CHAPTER 1

INTRODUCTION TO NATIONAL GHG INVENTORIES

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1 INTRODUCTION TO NATIONAL GHG INVENTORIES

Users are expected to go to Mapping Tables in Annex 1, before reading this chapter. This is required to correctly understand both the refinements made and how the elements in this chapter relate to the corresponding chapter in the 2006 IPCC Guidelines.

No refinement.

1.1 CONCEPTS

Inventories rely on a few key concepts for which there is a common understanding. This helps ensure that inventories are comparable between countries, do not contain double counting or omissions, and that the time series reflect actual changes in emissions.

Anthropogenic emissions and removals

Anthropogenic emissions and removals means that greenhouse gas emissions and removals included in national inventories are a result of human activities. The distinction between natural and anthropogenic emissions and removals follows straightforwardly from the data used to quantify human activity. In the Agriculture, Forestry and Other Land Use (AFOLU) Sector, emissions and removals on managed land are taken as a proxy for anthropogenic emissions and removals (Managed Land Proxy), and inter-annual variations in natural background emissions and removals, though these can be significant, are assumed to average out over time.

The *2019 Refinement* provides in Chapter 2 of Volume 4 an optional approach for estimation and reporting of anthropogenic greenhouse gas emissions and removals resulting from land use, land-use change and forestry with the intention to disaggregate the emissions and removals on managed land (i.e., emissions and removals estimated using the Managed Land Proxy) into those that are considered to result from human activities and those that are considered from natural disturbances (Volume 4, Chapter 2, Section 2.6). Where a country chooses to use this voluntary approach, it is *good practice* to report the total emissions and removals estimated using the Managed Land Proxy and the two disaggregated components, and to document the methods and assumptions used.

There are additional methods for estimating anthropogenic emissions and removals for flooded land that include the standard application of the Managed Land Proxy and an optional method to produce indicative estimates of anthropogenic component of GHG emissions. For details, see Volume 4, Chapter 7.[1]

Treatment of CO_2, CH_4 and N_2O emissions from combustion of biomass or biomass-based products

The overall IPCC approach to greenhouse gas emissions from combustion of biomass or biomass-based products (e.g., ethanol) at the national level allows for complete coverage of emissions and removals, and involves all IPCC sectors, including in particular, Energy, AFOLU, and Waste (see e.g. Volume 2, Chapter 2, Section 2.3.3.4; Volume 3, Chapter 3, Section 3.11; Volume 4, Chapter 12, Section 12.5; Volume 5, Chapter 5, Section 5.1).

Carbon dioxide (CO_2) emissions from the combustion of biomass or biomass-based products are captured within the CO_2 emissions in the AFOLU sector through the estimated changes in carbon stocks, e.g. from biomass harvest, even in cases where the emissions physically take place in other sectors (e.g., energy). This approach to estimate and report all CO_2 emissions from biomass or biomass-based products in the AFOLU was introduced in the first IPCC guidelines for national greenhouse gas emissions (IPCC 1995), reflecting close linkages with data on biomass harvesting, and for the pragmatic reason to avoid double counting.

In AFOLU, CO_2 emissions from biomass or biomass-based products used for energy purposes are calculated as an implicit component of carbon stock changes, e.g. for all forest types and other wood producing land categories, as part of carbon stock changes in the HWP pool, or when a country chooses to use more advanced (higher tier) methodologies for carbon stock changes in above ground biomass from annual crops.[2] The CO_2 emissions from biomass or biomass-based products used for energy purposes are not included in the sectoral total emissions in

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[1] In the *2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (Wetlands Supplement)*, additional methods are applied to the coastal wetlands that do not follow the standard application of the Managed Land Proxy.

[2] For annual crops, the IPCC Guidelines assume that biomass carbon stock lost through harvest and mortality equal biomass carbon stock gained through growth in that same year and so annual crops involve no net CO_2 emissions or removals from biomass carbon stock changes when using Tier 1 methods in the remaining categories of the AFOLU sector (see Section 1.2, Chapter 1, Volume 1 of the *2006 IPCC Guidelines*).

either the Energy or Waste sectors. This guidance is to avoid the possibility of double counting these emissions in two or more inventory sectors.

In the Energy sector, CO_2, methane (CH_4) and nitrous oxide (N_2O) emissions from combustion of biomass or biomass-based products for energy are estimated, but the CO_2 emissions are recorded as an information item that is not included in the sectoral total emissions for the Energy sector. This provides a complete picture of a country's energy system and avoids double counting of these emissions with those reported in the AFOLU sector. The CH_4 and N_2O emissions from the combustion of biomass or biomass-based products for energy are reported and included in the sectoral total emissions in Energy sector, as these are not covered by the estimation methods in the AFOLU sector.

Carbon dioxide emissions from waste incineration or burning under the Waste sector can derive from both, fossil and biomass materials. When waste is incinerated for energy, the CO_2, CH_4 and N_2O emissions from the biogenic part of waste are treated in the same way as emissions from other combustion of biomass or biomass-based products for energy (i.e., CO_2 emissions are recorded as an information item in the Energy sector). When waste is burned without energy recovery, CH_4 and N_2O emissions from the biogenic part of waste are estimated and included in the Waste sector, whereas the corresponding CO_2 emissions are not reported to avoid double counting with CO_2 emissions reported in the AFOLU sector.

National territory

National inventories include greenhouse gas emissions and removals taking place within national territory and offshore areas over which the country has jurisdiction. There are some special issues that are described in Section 8.2.1 of Volume 1. For example, emissions from fuel use in road transport are included in the emissions of the country where the fuel is sold and not where the vehicle is driven, as fuel sale statistics are widely available and usually much more accurate.

Inventory year and time series

National inventories contain estimates for the calendar year during which the emissions to (or removals from) the atmosphere occur. Where suitable data to follow this principle are missing, emissions/removals may be estimated using data from other years applying appropriate methods such as averaging, interpolation and extrapolation. A sequence of annual greenhouse gas inventory estimates (e.g., each year from 1990 to 2000) is called a time series. Because of the importance of tracking emissions trends over time, countries should ensure that a time series of estimates is as consistent as possible.

Inventory reporting

A greenhouse gas inventory includes a set of standard reporting tables covering all relevant gases, categories and years, and a written report that documents the methodologies and data used to prepare the estimates.

The *2019 Refinement* provides standardised reporting tables, but the actual nature and content of the tables and written report may vary according to, for example, a country's obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC). The *2019 Refinement* provides worksheets to assist with the transparent application of the most basic (or Tier 1) estimation methodology.

Greenhouse gases

The greenhouse gases covered in the *2019 Refinement* are reported in Chapter 8.

Other gases

The *2019 Refinement* also provides information for the reporting of the precursors although methods for estimating emissions of these gases are not given here. The list of precursors is reported in Chapter 8 of Volume 1.

Sectors and Categories

Greenhouse gas emission and removal estimates are divided into main sectors, which are groupings of related processes, sources and sinks:

- Energy;
- Industrial Processes and Product Use (IPPU);
- Agriculture, Forestry and Other Land Use (AFOLU);
- Waste;
- Other (e.g., indirect emissions from nitrogen deposition from non-agriculture sources[3]).

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[3] Estimates include N_2O emissions from deposition of anthropogenic nitrogen (N) from NO_x/NH_3 wherever deposited and from whatever source (but not allocated to specific sectors). The reason for this is that emission factors for nitrogen deposited are of the same magnitude for agricultural sources as for other nitrogen sources, even when the N is deposited in the ocean.

Each sector comprises individual categories (e.g., transport) and sub-categories (e.g., cars). Ultimately, countries will construct an inventory from the sub-category level because this is how IPCC methodologies are set out, and total emissions calculated by summation. A national total is calculated by summing up emissions and removals for each gas. An exception is emissions from fuel use in ships and aircraft engaged in international transport which is not included in national totals, but is reported separately.

In order to calculate a national total it is necessary to choose an approach to include harvested wood products (HWP). Countries can select any of the approaches reflected in Chapter 12 of Volume 4 for the AFOLU Sector to do this.

Reporting is generally organised according to the sector actually generating emissions or removals. There are some exceptions to this practice, such as CO_2 emissions from biomass combustion for energy, which are reported in AFOLU Sector as part of net changes in carbon stocks. Where CO_2 emissions are captured from industrial processes or large combustion sources, emissions should be allocated to the sector generating the CO_2 unless it can be shown that the CO_2 is stored in properly monitored geological storage sites as set out in Chapter 5 of Volume 2.

1.2   ESTIMATION METHODS

No refinement.

1.3   STRUCTURE OF THE GUIDELINES

No refinement regarding the structure of the *2006 IPCC Guidelines*. Regarding the structure of the *2019 Refinement*, see the Overview Chapter.

1.4   INVENTORY QUALITY

No refinement.

1.4A NATIONAL GHG INVENTORY ARRANGEMENTS

This section provides guidance on establishing GHG inventory arrangements that support the sustained updating and maintenance of high quality and continuously improving national GHG inventories.

It is considered *good practice* that countries improve the quality (transparency, accuracy, completeness, comparability and consistency (TACCC)) of national GHG inventories on a continuous basis. It is generally accepted that GHG inventories are useful to users if they are updated on a regular basis. There should be improvement over time to provide increasingly useful information on national GHG trends (including influencing factors) and transparent reporting. Establishing sustainable national GHG inventory arrangements will help to continuously improve and regularly update national GHG inventories.

Guidance provided in this section should not be considered prescriptive. It suggests possible approaches and examples of national GHG inventory arrangements demonstrated to be useful when developing sustainable GHG inventory systems that will improve quality.[4], timeliness, and use of resources.

National GHG inventory systems could benefit from being developed in cooperation or integration with other environmental and sustainability statistical data collection services and reporting activities (see Box 1.0a).

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[4] Transparency, accuracy, completeness, consistency and comparability.

BOX 1.0A (New)
LINKAGES OF GHG INVENTORY ACTIVITIES WITH OTHER DATA COLLECTION AND REPORTING

The following linkages can be beneficial and could be managed as a wider programme under GHG inventory arrangements.

National Statistical Systems provide a wide range of data that can be relevant for the GHG inventory compilation. These statistical systems collect data on a regular basis and establish standards for data quality. GHG inventory compilation is a specialised national data collection activity that requires the collection of additional data that are not typically in national statistics (e.g. emission factors). GHG inventories should use national statistics where possible. Countries may integrate their national GHG inventory arrangements, to varying degrees, with their national statistical systems.

Subnational GHG inventory compilation and facility-reporting (e.g. cities, states, provinces, territories, and facility emission registries) can bring benefit to and gain from engagement with more structured and coordinated national GHG inventory arrangements. This benefit can result from interest in and contribution to combined efforts to gather/collate/use geographically resolved data such as for regulated sites (including large industrial installations, waste disposal and recycling/treatment sites), and diffuse traffic and transport, agriculture and forestry. Use of common guidelines, approaches and assumptions and pooled resources/expertise between national and subnational estimation activities will also help to improve the efficiency and credibility of GHG estimates and decision-making processes associated with them.

National GHG and air pollutant inventories can be compiled in tandem. This cooperation or integration can improve quality across inventories, as a large proportion of the activity data (energy, agriculture, transport statistics) are the same for both. It may also improve linkages (through consistent use of data) between climate mitigation and air pollution reporting (e.g. to the UNFCCC and UNECE) and tracking the impact of air pollution and GHG measures to help decision makers understand the co-benefits and potential conflicts. Countries that apply this integrated or cooperative approach may pool resources and management systems for both GHGs and air pollutant inventories and operate more efficiently.

Other environmental and sustainability data gathering processes are undertaken in many countries. These processes involve the collection, reporting of environmental, and sustainability data, including GHG emissions and removals, (e.g., in support of indicators for the UN's Sustainable Development Goals and national statistical environmental economic accounts). These initiatives often have a direct links to GHG inventory compilation activities in either using data from the GHG inventory or providing inputs to its datasets.

1.4.1   Institutional Arrangements

This section introduces the concept of institutional arrangements. There is a wide diversity in approaches used by countries to monitor, report, verify, and respond to review of its GHG estimates on a regular basis. A sustainable process for compilation and continuous improvement is an important aspect of institutional arrangements. Recognising this, this section presents some common concepts and provides some examples of approaches that could be used when setting up or strengthening sustainable GHG inventory arrangements. Guidance provided in this section should not be considered prescriptive.

Institutional arrangements include the interactions between organisations that are involved with the GHG inventory inputs, compilation processes, and outputs. This could include environment, energy, transport, agricultural, and statistical ministries and/or agencies, academic/research institutions, private organisations and career experts and consultants.

Countries may also consider the need for new or modified laws or directives establishing requirements for data collection, archiving, reporting, and quality management to formalize institutional arrangements for national GHG inventory compilation in the context of existing national statistical data collection systems.

1.4.1.1 GHG INVENTORY OBJECTIVES

A useful concept to help define GHG inventory activities and outputs are a country's GHG inventory objectives and other decision-making needs for the GHG data. The identification of objectives will help define the GHG inventory's data and expertise needs, roles and responsibilities, scope (e.g. sectors, gases, geographies, time-series duration), and timeframes (e.g. schedule and updating frequency) for the inventory compilation, reporting, and review processes. Identifying and assessing objectives also helps the institutions involved in the compilation understand how/if objectives interact/conflict/mesh with IPCC *good practice*. An illustrative example of a simplified format that could be used to characterise objectives is presented in Table 1.1. Such a summary table could complement more detailed descriptions when presenting GHG inventory arrangements. An illustrative example summary constructed around the United Kingdom's GHG inventory objectives is presented in Table 1.2.

TABLE 1.1 (NEW) **AN ILLUSTRATIVE EXAMPLE STRUCTURE FOR CAPTURING AND SHARING INFORMATION ON THE OBJECTIVES OF THE NATIONAL GHG INVENTORY**							
Objective[1]	**Gases[2]**	**Sectors & categories[3]**	**Geographical resolution**	**Temporal resolution of estimates[4]**	**Time series span[5]**	**Reporting frequency[6]**	**Reporting formats[7]**
1. List the objectives that the national GHG inventory supports.							
2. Add gases included e.g. CO_2, CH_4, N_2O, fluorinated GHGs, other gases such as precursor pollutants.							
3. Add sectors included Energy, IPPU, AFOLU, Waste, other sectors.							
4. The temporal resolution is usually annual (e.g. 2010, 2011, 2012). Some GHG inventories have different durations spanning several years or sub-yearly (e.g. monthly data).							
5. Indicate the start and end date of the time series.							
6. How frequently is the data updated?							
7. Highlight any specific reporting formats (e.g. table structures, schemas, variables needed for specific reporting).							

TABLE 1.2 (NEW) ILLUSTRATIVE TABLE CONSTRUCTED AROUND UK GHG INVENTORY OBJECTIVES							
Objective	**Gases**	**Sectors & categories**	**Geographical resolution**	**Temporal resolution of estimates**	**Timeseries span**	**Reporting frequency**	**Reporting formats**
UNFCCC: Annual Reporting[a]	CO_2, CH_4, N_2O, Fluorinated gases, Precursors (SO_2, NOx, CO, NMVOC)	Energy, IPPU, AFOLU, Waste	UK + Overseas Territories	Annual estimates	Yearly values from 1990 until two years prior to current calendar year	Annual	NIR and CRF[f]
National Statistics Environmental Accounts[e]							Environmental Accounts[e]
EU Monitoring Mechanism Regulation[c]			Regulated installations within mainland UK				NIR and CRF
National Carbon Budgets[d]	CO_2, CH_4, N_2O, Fluorinated gases		UK				Carbon Budget
UNFCCC: Biennial Report						Biennial	CRF: Summary table 2
UNFCCC: National Communication			UK + Overseas Territories			Every four year	
UNFCCC: Nationally Determined Contributions[b]						5 Years	CRF: Summary table 2

[a] See decision 24/CP.19 on Revision of the UNFCCC reporting guidelines on annual inventories for Parties included in Annex I to the Convention. (Available at: https://unfccc.int/documents/8105).

[b] Article 4(9) of the Paris Agreement: http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf.

[c] UK reporting commitments to the EU valid from 08/07/2013: Regulation (EU) No 525/2013 of the European Parliament and of the Council of 21 May 2013 on a mechanism for monitoring and reporting greenhouse gas emissions and for reporting other information at national and Union level relevant to climate change and repealing Decision No 280/2004/EC. (Available at: https://rod.eionet.europa.eu/instruments/652).

[d] https://www.gov.uk/guidance/carbon-budgets.

[e] https://www.ons.gov.uk/economy/environmentalaccounts.

[f] NIR = National Inventory Report, CRF = Common Reporting Format.

1.4.1.2 STRUCTURING OF INSTITUTIONAL ARRANGEMENTS

Clarifying the structure of institutional arrangements can help formalise and communicate the functional roles of organisations in the national inventory compilation process. An illustrative structure provides an overview of the roles and responsibilities whether institutional arrangements are part of a larger statistical data gathering operation or a stand-alone and dedicated GHG inventory activity. An informative structure diagram could also include organisation names. An illustrative example structure with optional components is presented in Figure 1.0.

An overview of the roles and responsibilities within institutional arrangements is elaborated in Section 1.4.1.3.

Figure 1.0 (New) Illustrative example of GHG inventory institutional arrangements structuring[5]
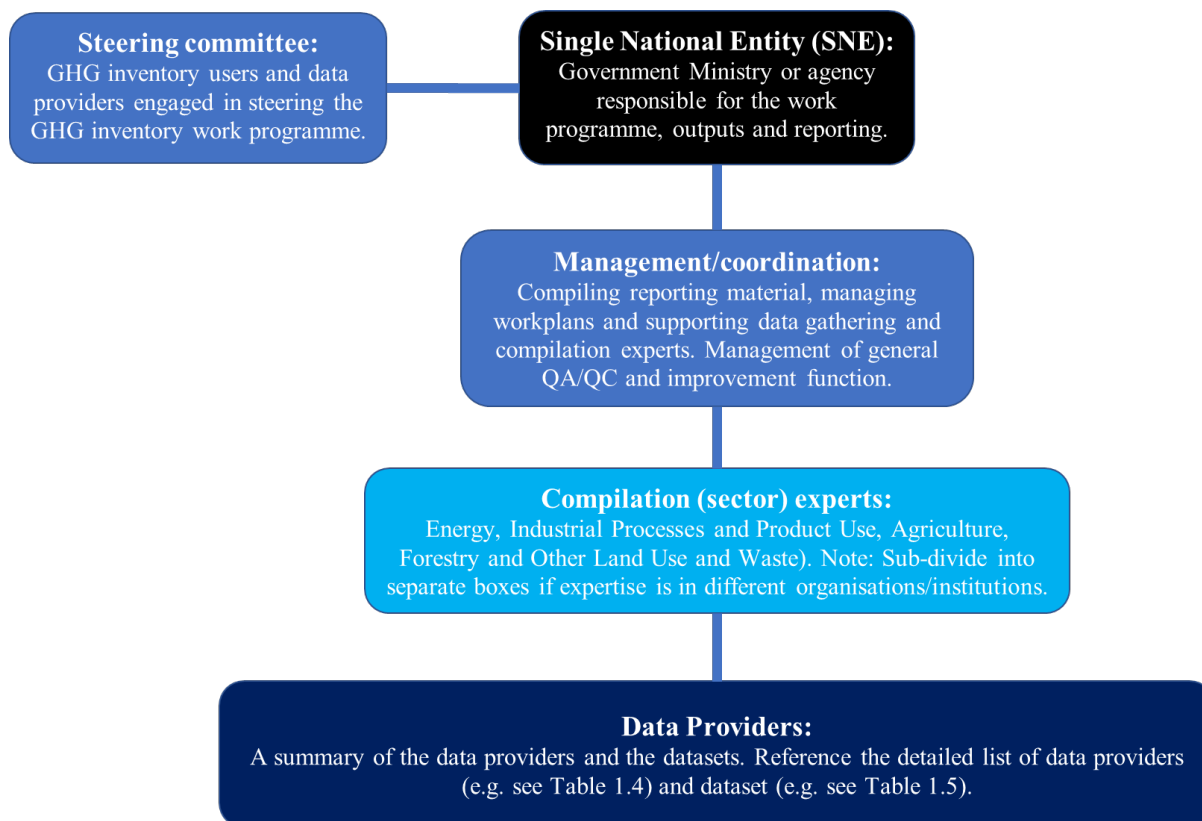
There are numerous approaches other than use of a Steering committee that can bring outside input into the GHG inventory process, such as through a public review period for the GHG inventory.

1.4.1.3 ROLES AND RESPONSIBILITIES

There are many actors and stakeholders involved with and/or interested in GHG inventory inputs, processes, and outputs. Common actors and stakeholder types are presented in Table 1.3. In some countries, a single individual/structure may serve in more than one actor role. Understanding the interests, contributions and involvement of these actors and stakeholders can help to establish a long-term and well-functioning national GHG inventory system.

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[5] The term "Steering Committee" has been used as a generic term to represent a group of interested stakeholders that have influence over the inputs to and development of the GHG inventory.

TABLE 1.3 (NEW) LIST OF COMMON ACTORS AND STAKEHOLDER TYPES WITH THEIR GENERAL ROLES AND CAPABILITIES		
Actor and Stakeholder Type	**Examples of Typical Roles**	**Necessary Capabilities**
Single National Entity (SNE) /National Focal Point (NFP) (see 1.4.1.4)	Acquisition and allocation of resources. Development of long-term strategy for GHG inventory support to national decision makers, climate action and reporting. Arranging contracts and agreements with collaborating entities that contribute data, research studies, estimate emissions or provide expert reviews, etc. Responsible for submission of GHG inventory.	Technical and administrative expertise, as well as formal government authority. Understanding of reporting requirements and IPCC *good practice* concepts. Capacity to coordinate and lead the process. Authority to engage other government departments and non-government organisations.
A group or management structure that contributes to steering the GHG inventory development and who is interested in its outputs and key messages on trends in GHGs (e.g. Steering committee, see 1.4.1.5)	Provide input to the planning, coordination, management and technical facilitation of inputs and outputs in the process, advisors to the National Focal Point. Advice on choice of methods with regard to data availability and decision-making needs.	Sectoral, dataset and/or government policy involvement, knowledge, and authority over data collection, research and national strategies. Involved with policy and decision making and negotiations (e.g. on target setting and mitigation implementation) that uses national GHG inventory data.
Inventory manager/coordinator (see 1.4.1.6)	Management of contracts and delivery of workplans. Coordination with all actors and stakeholders. Management of experts. Management of data supply and data supply agreements. Identification of resources necessary to improve data flows. Coordination of reviews and responses to independent review/analysis and tracking of recommendations. Technical reporting of GHG inventory data and formal submission of reports.	Project management & team management. Quality assurance/ Quality control (QA/QC) (see Section 1.6.3). Technical knowledge of the reporting requirements, review processes and IPCC methodologies. Technical awareness of tools, processes, and IT systems for gathering and reviewing data.
Compilation (sector) experts and researchers (see 1.4.1.7) • Energy • IPPU • AFOLU • Waste	Overall development of methods, data sources, data gathering, compilation and document management. Identify and propose ways to resolve cross cutting issues. Undertake research, data collection, calculations, drafting, quality control, archiving, and documentation. Coordinate with other sector experts. Specialist in a sector, category or group of categories. Identification of potential improvements to estimates.	Technical knowledge of the reporting requirements and IPCC methodologies. Technical skills to carry out the work required for the GHG inventory calculation (data analysis, QA/QC, calculations, documentation). Familiarity with national statistics. Specific national sectoral or sub-sectoral knowledge of practices and technologies employed, data sources, trade associations, networks, policies and key assumptions.

Actor and Stakeholder Type	Examples of Typical Roles	Necessary Capabilities
Data providers (see 1.4.1.8)	Timely delivery of input data in appropriate format. Management of data acquisition, processing and reporting systems, QA/QC requirements. Communication with SNE, the Inventory Agency and sector experts, as needed.	Technical skills/knowledge of, legal authority to improve and enhance data collection. Understanding of the datasets provided.
Other contributors and users	General interest in the work with provision of expertise, independent review, research or use of the data for other purposes.	Any
Policy analyst	GHG inventory data users that inform policies and feed into climate action analysis.	Any

TABLE 1.3 (NEW) (CONTINUED)
LIST OF COMMON ACTORS AND STAKEHOLDER TYPES WITH THEIR GENERAL ROLES AND CAPABILITIES

Each actor/stakeholder contributing to the national GHG inventory may need some form of terms of reference (ToR) to facilitate their engagement. Such a ToR can specify functional roles and responsibilities (e.g., inventory compilation, expert input, tool development and use, and/or data collection and storage) and the schedule for conducting this work. Existing terms of reference for duties such as environmental data gathering or industrial reporting may also be revised to address GHG inventory responsibilities.

The process of engaging actors and stakeholders is likely to vary between different countries and between sectors within countries. The development and maintenance of lists of actors and stakeholders, their roles, responsibilities and interests are quite common. Table 1.4 provides examples of metadata for listing actors and stakeholders involved in the GHG inventory process.

TABLE 1.4 (NEW)
EXAMPLES OF METADATA FOR TRACKING GHG INVENTORY STAKEHOLDERS

1.Name	2.Organisation	3.Contact	4.Mandate	5.Engagement Activities	6.Sector	7.Role

1. **Name**: stakeholders name.

2. **Organisation**: organisation affiliation.

3. **Contact**: contact details.

4. **Mandate**: mandate/terms of reference to contribute to the GHG inventory (if any).

5. **Engagement activities** (Activities that the stakeholder has been regularly involved with e.g. training, workshops, regular meetings attended, data provision etc.).

6. **Sector**: sectors/categories involved with (any particular sector or category involvement).

7. **Role**: type of involvement (e.g. as a data provider, data user, compilation expert, coordinators, data gathering, QA/QC, review, steering committee meetings, training, sectoral workshops, compilation and reporting activities, consultations, and reviews.

1.4.1.4 THE SINGLE NATIONAL ENTITY

The term "single national entity" (SNE) is often used to refer to the lead organisation with the responsibility for reporting official national GHG estimates. It is often aligned with the national focal point or international point of contact on climate reporting. The role of SNE is usually taken on by a government ministry with mandate to manage the country's GHG inventory reporting and response to climate change or may be with a national statistical or environmental agency. A key role within the SNE is that of overseeing the GHG inventory activities. A designated focal point coordinates the activities needed to ensure that outputs are prepared of sufficient quality to meet the country's commitments. The role of SNE is sometimes delegated by a government ministry, via mandates/terms of reference, to a climate change, environmental, or statistical agency with the technical capacity

to prepare national reports. The SNE could be the Inventory Agency with a mandate to report the GHG inventory data to the ministry or on behalf of the ministry internationally.

1.4.1.5 NATIONAL GHG INVENTORY TECHNICAL STEERING COMMITTEE OR WORKING GROUP

Countries may find it useful to establish a working group or committee of interested actors and stakeholders to participate in national processes for approving GHG inventory developments and estimates.

This group or committee can consist of actors and stakeholders representing users of (e.g. policy makers) and data providers to the national GHG inventory (e.g. research agencies, national statistical organisations, environment agencies, academic institutions, industrial trade associations, and consultancies). It can provide a forum for the SNE to coordinate and communicate on GHG inventory activities and to secure data provision and independent analysis.

This group of stakeholders can be also convened in support of prioritisation and implementation of inventory improvements.

1.4.1.6 INVENTORY MANAGER/COORDINATOR

Types of institutions that could serve as inventory manager/coordinator include:

- **A government ministry**. Inventory management and coordination can be implemented by a government ministry that also serves as the SNE, in which case it should have the appropriate coordination and technical capacity.

- **A national institution/agency.** Inventory management and coordination can be delegated to a competent institution (e.g. statistical, meteorological, or environmental). Such an institution is typically focused on providing technical support and analysis to government officials for decision making and reporting. It will often have expertise on certain sectors and access to some of the datasets needed for the compilation and will then outsource other data gathering and compilation for other sectors (e.g. Forestry and Other Land Use to forest agencies or institutions).

- **A private company, university or other non-government organisation**. The inventory management and coordination can be contractually delegated to an organisation outside of government, such as a university, research institute, or a consultancy/private company. This organisation may be selected for its technical competency and capacity to coordinate the activities and expertise for the compilation and reporting of the inventory. Contracts can be typically set-up with well-defined deliverables and quality objectives[6] and commitments to engage the organisation preferably over a suitable period (e.g. 4 to 6 years) to promote the sustained development and maintenance of the GHG inventory. Whether the inventory is managed within the national government or by external organisations, provisions could be in place for the transfer of data, documents, calculation and reporting tools and knowledge of the national GHG inventory to a new inventory manager/coordinator (e.g., from SNE to a new contracted organisation such as a private company), including consideration of adequate training investment. These provisions can help ensure national retention of institutional knowledge and capability to ensure that the inventory can continue to be delivered and achieve quality standards in the future.

1.4.1.7 COMPILATION EXPERTS

A national GHG inventory system can benefit from a committed team of inventory compilation experts. These experts understand the requirements for inventory quality (as defined in Chapter 1, Section 1.4 of the *2006 IPCC Guidelines*), IPCC methods, national emission/removal related sectoral processes/practices, and national datasets. It is advantageous for experts to have a good understanding of international reporting and review processes, which can be developed through participation in international or regional peer review activities.

As an example, roles and responsibilities for core compilation functions of the GHG inventory team are also outlined in a comprehensive templates prepared by the US EPA in the Greenhouse Gas Inventory Toolkit (EPA 2016). These are not the only examples, but they provide a useful starting point for specifying terms of reference.
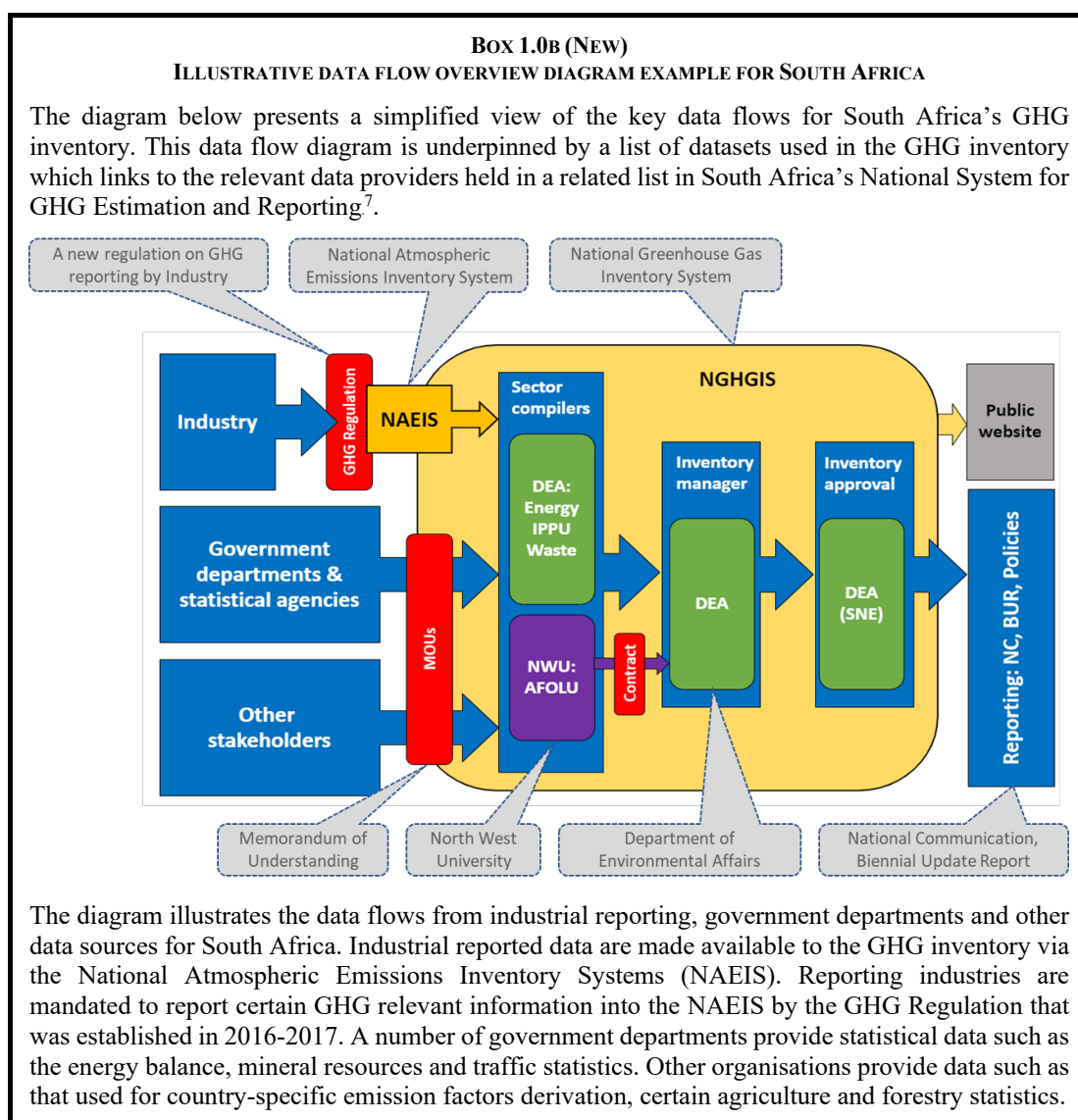
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[6] Linked to the quality principles (TCCCA referred to in Volume 1).

1.4.1.8 DATA PROVIDERS

Chapter 2 provides detailed identification of relevant data providers and sources of data. National statistical agencies often have a central role in a country's statistical data collection. Further examples for the formalisation of agreements with data suppliers are provided in Section 1.4.2.2.

1.4.2 Datasets and data flows

There are numerous datasets needed for GHG inventory compilation and many data providers (including national statistical agencies, research institutes, government ministries, etc.) who provide them. Approaches for data collection are provided in Chapter 2. Mapping the "flow" of data, in the form of a diagram, from initial data collection to final reporting, further documents and highlights importance of data providers for the inventory compilation process. An illustrative example of such a diagram is provided in Box 1.0b.

BOX 1.0B (NEW)
ILLUSTRATIVE DATA FLOW OVERVIEW DIAGRAM EXAMPLE FOR SOUTH AFRICA

The diagram below presents a simplified view of the key data flows for South Africa's GHG inventory. This data flow diagram is underpinned by a list of datasets used in the GHG inventory which links to the relevant data providers held in a related list in South Africa's National System for GHG Estimation and Reporting[7].

The diagram illustrates the data flows from industrial reporting, government departments and other data sources for South Africa. Industrial reported data are made available to the GHG inventory via the National Atmospheric Emissions Inventory Systems (NAEIS). Reporting industries are mandated to report certain GHG relevant information into the NAEIS by the GHG Regulation that was established in 2016-2017. A number of government departments provide statistical data such as the energy balance, mineral resources and traffic statistics. Other organisations provide data such as that used for country-specific emission factors derivation, certain agriculture and forestry statistics.

More detailed data flows for specific datasets, sectors, or categories can help document the process, improve transparency and build institutional memory.

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[7] Own construction based on the South Africa's 2nd Biennial Update Report. (Available at: https://unfccc.int/documents/39835).

1.4.2.1 Archive of datasets

An important component of institutional arrangements is a systematic approach to data management and the collection of data. A first step could be to create and maintain an archive and list of the datasets that are needed for the GHG inventory compilation. This archive and list, which can be established for each sector or as a centralised entity, can help to build and maintain institutional memory and support efficient and transparent compilation of regular updates. An illustrative outline for a list of datasets is presented in Table 1.5.

TABLE 1.5 (NEW) ILLUSTRATIVE LIST OF DATASETS USED IN THE GHG INVENTORY							
1.Name	**2.Status**	**3.Description**	**4.Reference**	**5.Location**	**6.Data Provider**	**7.Sector/ category**	**8.Update**

1. **Name**: This should be a unique name for the dataset.
2. **Status**: Provide a status to indicate if the dataset is received or pending receipt, outdated etc.
3. **Description**: A description of the dataset, including version and date.
4. **Reference**: A reference or link to a relevant data supply agreement if it exists (see Section 1.4.2.2).
5. **Location**: Where the received data are stored within the GHG Inventory archive.
6. **Data Provider**: The provider of the data.
7. **Sector/category**: The sectors/categories of relevance to the dataset.
8. **Update**: The regularity that the dataset is updated.

1.4.2.2 Data supply agreements (DSAs)

Chapter 2 on data collection refers to the establishment of agreements formalising data supply. A data supply agreement (DSA) is a document that defines what data, from whom, to whom, and when it will be supplied for GHG inventory compilation. Ideally, a DSA is arranged between the GHG inventory SNE and the data supplier. A DSA can be beneficial for both an SNE/inventory compiler and data supplier. A DSA can help secure data provision in the future. Also, a DSA can assist a data supplying organisations by establishing a formally recognized acknowledgement that can promote the allocation resources within the data supplying organisation to deliver high quality data on time.

There are many potential DSA formats. Where there are national laws for data supply, these can be referenced. Where data supply is less formal, DSAs act as an informal specification. Suitable examples of DSAs can be found in many of the countries that are Annex I Parties to the UNFCCC. Possible contents, taken from examples of DSAs,[8] that could form part of an agreement document between the GHG Inventory SNE and the data supplier stakeholder are suggested below:

- background on the needs/mandate for the GHG inventory compilation;

- reference to laws/terms of reference and co-operation between the data supplier and the GHG inventory representatives;

- objectives of the agreement with reference to an annex specifying the details;

- confidentiality provisions and commitments;

- procedures that enable the receiving party (the data user, e.g., SNE or inventory agency) to provide feedback to the data supplier on priorities for future improvement of the data set;

- signatures of GHG inventory representative and data supplier, if appropriate;

- technical annex containing details of the data to be supplied, including:

    (i)   unique title of the dataset (to avoid confusion with other datasets);

    (ii)   confidentiality flags;

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[8] There are many countries (e.g., United Kingdom, Austria and South Africa) that are working with and developing DSAs.

(iii)   description including format (electronic format) and scope (time-series, detail, nomenclature, categories, geographies);

(iv)   supplying department/service;

(v)   deadlines for supply;

(vi)   details of QA/QC applied to the data prior to supply;

(vii)   uncertainties in the data.

A generic template for the development of a DSA in the form of a memorandum of understanding with a data supplier can be found in the National Greenhouse Gas Inventory Templates developed by the United States Environmental Protection Agency and United States Agency for International Development hosted by the LEDs group (EPA 2016).

1.5   COMPILING AN INVENTORY

No refinement.

1.6   GHG INVENTORY MANAGEMENT TOOLS

The development of GHG inventory management tools will help to ensure efficiency and transparency in the GHG inventory compilation activities throughout the steps identified in the compilation cycle in Figure 1.1 of Section 1.5 of the *2006 IPCC Guidelines*. Tools include workplans, improvement plans, data management systems, quality systems, training and capacity building and documentation procedures.

The tools in this section should not be considered prescriptive. The sections below provide some suggested approaches and examples demonstrated to be useful when developing sustainable GHG inventory systems that will improve quality[9], timeliness, and use of resources.

1.6.1   Workplans

National GHG inventories compiled/updated on a regular basis can benefit from the development of a clearly defined workplan, which clarifies the schedule of steps for generating GHG inventory outputs. An illustrative example workplan for a regular inventory update cycle is presented in Table 1.6. Workplans should be reviewed, and where necessary, revised prior to the start of a new inventory update cycle. The GHG inventory manager/coordinator should maintain these workplans and formalize them with GHG inventory compilation contributors through communication of the workplan.

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[9] Transparency, accuracy, completeness, consistency and comparability.

TABLE 1.6 (NEW) **ILLUSTRATIVE WORKPLAN FOR THE PREPARATION OF A GHG INVENTORY INCLUDING AN INDICATIVE TIMELINE**		
Example Activity	**Illustrative Milestones[10]**	**Illustrative lead actor/stakeholder**
Agreement on the scope of work (including stakeholder consultation and identified improvements and updates to the time-series) and timeframes with stakeholders/steering committee	Week 1	SNE/Inventory manager/coordinator & steering committee engaged for prioritising improvements
Appointing/engaging the team of experts to deliver the scope of work needed (data collection, compilation, QA/QC, documentation and reporting) establishing/revising Terms of Reference: • Roles and responsibilities • Timelines • Deliverables • Time (budgets) allocation	Week 2-6	SNE/Inventory manager/coordinator
Sectoral estimation (e.g. Energy, IPPU, Agriculture, FOLU and Waste), including: • Collecting data (engaging with data suppliers) and checking data supplied • Agreeing any new methodologies and/or continuation of existing methodologies • Calculation of estimates • QC (checking of all estimates) • QA (peer review of new estimates) • Documentation • Finalisation of reporting formats	Week 3-30	Compilation experts
Collation of sectoral estimates into draft final datasets and national totals and trends (master summary files or database); compilation of uncertainty and *key category* analysis	Week 30-34	Inventory manager/coordinator. Compilation experts where needed for follow-up
QC of draft final estimates and documentation of changes and trends	Week 32-36	
Drafting (collation of the sectoral documentation on methods, data sources and assumptions, *key category* and uncertainty analysis) into the National Inventory Report	Week 34-40	
Consultation with stakeholders on draft final estimates and National Inventory Report and documented changes and trend features	Week 40-46	(SNE and steering committee engaged for stakeholder review/consultation on outputs)
Finalisation of estimates and the National Inventory Report and archiving of the GHG inventory material	Week 46-50	
Reporting and other deliverables to stakeholders and national decision-making processes	Week 50-52	

Table 1.6 is only illustrative. It may require adjustment to the specific national circumstances including the timeframes and time period of the GHG inventory cycle which may be more than 1 year (e.g., 2 or 4 years).

1.6.2 Data management system

The process of preparing and updating a national GHG inventory will involve the use of numerous datasets, documents, references, as well as the application of a range of assumptions, expert judgements, data conversions, and manipulations (e.g., combining data from multiple data sources). Volume 1, Chapter 2 provides guidance on documentation for data collection and Volume 1, Chapter 6 provides additional guidance on documentation.

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[10] Milestones should be specified as specific calendar dates.

There are many different data management systems used by countries. Some use sophisticated database tools connected to the internet and available for users to upload data and to operate from remote locations. However, many countries currently operate using a collection of spreadsheets, databases and bespoke software systems for calculating GHG estimates. Some key points around the differences between data management systems needed for calculating estimates and for aggregating and reporting GHG inventory data are provided below:

Calculating GHG Estimates: Sector compilation experts need flexibility to compile estimates using tools appropriate to national circumstances, including the complexity of their data and methods. Specialised models or spreadsheets may be appropriate. Spreadsheets are often used when starting out and for developing methods, as they are accessible to a range of experts. More complex methods will often entail use of specialised models or databases to facilitate complex calculations and/or the handling of large datasets. Whatever tools are used, applying a common practice for documentation within calculation tools including the following points should be considered:

1. using standard classification and nomenclatures for compilation of estimates (this nomenclature can be based on country-specific or IPCC or other recognised classifications (e.g. United Nations Statistics Division (UNSD) classifications.[11]);

2. including metadata in each file and maintaining a master list of the calculation files, their types, authors, and versions;

3. using a standard file naming convention across categories and inventory cycles;

4. documentation in tools with evidence of the implementation of QA/QC procedures;

5. colour coding or other visual formatting to differentiate between areas of data input, calculations, QA/QC checks, explanations, and outputs;

6. documenting where historical data or methods have been revised;

7. documentation of complex models (see Volume 1, Chapter 6); and

8. standard output format for all reported data.

Collation, Aggregation and Reporting: For analysis and reporting, inventory data needs to be collated, from what can be in the form of differently formatted spreadsheets or calculation models, into a coherent set of tables that can be aggregated to produce detailed reporting formats, national totals, and summary tables. This collation of data into a single format also enables general QA/QC to be applied more easily using tools that can identify anomalies in trends and missing data points. A suggested standardised structure for collating data within a database on emissions, removals, and relevant activity data from the range of categories, gases, fuels and other sub categories is presented in Table 1.7.

TABLE 1.7 (NEW) SUGGESTED INFORMATION IN A STANDARDISED DATA STRUCTURE FOR COLLATING GHG INVENTORY DATA									
1.Year	2.National Nomenclature	3.Reporting Nomenclature	4.Geography	5.Gas	6.Type of variable	7.Value	8.Units	9.Notation Keys	10.Reference

1. Year (the year of the value in the time-series).

2. National nomenclature (if relevant the nomenclature used nationally and linked to the statistics, national definitions and/or source data, allowing reports for national use in a nomenclature familiar to national actors and stakeholders).

3. Reporting nomenclature (e.g. IPCC categories and fuels/activities).

4. Geography (identifying which part of the national geographical area is represented).

5. Gas/pollutant.

6. Type of variable (e.g. emission/removal, activity data, implied emission factor).

7. The variable value.

8. Variable units.

9. Notation key (if relevant).

10. Reference/description of updates since previous compilation; and reference for the source of the value (calculation file).

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[11] https://unstats.un.org/unsd/classifications/.

1.6.3   Management of QA/QC & documentation material

Extensive guidance on QA/QC and documentation is presented in Volume 1, Chapter 6. The following components could be considered as part of QA/QC management and documentation of the GHG inventory:

- **QA/QC Plan** (see Section 6.5 of the QA/QC chapter of the *2006 IPCC Guidelines*), including general and category-specific QC procedures (see Sections 6.6 and 6.7).

- **A log of implemented QA/QC and verification activities** with reference to associated documentation and findings (see Sections 6.8 and 6.10 of the QA/QC chapter).

- An **inventory improvement plan** containing potential, planned and implemented improvements. This plan may include a simple table as illustrated in Table 1.8:

TABLE 1.8 (NEW) SUGGESTED DESCRIPTION OF POTENTIAL, PLANNED AND IMPLEMENTED IMPROVEMENTS IN INVENTORY IMPROVEMENT PLAN						
1.Categorisation	2.Name	3.Description	4.Origin	5.Status	6.Priority	7.Owner
1. The **categorization** of the improvement. This could include the sector or categories, and the type of improvement activity (e.g. improved QA/QC processes, improved uncertainties or key category analysis, improving activity data, moving to higher tier methods). 2. A short unique **name**. 3. Improvement **description** including information on timeframes and technicalities for development. 4. The **origin** of the improvement (e.g. recommendation or expert suggestion or international review process). 5. The **status** (e.g. suggested, proposed, planned, work in progress, implemented) of the improvement. 6. **The priority** of the improvement (informed by the *key category* analysis). 7. The **owner** is the person or entity responsible for implementing the improvement.						

- An **inventory archive** (see Section 6.11 of the QA/QC chapter) that structures and stores data on the latest and previous GHG inventory estimates, reports, methodology documents, and calculation files.

- **Country-specific training material** addressing country-specific methods and data management tools.

1.6.4   GHG inventory training activities

Suitably trained and/or experienced GHG inventory experts help support the national GHG inventory system to efficiently produce high quality outputs. Training and experience development can be focussed in three areas:

- Training in the methods in the latest *IPCC Guidelines* available from a number of training services and the UNFCCC/IPCC.

- Training in the application of relevant *IPCC Guidelines* to the country circumstances. This training may include country-specific or international courses and material.

- Participation in international review processes (e.g. UNFCCC process), which can provide experts with broader experience with GHG inventories undertaken by other countries.

Ready access to training and regular review participation can help build national capacity, understanding of international reporting requirements, and enhance sustainability of the national GHG inventory arrangements. It may be helpful for the Single National Entity to maintain a roster of identified trainers and archive of training material.

1.6.5   Education, awareness raising and public access to the information

A national GHG inventory can provide information (e.g. increasing or decreasing trends and sectoral contributions) to support stakeholder decision making. Education-related activities aimed at stakeholders (e.g. relevant government ministries) can help develop their technical capacity, enhance cooperation, and improve their knowledge that can in turn contribute to the continuous improvement of the GHG inventory.

There are activities that can be useful in promoting the GHG inventory processes and outputs. Some examples of such activities include:

- Organizing GHG inventory orientated **workshops with stakeholders.** These can range from technical workshops focused on overall inventory results or on specific sectors to awareness raising events for mass media.

- **Publication of the GHG inventory data in user-friendly forms** using visual tools such as infographics to engage with wider stakeholders, students, the press and policy makers.

- **Development of overview and sector specific indicators and factsheets** highlighting key stories on the trends and progress to targets.

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