

# **ANNEX 3**

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## **IMPROVEMENTS SINCE 1996**

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## ANNEX 3: IMPROVEMENTS SINCE 1996

This volume contains major changes and improvements to the section covering 'Industrial Processes' and 'Solvent and Other Product Use' in the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (1996 IPCC Guidelines)*. First, these *Guidelines (2006 IPCC Guidelines)* introduce practical guidance on allocation of carbon dioxide (CO<sub>2</sub>) emissions released from combustion of fuel in the Energy Sector and Industrial Processes Sector, which was not clear in the *1996 IPCC Guidelines*. Second, these *Guidelines* are based on the principle that emissions should be reported in the industries where these emissions occur. Accordingly, there has been a shift in the categories in which some emissions are reported, particular those from the use of limestone, dolomite and other carbonates.

Other major changes and/or improvements listed below are associated to each Chapter of this volume.

### A3.1 MINERAL INDUSTRY EMISSIONS

There are three key changes to the Mineral Chapter in the *2006 IPCC Guidelines*, as compared to the earlier guidance documents. Firstly, a new input-based method has been introduced for all source categories that estimates emissions based on the quantity, type and composition of carbonate inputs to the production processes. For example, in addition to the Tier 2 method based on clinker output during cement production, an alternate method is elaborated based on estimating emissions from the carbonate input to the kiln.

Secondly, clear guidance has been developed to specify where emissions from the use of limestone, dolomite and other carbonates should be reported. As noted above, these *Guidelines* are based on the principle that emissions should be reported in the industries where they occur. For example, where limestone is used as a flux for iron and steel production, emissions from the use of the limestone should be reported under Iron and Steel Production. Only emissions from limestone and dolomite used in the mineral industry should be reported in the Mineral Industry Chapter. Inventory compilers are encouraged to assess carefully how this change may impact, in particular, emission estimates for the Mineral Industry, the Chemical Industry, and Metal Production.

In addition while earlier guidance highlighted only limestone and dolomite use, these *Guidelines* also outline methods for estimating emissions from use of other carbonates, including magnesia and sodium carbonate. These *Guidelines* also establish three approaches for estimating emissions from glass production. Acid-induced release of CO<sub>2</sub> from acidification of carbonate-containing materials (e.g., phosphate ores) is also considered, although specific estimation methods are not provided.

### A3.2 CHEMICAL INDUSTRY EMISSIONS

New sources of emissions have been introduced: nitrous oxide (N<sub>2</sub>O) emissions from Production of Caprolactam, Glyoxal, and Glyoxylic acid, and CO<sub>2</sub> emissions from Titanium Dioxide Production. Soda Ash production was reallocated from Mineral Industry to Chemical Industry. In the Soda Ash Production section the methodology for synthetic (Solvay) soda ash production process, which was lacking in the *1996 IPCC Guidelines* and the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (GPG2000)*, has been introduced.

CO<sub>2</sub> emission factors have been added for Petrochemical Production processes, including emission factors for methanol, ethylene, ethylene dichloride/vinyl chloride, ethylene oxide, acrylonitrile, and carbon black production. Methane emission factors have been updated for these petrochemical production processes. Styrene production is no longer included in the guidance document. A systematic description of Tier 1, 2 and 3 methodologies for all source categories is provided in the text.

The descriptions of emission-related processes have been enlarged giving more information about their chemistry and technology aspects.

More systematic guidance is also given to avoid double counting fuel products used as a feedstock or reductant (cross-cutting issue with Energy Sector). This issue is discussed in regard to ammonia production, carbide production, and titanium dioxide, and petrochemical production (Sections 3.2, 3.6, 3.7, and 3.9).

A discussion of utilisation of CO<sub>2</sub> in Urea Production is included in the section on Ammonia Production. Emissions from urea use that were previously accounted for in the Industrial Processes Sector have been reallocated according to the sectors where urea is used (Energy Sector and Agriculture, Forestry and Other Land Use (AFOLU) Sector) to take proper account of exports urea produced in ammonia plants. Emissions from other

chemical products manufactured using CO<sub>2</sub> recovered in the ammonia production process are accounted together with emissions from ammonia production, as before.

The methodology for calculation of HFC-23 emissions from HCFC-22 production has incorporated the principal methods used within the industry, including continuous direct, proxy and in-process measurements in Tier 3 and efficiency-based material balance methods in Tier 2. In addition, explicit guidance has been added on fugitive and by-product emissions from the production of other fluorinated compounds including hydrofluorocarbons (HFCs), sulphur hexafluoride (SF<sub>6</sub>) and uranium hexafluoride (UF<sub>6</sub>).

### A3.3 METAL INDUSTRY EMISSIONS

The Metal Industry Section of *2006 IPCC Guidelines* incorporates a number of changes. Where carbon and carbon-containing materials, including carbonate containing minerals, are used in the metal production process for purposes other than the direct production of energy within the process, the CO<sub>2</sub> emissions are now counted within the metals guidance. For example, the CO<sub>2</sub> emissions from carbon-based electrodes for aluminium production are now included within the guidance for aluminium, and the CO<sub>2</sub> emissions from the use of limestone and dolomite used in iron and steel making are included within the guidance for iron and steel production.

The Metal Industry Section now includes guidance for estimating emissions of CO<sub>2</sub> and CH<sub>4</sub> from metallurgical (coal) coke production; however the CO<sub>2</sub> and CH<sub>4</sub> emissions from metallurgical coke production are to be reported under Energy Sector, not Industrial Processes and Product Use (IPPU) Sector. Emission factors for production of direct reduced iron (DRI), pellets, and sinter from iron ore and other iron-containing raw materials are now included under iron and steel production. Separate CO<sub>2</sub> emission factors are provided for blast furnace iron making and for steel making using the basic oxygen furnace (BOF), electric arc furnace (EAF) and open hearth furnace (OHF) processes.

CO<sub>2</sub> emissions from primary magnesium production based on dolomite and magnesite raw materials are also included in this section. In addition, new guidance has been developed and is available for calculation of CO<sub>2</sub> emissions resulting from production of zinc and lead. Separate CO<sub>2</sub> emission factors are provided for primary and secondary lead and zinc production processes. More comprehensive guidance is also included for ferroalloys production processes. Revised guidance is offered in the *2006 IPCC Guidelines* for magnesium for new gases reflecting efforts to replace sulphur hexafluoride as a cover gas. Finally, calculation factors have been updated to reflect the most recent experience for measured emission factors, typical compositions of process materials impacting calculations, and, in some instances new equations are included.

### A3.4 NON-ENERGY PRODUCTS FROM FUELS AND SOLVENT USE

Almost this entire source category, which is described in Chapter 5, is new within the IPPU Sector. The *1996 IPCC Guidelines* did cover emissions from asphalt and road paving, but in much less detail. The products covered here comprise: lubricants, paraffin waxes, bitumen/asphalt, and solvents.

Emissions from lubricants were previously covered under fuel combustion without any discrimination between emissions arising during lubricants use and any emissions from waste lubricants used for heat raising. The same is true for paraffin waxes. Asphalt emissions refer to production and use of asphalt for road paving, asphalt roofing and other applications. Asphalt emissions also include emissions from asphalt blowing. The subcategory '2D3 Solvent Use' refers to the subcategories 3A and 3B in the *1996 IPCC Guidelines*. Although asphalt and solvents are not significant sources of direct greenhouse gas emissions, they are included in this chapter to provide a description of them since they are sources of ozone precursors (non-methane volatile organic compounds (NMVOC), and in the case of asphalt also carbon monoxide (CO)). In particular, solvent use is a very substantial source of NMVOC.

### A3.5 ELECTRONICS INDUSTRY EMISSIONS

The *1996 IPCC Guidelines* and the *GPG2000*, described methods for estimating emissions from semiconductor manufacturing alone for seven fluorinated carbon compounds: CF<sub>4</sub>, C<sub>2</sub>F<sub>6</sub>, CHF<sub>3</sub>, C<sub>3</sub>F<sub>8</sub>, c-C<sub>4</sub>F<sub>8</sub>, NF<sub>3</sub> and SF<sub>6</sub>. The *2006 IPCC Guidelines* expands that scope to include additional manufacturing sectors and more gases, updates the Tier 1 methodology and emission factors, and provides explicit estimates of uncertainties for emissions factors and activity data. The *2006 IPCC Guidelines* incorporates emissions from liquid crystal display (LCD) manufacturing, photovoltaic (PV) cell manufacturing and the use of heat transfer fluids in semiconductor

manufacturing. In addition, the number of greenhouse gases in the *2006 IPCC Guidelines* has been expanded to include difluoromethane (CH<sub>2</sub>F<sub>2</sub>), octafluorocyclopentene (C<sub>5</sub>F<sub>8</sub>), hexafluorbutadiene (C<sub>4</sub>F<sub>6</sub>) and octafluorotetrahydrofuran (C<sub>4</sub>F<sub>8</sub>O); F<sub>2</sub> and COF<sub>2</sub> have also been added because, even though they are not greenhouse gases, CF<sub>4</sub> may be formed during their use. A new Tier 1 methodology is adopted that includes new default emissions factors and activity data for all sectors.

### **A3.6 EMISSIONS OF FLUORINATED SUBSTITUTES FOR OZONE DEPLETING SUBSTANCES**

The emissions in a number of the source categories (applications) covered by this chapter have been the subject of considerable study since the *1996 IPCC Guidelines* were written. This has been particularly the case for sectors with delayed emissions (e.g. refrigeration, foam and fire protection) where the earlier emission factor estimates proposed by Gamlen and others have been further developed to reflect the varying emission rates from a variety of sub-applications. Much of this was included in the *GPG2000*.

One of the consequences of this improved understanding has been recognition that the potential emissions approach used as Tier 1 in the *1996 IPCC Guidelines* is no longer appropriate. The potential emissions approach is still described in Annex 1 of this volume as a verification tool for completeness of sources and as a QC check of the sum of activity data per compound, which should be equal to the sum of apparent domestic consumption as calculated in the potential emissions approach. The Tier 1 approaches now proposed in these *Guidelines* are therefore actual emission estimation methods, although often based on default emission factors and with the potential to use global/regional activity databases where better information is not available. Chapter 7 of this volume contains examples of these new Tier 1 approaches and guidance on how to implement them. Simplified mass balance approaches have also been maintained in appropriate sectors, most typically where pressurised equipment is used and serviced (refrigeration & fire protection). Attention has also been addressed to the treatment of solvents contained in aerosols. Now emissions from all aerosol based products, irrespective of their purpose, will be reported within the aerosol application.

Activity information continues to be the biggest challenge in the ODS substitutes area, particularly at country-level, for two reasons. The first is that trade in products containing HFCs and/or perfluorocarbons (PFCs) can not easily be monitored and the second is that confidentiality of activity data for specific chemicals may need to be protected. Global/regional activity data from reputable sources may therefore provide significant help to some reporting countries and it is proposed that the IPCC Emission Factor Database (EFDB) act as the focal point for such data. However, while inclusion in the EFDB will provide a level of assurance that due process has been followed inventory compilers will remain responsible for assessing the appropriateness of such data for their purposes.

### **A3.7 OTHER PRODUCT MANUFACTURE AND USE**

The *1996 IPCC Guidelines* contained just two methods for estimating emissions of SF<sub>6</sub> from electrical equipment: (1) a potential approach that equated emissions to chemical consumption, and (2) a simple emission-factor-based approach that applied country-specific or global default emission factors to the quantities of SF<sub>6</sub> in operating and retiring equipment respectively. The *GPG2000* introduced three Tier 3 mass-balance methods and a more detailed Tier 2 emission-factor based approach that provided emission factors for each life cycle stage. In addition, the *GPG2000* provided regional default emission factors for the latter.

The *2006 IPCC Guidelines* simplify the *GPG2000* by (1) replacing two of the Tier 3 mass-balance methods with a single, flexible Tier 3 method that contains both mass-balance and emission-factor-based components. (2) moving the country-level mass-balance method to the QA/QC section, (3) moving the method for estimating potential emissions from the Methodological Choice discussion and into a separate section where it can be used for QA/QC, and (4) replacing the potential emissions approach with the default emission-factor-based approach, which has been moved from Tier 2 to Tier 1. These changes leave one Tier 3 method, one Tier 2 method, and one Tier 1 method. These *Guidelines* also update the regional emission factors provided in the *GPG2000*, providing values for additional types of equipment and for additional regions. Finally, these *Guidelines* incorporate new guidance on selecting and using alternative activity data when the preferred data are not available for all facilities. These updates incorporate the experience acquired over the past several years of reporting.

Specific methods for estimating emissions from research and industrial accelerators and from radar reconnaissance planes (e.g., AWACS) have been added to the 'Use of SF<sub>6</sub> and PFCs in Other Products' section. An indicative list of potential additional sources of SF<sub>6</sub> and PFCs has been added to guide the inventory preparer.

Also, Guidance on N<sub>2</sub>O emissions from product use such as medical application has been improved.

### **A3.8 COMPLETENESS AND ALLOCATION OF CO<sub>2</sub> FROM NON-ENERGY USES OF FUELS**

Two Quality Control (QC) approaches – a *CO<sub>2</sub> completeness check* and a *feedstock balance check* – have been introduced for checking the completeness of accounting CO<sub>2</sub> emissions from feedstock/reductant use of fossil fuels. Guidance is provided to facilitate the organisation and completion of this task: (a) checking that total reported bottom-up calculated CO<sub>2</sub> emissions from non-energy use sources (including uses as feedstock and reductant) at different subcategory levels are complete and consistent; and b) checking that feedstock/reductant requirements of processes included in the inventory are in balance with the non-energy use/feedstock supply as recorded in national energy statistics. Moreover, guidance is provided on documenting and reporting how these emissions are *allocated* in the inventory and how the completeness was checked (Section 1.4).

Section 1.3 provides an explanation of the principles which have guided the estimation and reporting of CO<sub>2</sub> emissions from the non-energy uses of fossil fuels, and describes the data issues related to the estimation methods.