blast furnace gas produced from coke used in blast furnaces may be combusted off-site (i.e. in a sector other than the iron and steel industry) and should thus be accounted for separately as fuel combustion in the Energy Sector.

(8) Carbon electrodes are generally manufactured from coke, coal or tar either on-site by the users themselves or separately by anode production plants and then sold to users domestically and/or exported. If anodes are also imported and/or exported, there is no direct correspondence between fuels used for anode production and the amounts of anodes used in the country.

(9) Mineral turpentines are often used as solvent, possibly blended with other liquids. Aromatics derived from coal oils may also be used as solvents.

(10) Emissions from asphalt production, paving of roads and roofing should be reported under 2D4. However, bitumen - and other oil as diluent or 'road oil' - used for this activity does not result in CO_2 emissions.

(11) CO_2 from blast furnace gas and chemical off-gases should be reported here only when utilised in public power or heat production.

1.5 CHOOSING BETWEEN THE MASS-BALANCE AND EMISSION-FACTOR APPROACHES

No refinement.

References

References copied from the 2006 IPCC Guidelines

SECTIONS 1.1 AND 1.2

EEA (2005). "EMEP/CORINAIR. Emission Inventory Guidebook – 2005", European Environment Agency, Technical report No 30. Copenhagen, Denmark, (December 2005). Available from web site see: http://reports.eea.eu.int/EMEPCORINAIR4/en

Eurostat (2005). Europroms. PRODCOM Data. The PRODCOM annual dataset DS-008451 is available at website: http://fd.comext.eurostat.cec.eu.int/xtweb/setupdimselection.do

IPCC (2001). Climate Change 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T.,Y. Ding, D.J. Griggs, M. Noguer, P.J. van der Linden, X. Dai, K. Maskell, and C.A. Johnson (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 881pp.

Milbrath, D. (2002). "Development of 3M™ Novec™ 612 Magnesium Protection Fluid as a Substitute for SF6 Over Molten Magnesium," International Conference on SF_6 and the Environment: Emission Reduction Technologies, November 21-22, 2002, San Diego, CA.

UN (2004). 2001 Industrial Commodity Statistics Yearbook. United Nations Statistics Division, Energy and Industry Statistics Section, Report no. ST/ESA/STAT/SER.P/41, 17 September 2004. Series P, No. 41, Sales number: E/F.03.XVII.10. Also available on CD-ROM as 'Industrial Commodity Statistics Dataset (1950-2002)'. See internet: http://unstats.un.org/unsd/industry/publications.htm

USGS (2005). International Minerals Statistics and Information. U.S. Geological Survey. Available at website: http://minerals.usgs.gov/minerals/pubs/country/index.html#pubs

SECTIONS 1.3 AND 1.4

EU Integrated Pollution Prevention and Control (2004). Draft Reference Document on Best Available Techniques in the Large Volume Inorganic Chemicals - Solid and Others Industry. (Draft August 2004)

Neelis, M.L., Patel, M., Gielen, D.J. and Blok, K. (2005). Modelling CO_2 emissions from non-energy use with non-energy use emission accounting tables (NEAT) model, *Resources, Conservation and Recycling*, Volume 45, Issue 3, pp. 226-251.

OECD/IEA/Eurostat (2004). Energy Statistics Manual. IEA PUBLICATIONS, 9 rue de la Fédération, 75739 PARIS Cedex 15 PRINTED IN FRANCE BY STEDI, September 2004. Available at website: http://www.iea.org/dbtw-wpd/textbase/nppdf/free/2004/statistics_manual.pdf.

Patel, M.K. (1999). Statistical definitions of non-energy use. 1st NEU-CO2 project workshop, 23-24 September 1999. IEA, Paris. Available at website: http://www.chem.uu.nl/nws/www/nenergy/wrkshp1c.htm.

Sjardin, M. (2003). CO_2 Emission Factors for Non-Energy Use in the Non-Ferrous Metal, Ferroalloys and Inorganics Industry. Copernicus Institute, Utrecht, The Netherlands. June 2003.

Voll, M. and Kleinschmit, P. (1997). 'Carbon Black' in Ullman's encyclopedia of industrial chemistry. 5th ed. on CD-ROM, Vol. A5. John Wiley and Sons; 1997.

SECTION 1.5

Schaefer, D. (2002). A Potential Error Associated with Using Chemical and Equipment Sales Data to Estimate Greenhouse Gas Emissions from Long-lived, Pressurized Equipment, Non-CO2 Greenhouse Gases: Scientific Understanding, Control Options and Policy Aspects, Proceedings of the Third International Symposium, Maastricht, The Netherlands, 21-23 January 2002, pp. 229- 230. Millpress, Rotterdam, Netherlands, 2002.