



Area-wide Emissions

Briefing Note 1: Introduction to Greenhouse Gas Estimation

May 2014

In partnership with



Sustainable Scotland Network (SSN) supports public sector action on sustainable development. This includes programmes on climate change and sustainable procurement. The Scottish Government provides funding to Keep Scotland Beautiful to develop SSN, and the SSN Steering Group guides the SSN agenda. Building on over a decade's work with local government, SSN is now opening up its support to the wider public sector.

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This set of briefing notes has been developed by the Sustainable Scotland Network (SSN) in partnership with Aether. They are designed to provide background information and advice on greenhouse gas inventories and data sources and their application for use by local area-wide inventory compilers. For further information or advice please contact the SSN team at Keep Scotland Beautiful either by email at ssn@keepscotlandbeautiful.org or by phone on 01786 471333.

Terminology

Due to the nature of this field, technical terminology and acronyms are commonly used. The glossary below gives a very quick introduction to these terms, which will subsequently be used throughout these briefing notes.



Air emission inventories:

inventories estimating the total emissions to air of certain pollutants that cause health or ecological problems.

Greenhouse gases (GHGs): gases that contribute to the greenhouse effect by absorbing infrared radiation.

Global warming potential (GWP): a relative measure of how much heat a greenhouse gas traps in the atmosphere. It compares the amount of heat trapped by a certain mass of the gas in question to the amount of heat trapped by a similar mass of carbon dioxide (over a 100 year time horizon). The current GWPs used in estimating emissions¹ listed below are on the [UNFCCC website](http://unfccc.org).

Greenhouse Gas	GWP used in calculations	Source of the greenhouse gas
Carbon dioxide (CO ₂)	1	the most significant gas, mainly from the burning of fuel
Methane (CH ₄)	21	mainly from livestock
Nitrous oxide (N ₂ O)	310	mainly from the use of fertilizers
Hydrofluorocarbons (HFCs)	~ 90 to 11,700	man-made gases mainly used in air conditioning and refrigeration
Perfluorocarbons (PFCs)	~ 6,500 to 8,700	man-made gases mainly used in industry
Sulphur Hexafluoride (SF ₆)	23,900	man-made gases mainly used in electrical circuitry

A [later assessment by the IPCC](#) has updated these GWPs. These updated values will be used for international reporting to the United Nations Framework Convention on Climate Change (UNFCCC) from 2015.

CO₂ equivalent (CO₂e): by using the global warming potential of each greenhouse gas, a total calculated estimate of emissions can be made. For example, 1 tonne of CO₂ and 1 tonne of methane would equate to 22 tonnes CO₂e.

Emissions and removals: greenhouse gases can be emitted or removed from the atmosphere e.g. by the growth of vegetation (or particularly trees) which store carbon. In some cases for crops there is a net emission due to the release of carbon from disturbed soils.



Anthropogenic emissions/removals:

these are greenhouse gases that have been emitted to or removed from the atmosphere because of human activities.

Following these simple terms, we can now look at how these calculations and estimates are used.

Historic emissions/removals: estimates of anthropogenic greenhouse gas emissions/removals are commonly calculated for a calendar year, and have been made for the years 1990 onwards. 1990 (some countries have argued for a different year e.g. 1988, 1989 etc) was the generally agreed base year for international reporting. This means that, at the international level, many countries have estimated annual emissions for at least 20 years.

¹ IPCCs Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report, page 22



Mitigation: This is action to reduce the rise in global emissions. It usually relates to **Policies and Measures (PAMs)**

to reduce greenhouse gas emissions or increase removals.

Projections: Projections are estimates of emissions/removals to future years. Usually emission inventories are used as a basis of projecting future emission trends, with assumptions on the future of the economy, expected changes in technology and mitigation actions also considered. **Scenarios** test the impact of these different assumptions.



Targets: are established goals for emissions reduction. These can be arrived at by calculating likely trends in emissions based on assumptions (as above) or through

the adoption of targets set by others. Targets can vary considerably assuming different technical boundaries, different base years or different annual requirements.

Reporting: Most activities involving GHG estimation and target setting will involve some form of formal or informal reporting/publication of results/progress. It is important that any publications of results are coupled with clear and transparent reporting so that users can understand the boundaries, assumptions and methods behind them. This is also true for the communication of projected emissions and PAMs.

We now look at some more detailed, technical terminology

Indirect greenhouse gases: As well as the six greenhouse gases, there are indirect greenhouse gases that do not have a global warming potential, but will lead to the creation of those that do in the atmosphere. These include Nitrogen Oxides (NO_x), Non Methane Volatile Organic Compounds (NMVOC), Sulphur Dioxide (SO₂), Carbon Monoxide (CO).



Intergovernmental Panel on Climate Change (IPCC)

Guidelines: these are international guidelines available online for all greenhouse gas emission inventory compilers

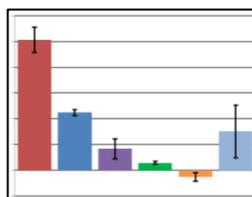
and contain comprehensive guidance for the calculation on emission and removal estimates. This includes methodology, terminology, activity data suggestions and emission factors.

Sectors, categories and sub-categories: emission inventories cover many different anthropogenic activities. Consequently, different formats have been created to categorise these emissions and removals. Under IPCC, sectors are the lowest resolution (e.g. Agriculture) and sub-categories (e.g. enteric fermentation from goats) are the highest resolution.

Key categories: these are the most important categories within an inventory that contribute most significantly to the total emissions. Identifying these key categories helps compilers prioritise improvements.

Tiers: the IPCC Guidelines provide a number of methodologies for each category that vary in complexity. A Tier 1 method will be the simplest approach whereas Tier 3 method will require more detailed data and knowledge of the category. Use of Tiers 2 and 3 is recommended for key categories.

Default emission factors: the IPCC Guidelines also provides default emission factors that support the use of the simple, Tier 1 methods. Such default emission factors are also seen in other guidance such as the Defra Company Reporting guidance.



Uncertainties: these are the margins of error likely for calculated greenhouse gas datasets.

Drivers – why do we estimate greenhouse gases?

There is growing scientific evidence that human activity is having a significant impact on the global climate. Monitoring is an important part of the assessment of this impact and improves understanding concerning the causes, impacts and trends.

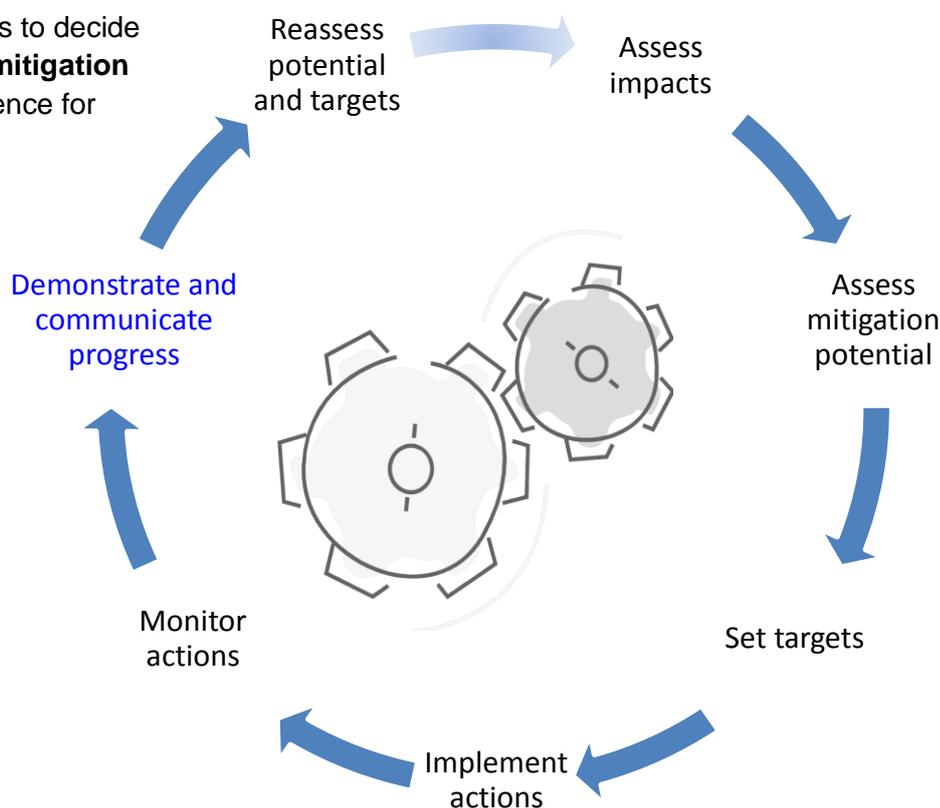
Many national and regional areas have responded to the climate challenge by putting in place targets for reducing greenhouse gas emissions from human activities. These targets need to be assessed, implemented and monitored effectively.

GHG estimates can form an important input to decision making and engagement processes along all of these steps. The first step is to **assess the impact** and uses of GHG estimates to highlight key categories and important trends. When we realise actions are needed to reverse upward trends, GHG estimates, projections and analysis of PAMs allow policy makers to decide on policies with the most promising **mitigation potential** and provides some confidence for **setting targets**.

Implementing actions effectively is dependent upon monitoring, and GHG estimates have a role here in providing feedback on the effectiveness of these policies. Together with GHG estimates, **monitoring of actions** can help to identify gaps, demonstrate where more action is needed and **communicate progress** to targets. After this, the targets and actions can be **reassessed** using GHG estimate updates to ensure that the most effective actions are continued.

This process aims to answer: “what can we change and how?”

It is important to communicate progress, or lack of it, to help engage with stakeholders.



Targets

There are a number of international frameworks, legislation and directives in place that drive the need for monitoring of emissions and the implementation of actions to reduce emissions. This section looks at how these high level factors filter down to the national and local level.

International

- Kyoto Protocol (UNFCCC)
- EU Monitoring Mechanism and Effort Sharing Decision
- Carbon Disclosure Project
- ICLEI (International Council for Local Environmental Initiatives)
- Covenant of Mayors
- Local Agenda 21
- EU 2020

UK

- UK Climate Change Committee

Scotland

- Net Scottish Emissions Account (NSEA)
- Second Report on Proposals and Policies (RPP2) and the Public Bodies Duties
- Scotland's Climate Change Declaration (SCCD) and Sustainable Scotland Network (SSN)
- Single Outcome Agreements (SOA)
- Climate Change (Scotland) Act

At the international level, the [UN Framework Convention on Climate Change](#) (UNFCCC) has 192 countries signed up to the commitment to limit increases of the average global temperature. In support of these commitments, countries provide documentation on emissions projections, PAMs, adaptation methods, capacity building and relevant financial information in the form of National Communication reports.

Under the Kyoto Protocol (KP), countries report and have verified (by review): annual greenhouse gas emission inventories, activities related to KP LULUCF (Kyoto Protocol Land Use, Land Use Change and Forestry, such as forest management activities) and National Systems (on which the reliability of reporting is based). The Kyoto Protocol also allows for flexible market-based mechanisms such as emissions trading systems.

Targets and Assigned Amounts are allocated to each country signed up to the Kyoto Protocol based on the base year emissions (usually 1990 for CO₂, CH₄ and N₂O and 1995 for HFCs, PFCs and SF₆ (the F-Gases). A compliance system is in place that affects the trading of Kyoto Protocol units.

In 2012 the 2nd Commitment Period was launched, which started on 1st January 2013 and will continue until 2020.

At the European level, the EU has put in place the EU Monitoring Mechanism and the Effort Sharing Decision in order to ensure that it meets its United Nations Framework Convention on Climate Change (UNFCCC) and KP commitments.

The Monitoring Mechanism ensures that Member States provide data to the European Commission on greenhouse gas emissions and other climate change related reporting.

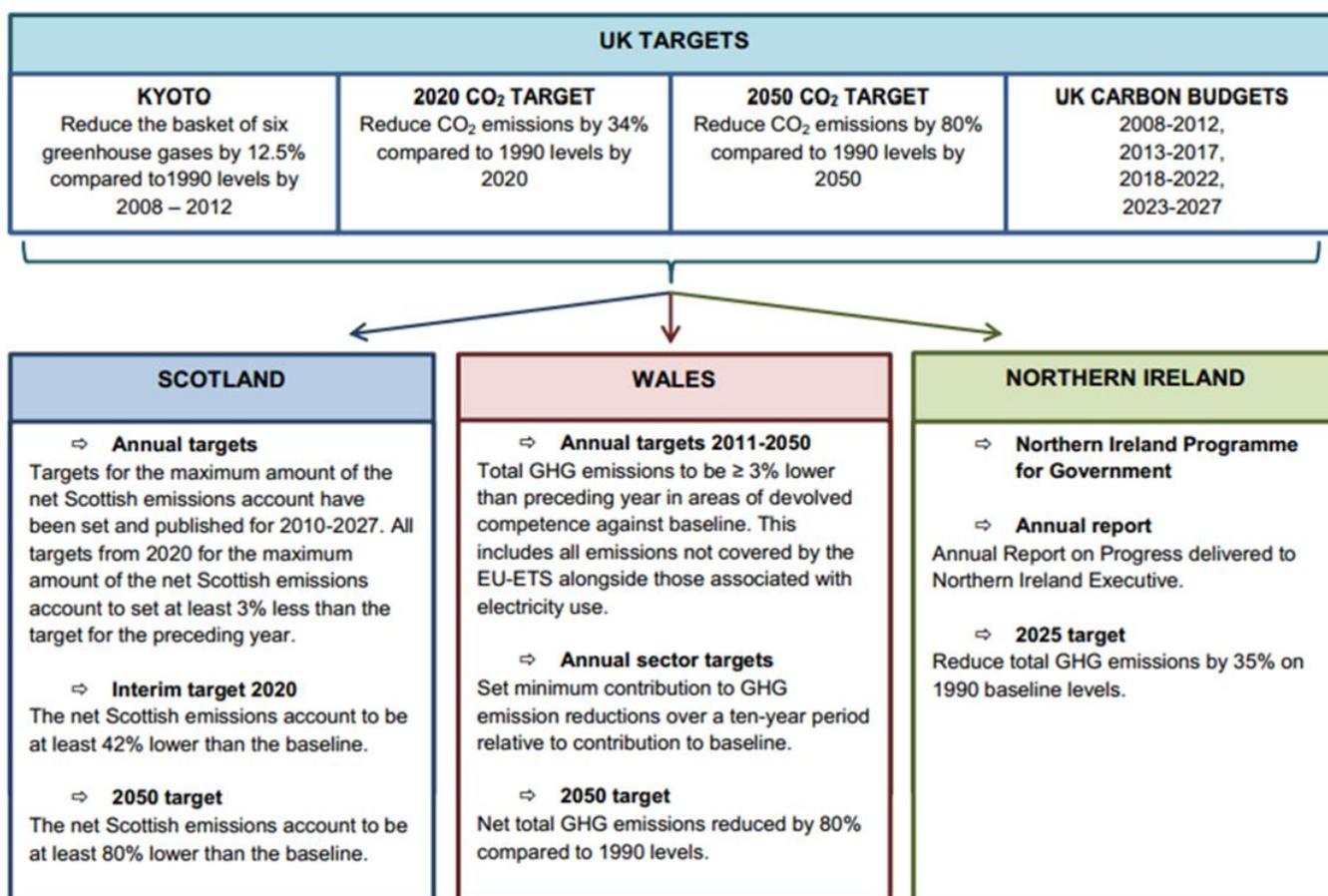
The Effort Sharing Decision is a binding annual greenhouse gas emission target for the Member State for the period 2013-2020. This target excludes emissions that are captured by the EU ETS (EU Emissions Trading Scheme) and emissions from LULUCF. The overall target is for emissions from these areas to be reduced by 10% by 2020 using 2005 as the baseline.

There are other international, initiatives and accounting and reporting mechanisms in place:

- Carbon Disclosure Project – includes GHG reporting from companies and cities such as London and Manchester.
- Covenant of Mayors – local and regional authorities voluntarily commit to increasing energy efficiency and use of renewable energy sources on their territories, aiming to exceed the EU 20% CO₂ reduction objective.
- ICLEI – UN network of sustainable cities operating worldwide, which facilitates local government input to the UN.
- Local Agenda 21 – this is a UN blueprint for sustainability in the 21st Century in which Local Agenda 21 is a commitment to sustainable development agreed by many of the world’s governments.

There are targets at the national level as shown in the diagram below. The UK Carbon Budgets ensure that the UK is on track to meet international commitments and develop a low carbon economy.

The diagram also highlights the individual targets adopted by each devolved administration. The Net Scottish Emissions Account (NSEA) is the Scottish approach for setting and managing targets aimed at meeting Scotland’s international commitments and at developing a low carbon economy for Scotland. Scotland’s Climate Change Declaration (SCCD), facilitated by SSN, provides a process for monitoring and analysis of actions by Scottish local authorities.

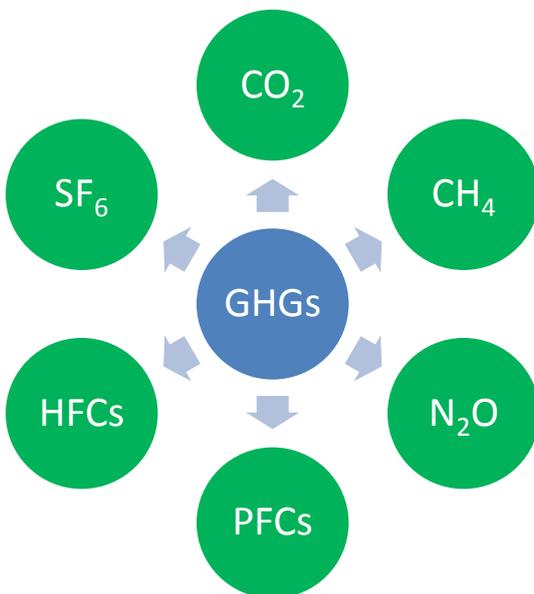


Global Accounting

What is measured?

There are six greenhouse gases that are measured to estimate the total emissions from a region. All emissions and removals due to human activity (anthropogenic) should be included unless the boundary is defined for a specific subset of categories.

The six greenhouse gases are generally estimated at a national level under sectors (coloured boxes, right) and categories (bullet points) as set out in the IPCC Guidelines.



IPCC Reporting sectors and some example categories:

Energy

- Fossil fuels
- Transport
- Electricity consumption

Industrial Processes

- Feedstocks
- Use of products
- Manufacturing and production

Agriculture and Forest practices

- Livestock
- Crops and soils
- Harvesting and processing of wood

Waste

- Wastewater
- Landfill
- Incineration
- Disposal of products

Defining boundaries

GHG emissions can be calculated and presented in a number of different ways. It is important to define the activities included as well as the geographical/organisational boundaries. GHG estimates can be presented for any of the entities presented in the box below.

- Countries
- Cities
- Organisations
- Products
- Projects/Events
- People

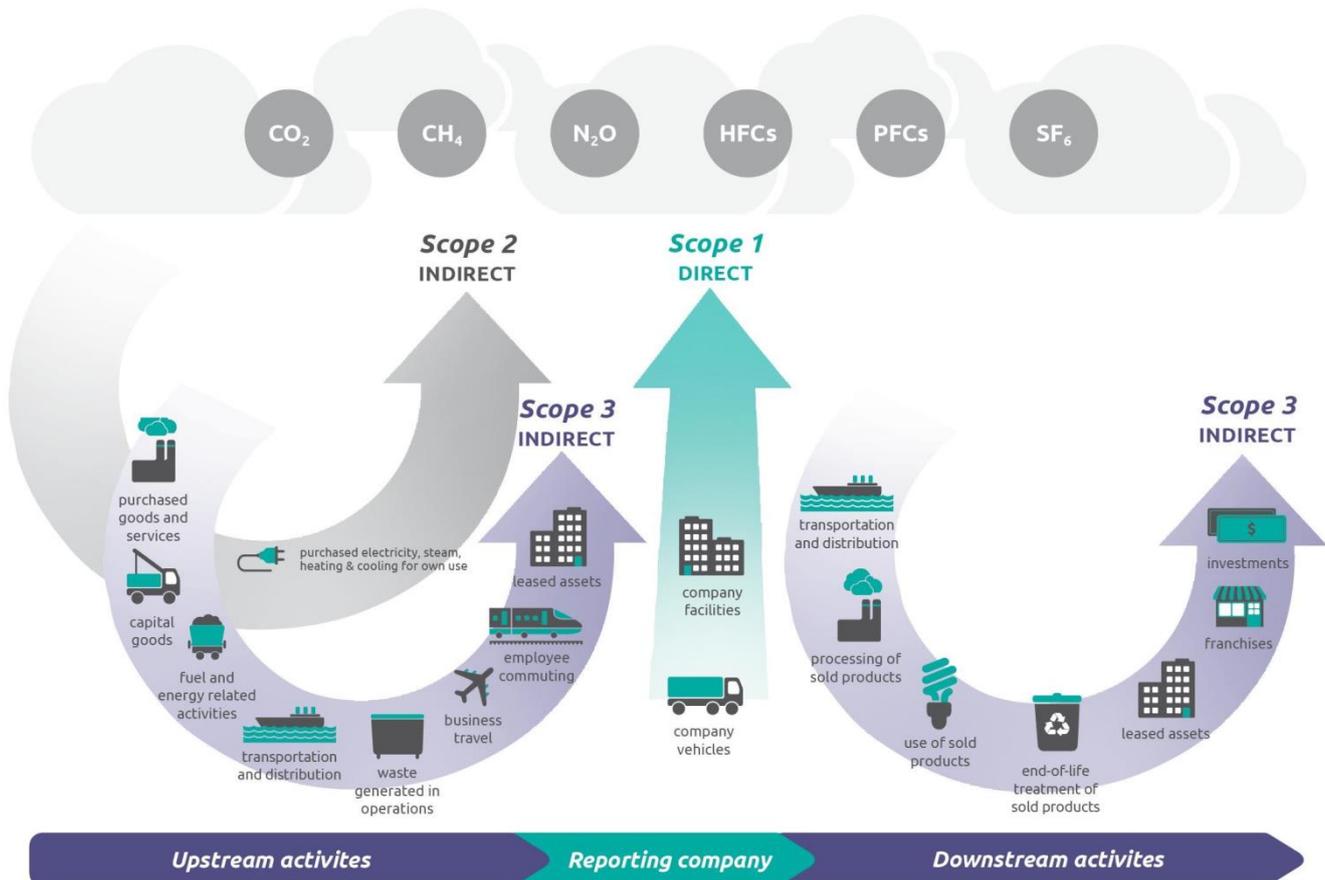
There are a number of standard definitions that help with setting consistent boundaries and these are presented in the diagram below.

There are **three scopes** used for estimating and reporting GHG data. Under the greenhouse gas Protocol, Scope 1 and 2 are essential and there is discretion as to whether Scope 3 should be included.

Direct emissions from operations and activities include:

- Direct fuel consumption for heat, steam and cooling at owned facilities
- Direct emissions from company owned vehicles.

Indirect emissions consist of purchased goods and energy and their subsequent emissions.



Source: GHG Protocol

Methods

There are a number of methods that have been designed for different reporting processes. These methods help to set-out standard reporting boundaries and methods and assumptions to use.

Organisational

- GHG Protocol
- ISO 14064
- Defra Company Reporting
 - Information for Scope 1, 2, 3
- CRC
 - Electricity and gas for non-EU ETS elements only

City Footprinting (PAS 2070)

- Direct plus Supply Chain (DPSC)
- Consumption-based (CB)

National (IPCC)

- Net Scottish Emissions Account (NSEA)

There are a number of guidance documents available to help compilers estimate area-wide emissions.

Organisational standards help define methods and assumptions for companies and organisations that operate buildings, vehicle fleets and industrial processes.

City footprinting focuses on the city as a mini country with similarly defined boundaries depending on the accounting approach. A new PAS (PAS 2070) standard provides a more exact and complex approach with two different perspectives.

The **Direct plus Supply Chain** method takes into account the direct emissions from within the city boundary as well as the indirect emissions from:

- The consumption of grid-supplied electricity
- heating and/or cooling
- transboundary travel
- the supply chains from key goods and services produced outside the city boundary
 - water supply
 - food
 - building materials

The **consumption-based** methodology considered emissions from the direct and life cycle greenhouse gas emissions for all goods and services consumed by residents of a city.

The Intergovernmental Panel on Climate Change (IPCC) have published comprehensive guidance on the methodology that should be applied when compiling **national** greenhouse gas emission inventories.

As well as this guidance, the IPCC have created a [database of emission factors](#) that can be used when estimating greenhouse gas emissions from sectors of the inventory. These include basic, default emission factors that are used in other inventories, not just national inventories.

These IPCC resources are focused on direct (Scope 1) estimates of emissions and removals and on general aspects of GHG estimation including uncertainties, data collection and how to ensure quality etc. There are a number of publications for this guidance. The 2006 IPCC Guidelines for National greenhouse gas Inventories provides comprehensive methodologies and emission factors for all sectors within the inventory and is the main source of information for inventory compilers.

This guidance includes a number of methods for each category that vary in complexity (Tier 1 for the simplest methods and Tier 3 for the most complex methods). The choice of method will depend on the availability of data and information.

At the international level, the continual improvement of the quality of the inventories has been an important part of the compilation and reporting process. The key principals (shown right) summarise the important quality requirements for international compilation and reporting.

Quality criteria for compilation and reporting of greenhouse gases:

Transparency

- *There is sufficient and clear documentation that clearly presents the methods, assumptions and data sources used for the estimates.*

Consistency

- *Estimates across different inventory years, gases and categories are made in such a way that differences in the results between years and categories reflect real differences in emissions and not changes in assumptions, methods or data sources.*

Completeness

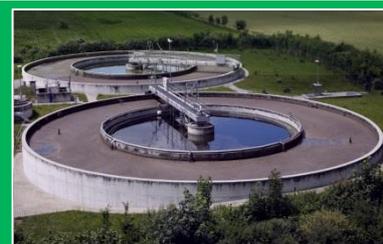
- *Estimates are reported for all relevant categories of sources and sinks, and gases that are defined in the scope of interest.*

Comparability

- *The greenhouse gas inventory is reported in a way that allows it to be compared with greenhouse gas inventories for similar entities (e.g. national, city, organisational)*

Accuracy

- *The greenhouse gas inventory contains neither over- nor under-estimates (bias) so far as can be judged. Uncertainties are understood and documented so that users of the data are aware of its limitations.*



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