NON-CO_2 EMISSIONS FROM STATIONARY COMBUSTION

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ABSTRACT

In parallel to CO_2 emissions due to the Stationary Combustion, five major non-CO_2 greenhouse gases are emitted during the combustion process: CH_4, N_2O, NO_x, CO, and NMVOCs. In addition, due to the sulphur content of fossil fuels, significant quantities of SO_2 are emitted during the combustion, and may influence the climate, although SO_2 is not a greenhouse gas.

All these gases are addressed by the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* (*IPCC Guidelines*). The technical approach in estimating CO_2 emissions is relatively simple and the accuracy level high since the CO_2 emission factors are mainly a function of the fuel properties, which are generally well addressed by most countries. The non-CO_2 emissions however are closely linked to a number of parameters which are specific to each combustion plant: the type of technology, the combustion process; operating and maintenance conditions, the size and the vintage of the combustion equipment, the emission control policy, the fuel characteristics, etc.

The most accurate **e**mission inventory of the non-CO_2 emissions due to stationary combustion would be therefore to have all the necessary details regarding the specific emission factors (EF) and the activity data (AD) of each combustion plant in a given country.

While the unavailability of detailed data is a major obstacle that prevents countries from applying such approaches, it should be noted that the contribution of non-CO_2 gases due to stationary combustion to the national emission budgets is low, particularly for CH_4 and N_2O.

In estimating non-CO_2 emissions, the most accurate result is obtained by:

- Using the best available data in the country and applying the national emission factors;
- Using the Tier 2 approach recommended by the *IPCC Guidelines* where the national activity data present the level of details that fits into the IPCC suggested default emission factors;
- Using the Tier 1 approach recommended by the *IPCC Guidelines* where the level of detail of the national activity data does not fit in the Tier 2 IPCC suggested default emission factors, and
- Reporting transparently on assumptions that are considered when carrying out the calculations.

In addition, there is some room for improving the methodological approaches, in particular in relation to:

- The development of more appropriate emission factors. These might be defined for instance by using the classification of the determining factors that were described above (e.g. classification according to combustion conditions in Organisation for Economic Cooperation and Development (OECD) countries, Countries with Economies in Transition, Developing Countries, etc.). This would eventually be achieved through relevant research and data collection processes at the international level, and
- The development of more appropriate default emission factors for biomass combustion, particularly in small devices, which are in use in the developing countries.

1 INTRODUCTION

1.1 Nature, magnitude, and distribution of source

Different non-CO_2 gases are emitted through energy combustion processes from stationary sources. The Revised 1996 *IPCC Guidelines for National Greenhouse Inventories (IPCC Guidelines)* include calculations for mainly six non-CO_2 gases: methane (CH_4), nitrous oxide (NO_2), nitrogen oxides (NO_X), carbon monoxide (CO), non-methane volatile organic compounds (NMVOCs) and sulphur oxide (SO_2)

On the other hand, five major end-use combustion sources are considered:

- Energy Industries (i.e. electricity generation, charcoal production, etc.);
- Manufacturing industries (including electricity self-generation);
- Commercial/institutional sector;
- Residential sector, and
- Stationary Agriculture/Forestry/Fishery sources.

Unlike the CO_2, the emission estimates related to these gases require much more detailed information regarding the specific emission factors and activity data.

Different greenhouse gases addressed by the *IPCC Guidelines*

CH_4

CH_4 is emitted in limited quantities from fuel combustion due to incomplete combustion of hydrocarbon in fuels. The emission of methane is dependant on the temperature in the boilers. In large combustion facilities and industrial applications, the emission rates are very low, while these emission rates are much higher in smaller applications such as residential (i.e. small stoves, open burning).

The contribution of the stationary combustion to total CH4 emissions is generally minor and the uncertainty is medium to high. Therefore according to the *IPCC Guidelines*, the use of the simplified Tier 1 Approach consists of an aggregated fuel/sources split. However, it might be necessary to pay greater attention to the methodological approach addressing the biomass use, given the significant contribution of the biomass combustion to CH_4 emissions in the countries with large biomass consumption, particularly in developing countries.

N_2O

N_2O is emitted directly from fuel combustion. The emission of N_2O is dependant on the temperature in the boilers. The emission rates are the highest when the combustion temperature ranges from 800K to 1200K, while the emissions are negligible below 800K and over 1200K. The mechanisms of N_2O chemistry is relatively well understood though the experimental data are limited.

Like CH_4, the contribution of the stationary combustion to total N_2O emissions is minor and the uncertainty is high. In addition, reliable emission factors are not yet available for all sources Therefore the *IPCC Guidelines* allow the use of a very simplified Tier 1 approach that considers an aggregated fuel/sources split. N_2O emission estimates due to biomass uses are poorly documented and the emission factors are uncertain.

NO_x

Nitrogen Oxides (NO_x[1]) are indirect greenhouse gases. Fuel combustion activities are the most significant anthropogenic sources of NO_x, in which energy industries and mobile sources are the most important. Two different formation mechanisms of NO_x can be distinguished:

- Formation of "fuel NO" from the conversion of chemically bound nitrogen in the fuel, and
- Formation of "thermal NO" from the fixation of the atmospheric nitrogen in the combustion process.

The majority of NO_x emitted from coal (80-90%) is formed from fuel nitrogen. Excess air and high temperatures, which depend on the boiler type and technological operations encourage the formation of NO_x.

[1] In the IPCC Guidelines the NOx emissions ($NO+NO_2$) from fossil fuels combustion are expressed on a full molecular basis assuming that all NOx emissions are emitted as NO_2.

For oil, less than 50% of the NO_x emitted is formed from fuel nitrogen, while the totality of NO_x emitted from gas is formed from thermal nitrogen.

The NO_x emission factors that are estimated should be adjusted according to the emission control used in the country. The *IPCC Guidelines* provide some default reduction efficiencies for coal-fired installations when information related to these equipment are not available in the country.

CO

Carbon Monoxide (CO) is an indirect greenhouse gas. While the motor vehicles are the most significant fuel combustion sources of CO, the small residential combustion equipment are also important.

The formation process of CO is directly influenced by usage patterns, technology type and size, vintage, maintenance and operation of technology. It should be noted that the emission rates may vary by several orders of magnitude and are particularly highly affected by the operating and maintenance conditions, particularly in the case of older or smaller equipment. The small woodstove devices that are widely used in the developing world have a particular high emitting potential (and variable according to the region and conditions of use) due to the inefficient combustion.

Overall, the stationary combustion generally contributes to a small but still significant portions of national CO emissions.

NMVOCs

The Non-Methane Volatile Organic Compounds (NMVOCs[2]) are indirect greenhouse gases. The NMVOCs are a result of an incomplete combustion and are directly influenced by usage patterns, technology type and size, vintage, maintenance and operation of technology. It should be noted that the emission rates may vary by several orders of magnitude as a function of the operating and maintenance conditions, particularly in the case of older or smaller equipment. The emissions are generally very low for larger combustion plants where combustion process is more efficient.

While the mobile sources are the most significant fuel combustion sources of NMVOCs, the small residential combustion devices, particularly those using biomass, are also important. The small woodstove devices that are widely used in the developing world have a particular high emitting potential (and vary according to the region and conditions of use) due to the inefficient combustion devices.

1.2 Sources of emissions associated with stationary combustion

The *IPCC Guidelines* consider five main sources (or sectors) of Stationary Combustion. The minimum data requirement is therefore to have a detailed energy consumption picture presenting the energy consumption by sector and by energy product.

Energy industries

This sector includes all combustion sources, whose primary activity is to exploit, treat and transform primary energy products, and to supply secondary energy products. These include:

- Public Electricity and Heat Production (combined or not);
- Petroleum Refining;
- Manufacture of Solid Fuels (such as production of coke, brown coal briquettes, charcoal, etc.), and
- Other energy industries (combustion arising during coal-mining and oil and gas extraction activities, etc.).

Manufacturing industries and construction

This sector includes all combustion arising in the manufacturing industries including combustion for the generation of electricity and heat that occurs at the level of industrial units. Emissions due to electricity self-generation should be assigned to the sectors where they occurred. These should also be separated from the emissions that are generated in the combustion plants, and where possible, the specific emissions due to electricity and heat generation should be reported separately.

[2] All hydrocarbon compounds excluding those inventoried under the Montreal Protocol are considered as NMVOCs. These gases are volatile under ambient air and expresses as mass units.

Emissions from Manufacturing Industries should be specified by sub-sectors that correspond to the International ISIC Classification. The *IPCC Guidelines* suggest the following sub-sectors:

- Iron and Steel;
- Non-Ferrous Metal;
- Chemicals;
- Pulp, Paper and Print;
- Food Processing, Beverages and Tobacco, and
- Other industries.

A particular issue related to the combustion in coke ovens within the Iron and Steel industry, which *IPCC Guidelines* recommend to report under Energy Industries (Volume I - Reporting Instructions, p.1.4) needs to be clarified.

Other sectors

These include three main emission sources:

- Emissions due to the combustion in Commercial and Institutional Buildings;
- Emissions due to the combustion in household devices, and
- Emissions due to stationary combustion in Agriculture and Forestry sectors.

1.3 Current state of inventory methodologies

The *IPCC Guidelines* describe two approaches in estimating non-CO_2 emissions from Stationary Combustion: Tier 1 and Tier 2. However, these approaches are based on a similar calculating principle:

$$Emission_i = \Sigma\ (EF_{ab} \bullet Activity_{ab})$$

Where:

i:	The concerned gas (CH_4, N_2O, etc.)
EF:	Emission Factor (kg/TJ)
Activity:	Energy input (TJ)
a:	Fuel Type (or energy product)
b:	Sector Activity

Tier 1 Approach

The Tier 1 approach is used because of the limited availability of the national activity data and emission factors. Therefore, the calculation method does not take into account the combustion technology and conditions under which the fuels are consumed.

The *IPCC Guidelines* suggest a specific table for each gas, presenting the aggregated EF (by source sector and by group of energy product[3]) that could be utilized under the Tier 1 approach. This table was compiled using different international sources:

- CORINAIR90 database;
- CORINAIR94 default emission factors;
- The EDGAR version 2.0 database;
- National Communications to FCCC;
- Berdowski and 1993a and 1993b;
- Radian Corporation, and
- USEPA.

[3] E.g. coal, natural gas, oil, etc. Refer to ANNEX 1 attached to this paper.

Tier 2 Approach

The Tier 2 approach implies a wider degree of refinement. The use of this approach is recommended when detailed and accurate activity data on the technology contribution within a given emitting source are available. In addition, the corresponding emission factors should be available or easily derived (e.g. by using the default information provided by the *IPCC Guidelines*), assuming an acceptable knowledge of the combustion technologies and conditions under which the fuel is consumed.

The Tier 2 approach focuses on the combustion of all commercial fuels. It also covers the biomass that is generally traded commercially and used in large combustion plants, while the biomass used in small residential devices is not considered by the IPCC default emission factors.

Special considerations on Biomass sources

The *IPCC Guidelines* provide some rough guidance for estimating non-CO_2 emissions from biomass.

In the Tier 1 approach, some rough default emission factors are presented. The approach that was used in estimating these emission factors (EF) is not described by the *IPCC Guidelines*. Moreover, the figures are highly aggregated. For example, the EF related to wood and other biomass and waste are similar. In addition, the *IPCC Guidelines* only differentiate between the large combustion plants (Energy Industries, Manufacturing Industries and Construction) and the smaller combustion equipment (commercial, residential, agriculture). The various combustion conditions of the small equipment, which are the major bio-fuel consuming devices in the developing world, would need further research and evaluation.

In the Tier 2 approach, the default emission factors are again provided only for large combustion plants. The carbon emission rates, and hence the non-CO_2 emission rates of each biomass type are directly influenced by the following determining parameters:

- The moisture content;
- The net calorific value;
- The carbon fraction of each bio-fuel type, and
- The combustion efficiencies.

The *good practice* in addressing this emission module is to use the national data regarding these parameters. However, the *IPCC Guidelines* provide default moisture content and net calorific values that could be used in case of unavailability of these data.

In addition, the *IPCC Guidelines* provide default carbonization efficiencies (6 kg of wood for 1 kg of charcoal), default carbon content that could be considered for charcoal, as well as the default non-CO_2 emission factors (Table 1).

TABLE 1
DEFAULT NON-CO_2 EMISSION FACTORS FOR CHARCOAL PRODUCTION (KG/TJ)

	Default Emission Factor (kg/TJ of Wood input)	Default Emission Factor (kg/TJ of charcoal produced)
CH_4	300	1000
N_2O	N/A	N/A
NOx	5	10
CO	2000	7000
NMVOCs	600	1700

Source: Table 1-14 – Vol. 3 - IPCC Guidelines, 1996.

2 METHODOLOGICAL ISSUES

2.1 Selection of good practice methods

The *IPCC Guidelines* provide some explanation on the approach to be used when undertaking non-CO_2 calculations from stationary combustion equipment.

When actual non-CO_2 emissions from stationary sources are not available, it is possible to use the Tier 2 approach, which provides a satisfactory level of accuracy, and uses three distinct sets of data assumptions:

- Emission Factors;
- Energy Activities, and
- Relative share of technologies in each of the main energy activities, which should be available (bottom-up: actual data detailed by individual source), or might be derived at national level (top-down: statistical sampling, engineering judgment, etc.).

The *IPCC Guidelines* recommends six main steps to carry out the inventory calculations:

- Determine the source and form of the best available energy activity data with the highest level of desegregation. The *good practice* is to collect the national consolidated energy data, which are generally adequately established at national levels, while the international ones may not be sufficiently accurate or are based on rough estimates;
- Determine the main categories of emission factors that fit into the national energy system;
- Compile the best available emission factors, preferably from national sources. Where national sources are not available, the selected EF should to some extent, have a minimum consistency with the technological and operating conditions of the country, and take the pollution control regulations that are in place in the country, into account;
- Identify the technology categories to be used in the national inventory;
- Develop estimates of non-CO_2 emissions (the six considered gases for each of the main sources), and
- Sum the individual calculated GHG emission estimates.

Ultimately, the *IPCC Guidelines* recommend the use of Tier 1 approach in case of important gaps on activity data or inadequate emission factors.

2.2 Emission factors

Unlike the CO_2 emissions where emission rates are linked to almost solely the fuel properties, the non-CO_2 emission factors are mostly influenced by various parameters that are specific to each country, and also to the specific conditions of each combustion equipment or plant viz:

- The fuel characteristics;
- The type of technology;
- The combustion, operating and maintenance conditions;
- The size and the vintage, and
- The emission control policy.

Therefore, the determination of the emission factors is a crucial issue for the quality, completeness, and consistency of the inventory results.

The best approach is therefore to use the actual emission rates, or at least the most specific emission factors available in each country. However, since it is not possible to find a full set of specific EF in each country, particularly in the developing ones, the *IPCC Guidelines* suggest a set of default EF in order to improve the completeness of the inventory work.

Tier 1

In many countries, the difficulties of deriving country-specific emission factors are combined with data availability constraints that prevent applying the default EF that are derived from other countries or international data, such as those presented by CORINAIR.

In order to overcome this barrier, the *IPCC Guidelines* provide an aggregated EF table for each of the non-CO_2 gases. These tables[4] present emission factors in terms of kg/TJ according to the sectoral sources of emissions (Energy industries, Manufacturing Industries, etc.) and the Energy Product (Oil, Gas, etc.).

[4] Refer to ANNEX 1 attached to this paper.

It should be noted that the EF tables related to non-CO_2 emission factors represent very aggregated figures, whose estimating approach is not described by the *IPCC Guidelines*. For example, in many instances, the *IPCC Guidelines* do not discriminate the EF among the main sources (Energy Industries, Manufacturing Industries and Construction, Commercial, Residential, Agriculture), as a function of the main determining factors such as operating conditions, vintage or equipment size.

Therefore, while this simplified approach allows improving, as much as possible, the completeness of the inventory, particularly for the developing countries, it neither guarantees the accuracy of the results, nor does it allow carrying out a quantified or even a qualitative quality control assessment.

Tier 2

Some representative detailed default emission factors are presented in the *IPCC Guidelines* for CH_4, N_2O, NO_x, CO, and NMVOCs. As mentioned in the *IPCC Guidelines,* these data were derived from a few international sources (*US-EPA, Radian 1990*, etc.), and were already included in the first version of the OECD/IPCC Manual (1991). These emission factors were presented in five tables:

- Table 1-15 - Utility boiler source performance:
    - Emission performances are presented for 15 different coal technologies;
    - Emission performances are presented for 6 different oil technologies;
    - Emission performances are presented for 3 different Natural gas technologies, and
    - Emission performances are presented for 2 different Municipal Solid Waste Energy recovering technologies.
- Table 1-16 - Industrial boiler source performance:
    - Emission performances are presented for 12 different coal technologies;
    - Emission performances are presented for 8 different oil technologies;
    - Emission performances are presented for 6 different Natural gas technologies, and
    - Emission performances are presented for 4 different wood technologies;
    - Emission performances are presented for 6 different Municipal Solid Waste Energy recovering technologies.
- Table 1-17 - Kilns, Ovens, and dryers source performance:
    - Emission performances are presented for 3 cement energy sources technologies;
    - Emission performances are presented for 1 cooking steel energy source technology, and
    - Emission performances are presented for 3 chemical processes energy sources technologies.
- Table 1-18 - Residential source performance:
    - Emission performances are presented for 4 different coal technologies;
    - Emission performances are presented for 4 different oil technologies;
    - Emission performances are presented for 2 different Natural gas technologies, and
    - Emission performances are presented for 8 different wood technologies.
- Table 1-19 - Commercial source performance:
    - Emission performances are presented for 1 coal technology;
    - Emission performances are presented for 6 different oil technologies;
    - Emission performances are presented for 1 Natural gas technology;
    - Emission performances are presented for 1 wood technology, and
    - Emission performances are presented for 3 different Municipal Solid Waste Energy recovering technologies.

These EF's are still useful in showing the range of emission rates according to the different sources. However these tables present many gaps particularly for N_2O and NMVOCs, and the range is likely to be higher according to the different determining factors. In addition, the standard deviation of the emissions is rarely reported.

According to a study (Eggleston and McInnes, 1987), variation of emission factors within energy activity ranges from 20 to 50 percent.

If they are to be used by countries, these uncontrolled emission factors would have to be adjusted in order to take into account any possible control policies that are in place in each OECD country. The *IPCC Guidelines* present 4 different tables of some emission control technologies in use in the OECD countries, and their representative emission reduction rates:

- Table 1-20 - Utility boiler emission controls performance (23 alternative technologies);
- Table 1-21 - Industrial boiler emission controls performance (19 alternative technologies);
- Table 1-22 - Kilns, Ovens, and dryers emission controls performance (5 alternative technologies), and
- Table 1-23 - Residential and Commercial emission controls performance (24 alternative technologies).

These tables are more relevant for large stationary sources and should be used in combination with the net emission factors for each of the technologies considered in the Tier 2 approach.

2.3 Activity data

Activity data include the energy use (in TJ) in each of the concerned emitting sources. The availability and the level of details of the data determine, to a large extent, the approach to be adopted. While data at end-use levels are not automatically available, some relevant approximation might be alternatively carried out by some industrialized countries, given their well developed statistical infrastructure.

The Tier 2 approach requires more refined activity data, which should be combined with the default emission factors that are suggested by *IPCC Guidelines*. When using this approach, it is necessary to have a good knowledge of the technology split, and a minimum guarantee of the relevance of the adoption of the default factors. Again, the use of this approach is possible after carrying out a good approximation of the activity data figures for each kind of technology, and is conditioned by a minimum knowledge of the technological characteristics of the combustion plants in the country.

Ultimately, the aggregated approach (Tier 1) might help in presenting a more complete inventory. Activity data include the energy use (in TJ) in each of the concerned energy consuming sectors by group of energy product. Six groups of energy products were defined by the IPCC methodology: Coal, Natural Gas, Oil, Wood/Wood waste and other Biomass and Wastes.

In general, the energy balance provide enough details to meet the minimum data requirements for the Tier 1 method. When the energy balance is not available for GHG inventory activities, a specific effort (realistically feasible within the framework of the inventory activity) should be made in order to get the activity data.

2.4 Uncertainty

It is worth noting that uncertainty levels related to non-CO_2 emissions associated with stationary combustion sources are generally high. This is particularly true for the Non-Annex I countries, which are generally obliged to adopt aggregated emission factors. But it is also true for some Annex I countries. According to the first Review of the first National Communications of the Annex I Parties (UNFCCC 1997), the quality of the emission estimate was quoted MEDIUM for CH_4, and LOW to MEDIUM for N_2O, CO and NMVOCs. For illustration, some Annex 1 Parties have even described the quality of the emission estimate due to stationary combustion for CH_4, N_2O and NMVOCs as LOW.

2.5 Completeness

While the activity data should be completely available and accurate enough, at least for the Tier 1 approach, the availability or adequacy of emission factors may dramatically limit the completeness of the estimates, particularly for N_2O. Countries might consider consulting other national communications, and adopting the most appropriate EF according to the specific conditions of each country, in order to fill in the gaps. In any case, such an approach will allow presenting estimates that are closer to the reality and therefore to improve the comparability across national inventories.

In order to allow the comparability of inventories and review by any Party, as well as to improve their transparency, Parties are recommended to report the following:

- Clear definitions of what is included in a particular IPCC source category (i.e., the sub-sources);

- Clear definitions of thresholds for reporting, and the use of terms such as "Not Applicable (NA)", "Not Estimated (NE)", and "Not Occurring (NO)", and
- Identification of the documentation needed to demonstrate completeness, including confirmation of non-occurring sources.

2.6 Other important issues

Baseline emission determination

The non-CO_2 emissions are the most sensitive to methodological development and emission factor changes. In addition, given the low quality of the EF related to these gases, there are likely to be significant improvements in the future with the development of statistical systems. Once a new approach, a new source or a new EF is adopted, it is important to recalculate the previous historical estimates in order to keep consistency of the time series.

Treatment of emissions from pipeline transport

The emissions due to combustion in pipeline's compression devices should be approached with the appropriate guidance as to be realistically estimated. While the corresponding emissions might be included in the Transport sector (although combustion plants are stationary), this might not be consistently understood, by the inventory teams, and should therefore be better clarified by the *IPCC guidelines*.

Consistency among sources

The way to account for the emissions due to the combustion in coke ovens, particularly in the iron and steel industry should be clarified, as well as possible double counting or omissions (e.g. energy combustion versus industrial processes).

On the other hand, the approach to address the fuel gas, heat or the refinery gas that is recovered from primary combustion activities should be clearly explained in the energy statistics so as to avoid double counting.

3 REPORTING AND DOCUMENTATION

The Reporting Instructions of the Guidelines establish:

- A common Reporting Framework: Standard tables, definitions, units, and time intervals for reporting all types of emissions to ensure consistency of reporting across countries;
- Documentation Standards: The necessary documentation to enable comparison of national inventories, including worksheets, major assumptions, methodological descriptions, and enough data to allow a third party to reconstruct the inventory from national activity data and assumptions, and
- Verification and uncertainty assessment.

Non-CO_2 emission tables are reported under the IPCC category I A within the Energy sector. The Reporting instructions desegregate the non-CO_2 emissions into sources (sectors) and sub-sources (sub-sectors or branches are only considered for Energy Industries and Manufacturing Industries).

More aggregated Reporting tables consist of presentation of the emission results across sectors only (commercial, residential and agriculture are grouped under a single row called: Other Sectors). General issues such as supplemental reporting of emissions calculated with reference and default methods, baselines, time series, and double counting should be addressed in the context of individual sources.

In addition to the information currently requested by the IPCC inventory experts should discuss the suitability of reporting the following information:

- An identification and description of the underlying method, including algorithms and equations;
- A discussion of methodological changes from previous years and the impact on estimates;
- An analysis of the trends, with special emphasis on explaining anomalies;
- All activity data, including any permutations performed on standard data to derive a value used in the inventory;
- All emissions factors, including explanations of why emissions factors were changed from previous years, and

- Complete bibliographical information for activity data and emissions factors.

4 QUALITY ASSURANCE AND QUALITY CONTROL (QA/QC)

An adequate quality assessment of an inventory requires both **internal** and **external** control procedures.

Internal control activities are intended to ensure accuracy, documentation and transparency of the inventory operations. This control is first implemented by the agency that is responsible for compiling the inventory in each country during the compilation of the data and calculations. Efforts should be made by this agency to check actual data availability, correctness, consistency and completeness, and to document the origin of data and the specific assumptions adopted. The implementation of an approved standardized procedure for emission calculations may facilitate the accuracy of an inventory and the internal control.

In addition, the inventory activities should be implemented in a cooperative approach in such a way that the specific skills needed in order to make decisions and assumptions could be provided by the different national experts involved in the work. It is also highly recommended to systematically describe the specific context of each emission source in the inventory report, and to present the inventory results publicly so as to stimulate the feedback from the national experts.

The external control is undertaken through relevant external reviews, and is designed to minimize the potential errors and bias. The way in which the internal QA (quality assurance)/QC (quality control) is conducted determines the potential conclusions of the external control.

4.1 General information requirements for QA/AC systems

Prerequisites to data quality assurance for estimating non-CO_2 emissions due to stationary combustion are dependant on good data acquisition and handling procedures. The national data that are required to carry out the inventory generally come from the national energy statistics. However, accurate and updated, data should be requested from the direct energy consumers (e.g. Manufacturing Industrial units, etc.) or producers (Public Utilities, Refineries, etc.), when the energy balance is not accurate enough.

In general, an inventory team that involves the major actors of the energy sectors should be constituted. This ensures a rapid collection and good interpretation of the information.

4.2 Information needed to provide transparency

In addition to the inventory document, which should be in line with the *IPCC Guidelines*, all information that is needed by any Party to understand the assumptions and the calculation approach should be reported.

It is important to describe and to list the types of information that should be provided and in which form they should be presented. For example, the national energy statistics might not be sufficient to recalculate the inventory. Moreover, it might be necessary where a Tier 2 approach was used, to provide some information on the energy consumption by end-use, or the approaches used to determine them.

4.3 Public/peer reviews verification/validation

The GHG inventory should normally be reviewed and validated domestically prior to its publication. Regarding Stationary Combustion, the full involvement of all actors at an early stage of the inventory process would reduce the risks of wrong interpretation of the data or of producing highly uncertain estimates.

On the other hand, since the methodologies and approaches are still under development, it might be interesting to seek informal external review for the inventory report.

5 IDENTIFICATION OF PRIORITY AREAS

With the exception of countries which rely heavily on biomass-energy in meeting their energy needs, the non-CO_2 emissions due to stationary combustion have generally a minor contribution to the emission budget in terms of CO_2 equivalent. However, in order to improve the completeness and the quality of the inventory there is a need to develop more appropriate emission factors. In addition, to some measurement campaigns, some research that attempts to link emission factors to operating conditions, for instance by region, could be undertaken. This would allow countries to complete a better estimate of their non-CO_2 emissions.

Regarding biomass transformation and combustion, there is a need to develop more appropriate default emission factors, particularly in small devices that are in use in developing countries.

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ANNEX 1 THE AGGREGATED EMISSION FACTORS TABLES

TABLE 2

CH_4 DEFAULT (UNCONTROLLED) EMISSION FACTORS (KG/ TJ)

Emitting Sources		Coal	Natural Gas	Oil	Wood /Wood Waste	Charcoal	Other biomass and Wastes
Energy Industries (emission due to consumption)		1	1	3	30	200	30
Energy Industries (emissions due to Charcoal Production)	kg CH_4/TJ wood input				300		
	kg CH_4/TJ charcoal output					1000	
Manufacturing Industries and Construction		10	5	2	30	200	30
Other	Commercial/Institutional	10	5	10	300	200	300
Sectors	Residential	300	5	10	300	200	300
	Stationary Agriculture/ Forestry / Fishing	300	5	10	300	200	300

TABLE 3

N_2O DEFAULT (UNCONTROLLED) EMISSION FACTORS (KG/ TJ)

Emitting Sources		Coal	Natural Gas	Oil	Wood /Wood Waste	Charcoal	Other biomass and Wastes
Energy Industries (emission due to consumption)		1.4	0.1	0.6	4	4	4
Energy Industries (emissions due to Charcoal Production)	kg N_2O /TJ wood input						
	kg N_2O /TJ charcoal output						
Manufacturing Industries and Construction		1.4	0.1	0.6	4	4	4
Other	Commercial/Institutional	1.4	0.1	0.6	4	1	4
Sectors	Residential	1.4	0.1	0.6	4	1	4
	Stationary Agriculture/ Forestry / Fishing	1.4	0.1	0.6	4	1	4

TABLE 4

NO_X DEFAULT (UNCONTROLLED) EMISSION FACTORS (KG/ TJ)

Emitting Sources			Coal	Natural Gas	Oil	Wood /Wood Waste	Charcoal	Other biomass and Wastes
Energy Industries (emission due to consumption)			300	150	200	100	100	100
Energy Industries (emissions due to Charcoal Production)		kg NO_x /TJ wood input				5		
		kg NO_x /TJ charcoal output					10	
Manufacturing Industries and Construction			100	150	200	100	100	100
Other	Commercial/Institutional		100	50	100	100	100	100
Sectors	Residential		100	50	100	100	100	100
	Stationary Agriculture/ Forestry / Fishing		100	50	100	100	100	100

TABLE 5

CO DEFAULT (UNCONTROLLED) EMISSION FACTORS (KG/ TJ)

Emitting Sources			Coal	Natural Gas	Oil	Wood /Wood Waste	Charcoal	Other biomass and Wastes
Energy Industries (emission due to consumption)			20	20	15	1000	1000	1000
Energy Industries (emissions due to Charcoal Production)		kg CO /TJ wood input				2000		
		kg CO /TJ charcoal output					7000	
Manufacturing Industries and Construction			150	30	10	2000	4000	4000
Other	Commercial/Institutional		2000	50	20	5000	7000	5000
Sectors	Residential		2000	50	20	5000	7000	5000
	Stationary Agriculture/ Forestry / Fishing		2000	50	20	5000	7000	5000

TABLE 6

NMVOCS DEFAULT (UNCONTROLLED) EMISSION FACTORS (KG/ TJ)

Emitting Sources		**Coal**	**Natural Gas**	**Oil**	**Wood /Wood Waste**	**Charcoal**	**Other biomass and Wastes**
Energy Industries (emission due to consumption)		5	5	5	50	100	50
Energy Industries (emissions due to Charcoal Production)	kg NMVOCs /TJ wood input				600		
	kg NMVOCs /TJ charcoal output					1700	
Manufacturing Industries and Construction		20	5	5	50	100	50
Other	Commercial/Institutional	200	5	5	600	100	600
Sectors	Residential	200	5	5	600	100	600
	Stationary Agriculture/ Forestry / Fishing	200	5	5	600	100	600

Source: 1996 IPCC Guidelines Vol. 2.