

# **TRAINING COURSES FOR NATIONAL EXPERTS INVOLVED IN THE DEVELOPMENT OF GHG INVENTORY – ENERGY SECTOR**

## **Stationary combustion**

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# Stationary combustion

Stationary combustion includes the following categories:

- **Energy industries** such as fuel extraction, energy production and transformation, including electricity generation, petroleum refining, etc.
- **Manufacturing industries and construction** such as iron and steel production, non-ferrous metal production, chemical manufacturing, pulp, paper and print, food processing, beverages and tobacco, construction, etc. Combustion for the generation of electricity and heat for own use in these industries is included here.
- **Other sectors** comprising combustion occurring at commercial and institutional buildings and households, and activities such as agriculture, forestry, fisheries and fish farms. Mobile combustion in traction vehicles on farmland and in forest also falls under this category, despite that the category other sectors is under stationary combustion.

Combustion activities, both stationary and mobile, that have not been specified above fall under the category other, which includes fuel use by the military, not engaged in multilateral operations.

# Energy industries

1 A Fuel Combustion Activities				Emissions from the intentional oxidation of materials within an apparatus that is designed to raise heat and provide it either as heat or as mechanical work to a process or for use away from the apparatus.
1 A 1	<i>Energy Industries</i>		Comprises emissions from fuels combusted by the fuel extraction or energy-producing industries.	
1 A 1	a	Main Activity Electricity and Heat Production	Sum of emissions from main activity producers of electricity generation, combined heat and power generation, and heat plants. Main activity producers (formerly known as public utilities) are defined as those undertakings whose primary activity is to supply the public. They may be in public or private ownership. Emissions from own on-site use of fuel should be included.	
1 A 1	a	i	<i>Electricity Generation</i>	Emissions from autoproducers (undertakings which generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1 A 1 a. Autoproducers may be in public or private ownership.
1 A 1	a	ii	<i>Combined Heat and Power Generation (CHP)</i>	Emissions from production of both heat and electrical power from main activity producers for sale to the public, at a single CHP facility.
		iii	<i>Heat Plants</i>	Production of heat from main activity producers for sale by pipe network.

1 A 1	c	Manufacture of Solid Fuels and Other Energy Industries		Combustion emissions from fuel use during the manufacture of secondary and tertiary products from solid fuels including production of charcoal. Emissions from own on-site fuel use should be included. Also includes combustion for the generation of electricity and heat for own use in these industries.
1 A 1	c	i	<i>Manufacture of Solid Fuels</i>	Emissions arising from fuel combustion for the production of coke, brown coal briquettes and patent fuel.
1 A 1	c	ii	<i>Other Energy Industries</i>	Combustion emissions arising from the energy-producing industries own (on-site) energy use not mentioned above or for which separate data are not available. This includes the emissions from own-energy use for the production of charcoal, bagasse, saw dust, cotton stalks and carbonizing of biofuels as well as fuel used for coal mining, oil and gas extraction and the processing and upgrading of natural gas. This category also includes emissions from pre-combustion processing for CO <sub>2</sub> capture and storage. Combustion emissions from pipeline transport should be reported under 1 A 3 e.

# Manufacturing industries and construction

1 A 2	<i>Manufacturing Industries and Construction</i>	Emissions from combustion of fuels in industry. Also includes combustion for the generation of electricity and heat for own use in these industries. Emissions from fuel combustion in coke ovens within the iron and steel industry should be reported under 1 A 1 c and not within manufacturing industry. Emissions from the industry sector should be specified by sub-categories that correspond to the International Standard Industrial Classification of all Economic Activities (ISIC). Energy used for transport by industry should not be reported here but under Transport (1 A 3). Emissions arising from off-road and other mobile machinery in industry should, if possible, be broken out as a separate subcategory. For each country, the emissions from the largest fuel-consuming industrial categories ISIC should be reported, as well as those from significant emitters of pollutants. A suggested list of categories is outlined below.	
1 A 2	a	Iron and Steel	ISIC Group 271 and Class 2731
1 A 2	b	Non-Ferrous Metals	ISIC Group 272 and Class 2732
1 A 2	c	Chemicals	ISIC Division 24
1 A 2	d	Pulp, Paper and Print	ISIC Divisions 21 and 22
1 A 2	e	Food Processing, Beverages and Tobacco	ISIC Divisions 15 and 16
1 A 2	f	Non-Metallic Minerals	Includes products such as glass, ceramic, cement, etc.; ISIC Division 26
1 A 2	g	Transport Equipment	ISIC Divisions 34 and 35
1 A 2	h	Machinery	Includes fabricated metal products, machinery and equipment other than transport equipment; ISIC Divisions 28, 29, 30, 31 and 32.
1 A 2	i	Mining (excluding fuels) and Quarrying	ISIC Divisions 13 and 14
1 A 2	j	Wood and Wood Products	ISIC Division 20
1 A 2	k	Construction	ISIC Division 45
1 A 2	l	Textile and Leather	ISIC Divisions 17, 18 and 19
1 A 2	m	Non-specified Industry	Any manufacturing industry/construction not included above or for which separate data are not available. Includes ISIC Divisions 25, 33, 36 and 37.

# Other categories

1 A 4	<i>Other Sectors</i>			Emissions from combustion activities as described below, including combustion for the generation of electricity and heat for own use in these sectors.
1 A 4	a	Commercial / Institutional		Emissions from fuel combustion in commercial and institutional buildings; all activities included in ISIC Divisions 41, 50, 51, 52, 55, 63-67, 70-75, 80, 85, 90-93 and 99.
1 A 4	b	Residential		All emissions from fuel combustion in households.
1 A 4	c	Agriculture / Forestry / Fishing / Fish farms		Emissions from fuel combustion in agriculture, forestry, fishing and fishing industries such as fish farms. Activities included in ISIC Divisions 01, 02 and 05. Highway agricultural transportation is excluded.
1 A 4	c	i	<i>Stationary</i>	Emissions from fuels combusted in pumps, grain drying, horticultural greenhouses and other agriculture, forestry or stationary combustion in the fishing industry.
1 A 4	c	ii	<i>Off-road Vehicles and Other Machinery</i>	Emissions from fuels combusted in traction vehicles on farm land and in forests.
1 A 4	c	iii	<i>Fishing (mobile combustion)</i>	Emissions from fuels combusted for inland, coastal and deep-sea fishing. Fishing should cover vessels of all flags that have refuelled in the country (include international fishing).
1 A 5	<i>Non-Specified</i>			All remaining emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries that are not engaged in multilateral operations.
1 A 5	a	Stationary		Emissions from fuel combustion in stationary sources that are not specified elsewhere.
1 A 5	b	Mobile		Emissions from vehicles and other machinery, marine and aviation (not included in 1 A 4 c ii or elsewhere).
1 A 5	b	i	<i>Mobile (aviation component)</i>	All remaining aviation emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in multilateral operations.
1 A 5	b	ii	<i>Mobile (water-borne component)</i>	All remaining water-borne emissions from fuel combustion that are not specified elsewhere. Include emissions from fuel delivered to the country's military as well as fuel delivered within that country but used by the militaries of other countries that are not engaged in multilateral operations.
1 A 5	b	iii	<i>Mobile (other)</i>	All remaining emissions from mobile sources not included elsewhere.
Multilateral operations (Information item)				Emissions from fuels used in multilateral operations pursuant to the Charter of the United Nations. Include emissions from fuel delivered to the military in the country and delivered to the military of other countries.

# Specification for commercial/institutional sector according to ISIC division

41- collection, purification, distribution of water

50-52 – trade and repair

55 – hotels and restaurants

63 – transport supporting activities

64-66 – post, telecommunication, financial

69-75 – real estate, ranting

80 – education

85 – health

90 – sewage and refuse disposal

95 – private household with employed personal

# Methodological tiers

The main features of each tier are summarized below (the approaches are listed in increasing order of detailed information and effort):

- **tier 1:** fuel-based approach with amount of fuel combusted (in general from national energy statistics) and average emission factors (EFs) (IPCC tier 1 default values);
- **tier 2:** fuel-based approach with amount of fuel combusted estimated similarly to the tier 1 approach and country-specific EFs; and
- **tier 3:** model-based approach or measurement-based approach.

One decisive consideration in selecting a tier approach is whether the emission estimates are conducted for a key category. Although the question on key category comes last in the generalized decision tree, it is of utmost importance as it is not good practice to estimate emissions from a key category using a tier 1 approach.

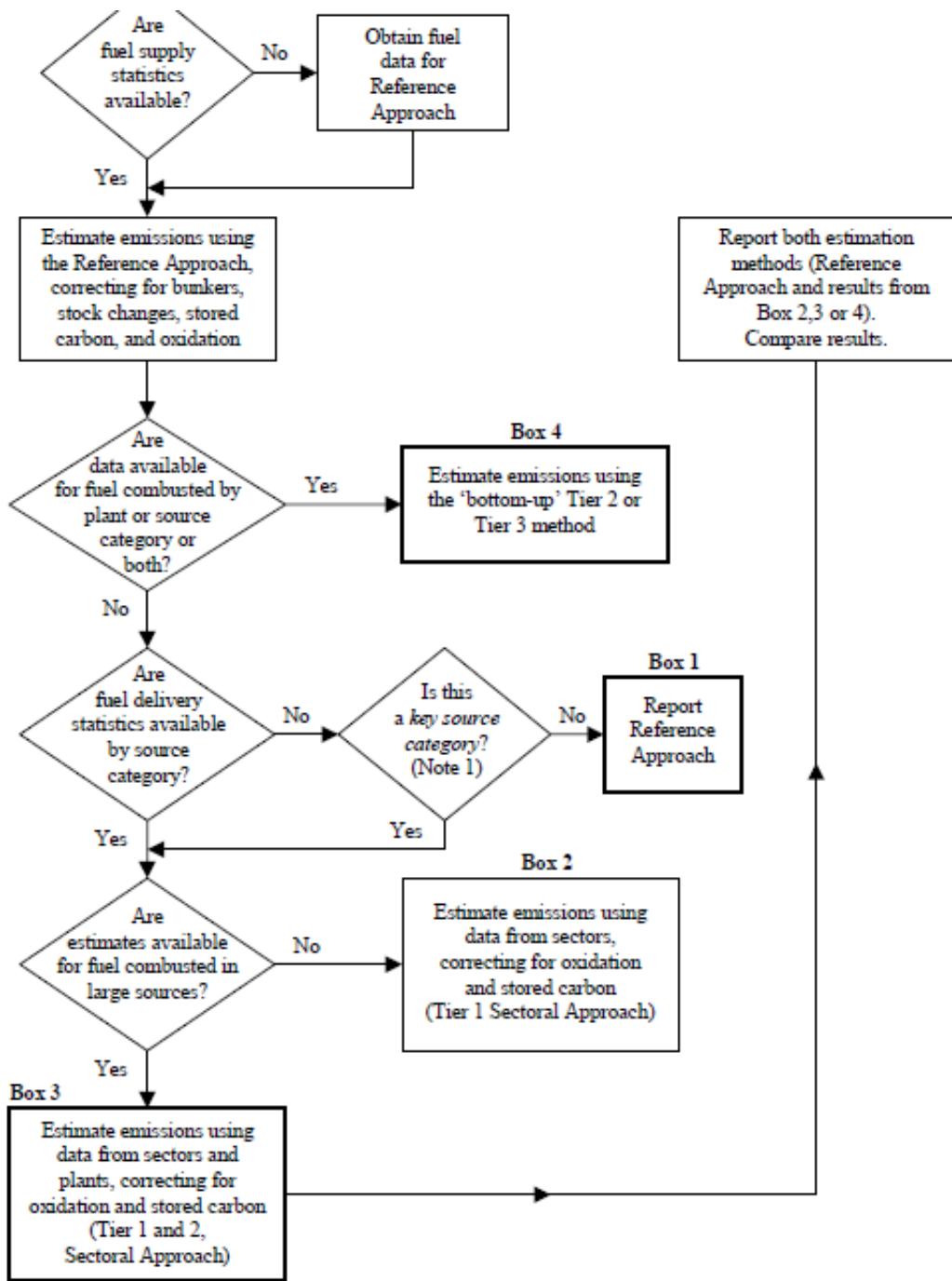
In fact, most of the generalized decision trees deal with the considerations relative to the use of tier 3 methods. It is expected that properly applied tier 3 methods would provide more accurate estimates than lower tier approaches, particularly for non-CO<sub>2</sub> gases. However, tier 3 methods demand either emission-related measurements with adequate quality control (QC) for single sources or a detailed estimation model, which usually requires a significant number of country-specific parameters.

# Choice of method

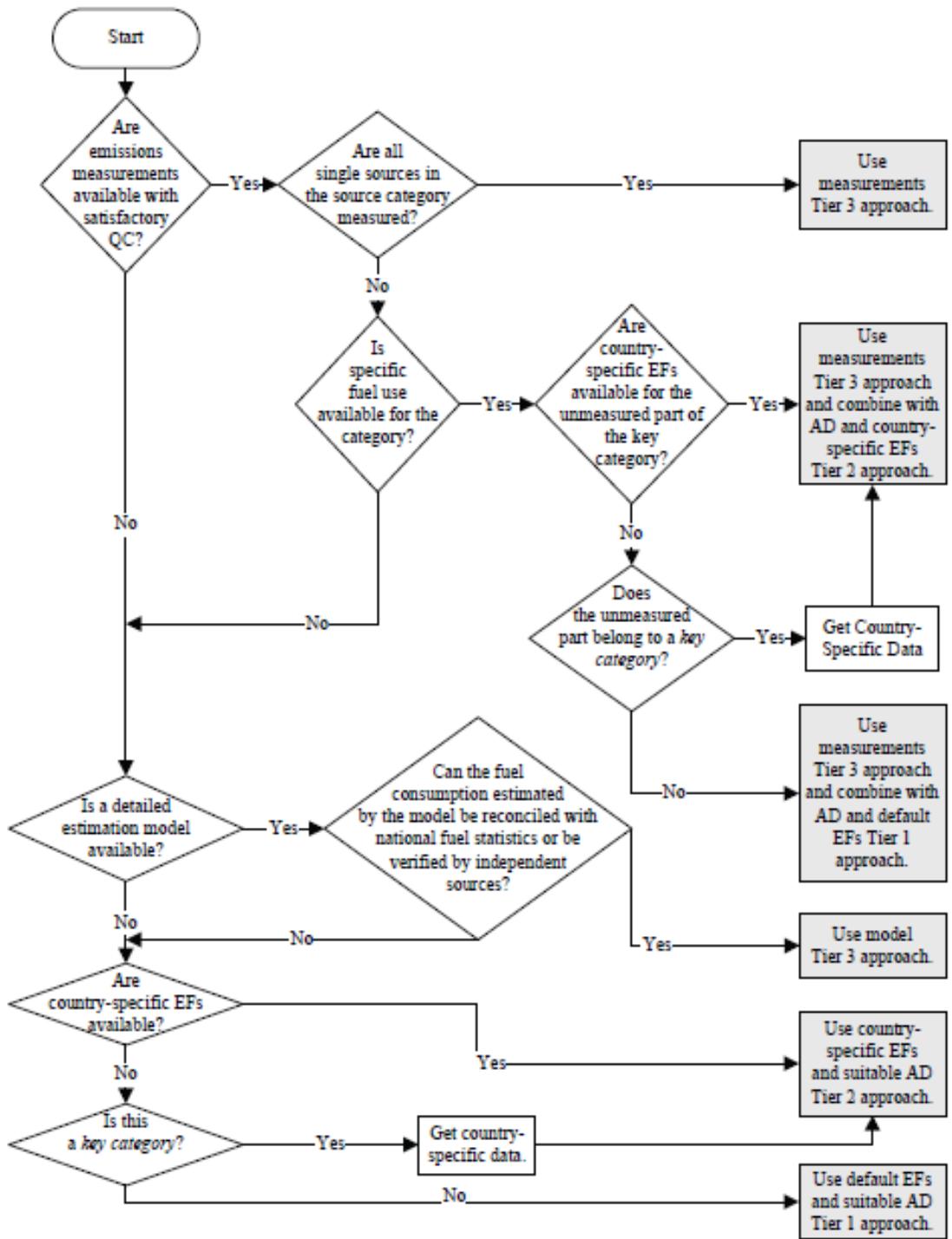
The choice of estimation method is country specific and is determined by whether the emissions are estimated for a key category and the level of detail in the available data.

In general, emissions of each greenhouse gas from stationary sources are calculated by multiplying fuel consumption by the corresponding emission factor. In the Sectoral Approach, “Fuel Consumption” is estimated from energy use statistics and is measured in terajoules. All tiers use the amount of fuel combusted as the activity data. Different tiers can be applied for different fuels and gases, consistent with the requirements of *key category* analysis and avoidance of double counting

# Decision tree to choose methodological approach (GPG, 2000)



# Decision tree to choose methodological approach (2006 IPCC)



# Other consideration and verification

Hybrid approaches (i.e. the use of different tiers for the same category) may be selected when using a measurement-based tier 3 method. This flexibility is necessary to ensure completeness when measurements are available only for a fraction of all single sources under the category considered.

For model-based approaches for which the amount of fuel combusted is not the main AD (e.g. those based on the distance travelled that are used to estimate emissions from road transportation), it is crucial that the fuel consumption estimated by the model be reconciled with national fuel statistics or verified by independent sources. For tier 3 approaches, verification is essential in estimating, reporting and reviewing emissions, as the UNFCCC reporting guidelines on annual inventories for Annex I Parties indicate:

*'Annex I Parties that prepare their estimates of emissions and/or removals using higher-tier (tier 3) methods and/or models shall provide in the NIR verification information consistent with the 2006 IPCC Guidelines.'*

In addition to the three-tiered bottom-up approach, the 2006 IPCC Guidelines present an alternative method to estimate CO<sub>2</sub> emissions using a top-down approach, known as the IPCC reference approach. This is to be used by Annex I Parties only for verification purposes as indicated in the UNFCCC reporting guidelines:

*'For the purposes of verification, Annex I Parties should compare their national estimates of CO<sub>2</sub> emissions from fuel combustion with those estimates obtained using the IPCC reference approach, as contained in the 2006 IPCC Guidelines, and report the results of this comparison in the NIR.'*

The 2006 IPCC Guidelines provide a three-tiered approach for all stationary combustion categories. There is nothing to be added to what has been said in relation to:

- the choice of tier 1 or tier 2 approaches and the corresponding EFs and AD;
- ensuring completeness when a measurement-based tier 3 method is used; and
- reconciliation and/or verification of fuel consumption when a model-based tier 3 method is used.

# Tier 1

Applying a Tier 1 emission estimate requires the following for each source category and fuel:

- Data on the amount of fuel combusted in the source category
- A default emission factor

Emission factors come from the default values provided together with associated uncertainty range in the IPCC Guidelines (will be discussed later)

The following equation is used:

## **GREENHOUSE GAS EMISSIONS FROM STATIONARY COMBUSTION**

$$\text{Emissions}_{\text{GHG, fuel}} = \text{Fuel Consumption}_{\text{fuel}} \bullet \text{Emission Factor}_{\text{GHG, fuel}}$$

Where:

- Emissions (GHG ,fuel) = emissions of a given GHG by type of fuel (kg GHG)
- Fuel Consumption (fuel )= amount of fuel combusted (TJ)
- Emission Factor(GHG, fuel )=

default emission factor of a given GHG by type of fuel (kg gas/TJ).

For CO<sub>2</sub>, it includes the carbon oxidation factor, assumed to be 1.

The Revised 1996 Guidelines provide different approach for carbon oxidation factor

TABLE 1-6 FRACTION OF CARBON OXIDISED (RECOMMENDED DEFAULT ASSUMPTIONS)	
Coal <sup>(a)</sup>	0.98
Oil and Oil Products	0.99
Gas	0.995
Peat for electricity generation <sup>(b)</sup>	0.99

(a) This figure is a global average but varies for different types of coal, and can be as low as 0.91.

(b) The fraction for peat used in households may be much lower.

# Tier 2

Applying a Tier 2 approach requires:

- Data on the amount of fuel combusted in the source category;
- A country-specific emission factor for the source category and fuel for each gas.

Under Tier 2, the Tier 1 default emission factors are replaced by country-specific emission factors.

- Country-specific emission factors can be developed by taking into account country-specific data, for example carbon contents of the fuels used, carbon oxidation factors, fuel quality and (for non-CO<sub>2</sub> gases in particular) the state of technological development.
- The emission factors may **vary over time** and, for solid fuels, should take into account the amount of carbon retained in the ash, which may also vary with time.
- It is *good practice* to **compare** any country-specific emission factor with the default ones. If such country-specific emission factors are outside the 95 percent confidence intervals, given for the default values, an **explanation** should be sought and provided on why the value is significantly different from the default value.
- Since the country-specific value should be more applicable to a given country's situation, it is expected that the uncertainty range associated with a country-specific value will be smaller. This expectation should mean that a Tier 2 estimate provides an emission estimate with lower uncertainty than a Tier 1 estimate.

In reality,  
emissions depend on the:

- fuel type used,
- combustion technology,
- operating conditions,
- control technology,
- quality of maintenance,
- age of the equipment used to burn the fuel.

## Tier 3

Plant-specific data can be based on fuel flow measurements and fuel chemistry or on flue gas flow measurements and flue gas chemistry data.

Continuous emissions monitoring requires attention to quality assurance and quality control.

Application of a Tier 3 emission estimation approach requires:

- Data on the amount of fuel combusted in the source category for each relevant technology (fuel type used, combustion technology, operating conditions, control technology, and maintenance and age of the equipment).
- A specific emission factor for each technology (fuel type used, combustion technology, operating conditions, control technology, oxidation factor, and maintenance and age of the equipment).
- Facility level measurements can also be used when available.

Using a Tier 3 approach to estimate emissions of CO<sub>2</sub> is often unnecessary because emissions of CO<sub>2</sub> do not depend on the combustion technology. However, plant-specific data on CO<sub>2</sub> emissions are increasingly available and they are of increasing interest because of the possibilities for emissions trading.

# Activity data

Fuel consumption statistics by fuel type and economic sector are usually sufficient AD to estimate emissions using a tier 1 approach. Similar AD are required for a tier 2 approach, for which the degree and type of disaggregation is determined by the GHG (CO<sub>2</sub> or non-CO<sub>2</sub>) emissions being estimated.

For a tier 3 approach, fuel consumption statistics disaggregated by fuel type, economic sector and combustion technology type are needed. This type of more detailed AD is required for estimating emissions or for verification purposes. Some tier 3 methods use other types of AD (e.g. kilometres travelled) as a proxy to estimate fuel consumption. This type of approach is generally used for estimating mainly non-CO<sub>2</sub> emissions, because CO<sub>2</sub> emissions are not technology dependent.

# Sources of activity data

The amount and types of fuel combusted are obtained from one, or a combination, of the sources in the list below:

- national energy statistics agencies (national energy statistics agencies may collect data on the amount and types of fuel combusted from individual enterprises that consume fuels)
- reports provided by enterprises to national energy statistics agencies (these reports are most likely to be produced by the operators or owners of large combustion plants)
- reports provided by enterprises to regulatory agencies (for example, reports produced to demonstrate how enterprises are complying with emission control regulations)
- individuals within the enterprise responsible for the combustion equipment
- periodic surveys, by statistical agencies, of the types and quantities of fuels consumed by a sample of enterprises
- suppliers of fuels (who may record the quantities of fuels delivered to their customers, and may also record the identity of their customers usually as an economic activity code).

# Activity data collection

- It is *good practice* to use, where possible, the quantities of fuel combusted rather than the quantities of fuel delivered.
- Comparable statistics are published by the International Energy Agency (IEA), based on national returns. If national data are not directly available to the national inventory compiler, a request could be sent to the IEA at “[tats@iea.org](mailto:tats@iea.org)” to receive the country’s data free of charge.
- *Good practice* for electricity autoproduction (self-generation) is to assign emissions to the source categories (or sub-source categories) where they were generated and to identify them separately from those associated with other end-uses such as process heat.
- It is a good practice to check fuel mass balance to verify completeness

# Autoproducers

- An autoproducer of electricity and/or heat is an enterprise that, in support of its primary activity, generates electricity and/or heat for its own use or for sale, but not as its main business. This should be contrasted with main activity producers who generate and sell electricity and/or heat as their primary activity. Main activity producers were previously referred to as “Public” electricity and heat suppliers, although, as with autoproducers, they might be publicly or privately owned. Note that the ownership does not determine the allocation of emissions.
- The *IPCC 2006 Guidelines* follow the *IPCC 1996 Guidelines* in attributing emissions from autoproduction to the industrial or commercial branches in which the generation activity occurred, rather than to 1 A 1 a. Category 1 A 1a is for main activity producers only.
- With the complexity of plant activities and inter-relationships, there may not always be a clear separation between autoproducers and main activity producers. The most important issue is that all facilities be accounted under the most appropriate category and in a complete and consistent manner.
- Emissions from autoproducers (public or private undertakings that generate electricity/heat wholly or partly for their own use, as an activity that supports their primary activity) should be assigned to the sector where they were generated and not under 1 A 1 a.

# Agriculture/ Forestry / Fishing

- Emissions from off-road transport combustion should be included in this category
- Methodology to calculate emissions from off-road transport is provided in Mobile combustion chapter of the Guidelines
- Be careful to use correct EFs for CH<sub>4</sub> and N<sub>2</sub>O emissions calculation from off-road transport

# Avoiding double counting activity data with other sectors

Figure 14 illustrates the main connections between the Energy sector and the other inventory sectors, namely, Agriculture, Industrial Processes and Product Use (IPPU), LULUCF and Waste.

When reviewing, care must be taken that both double counting and omission of emissions are avoided when estimating and reporting emissions associated with these linkages.

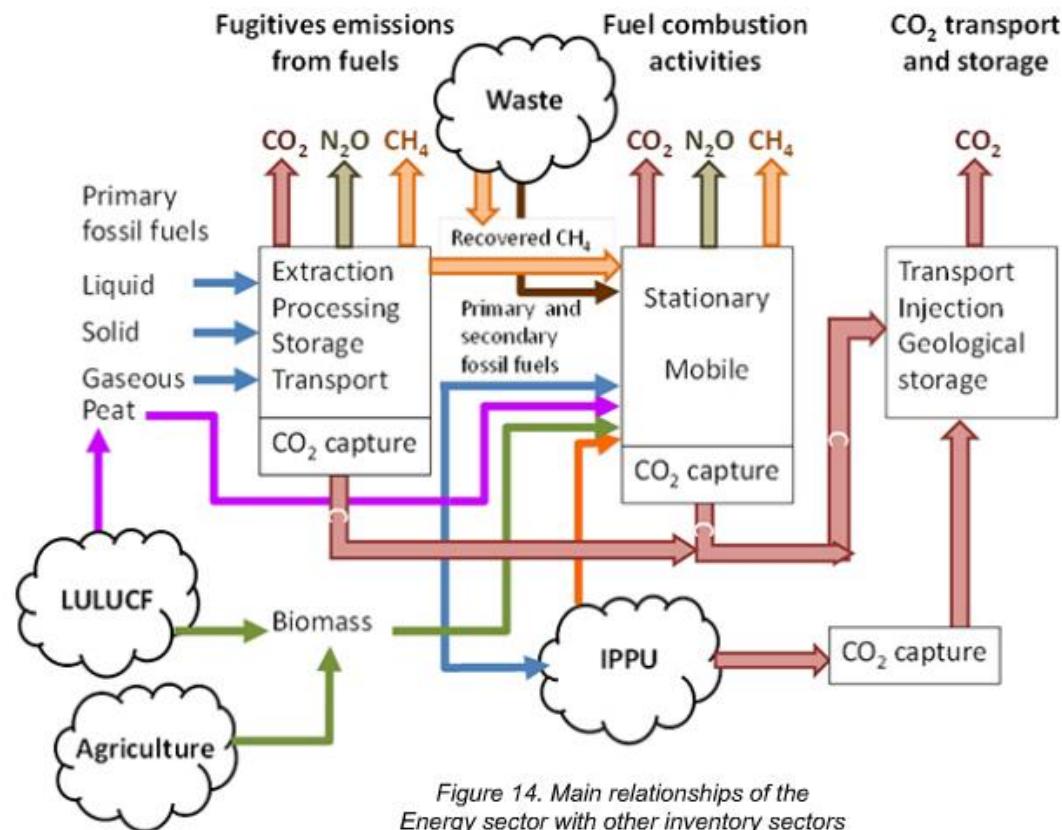


Figure 14. Main relationships of the Energy sector with other inventory sectors

# Energy, Agriculture, LULUCF

The combustion for energy purposes of biomass fuels, including agricultural crop residues (part of other primary solid biomass), is the main connection with the Agriculture and LULUCF sectors. Emissions of CO<sub>2</sub> from biomass fuels are estimated and reported in the LULUCF sector as part of the Agriculture, Forestry and Other Land Use methodology in the 2006 IPCC Guidelines.

in the Energy sector. CO<sub>2</sub> emission estimates are included as an information item in the Energy sector, but not included in the sectoral or national totals. However, the emissions of CH<sub>4</sub> and N<sub>2</sub>O are estimated and included in the sector and national totals because their effects are in addition to the stock changes estimated in the LULUCF sector.

**Informal sector fuel use** is an important issue if not captured in energy statistics:

- Household kerosene use can be approximated based on expert judgement or proxy data.

# Energy and waste

Two different types of connections exist between the Energy and the Waste sectors: (i) waste incineration with energy recovery and (ii) the use of recovered CH<sub>4</sub> for energy purposes. When energy is recovered from waste combustion, the associated GHG emissions are reported under stationary combustion, while emissions from waste incineration without energy recovery are reported in the Waste sector (CRF table 5).

When reviewing emissions from waste incineration, it is important to check whether:

- (i) the waste content has been assessed;
- (ii) the biogenic and non-biogenic components have been differentiated and;
- (iii) the associated CO<sub>2</sub> emissions have been reported accordingly.

CO<sub>2</sub> emissions from the biomass part are reported as an information item, while CO<sub>2</sub> emissions from the fossil C part are reported under the Energy sector, arising from other fossil fuels. CH<sub>4</sub> can be recovered from waste disposal sites, anaerobic digestion at biogas facilities and wastewater treatment, and utilized in several devices for energy purposes. Recovered CH<sub>4</sub> from waste treatment follows the same approach as that recovered from coal mining. If this recovered CH<sub>4</sub> is transported and/or distributed and used as natural gas, the fugitive emissions are dealt with in the oil, natural gas and other emissions from energy production category.

# Energy and IPPU

The linkages with the IPPU sector are mainly through:

- (i) the use of hydrocarbons as feedstock,
- (ii) the use of gaseous, liquid and solid fuels as reductants and
- (iii) the non-energy use of fuels.

Emissions from the non-energy use of fuels such as bitumen, lubricants, paraffin waxes and white spirit are, in general, estimated and reported under the IPPU sector. Care should be taken with some non-energy products such as lubricants and petroleum waxes that may, in part, be combusted. Under mobile combustion, lubricants are mixed with gasoline and combusted in two-stroke engines; emissions from this use should be estimated and reported under the Energy sector. Candles made of paraffin waxes may be burned in heating or warming devices (e.g. chafing dishes); the AD for these small sources is difficult to identify and allocate, but when this is possible, the corresponding emissions should be estimated and reported under the Energy sector.

According to the Revised 1996 IPCC Guidelines the emissive part of carbon contained in the fuels from non-energy use should be accounted under the sectoral approach, which is included in:

- Volume 3, Reference Manual, page 1.32, paragraph entitled “Carbon release during the non-energy-use of fuels”
- Volume 2, Workbook, section 1.2.2 entitled “CO<sub>2</sub> Emissions by Source Categories”, pages 1.9-1.14; and workbook 1-2, pages 1.38-1.53).

# Exercise 1:

- Use decision tree to choose tier approach for energy industries category.

## Exercise 2:

- Disaggregate data for food industry, non-metallic industry and other industries for the 2013 and check fuels mass balance and data completeness.

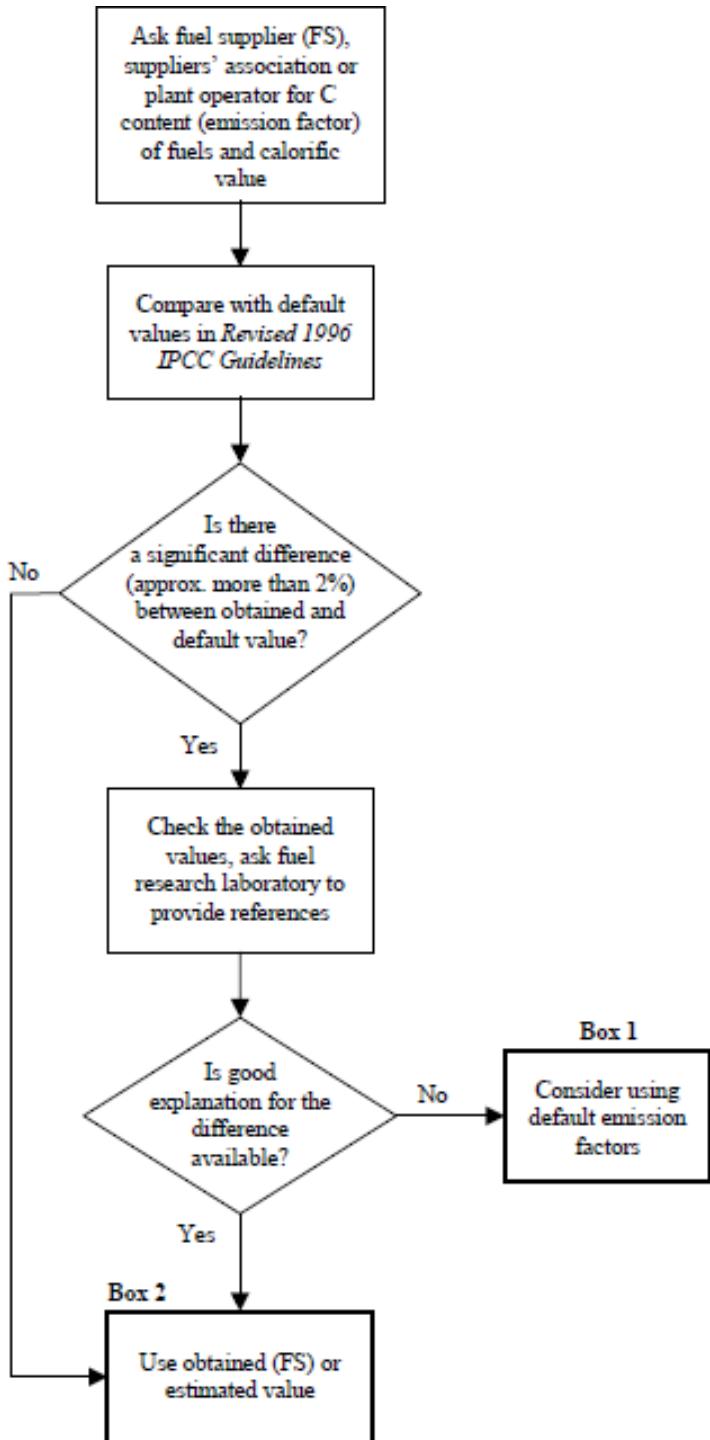
OR

- Evaluate AD for commercial/institutional sector taking into account stationary combustion at transport enterprises for 2013

# Conversion to common energy unit

- Convert :
  - Fuel data into a common energy unit
  - Production and consumption of solid and liquid fuels in tonnes
  - Gaseous fuels in cubic metres
  - Original units into energy units using calorific values (i.e. heating values).
- Reference approach: use different calorific values for production, imports and exports.
- Country specific NCVs can be used.
- NCVs for coal use to change from year to year. Use years/categories CS NCVs for some fuels as coal
- Calorific values used should be reported
- To avoid uncertainties - use AD in TJ where it is available

# Decision tree for selecting calorific values and carbon content



# Estimate Total Carbon Content of Fuels Consumed

## Natural gas

- Depends on composition (methane, ethane, propane, butane and heavier hydrocarbons)
- Natural gas flared at the production site will usually be “wet” – its carbon content factor will be different

## Oil

- Lower carbon content for light refined petroleum products such as gasoline
- Higher for heavier products such as residual fuel oil

## Coal

- Depend on coal's rank and composition of hydrogen, sulphur, ash, oxygen and nitrogen

# Emission factors

- The Revised 1996 IPCC Guidelines provides EF for CO<sub>2</sub> in kg C/ TJ.
- To express the results as CO<sub>2</sub>, multiply the quantity of carbon oxidized by the molecular weight ratio of CO<sub>2</sub> to C (44:12).
- The 2006 IPCC guidelines provides CO<sub>2</sub> Efs in kg CO<sub>2</sub>/ TJ
- CS EF for Tier 2 are not provided this in a responsibility of each Party

## CO<sub>2</sub> emission factors

Only the C content and the energy content of each fuel are needed to derive the corresponding CO<sub>2</sub> EFs, because it has been assumed that all C-containing combustion gases are fully oxidized. However, a small fraction of the C remains unoxidized and emitted in the solid phase as soot and ash.

The 2006 IPCC Guidelines provide updated default C content for 53 fuels and the corresponding CO<sub>2</sub> EFs (please see [table 1.4](#) of volume 2 of the 2006 IPCC Guidelines), which were calculated with the assumption that the C was fully oxidized (fraction of C oxidized=1). However, the 2006 IPCC Guidelines indicate that for certain fuels, the unoxidized fraction of the fuel may not be negligible and Parties should use, if available, representative country-specific values for the fraction of C oxidized that have been estimated from measurements.

In addition to providing a tier 1 default CO<sub>2</sub> EFs for each of the 53 fuels considered, the 2006 IPCC Guidelines report the corresponding lower and upper limits of the 95 per cent confidence intervals, which were estimated from data of national inventory reports (NIRs), data from the IEA and from various available national data. This information is valuable for the reviewer, for example, when assessing accuracy and comparability of country-specific CO<sub>2</sub> EFs.

The tier 1 default CO<sub>2</sub> EFs in the 2006 IPCC Guidelines differ from the resulting tier 1 default CO<sub>2</sub> EFs that were previously calculated according to the Revised 1996 IPCC Guidelines. For this purpose, the C content of the fuels, reported in the Revised 1996 IPCC Guidelines, and a fraction of C oxidized less than 1 (0.995 for natural gas, 0.99 for oil derived products and 0.98 for coal) were used.

## Non-CO<sub>2</sub> emission factors

As has been mentioned, the emissions of CH<sub>4</sub> and N<sub>2</sub>O are strongly dependent on technology and operating practices; however, the 2006 IPCC Guidelines (volume 2 (Energy)) provide enough information to estimate non-CO<sub>2</sub> emissions using a fuel-based tier 1 method with fuel consumption data at the category level only. For this purpose, tier 1 default CH<sub>4</sub> and N<sub>2</sub>O emissions are reported for:

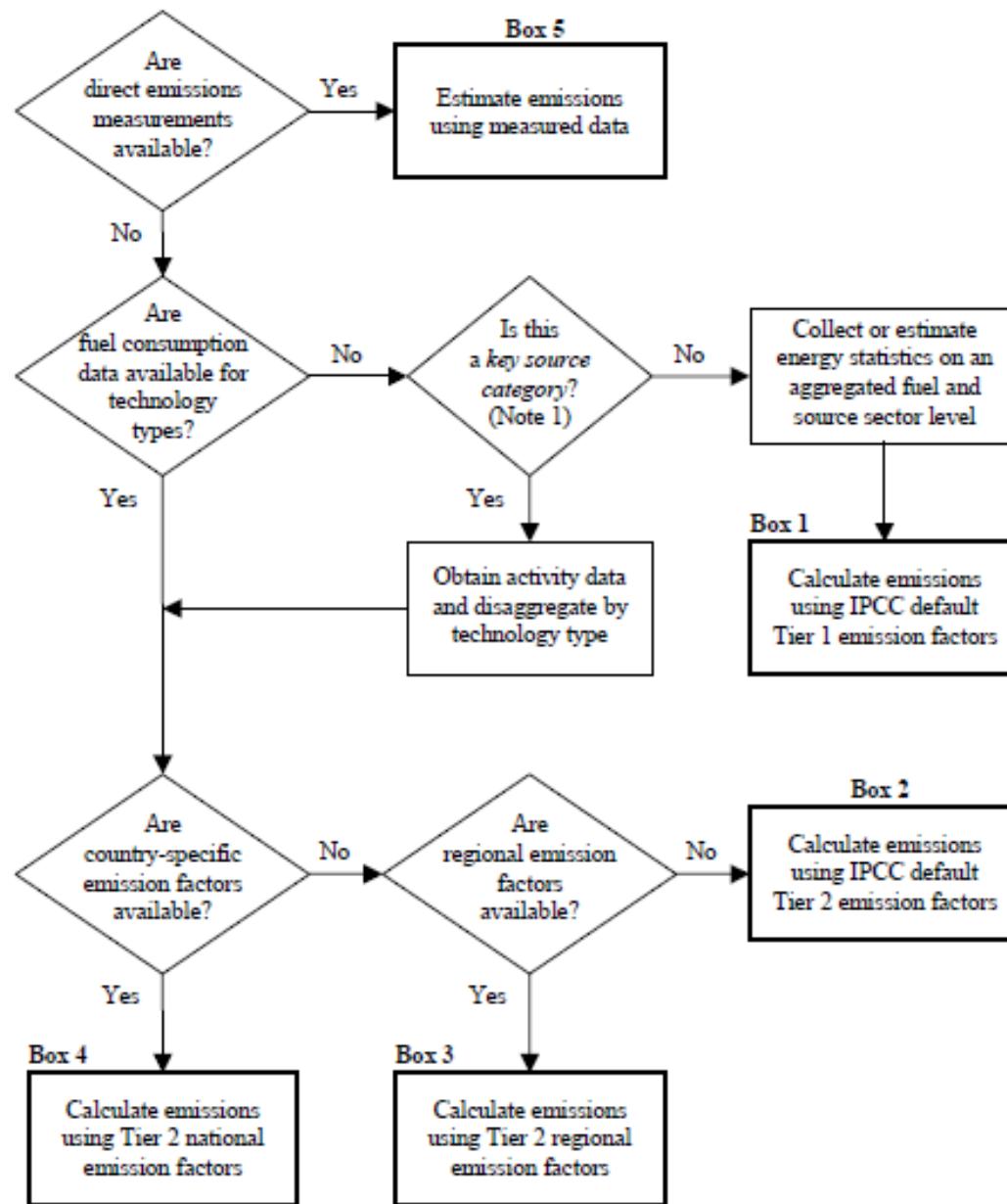
- all stationary combustion categories ([tables 2.2–2.5](#), chapter 2);
- aviation ([table 3.6.5](#), chapter 3);
- road transportation ([table 3.2.2](#), chapter 3);
- railways ([table 3.4.1](#), chapter 3);
- navigation ([table 3.5.3](#), chapter 3); and
- off-road road vehicles and other machinery ([table 3.3.1](#), chapter 3).

As for CO<sub>2</sub> EFs, the lower and upper limits of the 95 per cent confidence intervals are reported for each IPCC default non-CO<sub>2</sub> EF.

For certain categories, some technology-specific CH<sub>4</sub> and N<sub>2</sub>O EFs are provided, mostly as examples, in the 2006 IPCC Guidelines, volume 2 (Energy). The information provided relates to:

- various technologies used in the main stationary combustion categories ([tables 2.6–2.10](#), chapter 2);
- the distance-travelled approach for road transportation in gasoline and diesel vehicles in the USA and Europe ([table 3.2.3](#) and [table 3.2.5](#), respectively, chapter 2); and
- landing and take-off (LTO) for typical aircraft ([table 3.6.9](#), chapter 3).

**Figure 2.3 Decision Tree for Non-CO<sub>2</sub> Emissions from Stationary Combustion**



## **Biomass is a special case:**

- Emissions of CO<sub>2</sub> from biomass fuels are estimated and reported in the AFOLU sector as part of the AFOLU methodology. In the reporting tables, emissions from combustion of biofuels are reported as information items but not included in the sectoral or national totals to avoid double counting. In the emission factor tables presented in this chapter, default CO<sub>2</sub> emission factors are presented to enable the user to estimate these information items.
- For biomass, only that part of the biomass that is combusted for energy purposes should be estimated for inclusion as an information item in the Energy sector.
- The emissions of CH<sub>4</sub> and N<sub>2</sub>O, however, are estimated and included in the sector and national totals because their effect is in addition to the stock changes estimated in the AFOLU sector.
- For fuel wood, activity data are available from the IEA or the FAO (Food and Agriculture Organisation of the United Nations). These data originate from national sources and inventory compilers can obtain a better understanding of national circumstances by contacting national statistical agencies to find the organisations involved.
- For agricultural crop residues (part of other primary solid biomass) and also for fuel wood, estimation methods for activity data are available in Chapter 5 of the AFOLU volume.
- In some instances, biofuels will be combusted jointly with fossil fuels. In this case, the split between the fossil and non-fossil fraction of the fuel should be established and the emission factors applied to the appropriate fractions.

## Biomass Fuels

- CO<sub>2</sub> emissions from biomass fuels **should not be included in national emission totals from fuel combustion.**
- **Reported for information only...**
  - Household fuelwood
  - Ethanol and biodiesel for transport.
- Account for **mixed fuels** (e.g. ethanol blends).
- **Net CO<sub>2</sub> emissions implicitly accounted for under the LULUCF sector**
- Non-CO<sub>2</sub> emissions from biomass combustion **should** be estimated and reported under the energy sector!

# Cross-cutting issues have to be checked

## Completeness

- The Party must estimate and report CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O emissions from all fuels and categories identified within the 2006 IPCC Guidelines.
- Fuel statistics must account for the amounts of all fuels delivered by producers. Direct imports by final consumers and own use of fuels, if any, deserve particular attention.
- Biomass and waste fuels may not be sufficiently covered. The amounts of fuels used for stationary combustion need to be checked.

## **Cross-cutting issues - Time-series consistency**

- The implementation of the use of the 2006 IPCC Guidelines implies some changes with respect to the reporting using the Revised 1996 IPCC Guidelines:
  - changes in CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O tier 1 IPCC default EFs;
  - a tier 1 oxidation factor equal to 1; and
  - sectoral classification, particularly that relative to the use of fuels as feedstock and reporting under the IPPU or Energy sectors (see discussion above).
- Variability in the physical properties of fuels:
  - properties of primary fuels typically vary within the country and throughout the years; properties of secondary fuels typically exhibit less variability as they are delimited by market and regulatory constraints; and
  - origin of imported fuels may vary frequently.

# Cross-cutting issues have to be checked

## Uncertainty analysis

- The main concern relates to the uncertainty values for:
  - EFs; and
  - AD.

The 2006 IPCC Guidelines provide examples of uncertainty ranges for CO<sub>2</sub>, non-CO<sub>2</sub> EFs (please see [section 2.4.1](#), volume 2 of the 2006 IPCC Guidelines) and AD (please see [section 2.4.2](#), volume 2 of the 2006 IPCC Guidelines).

## Transparency (reporting and documentation)

- Summary of methods used and references of data sources reported in the NIR.
- Provide sufficient documentation for country-specific EFs.
- For tier 3 emission estimates, the associated AD are to be reported.

## **Cross-cutting issues - Quality assurance/quality control**

Some specific components of QA/QC procedures for stationary combustion include:

- Comparison of emission estimates using different approaches:
  - comparison of CO<sub>2</sub> emission estimates between the sectoral approach and those from the IPCC reference approach is reported by the Party and reviewed by the expert review team (ERT).
- AD checks.
- EF checks.
- For estimates using a measurement-based tier 3 approach, assessment of QC applied to direct measurements.
- Checks of the amount of CO<sub>2</sub> captured and the associated amount of CO<sub>2</sub> emitted. Cross-checks with category 1.C.
- Involving external energy experts and stakeholders for external reviews.