INFORMATION BRIEF

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LOW EMISSION CAPACITY BUILDING PROGRAMME

STRENGTHENING NATIONAL GREENHOUSE GAS (GHG) INVENTORY SYSTEMS

1. BACKGROUND

A national greenhouse gas (GHG) inventory is a cornerstone of a country's reporting obligations to the United Nations Framework Convention on Climate Change (UNFCCC). It can also be a valuable tool for understanding development trends, improving resource management and energy efficiency, and developing policies and programmes to address climate change. More accurate GHG inventories enable decision makers to make more informed policy choices, with greater confidence.

In the context of the Low-Emission Capacity Building (LECB) Programme, a high-quality GHG inventory supports the underlying scientific basis for Nationally Appropriate Mitigation Actions (NAMAs) and Low Emission Development Strategies (LEDS), and sets the foundation for the Measuring, Reporting & Verification (MRV) requirements associated with NAMAs and LEDS. Outcome 1 of the LECB Programme invites countries **to establish robust national systems for preparation of GHG emission inventories at the national level**. A national GHG inventory system incorporates all the legal, institutional, and procedural elements needed to estimate, report, and archive GHG emissions and sinks. This includes the description of the procedures for preparing GHG inventories and the documentation of data sources, methodological choice, and assumptions. Robust national inventory systems also include quality assurance and quality control (QA/QC) measures and introduce legal and institutional mechanisms for ensuring periodic reporting of data. Thus, an inventory system comprises both the documentation of the GHG inventory itself as well as documents "around" the inventory describing how to make an inventory, e.g., workplans, manual of procedures, legal arrangements, roles & responsibilities, reporting obligations, etc (UNDP, 2005).

Although developing countries have made significant improvements in preparing GHG inventories, very few have put in place national GHG inventory systems. The lack of systems to establish a sustainable inventory process and, eventually, to develop MRV systems is a significant barrier to improving GHG inventory quality (see side bar). The most common constraints reported include lack of: adequate

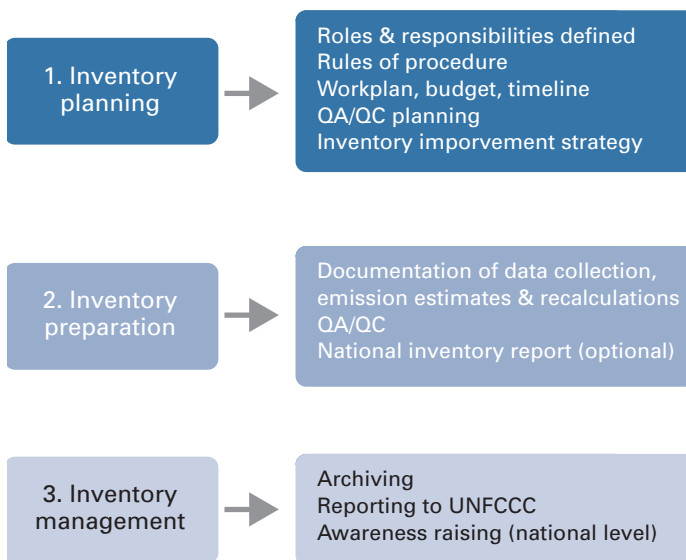## The IPCC defines five indicators of inventory quality:

- **Transparency:** Assumptions and methods are explained clearly so the inventory can be understood and replicated;

- **Accuracy:** Estimates reflect actual emissions and removals, with no systematic overestimation or underestimation;

- **Completeness:** All existing, relevant sources, sinks, and gases across a country's full geographic area are included;

- **Consistency:** The same methodologies and consistent data sets are used for the base and all subsequent years in estimating emissions and removals, so differences in results between years and categories reflect real differences in emissions;

- **Comparability:** The methodologies used to develop estimates of emissions and removals, and how the inventory is reported, allow the inventory to be compared to those developed by other countries.

Source: US EPA/US AID

archiving and management of data required for regular updates of GHG inventories; application of QA/QC procedures in inventory compilation; procedures to fill data gaps; and use of methodologies to assess uncertainties of GHG inventories, among others.

2. APPROACH

A national inventory system can help streamline the three main phases of an inventory process, i.e., inventory planning, inventory preparation, and inventory management. There is no one specific approach to establishing a national GHG inventory system – the system should be designed based on national circumstances and the processes already in place for preparing the national GHG inventory as part of the National Communication to the UNFCCC.

1. Inventory planning	→	Roles & responsibilities defined Rules of procedure Workplan, budget, timeline QA/QC planning Inventory imporvement strategy
2. Inventory preparation	→	Documentation of data collection, emission estimates & recalculations QA/QC National inventory report (optional)
3. Inventory management	→	Archiving Reporting to UNFCCC Awareness raising (national level)

Some initial considerations are:

- *Has a key category analysis been undertaken?* It is recommended to focus on improving the quality of those sources (and sinks) that have a significant influence on a country's total inventory of direct GHGs, in terms of absolute level of emissions, trend in emissions, or both.

- *What is the quality of data for the key sources (sinks)?* Are there uncertainties that need to be addressed? What new data sources might be needed? What should be done in cases where data is confidential (e.g., military, private sector)? Is there a strategy for

improving the data and filling data gaps? (Figure 1 from the IPCC guidance shows decision-making process).

- *Is there already a robust system for collecting and reporting data?* If not, what are the main issues and what is a way to overcome these issues (e.g., MOUs with data providers, templates for data provision, etc)?

- *Is there already a robust system for archiving data and documenting assumptions and other key sources of information?* If not, what processes can be put in place to improve this task, taking into account the national context and existing processes (e.g., development of rules of procedure for documentation and archiving, version control of spreadsheets, etc)? Is there a way to work within the current data collection practices of the institution to obtain the additional data needed without creating entirely new processes?

- *Are there QA/QC procedures in place?* If not, what processes can be put in place to improve this task, taking into account the national context and existing processes? (e.g., QA/QC plan)?

- *Is there a manual (or blueprint) of procedures that describes the entire GHG inventory planning and implementation process -- including the typical timeline for preparing the inventory and the associated budgetary costs?* That is, is there sufficient guidance and documentation that a new inventory team would be able to recreate the existing GHG inventory(ies)?

- *Is there a medium- to long-term inventory improve-ment strategy in place?* This might focus on longer-term capacity building, development of national emission factors, and improvement of data. The development of a national GHG inventory system is an iterative process, as certain components will be updated after the preparation of each GHG inventory.

- *Is there an awareness-raising strategy in place for public dissemination of inventory results?* It may also be useful to consider developing a strategy to engage key providers of data (either existing or new).

3. LECB PROGRAMME OUTPUTS & ACTIVITIES

The following examples of outputs and activities to strengthen and/or establish national GHG inventory systems have been collated from various national LECB project documents to demonstrate the range of activities that can be undertaken. It is expected that this work is being undertaken in close consultation with the GHG inventory team for the National Communications to ensure synergies between efforts.

Output 1: Institutional arrangements for National Inventory System described and enhanced

It is important to establish arrangements (formal or informal) with data providers to ensure access to data that will be used to develop GHG emission estimates. The arrangements may vary depending on the availability of information (for example, some information is publicly available, while some private data may have restrictions for use). It is recommended to define functional roles and arrangements for data providers in each sector. Documenting these institutional arrangements will allow the current and future inventory teams to easily identify the responsible persons for each sector/source, and to clearly communicate the commitments needed from the responsible entities. The US EPA has a template that can be used for this purpose: http://www.epa.gov/climatechange/Downloads/EPAactivities/Template-1-Institutional-Arrangements.doc

Potential activities

- Establish thematic working group on GHG Inventory System

- Identify inventory management team

- Identify source leads, establish cooperation agreements (e.g., MOUs, TORs, legislation, meetings, agreements, etc) and document how the arrangements were established

- Document sectoral roles and arrangements (e.g., existing arrangements for obtaining, compiling and reviewing inventory data)

- Assess specific capacity building needs of specific institutions and persons

- Undertake awareness raising and training of lead agencies, as required

- Recommend improvements to institutional arrangements

Output 2: Key categories identified

The 2006 IPCC Guidelines for National Greenhouse Gas Inventories define a key category as a "category that is prioritized within the national inventory system because its estimate has a significant influence on a country's total inventory of greenhouse gases in terms of the absolute level, the trend, or the uncertainty in emissions and removals. Whenever the term key category is used, it includes both source and sink categories." By completing a key category analysis, the inventory team can identify the areas on which should be focused in order to improve estimates (so that resources are used most efficiently) –see Figure 1. A Tier 1 level analysis can be conducted once one year of GHG inventory data is available, while a Tier 1 trend analysis requires two years of GHG inventory data. The Tier 2 analysis incorporates accounting for uncertainties. The US EPA has a template that can be used for this purpose: http://www.epa.gov/climatechange/Downloads/EPAactivities/Template-5-Key-Category-Analysis.doc

Potential activities

- Complete Tier 1 key category "base year level analysis" and "trend analysis"

- Complete Tier 2 key category "base year level analysis" and "trend analysis", as appropriate

- Undertake awareness raising on results, as required

Figure 1: IPCC Decision Tree to choose a good practice method
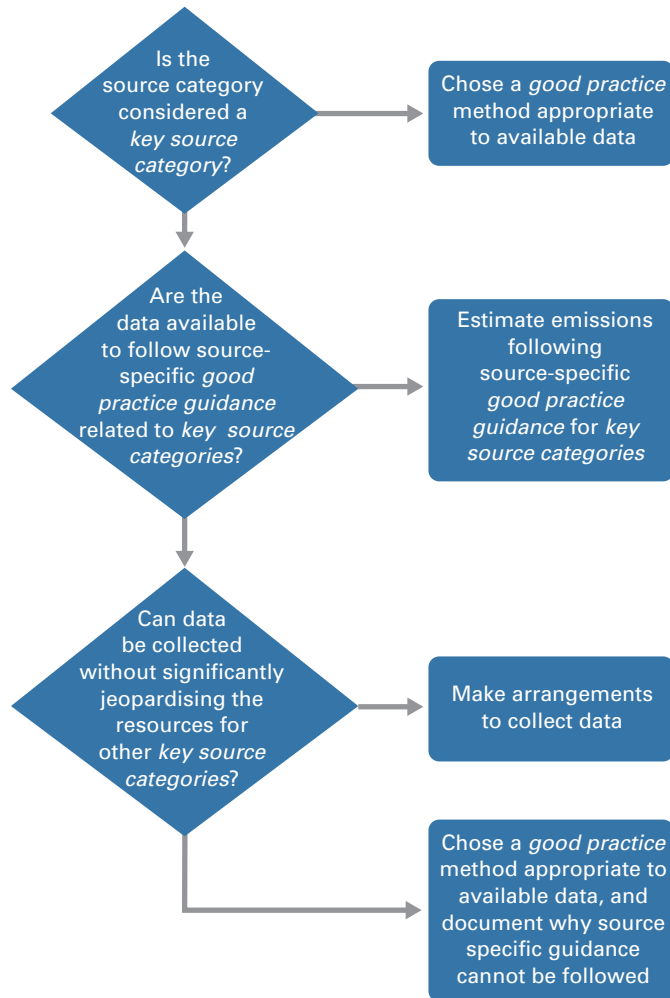
Source: Good Practice Guidance and Uncertainty Management in National GHG Inventories (IPCC, 2000), Chapter 7, Figure 7.4, p7.15

Output 3: Data collection & analysis strategy developed

In many countries, there are GHG inventory data gaps for which data exists, but for which there are barriers to collection. One approach under LECB is to first identify available international and regional data sources that can fill gaps, and then prepare a strategy for overcoming barriers to obtaining the national data as part of the inventory improvement strategy. Ideally, the National Communications GHG inventory team can then apply the proposed LECB solutions for overcoming data barriers.

Potential activities

- Determine the availability and quality of existing activity data to fill inventory data gaps

- Identify sources of available regional and international data in key source categories for selected sectors

- Identify national sources of data in key source categories for selected sectors

- Identify barriers to obtaining available data in key source categories

- Recommend country solutions (practices) to overcoming barriers (i.e., improvement strategy)

- Prioritise emission factors needing improvement using key source analysis and Good Practice Guidance tools such as sensitivity analysis

Output 4: Data gaps reduced

In contrast to Output 3, there are certain situations where available source of key category data cannot be identified and must be compiled. Under LECB, various approaches and methods for extrapolating such data can be proposed. Ideally, the National Communications GHG inventory team can then apply the proposed LECB solutions for overcoming data barriers.

Potential activities

- Identify data that must be compiled/developed to fill gaps in key source categories for selected sectors

- Identify appropriate methods/approaches to overcome data gaps e.g. compare inventories across years to identify trends in emissions and removals, use interpolation/extrapolation methods, etc.

- Recommend country solutions/methods for overcoming data gaps (i.e., improvement strategy)

Output 5: Methods and data documented

Documentation is a critical success factor for the sustainability of a national inventory system. In order to be able to reproduce a GHG inventory, it is essential to capture critical information for each source and/or sink that systematically describes the national context, and the methods, data and emission factors used to calculate emissions. The US EPA has a template that can be used for this purpose: http://www.epa.gov/climatechange/Downloads/EPAactivities/Template-2-Method-and-Data-Documentation.doc

Potential activities

- Archive relevant information (i.e., activity data, emission factors, conversion factors)

- Document the selection process for all information

- Document the methods used and assumptions made

- Document the data collection methods and procedures of data providers

- Elaborate a national manual of procedures for the inventory cycle (planning, preparation, and management)

- Recommend improvements to data analysis

- Undertake capacity building for institutions to disseminate the results

Output 6: Quality Assurance/Quality Control (QA/QC) measures put in place

Implementation of QA/QC procedures enhances the credibility of the national GHG inventory, as by following prescribed QA/QC measures, a national GHG inventory team will be able to uncover calculation errors and ensure the reliability and accuracy of the inventory. The first step in developing a QA/QC plan is to assess and identify any existing QC or QA procedures that are being applied. The next step is to identify additional needed QA/QC procedures, define roles for all involved entities and develop a schedule for the QA/QC plan. The US EPA has a template that can be adapted for this purpose: http://www.epa.gov/climatechange/Downloads/EPAactivities/Template-3-QA-QC-Procedures.doc

Potential activities

- Elaborate and/or review the main elements of QA/QC plan

- List key QA/QC personnel and any country-specific additional QA/QC responsibilities

- Define procedures and prepare a Tier 1 QA/QC checklist for the national GHG inventory team

- Define procedures and prepare a Tier 2 QA/QC checklist for the national GHG inventory team, as appropriate

- Establish peer review group (may include external experts)

- Undertake capacity building on QA/QC procedures, as required

Output 7: Archiving system described

The inventory archive is the starting point for future inventories, and a robust archive can greatly reduce the efforts that future teams have to invest in understanding and recalculating the estimates. To implement an effective archiving system, the US EPA suggests that information be archived in a single location and in both electronic and paper formats. The inventory team should also maintain additional copies in the event that materials are lost or damaged. Key information to archive at a minimum are: activity data; methods; emission factors; estimates; documentation of how these data, factors and estimates were obtained; and documentation of QA/QC procedures, reviews and key categories. The US EPA has a template that can be used for this purpose: http://www.epa.gov/climatechange/Downloads/EPAactivities/Template-4-Archiving-System.docx

Potential activities

- Describe the existing archiving program and procedures

- Evaluate the current archiving system

- Elaborate improved procedures for archiving file management

- Establish a system of electronic archiving (e.g., a database, website), as appropriate

Output 8: Inventory improvement strategy elaborated

The purpose of an inventory improvement strategy is to help inventory teams identify and prioritize incremental improvements to their national systems. The US EPA has a template that can be used for this purpose: http://www.epa.gov/climatechange/Downloads/EPAactivities/Template-6-National-Inventory_Improvement-Plan.docx

Potential activities

- Provide country-specific objectives

- Summarize findings for improving national inventory system based on Outputs 7-1 above

- Define GHG inventory products and results dissemination plan

- Describe communication, outreach, and training activities/plans

- Prioritize inventory improvements (immediate, medium, and long-term)

Output 9: Number of qualified national GHG inventory experts increased

- Undertake capacity needs analysis and develop plan for capacity building

- Prepare training programmes on general inventory practices

- Prepare source-specific training programmes

4. LEARNING FROM PREVIOUS EXPERIENCE

Under the UNDP-GEF project, Capacity Building for Improving the Quality of Greenhouse Gas Inventories (Europe/CIS region) (June 2003 – September 2006), countries applied the good practice inventory principles of the Intergovernmental Panel on Climate Change (IPCC) to strengthen institutional arrangements for compiling, archiving, updating, and managing GHG inventories in order to create a more sustainable inventory process. Twelve countries participated in the $2.8M project, funded by the Global Environment Facility and Switzerland: Albania, Armenia, Azerbaijan, Croatia, Georgia, FYR Macedonia, Moldova, Mongolia, Slovenia, Tajikistan, Turkmenistan and Uzbekistan. Project results are archived here: http://archive.rec.org/ REC/Programs/UNDP-GHGInventories/Default.html

The key takeaway was the realisation that focusing on the improvement of management systems and processes and institutional arrangements was as important (if not more so) as focusing on improvement of activity data and emission factor estimates. This change in perception demonstrated the maturation in thinking from inventory teams in the region towards a strategic, incremental approach to inventory improvement, centred on the key category analysis.

Other lessons learned from the project were:

- *Complete documentation and archiving of the national GHG inventory is a critical success factor for enhancing the sustainability of the GHG inventory process.* Although preparing a national manual of procedures is time- and labour-intensive, it is important to document why activity data, methods, emission factors and results were (or were not) selected for the national GHG inventory, as well as underlying assumptions and uncertainties. Without such systematised information, inventory teams and the national inventory itself will not be able to benefit from the work that has been done before.

- *Activity data gaps and uncertainties are some of the most commonly reported problems in non-Annex I countries.* The identification of alternative data providers (including regional and international sources) and use of standardised methods for filling in data gaps can help to complete the inventory. Data flow charts are a useful method for mapping this information.

- *The inventory improvement strategy is an important mechanism in order to identify and prioritise tasks, and should be centred on the results of the key category analysis.* Each new inventory is an opportunity to not only improve the accuracy and comprehensiveness of emission estimates, but also to improve the management systems designed to carry out all phases of the inventory. Nonetheless, it cannot be expected to improve all elements of an inventory at the same time. Rather, the inventory process should be seen as an ongoing, iterative process that focuses first and foremost on the results of the key category analysis.

- *Regular contact with policymakers, data providers and the scientific community is important for ensuring ongoing assistance with the national GHG inventory.* Awareness-raising efforts should highlight the multiple benefits of the GHG inventory, such as improved information for national resource management, mitigation assessments, and urban/transport planning.

- *Inventory review training is a useful capacity-building exercise.* Developing countries should strive to

integrate more national experts in the UNFCCC in-depth review process.

- *IPCC default emission factors can be inappropriate for sources highly dependent on local conditions, however developing local emission factors is a long and costly undertaking.* Elaboration of local emission factors should be considered only when the emission category is key and the inventory improvement strategy has labelled the work as a priority. Under the project, countries achieved good results by instead focusing on the improvement of activity data and the use of simplified, higher tier approaches.

5. KEY RESOURCES

UNDP, through the GEF-funded National Communications Support Programme, and **US-EPA** have prepared complementary guidance materials that describe how to elaborate and document the GHG national inventory system:

- UNDP 2005 Handbook: Managing the National GHG Inventory Process

- US EPA/US AID 2011 Template Workbook: Developing a National GHG Inventory System (English, Spanish, French) and Key Category Analysis Excel tool (English, Spanish)

The **UNFCCC Consultative Group of Experts (CGE)** has elaborated a range of training materials on the GHG inventory process, including presentations, guidance notes, and exercises:
http://unfccc.int/national_reports/non-annex_i_natcom/training_material/methodological_documents/items/349.php

The **Intergovernmental Panel on Climate Change (IPCC)** Task Force on National GHG Inventories (http://www.ipcc-nggip.iges.or.jp/) oversees the elaboration of internationally adopted approaches for estimating GHG emissions, as well as good practice guidance. These materials are available in all UN languages:

- IPCC Guidelines for National Greenhouse Gas Inventories (1996 Revised, 2006)

- IPCC 2000 Good Practice Guidance & Uncertainty Manual (GPGAUM)

- IPCC 2003 Good Practice Guidance for Land-Use, Land-Use Change & Forestry

The **IPCC Emission Factors Database (EFDB)** library is where users can find emission factors and other parameters with background documentation or technical references that can be used for estimating greenhouse gas emissions and removals:
http://www.ipcc-nggip.iges.or.jp/EFDB/main.php

FAOSTAT offers newly updated estimates for Agriculture (2011-1961, plus projections to 2030 and 2050) and Land Use (2010-1990) for all countries:

Emissions – Agriculture

http://faostat3.fao.org/faostat-gateway/go/to/browse/G1/*/E (Browse data)

http://faostat3.fao.org/faostat-gateway/go/to/download/G1/*/E (Download data)

Emissions – Land Use

http://faostat3.fao.org/faostat-gateway/go/to/browse/G2/*/E (Browse data)

http://faostat3.fao.org/faostat-gateway/go/to/download/G2/*/E (Download data)

6. CASE STUDIES

Many domestic practitioners and international agencies are dealing with the question of how to best build national capacity for GHG emissions inventories. However, effectively answering this question first necessitates an understanding of what exactly we mean by capacity and which specific capacities (including personnel, institutional, knowledge and information technology, and/or financial capacities) need to be prioritized.

From March 2013, the World Resources Institute (WRI) has been releasing a series of case studies under the Measurement and Performance Tracking (MAPT) project. These commissioned case studies, written by national inventory experts, document key aspects in the development and management of GHG inventory systems in **Brazil, Colombia, India, Mexico and South Africa** (including capacity challenges and capacity-

building solutions) on the following themes:

- Initiating a national GHG inventory system and making it sustainable;

- Management and coordination of the inventory process by the lead institution;

- Producing an inventory for the land use, land-use change and forestry (LULUCF) sector;

- Producing an inventory for the industrial sector;

- National GHG inventory data management systems;

- From the GHG Measurement Frontline: A Synthesis of Non-Annex I Country National Inventory System Practices And Experiences; and

- Exploring linkages between national and corporate/facility GHG inventories

The case study series delves into these issues by exploring the capacity constraints countries are facing as well as innovative solutions for overcoming barriers. The intention is that the lessons learned and experiences described will be of benefit to other countries grappling with similar inventory management concerns and capacity constraints. The case studies can be downloaded here: https://sites.google.com/site/maptpartnerresearch/national-ghg-inventory-case-study-series

The case study series is an initiative of WRI's MAPT project, which is made possible through the support of the German Government's International Climate Initiative. The MAPT project helps to build national capacities in developing countries to measure GHG emissions and track performance toward low-carbon development goals. MAPT supports domestic capacity-building efforts through a combination of tools, case studies, training and technical guidance. To learn more about MAPT visit www.wri.org/mapt. Additionally, if you are interested in sharing your country's experience, please contact Thomas Damassa: tdamassa@wri.org