MacArthur Foundation

The Energy and Resources Institute

BEST PRACTICES ON NATIONAL GHG INVENTORY MANAGEMENT SYSTEM

Case studies from South Africa, Ghana, South Korea, Japan, and Chile

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INTRODUCTION

The Paris Agreement established a Transparency Framework in order to build mutual trust and confidence and to promote effective implementation, an enhanced transparency framework for action and support, with built-in flexibility which takes into account Parties' different capacities and builds upon collective experience. As per Article 13, paragraph 7(a), of the Paris Agreement, each Party will regularly provide a national inventory report (NIR) of anthropogenic greenhouse gas (GHG) emissions by sources and removal by sinks, prepared using good practice methodologies accepted by the Intergovernmental Panel on Climate Change (IPCC) and agreed upon by the Conference of the Parties serving as the meeting of the Parties to the Agreement (CMA).

The national GHG inventories provide the foundation for tracking progress towards the Nationally Determined Contributions (NDCs). A complete and transparent national GHG inventory is an essential tool for understanding emissions and trends, projecting future emissions and identifying sectors for cost-effective emission reduction opportunities. A national inventory is also a core element of national communication reports to the United Nations Framework Convention on Climate Change (UNFCCC).

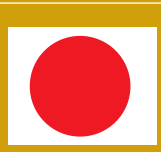
A national GHG inventory system creates a process for documenting the procedures and processes involved in estimating GHG inventories and ensuring that data, information, and assumptions are reported and archived. Robust national inventory systems also include quality assurance and quality control (QA/QC) measures and introduce legal and institutional mechanisms for ensuring periodic reporting of necessary data. Thus, an inventory system comprises both the documentation of the GHG inventory itself (i.e., what was calculated, how, and what does it mean) as well as documents "around" the inventory describing how to make an inventory, e.g., work plans, manual of procedures, legal and organizational basis, responsibilities, reporting obligations, etc. (UNDP, 2005).

The reporting and review procedures and requirements can be challenging for participating governments. The most common constraints reported by developing countries in this context include lack of adequate archiving and management of data; application of quality assurance/quality control (QA/QC) procedures in inventory compilation; procedures to fill data gaps; and use of methodologies to assess uncertainties of GHG inventories, among others.

The compendium elucidates on the background and insights on Best Practices on National Inventory Management System followed in five countries (South Africa, Ghana, South Korea, Japan, and Chile). The document extensively clarifies on the demographical background, geographical conditions, energy profile, institutional frameworks, environmental conditions & effects, key challenges, methodology adopted for estimation of GHG inventory, preparatory processes, and policies pertaining to the environment for the five countries. The publication also documents the best and simple methodological approach adopted by these five nations in developing the national inventory management system, in turn helping the developing countries to adopt the same practices in estimating their GHG inventories.

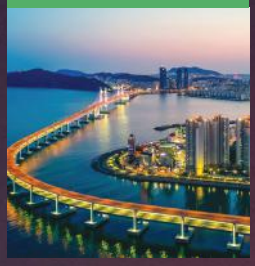
References:
UNDP. 2005. Managing the National Greenhouse Gas Inventory Process'. Available online at <https://bit.ly/2vQ6ZCi>.

The following table elucidates the comparative analysis of five countries' inventory system, framework, challenges, etc.

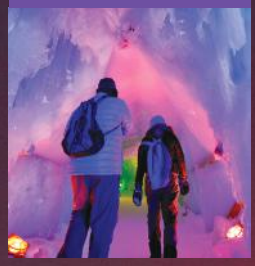
NO.	PARAMETERS	SOUTH AFRICA	GHANA	SOUTH KOREA	JAPAN	CHILE
						
1.	Area (sq.km)	1,219,090	238,533	99,720	364,485	756,102
2.	Population	54,300,704	26,908,262	50,924,172	126,702,133	17,650,114
3.	Capital	Cape Town	Accra	Seoul	Tokyo	Santiago
4.	Classification under UNFCCC	Non-Annex I	Non-Annex I	Non-Annex I	Annex I	Non-Annex I
5.	Signed UNFCCC (Year)	1993	1992	1992	1992	1994
6.	First National Communication to UNFCCC (Year)	1998	2001	1998	1994	2000
7.	Latest submission (Year)	2nd National Communication (2011)	3rd National Communication (2015)	3rd National Communication (2012)	6th National Communication (2013, revision 2014)	3rd National communication (2016)
8.	Governing body	Department of Environmental Affairs (DEA)	Ghana Environmental Protection Agency (EPA)	Ministry of Environment	Ministry of Environment	Department of Climate Change, Ministry of Environment
9.	Key sectors / sources	1. Public electricity and heat production 2. Road transport 3. Iron and steel 4. Enteric fermentation	1. Industry 2. Residential 3. Non-residential	1. Industry 2. Residential 3. Transport 4. Commercial	1. Industry 2. Residential 3. Transport 4. Commercial	1. Industry 2. Residential 3. Transport 4. Commercial

GHANA

SOUTH KOREA



JAPAN



CHILE

REPUBLIC OF SOUTH AFRICA

Background: The Republic of South Africa signed the United Nations Frame¬work Convention on Climate Change (UNFCCC) in June 1993 and ratified it in August 1997. The South African National Climate Change Response Policy (NC¬CRP) regards climate change as one of the greatest threats to sustainable development and commits South Africa to strengthen and ensure full implementation of the Convention.

South Africa has prepared three national GHG inventories and submitted two of these as part of their national communications (Figure 1). The first GHG inventory in South Africa was prepared in 1998 using 1990 activity data. This inventory was compiled by the Council for Scientific and Industrial Research (CSIR), a scientific and technology research development and implementation organization in Africa, and coordinated by the Department of Environmental Affairs (DEA). The second GHG inventory was published in 2004 using 1994 activity data. The 1990 and 1994 inventories were developed using the 1996 Intergovernmental Panel on Climate Change (IPCC) guidelines and were summarized in South Africa's Initial National Communication to the UNFCCC. The latest national GHG inventory was published in 2009, using 2000 as a base year, and was developed using the 2006 IPCC guidelines.

At COP 15 (2009) in Copenhagen, South Africa committed to reduce its emissions by 34 per cent in 2020 and by 42 per cent in 2025 relative to usual levels. There are various factors that can influence a nation's GHG emissions, including governments (infra) structure, population growth, geography, economic growth, energy consumption, technology development, agriculture, and land use management.

The DEA, the central coordinating and policymaking authority with respect to environmental conservation in South Africa, is responsible for overseeing the entire national inventory process from the early stages of data collection through processing and reporting. Furthermore, the DEA is the lead national institution responsible for all climate-change activities, including the compilation and updation of national GHG inventories.

A standing Project Steering Committee (PSC) has been established by the Director General of the DEA to provide oversight on the compilation of these reports, including reviewing and providing inputs on technical information, in order to ensure the reports reflect the national circumstances.

South Africa is a three-tier democracy with national, provincial, and local governance.

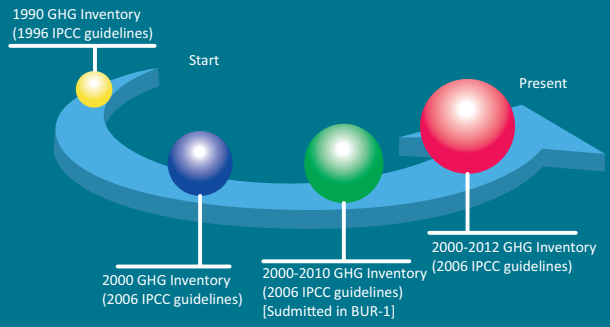


Figure 1: The evolution of submitted GHG inventories over the years

Key Categories: It refers to the emission sources which contribute about 95% of the total GHG emissions in the country. An analysis of key categories using previous inventories was made in order to determine the most significant emission sources in the country. Using level and trend assessment on the basis of the 1990 and 1994 GHG inventories, the most significant emission sources contributing to more than 95% of total South Africa's emissions were identified. The first five emission sources in the list of key emission sources in South Africa, together accounting for 62.5% of emissions, were as follows:

1. Public electricity and heat production
2. Road transport
3. Iron and steel energy consumption
4. Iron and steel production (process emissions)
5. Enteric fermentation

Overview of source and sink category emission estimates and trends

Sector	2000 (Gg CO_2eq)	2012 (Gg CO_2eq)	% change between 2000–2012
Energy	340,299	423,987	24.6%
IPPU	44,907	46,897	4.4%
AFOLU	40,420	25,868	-36.0%
Waste	12,288	21,928	78.5%
Total (incl. FOLU)	437,915	518,682	18.4%

- South Africa is developing a National Atmospheric Emissions Inventory System (NAEIS) that will manage the mandatory reporting of GHG emissions. Due to their complex emission estimating methods, emission sectors such as agriculture, forestry and land use, and waste are to be estimated outside the NAEIS. The NAEIS, in turn, will ingest the outputs of models used in these sectors so that it can generate a national emissions profile.

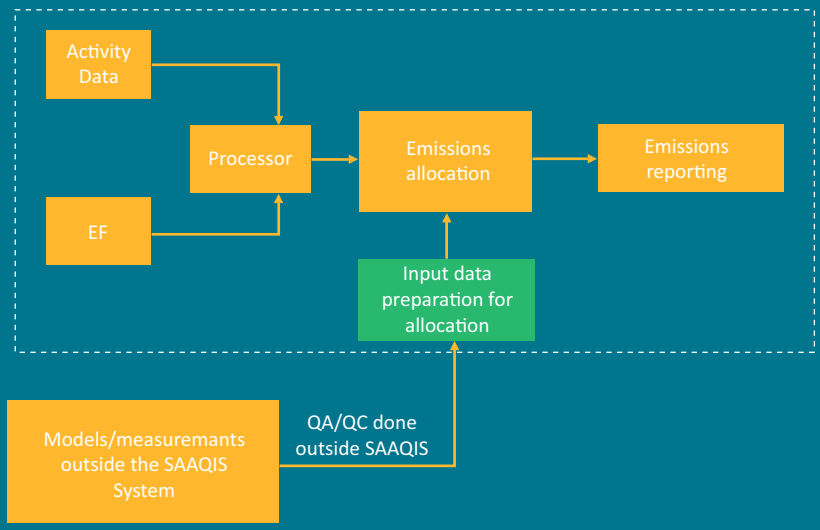


Figure 2: Information flow in NAEIS

Institutional Arrangements: The DEA is responsible for the co-ordination and management of all climate change-related information, including mitigation, adaption, monitoring and evaluation, and GHG inventories. Although the DEA takes a lead role in the compilation, implementation, and reporting of the national GHG inventories, other relevant agencies and ministries play supportive roles in terms of data provision across relevant sectors.

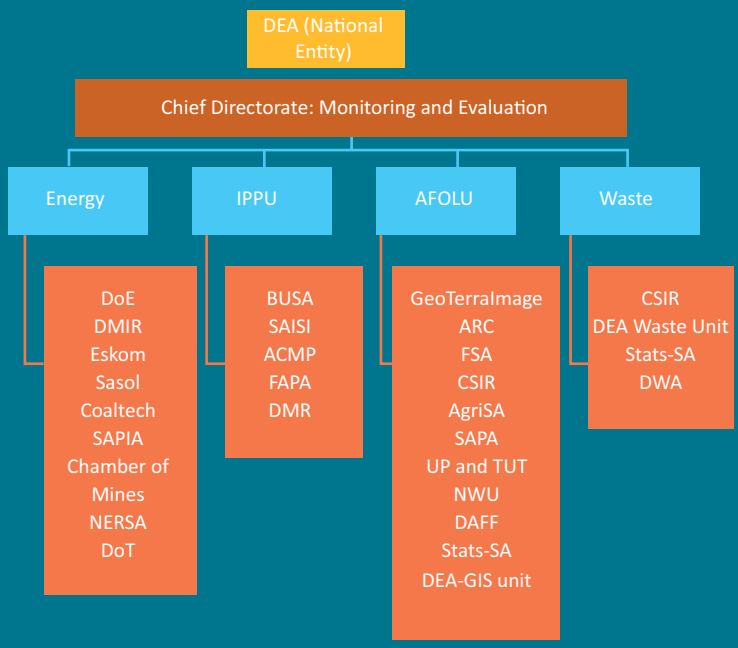


Figure 3: Institutional arrangements for national GHG inventory preparation

The branch responsible for the management and co-ordination of GHG inventories at the DEA is the Climate Change and Air Quality Management branch, whose purpose is to improve air and atmospheric quality, as well as support, monitor, and report international, national, provincial, and local responses to climate change.

Although the DEA takes a lead role in the compilation and reporting of the national GHG inventories, there are many other relevant agencies and ministries that play supportive roles in terms of data provision across relevant sectors

Roles of various institutional sectors

Sector	Institution	Role
Energy	Electricity Supply Commission(Eskom)	Provides information on GHG emissions associated with electricity generation
	Department of Energy(DoE)	Publishes energy balance and estimates energy emissions
	Department of Mineral Resources(DMR)	Provides energy-related information in the form of the South African Minerals Industry (SAMI) report
IPPU	Business Unity South Africa (BUSA) and industry:	Provide GHG information for the IPPU sector
	South African Iron and Steel Institute (SAISI)	Provides GHG information for the iron and steel industry
	Association of Cementitious Material Producers (ACMP)	Provides GHG information for the cement industry
AFOLU	Agricultural Research Council (ARC)	Provides data and technical support when compiling GHG emissions for agriculture
	Council for Scientific and Industrial Research (CSIR)	Provides technical support when compiling GHG emissions for land
	GeoTerraImage	Provides maps for the land sector
Waste	DEA Waste Unit	Provides information on the waste sector
	Statistics South Africa (StatsSA)	Provides statistical parameters that can be applied when estimating GHG emissions from the waste sector
	Department of Water Affairs (DWA)	Provides information on the country's wastewater treatment works.

Challenges in inventory preparation:

- Inconsistent and irregular inventory preparation on the part of the institutions.
- The staff responsible for GHG inventory process is very small. The staff is already burdened with other responsibilities apart from GHG inventories that have to be fulfilled within the lead institution.
- South Africa currently does not have a system that will sustainably manage and regularly update the GHG inventory process. As a result, the documents and information that were used in the past years for preparation of GHG inventories have either been misplaced or lost.
- Data availability has been the key challenge in the compilation of GHG inventories in the past. As a result, the Tier 1 approach has been used for most of the IPCC sectors.
- The data and information are often collected from national aggregated levels rather than from point or direct sources.

Overcoming challenges:

- Used the revised 2006 IPCC methodology for quantification of emissions.
- **GHG Information Management:** The system will allow key data collection of all significant sources of GHG emissions in South Africa, with proper data archiving and processing and the most current revised emissions factors for the calculation of GHG emissions.

- **GHG Monitoring and Reporting:** Currently, there is no policy that mandates data providers to provide the lead institution with the necessary information for the compilation of GHG inventories in South Africa. This challenge can be addressed by drafting a policy that will require all the data for GHG inventory preparation.
- **Training and Capacity Building:** It will ensure that everyone responsible for the GHG process is fully capable in the management and reporting required for the GHG inventory process.

Conclusion: The compilation of the GHG inventory continues to be a challenge, especially in the availability of data for computation of GHG emissions. The 2000 to 2012 GHG emissions results showed that there is an increase in emissions majorly from two sectors—energy and waste. Emissions from Industrial Processes and other Product Use (IPPU) sector have increased till 2006 and decreased after 2007. The energy sector in South Africa continued to be the main contributor of GHG emissions (>75%) in the year 2010* and was found to be a key category in the years thereafter.

The most challenging sectors for data collection were AFOLU (Agriculture, Forestry and Other Land Use) and IPPU. AFOLU caused a greater annual variation in the emission number but there was a decline in this sector. For the AFOLU sector, spatial data, in-depth research, and modelling studies are required in order to create a robust database for land use and land use changes.

During the implementation of the third national GHG inventory, the ESA capacity-building programme, along with the formation of a PSC, induced the involvement of other departments (e.g., agriculture and transport) in the development of sectoral GHG inventories. The role of DEA in both cases has been to provide guidance and support and to ensure that both sectoral inventories are compiled in a manner that is consistent with the national GHG inventory.

References:

- UNFCCC Report on South Africa GHG Inventory
- GHG inventory South Africa, National Inventory Report 1990-2000 by UNFCCC
- GHG National Inventory Report 2000-2012
- Initiating A National GHG Inventory System and Making it Sustainable: Case Study from South Africa
- South Africa's 2nd Biennial Update Report (BUR)


SOUTH KOREA
JAPAN
CHILE

REPUBLIC OF GHANA

Background: Ghana is one of the West African countries whose inventory system has evolved from a group of impromptu working experts to a more planned and wide-ranging one incorporating multiple institutions and knowledge. It has been set up with the objective of determining the extent to which national GHG emissions and removals are unswervingly attributable to human activity and undergo habitual improvements based on the gaps recognized during each inventory.

The country of Ghana made early directives to somehow cover issues related to environmental development. This helped in indirectly covering climate change through its constitution in the year 1992 (Government of Ghana, 2003). The Constitution, signing up with UNFCCC at the Rio de Janeiro Earth Summit in 1992 and the Climate Convention in the year 1995 led to the formation of the First Medium Term Development Plan (MTDP) in the year 1996 as Ghana's Vision for 2020 (Version and Benefoh, 2016). The agreement had protocols by which countries were supposed to submit progress reports (National Communications and Biennial Reports) in terms of understanding and mitigating climate change

Covering the progress of the years 1990–1996, Ghana sent its Initial National Communication to UNFCCC in the year 2001. This served as the groundwork for advancement of better climate change initiatives in the country. In the year 2000, MTDP was discontinued due to some imbalances leading to formulation of other policies in the future. The Second National Communication of Ghana was submitted to UNFCCC in 2011 covering new climate change initiatives, such as the *Low Carbon Growth Strategy or Low Emissions Development (LED)*, *National Climate Change Adaptation Policy*, and *Ghana National Youth Policy*, amongst existing climate change initiatives (Institute of Green Growth Solutions, 2015). The *Low Carbon Growth Strategy* covered the aspects of producing fewer greenhouse gas emissions while bridging the break between development policy and climate policy. The adaptation strategy aimed at enhancement of Ghana's current and future adaptation capacity in regard to climate change resilience and other ecosystems. The youth policy was an innovative step taken by the government about creating more awareness amongst the young generation and more public participation towards the country's national development and climate policies.

With good advancement methods and future perspectives, the Republic of Ghana recently published two different reports—Third National Communication and First Biennial Report. These reports cover policies and action plans, such as the *Ghana Shared Growth and Development Agenda (GSGDA)*, *National Environment Policy (2013), development of a National Climate Change*

Learning Strategy (2013), and National Climate Change Policy of 2014. The reports also talk about the country's upcoming and future plans for reducing the emissions of their country like:

- Launch of REDD-Readiness Framework
- Development of National Appropriate Mitigation Actions (NAMA) under the Low Emissions Capacity Building Project
- Inclusion of a central online database system covering inventory data since the 1900s
- The President Obama "Power Africa Initiative"
- Construction of the largest solar power plant in Ghana
- Setting up of a new university focussing on environmental science (Version and Benefoh, 2016).

Figure 1: Elements of Ghana's Current National GHG Inventory Management System

Source: Government of Ghana, 2011

Institutional Arrangement: From an undefined and unstructured layout of institutions and stakeholders in the 1900s, the inventory reporting system of Ghana has finally transformed into a comparatively strong and well defined one since 2009. According to 'Good Practices on GHG Inventories for the Waste Sector in Non Annex-I Countries', Ghana's transformation of institutional arrangement is deemed as an example to be followed. From a single person preparing the first National Communication and the second by a team of experts to the third being prepared by a couple of working groups specially established for the purpose of handling climate change-related activities is considered as a good practice (Republic,2015).

Process of reporting information to UNFCCC:

- International data sources, such as the Food and Agriculture Organization (FAO) and International Energy Agency (IEA), and National Data Owners provide information from their respective organizations to the sectoral ministries.
- The sectoral ministries compile and send information from the data providers as well as their own collected information to External and Internal Reviewers. These, in turn, send it to Environmental Application and Technology (emission compilers).
- The emission compilers then send this information to Environmental Protection Agency (EPA), Ghana.

- EPA then sends this information to Ministry of Environment Science and Technology (MEST), Ghana.
- Acting as the messenger, MEST then sends the inventory information to UNFCCC in the form of national communications and biennial reports (Government of Ghana, 2011).

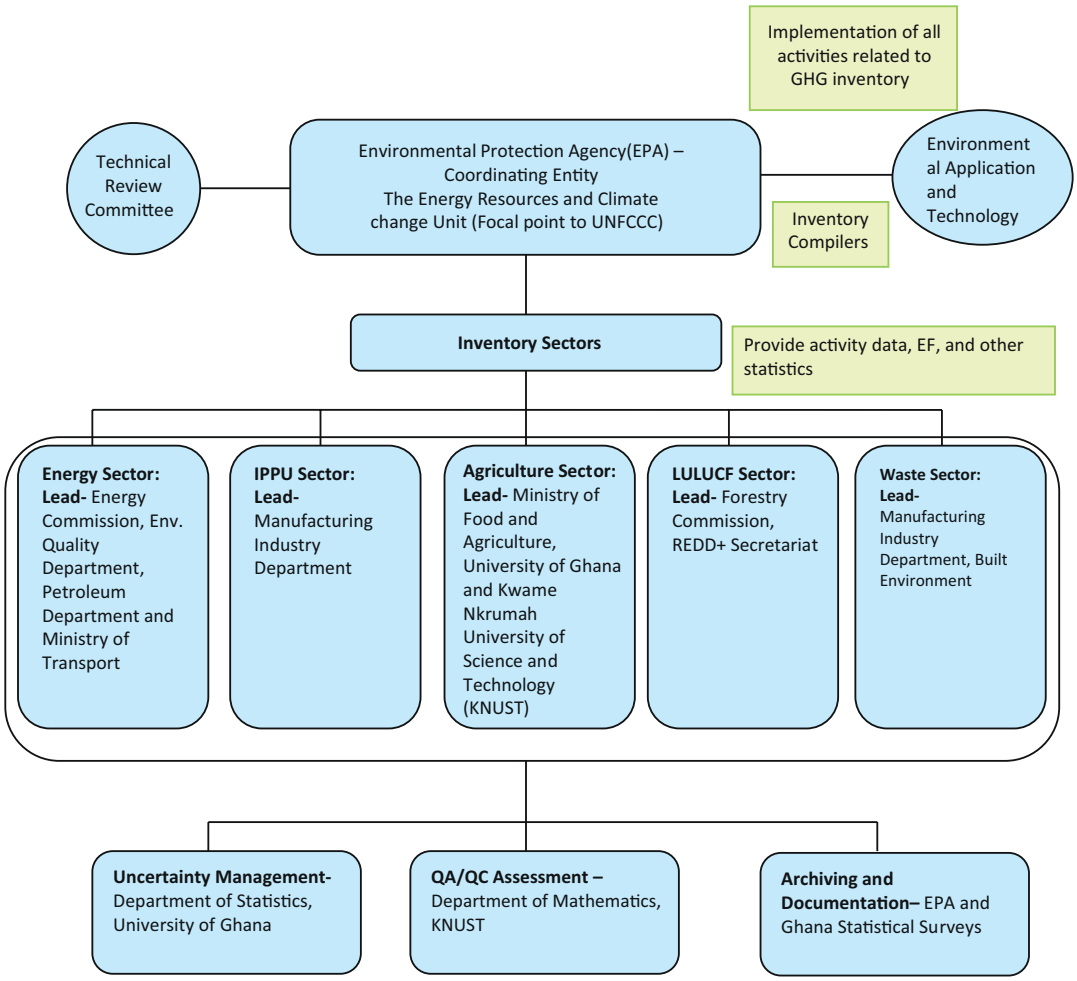


Figure 2: Current Institutional framework of Ghana (Agency, 2012)

Process of Inventory Preparation: In a two year time frame, the following process is carried out.

Barriers and challenges faced in the process of inventory preparation: After conducting successful GHG inventories with noticeable improvements in the second inventory, the Republic of Ghana faced some challenges before the year 2014 while setting up the recent inventory process like:

- **Data acquisition and management a difficult task:** A major challenge was the unavailability of data such as emission factors, Tier II, onwards. Some data providers restricted the amount of information going out from their organizations, since it was deemed as confidential, unpublished or unfinished. No system of archiving data and dissemination was present.
- **Ad-hoc institutional arrangements based on individuals:** Since the system was based on a few specific individuals performing the job, there was always an uncertainty about team members leaving the process at any given time (National Communication Support Programme, 2012).

Figure 3: Process of Inventory Preparation (UNDP, 2015)

- **Lack of mechanisms to ensure training programmes be embedded in the national system:** To guarantee consistency in the reporting as well as estimation process of the inventory, continuous training was required as and when new members joined the teams in many areas such as use of IPCC software, estimating gaseous emissions, etc.
- **Collaboration between EPA and other institutions was initially difficult:** Since there was no legislation or framework to bind the inventory process aiding the EPA to collect data from the institutions, it was tricky to obtain quality efficient and correct information from institutions, such as the Energy Commission, Ministry of Transport, Ministry of Food and Agriculture, among others (UNDP, 2015). Getting the private sector to work with the public sector and agreeing on the same views (Government of Ghana, 2013) is a key challenge.
- **Lack of awareness among the public about climate change and national inventory system:** There was a great deal of unawareness and uncertainty within the wider masses of the country about climate change and Ghana's submission of inventories to UNFCCC over the years leading to low participation and neglect in use of resources of the country.
- **Moving from Tier I to higher levels of methodology was difficult:** Initially, most of the data were estimated using Tier I approach with default emission factors from IPCC Guidelines. So, there existed a dire need to move from this level to higher levels for better estimation of emissions from different emission source categories (Government of Ghana, 2011).
- **Insufficient financial resources to create a strong setup in the country:** Being a developing country with low resources and economy, the biggest challenge was getting funds for mitigating climate change problems and building a national system (Government of Ghana, 2013).

Overcoming Barriers and Challenges: Based on the challenges till the second national communication, key solutions after the year 2011 for overcoming the most common barriers are identified as follows:

- **Better data management:** Majority of the emission factors are being developed by the country itself instead of relying on default emission factors from the IPCC Guidelines. Clear cut roles and responsibilities of institutions are being laid out so that there is no interference with collecting and distributing the data. Recent online web-based systems for different sectors (6 in number)—Online Climate Change Data Hub, National Energy Data Processing and Information Centre, National Forestry Inventory Web GIS Portal, Ghana Climate Change Adaptation Network, Biomass Map and Ghana Climate Change Agriculture and Food Security Platform have been developed for the inflow and outflow of data. This aids in data archiving and dissemination with easy accessibility (Ghana, 2015).
- **New institutional arrangements:** To rectify the ad hoc nature of the institutions, the Government of Ghana has finally changed its disposition. Specific institutions are now properly given the agenda for data provision and not just the individuals, all supervised by EPA (National Communication Support Programme, 2012).
- **Continuous training sessions for team members:** Training sessions are now becoming a critical component of the inventory process; efforts are being put in by the UNFCCC Annex 1 GHG inventory roster team (team members of training programmes) for incorporation of such improvements. Since all team members cannot go through the IPCC training process, the people who have already undergone the training would be responsible for teaching the same to the others (Trainer of Trainers Programme). The National GHG Inventory Manual of Procedures has also been set for providing guidance to the new members as well as to enhance the capacity-building theme of Ghana (UNDP, 2015).
- **Easier collection of data and better public participation through implementation of necessary legislation:** The EPA Act, Act 490, was implemented in the country to aid the agency in obtaining data from the institutions, assigned for providing the inventory data without any difficulty (UNDP, 2015). The *National Youth Policy of 2010* was implemented for creating awareness among the masses about the national inventory and to receive better results in public participation (Institute of Green Growth Solutions, 2015).

- **Movement of estimation methods from Tier I to Tier II majorly:** Many sectors like the transport sub-sector, metal production sub-sector, and the land sub-sector of agriculture sector have seen the advancement of Tier I approach to a combination of Tier I and II approaches as well as only Tier II approach in the recent inventories (Ghana, 2015).
- **Increased use of indigenous/local knowledge and better funding for capacity building:** The *National Climate Policy of 2013* has been efficiently implemented by the Government of Ghana so that the indigenous knowledge is tapped into for providing solutions to scarcity of resources. The policy also discusses about Ghana's national finance provider, the Public Financial Management System, which would aid in providing funding for all climate change initiatives in the country. Negotiations with international countries and their institutions for supporting projects related to Ghana's climate change mitigation as well as assessment have also been mentioned (Government of Ghana, 2013).

Conclusion: The Republic of Ghana is one of the few selected countries which give out minute greenhouse gaseous emissions as compared to the global rate. Yet, the country has taken all possible steps to mitigate those little emissions. Implementing effective policies with regard to climate change, building stable institutional framework for climate change, setting defined responsibilities, launching continuous training programmes, creating online database systems for easy access to data, involving the public in matters of inventory system, and taking funds for those areas requiring heavier budget than the country has, Ghana is setting an example for other non-Annex-I countries to emulate.

Over the years, the inventory system has evolved to a fine example of good practice inventory systems. One such example is the waste sector of the GHG inventory. In a research conducted on 'Good Practice study on GHG Inventories for the Waste Sector of Non Annex I countries' in 2015 by the German Ministry of Environment, the country of Ghana was reviewed. The study discussed about the Government of Ghana involving more appropriate stakeholders in managing the waste sector over time with surveys being conducted for improved management of activity data. Few other approaches involved workshops being held to receive different

ideas on how to apply new methods for mitigation, further improvements being documented in future documents to UNFCCC, and involving the local government for collection of data on incineration of food and biomedical waste.

The country though has taken multiple steps to improve its national system still requires more work for it. The need for building a stronger and better defined institutional framework, involvement of more approaches from private sector, and advancement of Tier I methods to Tier III remains as such. Traditional knowledge needs to be tapped into gaseous emissions from energy sector as well as industry sector need to be reduced, local people need to be brought into a better understanding of the inventory system not just based on policies and the country needs to reduce other gaps in technological use and sustainable use of resources. This will guarantee a healthier and efficient working system.

References:

Agency, E P. 2012. 'Sharing Africa Experience on GHG Inventory and MRV of Emissions f ocus on the role of " integrated climate data management " In Ghana Environmental Protection Agency, Ghana Snapshot of the National System for GHG inventory'.

Ghana, R. 2015. 'Ghana's Third National Communication Report to the UNFCCC'.

Government of Ghana. 2003. 'Ghana's Climate Change Technology Needs and Needs Assessment Report Under the United Nations Framework'.

Government of Ghana. 2011. National Greenhouse Gas Inventory Report for 1990-2006.

Government of Ghana. 2013. 'Ghana National Climate Change Policy', p. 88.

Institute of Green Growth Solutions. 2015. 'CLIMATE CHANGE LEARNING STRATEGY IN GHANA : BACKGROUND REPORT Climate Change Learning Strategy in Ghana : Background Report By : Institute of Green Growth Solutions', pp. 1–73.

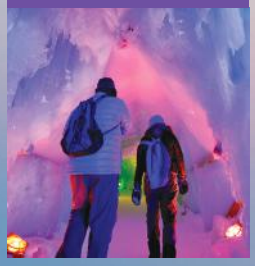
National Communication Support Programme. 2012. 'Country papers : Preparation of National Communications from Non-Annex I Parties to the UNFCCC A Compilation of Lessons Learned and Experiences from'.

Republic, F. 2015. 'Good Practice Study on GHG-Inventories for the Waste Sector in Non-Annex I Countries'.

UNDP. 2015. 'National Greenhouse Gas Inventory Manual of Procedures'.

Version, D and Benefoh, T. 2016. 'Energy and low carbon development efforts in Ghana : institutional arrangements, initiatives, challenges and the way forward'. doi: 10.3934/energy.2016.3.481.

JAPAN



CHILE

SOUTH KOREA

Background: The inventory of Korea is based on two principles which ensure the credibility of NAMA as well as the cost effectiveness of the national climate policy. In the initial stages of preparation of Korea's inventory, it was analysed as well as announced by the Ministry of Knowledge Economy (formerly known as Ministry of Commerce, Industry and Energy) with respect to the Framework Act on Energy. It was then changed to be based upon Framework Act on Low Carbon- Green Growth (known as Green Law since 2010). The preparation system is formed of three main councils, the Management Committee, the Working Level Council, and the Technical Committee. The Management Committee is responsible for deliberation and voting for final national greenhouse gases while the Working Level Council and Technical Committee are responsible for the roles of working level consultation and technical advice, respectively.

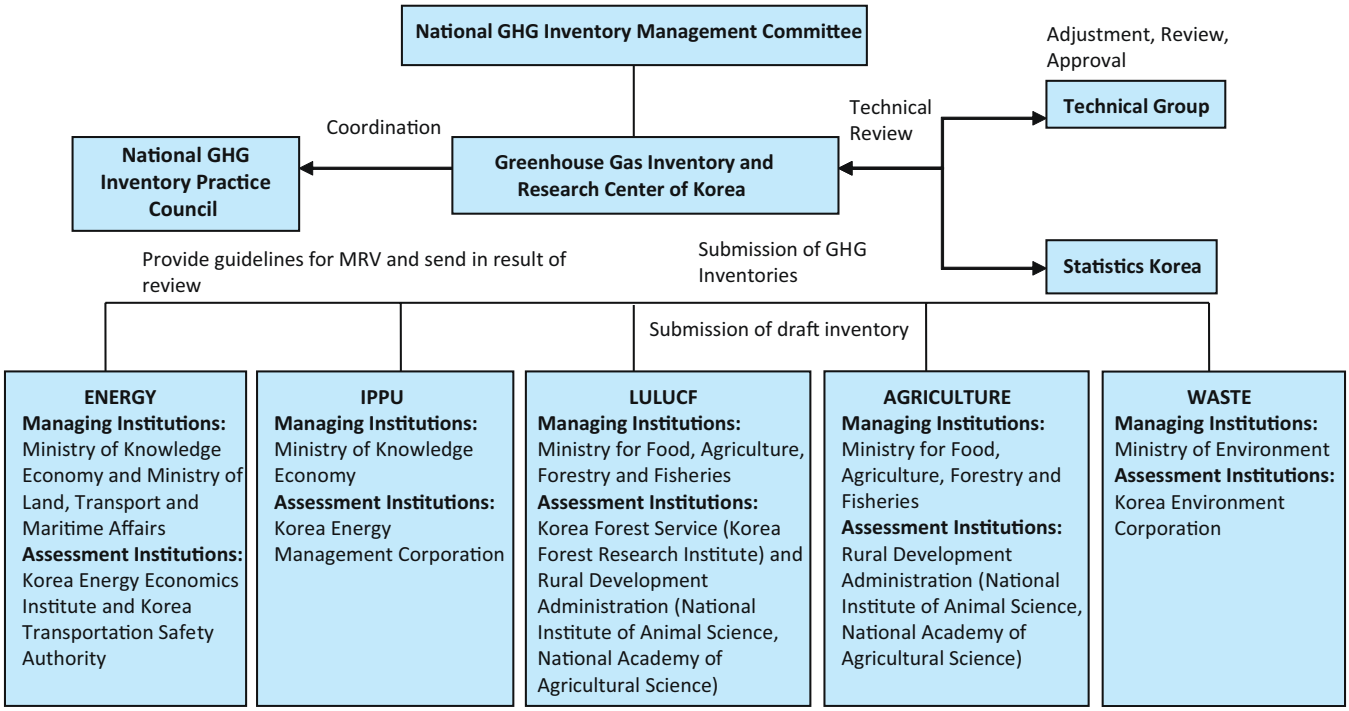
A system known as the Clean Air Policy Support System or CAPSS which aids in inventory preparation has been set up since the year 1999. CAPSS is an annual national emission data system which estimates all emissions based on inventories (point, area, mobile). A GHG Clean Air Policy Support System exists under the National Institute of Environmental Research (NIER) which supports planning reduction strategies and effect analysis of Air Quality Control Policy and Climate Change Policy (2007–2008). This GHG system also acts as a link between Source Classification Code and CRF in IPCC. For example, this system has been reviewed for the energy and manufacturing industries and construction sub-sector. The estimation process was divided into three parts—data collection, data compilation and checking, and inventory reporting. Emission trends for metropolitan area, by each corporation (SEMS) and for different years was also given for the entire energy sector for SOx, NOx, PM_{10}, NH_3, CO, VOC, TSP, CO_2, CH_4, and N_2O gases using the bottom-up approach.

Korea's national system has been successful due to its major strengths being the use of GHG CAPSS system for the compilation and validating inventory data and the improvement of inventory process by the 'Review Committee for GHG Inventory' which included 31 external reviewers from different institutes, academies, etc., and an overall review in NIR and CRF inclusive of the format, methodologies, and emission factors. The weaknesses as identified by the government was the need for better linkage between the agencies in the inventory process and the lack of experiences in the National Inventory Report, such as voluntary peer-review, consultancy, etc.

Institutional Arrangement:

The Ministry of Environment, Republic of Korea has established the Greenhouse Gas Inventory and Research Centre of Korea (GIR) in 2010 with the mandate of comprehensive management of national GHG statistics apart from establishment and operation of National GHG system (NGMS) for Greenhouse Gas and energy targets. The current institutional arrangement for the national inventory comprises of:

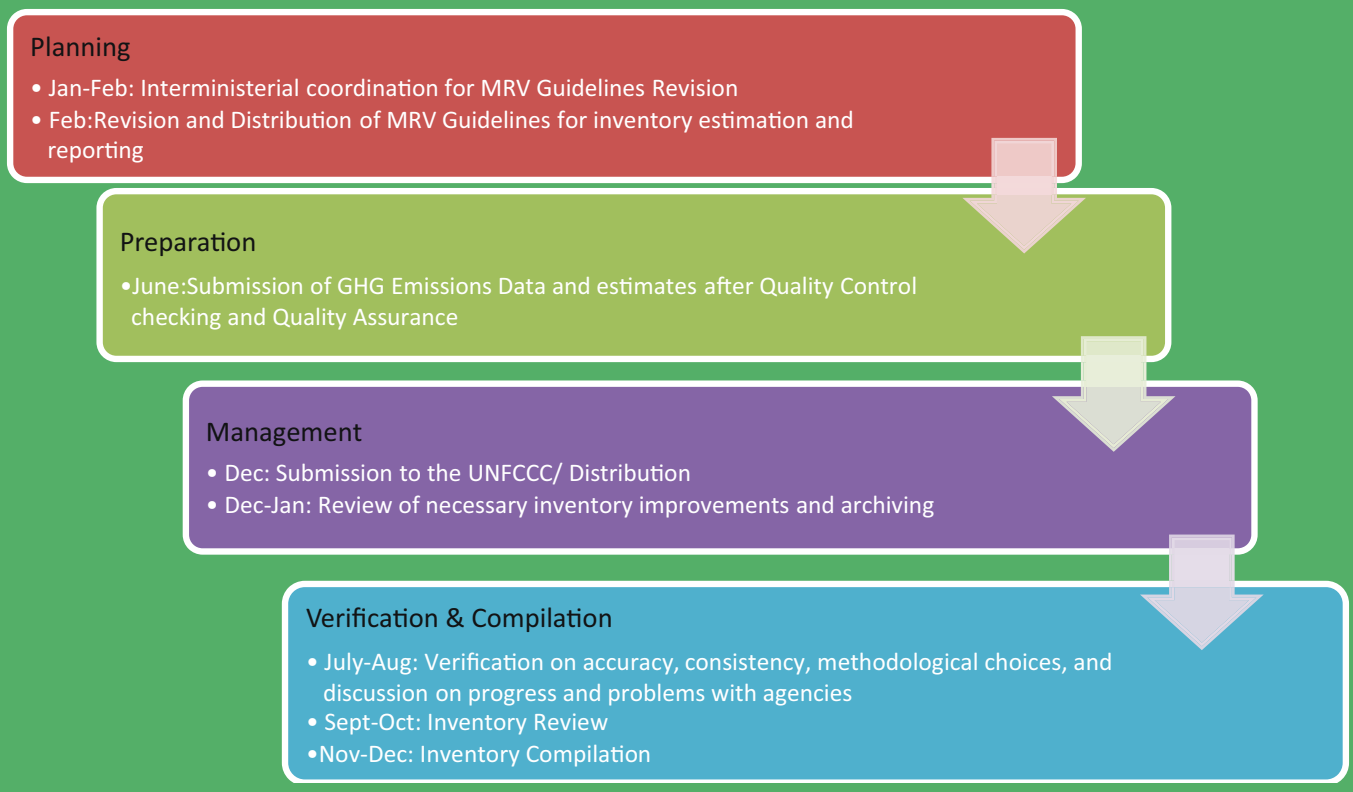
Figure: Current institutional arrangement for the national inventory of Korea



Further, the local inventories were set up with the aim of supporting the local government's climate policy implementation and fostering the experts associated with it based on local government's green growth (in relation to low carbon and the green growth plan of the central government). Some of the factors considered were the migration of waste, transportation and product movement between local governments. Other factors included the challenges associated with the policy ability of local governments for each of the emission sources and GHG management at the local level, such as facilitating local carbon lifestyle, energy efficient investment, etc.

Key features of the local inventory:

- Ensuring cost effectiveness, consistency, and excellent comparison with other local inventories
- Public participation through 16 Regional Environmental Centers which comprised students from universities all over the country
- Use of top-down (national inventory) and bottom-up inventory approaches with review by GHG-CAPSS



Barriers and challenges faced in the process of inventory preparation: Setting up institutional framework, with cooperation from all ministries, required the organizations to face some challenges. These are enumerated as follows:

- **Inadequate institutional collaboration: As a result of the** intricate institutional collaboration among public and private sector entities, a robust institutional framework was set up to enhance collaboration among different entities who are engaged in the process of preparing national inventory.
- **Varied quality of sources:** Quality of activity data amongst sectors was varied which had to be enhanced and cross verified multiple times.
- **Selection of verifiers and systems of measuring and reporting at the utility level was another issue:** Searching for available, trained, and capable persons to act as verifiers as well as choosing the correct systems for measuring and reporting at the utility level were tricky tasks.
- **Conflict about the public disclosure of information provided by the CEs:** At different phases, conflicts arose whether or not certain information relating to some business interests should be disclosed publicly provided by CEs.
- **Defining a baseline for energy consumption and GHG emissions for the CEs** was difficult since getting a census among organizations was time consuming.

Overcoming Barriers and Challenges: The numerous challenges were overcome through certain ways such as:

- Discussions held for setting targets in the absence of penalty at the time of non-compliance created a cooperative approach between the government and private sector. This helped in setting a monitoring, reporting, and verification (MRV) system for emissions trading system (ETS) for public as well as private sector.

- The government was responsible for training persons for the verification and certification process and a common reporting format along with templates were provided for creating a better framework at the utility level.
- A rule was set through which if a utility asks for confidentiality on certain information in regard to his business interests or others and the Evaluation Committee agrees, then the information would not be disclosed to the public otherwise as default all information is disclosed to the public.
- To mitigate the challenge of defining a baseline, the government in cooperation with the private sector used existing data from ministerial statistical records and decided on a point of reference.

Conclusion: The South Korea is one of the chief developing countries to establish a successful and dynamic MRV system. Since the time the South Korea signed the treaty with UNFCCC, regular steps such as taking the assistance of GHG CAPSS to ensure correct data and grounding the inventory system to Framework Act on Low Carbon and Green Growth (2010) were taken to set up a cost efficient institutional framework with the aim of reducing energy consumption. Efficiency and planning helped them in eventually developing a web-based National GHG Management System (NGMS) in 2013 with its guidelines being continuously revised by the Ministry of Environment. NGMS is financially supported by the Ministry of Environment with good quality and correct continuous flow of data from different local and national organizations.

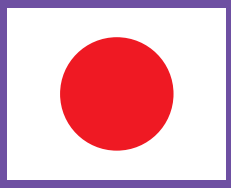
The inventory system has also been deemed as good practice which is due to many reasons. One of them being that it is not a typically controlled system but a fair networking system between the private and the public sector. Their regular tracking methods gives an idea about the progress achieved and quality assurance is achieved through NGMS by time series analysis, done by the government as well as cross verification done by external experts. Since it is adequately funded and involves satisfactory public participation, more awareness and continued involvement of the generation is also seen.

The system can be replicated through consultation and case by case studying of challenges also keeping in mind the commercial concerns of the private sector. On a small scale, the work can be progressed to a larger scale in terms of giving examples and holding meetings with compulsory active participation and less penalization. This will ensure cordial relations and a healthy structure of working.

References

http://eng.me.go.kr/eng/web/index.do?menuId=202
http://eng.me.go.kr/eng/web/index.do?menuId=107
http://www-gio.nies.go.jp/wgia/wg7/pdf/4.1.5.%20Jang-won%20Lee.pdf
mitigationpartnership.net/sites/default/files/u1585/day_1-3.ipm8juillet2014.pdf
https://gpd.transparency-partnership.net/sites/default/files/ws15223_south_korea_gpa2015_en_long-fin.pdf


CHILE



JAPAN

Background: Japan is one of the few Annex I countries which has frequently sent its progress reports in the form of 7 National Communications (NCs) and 3 Biennial Update Reports (BURs) preparing its first National Communication before time.

The Kyoto Protocol was adopted in Japan in the year 1997 but entered into force in the year 2005 (United Nations, 2018). The first National Communication was prepared in the year 1994 and submitted in electronic form after recovering the lost data in the year 1997. The report comprises of an ***Action Program to Arrest Global Warming*** (mentioned in Article 4 of UNFCCC) discussing about short-term future plans of combating global warming, measures to control CO_2, CH_4, N_2O, and other greenhouse gases as well as creating awareness among the local people for better understanding, participation, and cooperation with the international countries. The report also talks about how the action plan got incorporated into a new environmental plan called the ***Basic Environmental Plan*** implemented by the Government of Japan in the year 1993. The law was about creating a healthy and sustainable environment (also through combat of global warming) as well as conservation of environment globally through associations with international countries (Government of Japan, 1994). The second National Communication engulfed the Basic Environmental Plan which was still being followed in the country and the local organizations finally having their own local plans/programmes for implementing policies regarding global warming and combating climate change through reduction of greenhouse gases (Government of Japan, 1997).

By the year 1997, a new institution, ***The Global Warming Prevention Headquarters*** was established in response to COP3 of UNFCCC. This set up brought new guidelines to be implemented in the country, based on promoting the Kyoto Protocol and reducing the emissions from the country (Government of Japan, 2002). After the implementation of Marrakesh Agreement in 2001, a new Outline for Promotion of Efforts to Prevent Global Warming was set by 2002 (Government of Japan, 2006). In the same year, The Greenhouse Gas Inventory Office of Japan (GIO) was also established in the Centre for Global Environmental Research (CGER) and National Institute of Environmental Studies (NIES) which also publishes data online. Its role is to compile inventory data as well as to implement the activities related to the inventory like technical review of National GHG Inventory and provide any other assistance or support for capacity building of Asian countries in developing and improving their GHG Inventories (Academic Library, 2018). The Centre updates its information online frequently for easy accessibility and better updated knowledge for local as well as international use.

The years after 2002 saw the rise in efforts made by Government of Japan in achieving targets like the Kyoto Protocol Target Achievement Plan for cutting 6% of emissions which was revised and updated by the year 2008 (Government of Japan, 2010) and the aim to achieve 25% reduction in emissions by COP19. All efforts came to a halt after the Great East Japan Earthquake struck in the year 2011, destroying major areas of Japan and also increasing GHG emissions to a great extent. Following which, the Government of Japan decided to implement the 4th Basic Environmental Plan and focus mainly on global warming reduction policies. The 25% reduction target was revised, changed to 3.8% reduction as compared to the 2005 target and sent to UNFCCC in the year 2013 (The Government of Japan, 2013). Japan was able to complete its first commitment period but could not complete the second commitment period. Due to this, they made double efforts to combat the increased emissions also ratifying the Paris Agreement in 2016 (Government of Japan, 2017).

Currently, the National GHG Inventory Management system of Japan is based on requirements of UNFCCC with municipality level, corporate level, and project level collection of data being based on Act on Promotion of Global Warming Countermeasures implemented in the year 2016 (Kosaka, 2016).

Institutional Arrangement:

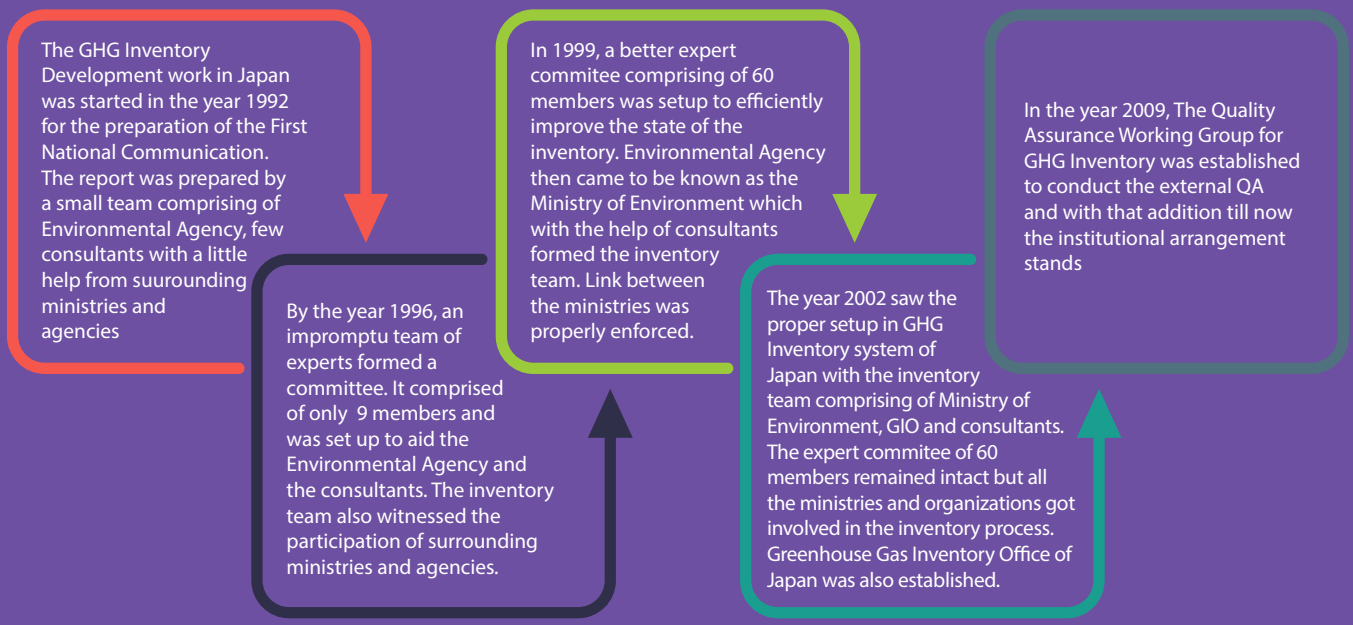


Figure 1: Development of institutional arrangement of Japan

Source: (CGER; NIES; GIO, 2013)

Process of Inventory Preparation: The inventory preparation process is set in combination with the country's fiscal year (beginning 1st April and finishing 31st March the next year) with the deadline being 15th April of the next fiscal year. The annual preparation cycle is shown below:

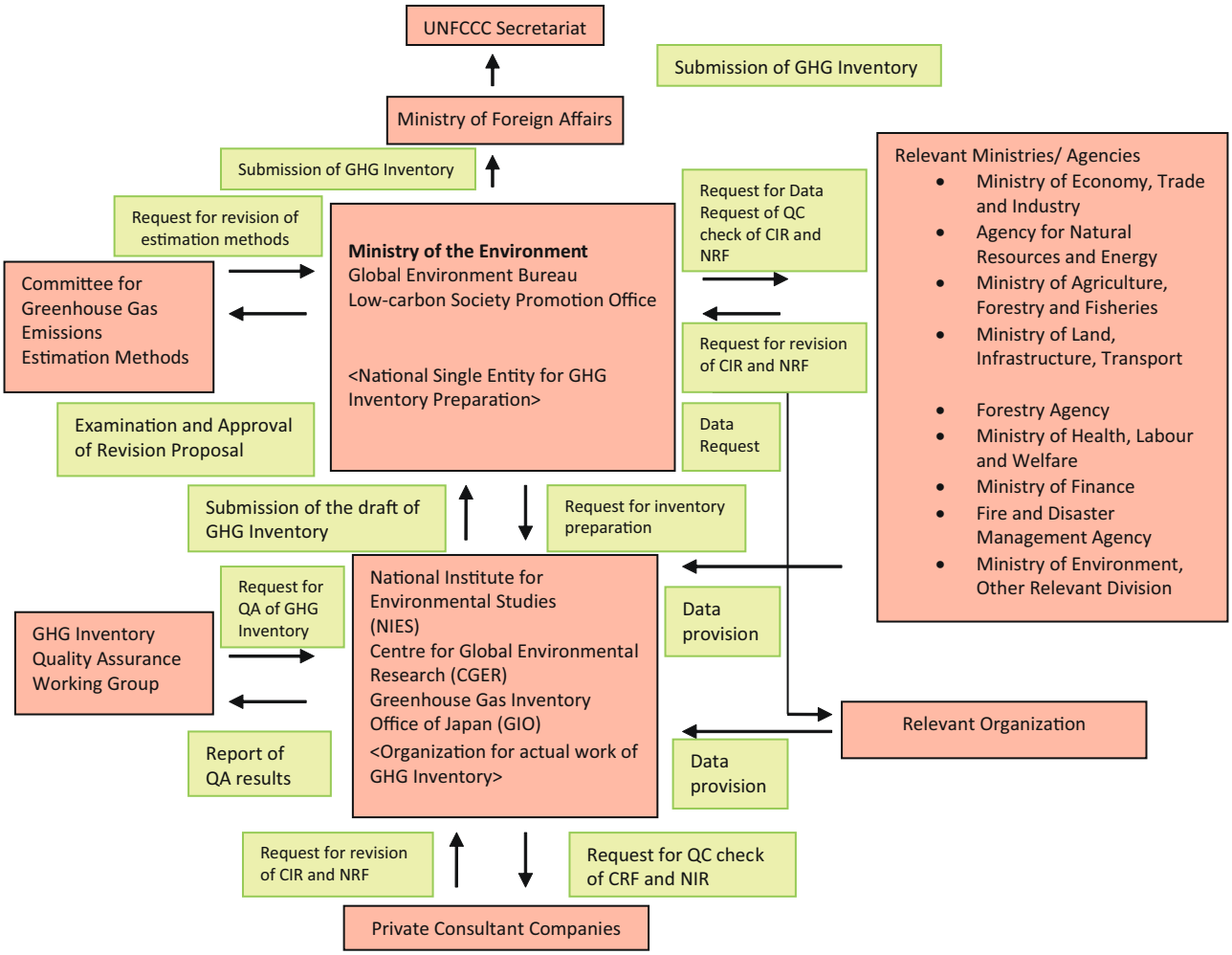


Figure 2 Preparatory cycle of National GHG Inventory (Government of Japan, 2013)

Barriers and challenges faced in the process of inventory preparation: Since the ratification of UNFCCC by Japan till the submission of third biennial report in 2017, the challenges faced by the Government of Japan while preparing the inventory and creating a strong system are enumerated as follows:

- **No clear and defined roles and responsibilities for participating ministries:** There was an ad hoc arrangement of people trying to work as a team with limited or no participation from the surrounding ministries (Kato, 2007).
- **Low public awareness and participation:** On the subjects of climate change and environment sustainability, there was very little awareness and thus no participation (Government of Japan, 2010).
- **Absence of s documentation and archiving system:** The need for archiving and documenting the inventory data important for future use and for ensuring transparency was lacking (Mitsubishi UFJ Research and Consulting, 2014).
- **Lack of quality assurance:** Since there lacked an external team of experts who could guarantee the quality of the work done and suggest further improvements, the national system had an inefficient reviewing system (Mitsubishi UFJ Research and Consulting, 2014).

- **Discrepancies in data between CRF tables and IEA Statistics:** Frequent differences in data occurred between the IEA statistics and Japan due to difference in data parameters resulting in discrepancies (CGER; NIES; GIO; MOE, 2010) .
- **Striking of Great East Japan Earthquake and Fukushima Nuclear Disaster:** In 2011, when the earthquake struck leading to the nuclear disaster, the country had to revise all its strategies and targets. The country shifted away from its major target of reducing emission by 25% by COP19 and also had to replace its nuclear energy in its national energy plans. On top of that, in the same year emissions from Japan increased to almost double (Kuramochi, 2014).
- **Some sectors lagging behind in methodological advancements:** Certain subsectors such as CO_2 and CH_4 emissions from off-road vehicles from transport sector, CH_4 and N_2O emissions from railways, domestic navigation, post mining activities, fugitive emissions from oil production, CO_2 emissions from titanium oxide, CO_2 and CH_4 from methanol production, CH_4 emission from enteric fermentation, CH_4 and N_2O from manure management, CO_2 emissions from urea application and liming, etc., are still following the Tier I approach of estimation of gases (Japan Ministry of the Environment, 2017).

Overcoming Barriers and Challenges: To the submission of the third biennial report in 2017, some approaches used by the government in overcoming the challenges have been listed as follows:

- **Stronger institutional arrangement set:** By 2002, a team of 60 members comprising of all ministries as well as the private sector was set up. This created a stronger networked institutional framework that was responsible for building and improving the national GHG inventory (Enoki, 2008).

- **Creation of platforms like Greenhouse Gas Inventory Office (GIO) and National Registry**: There was a need for setting up systems ensuring documentation, archiving, and transparency of information. This was done with the help of setting up of GIO in 2002 and National Registry in 2010.
- **Promotion of environment education through campaigns and laws:** The Government of Japan has been making sure the local people understand the concept of climate change and global warming. This is being done through keeping the inventory programme public where the data can be accessed on the GIO website, through implementation of laws, such as Law Concerning the Promotion of the Measures to Cope with Global Warming of 1999 and Law Concerning the Promotion of Procurement of Eco-friendly Goods and Services in 2000 (Government of Japan, 2010).
- **Reviewing and quality checking system set:** In the year 2009, a couple of external experts who were not involved in the process of inventory preparation were grouped together to form a Quality Assurance Working Group. This group helped in suggesting improvements for future preparation of inventories (Mitsubishi UFJ Research and Consulting, 2014) .
- **Discrepancies in data were always justified through explanations:** Frequent discrepancies that occurred in data figures between CRF tables and IEA Statistics were generally attributed to the two different facts—Both the entities treat international aviation and marine bunker fuels differently in their respective energy balances and also both have different classifications of fuel oil (CGER; NIES; GIO; MOE, 2010).
- **Bouncing back from the earthquake and nuclear disaster through revised strategies and targets:** After the striking of the two major disasters of Japan, the government revised

its strategies. They implemented a new 4th Basic Environmental Plan, added a global warming tax and a feed-in tariff scheme for promoting renewable electricity. The country of Japan also took a number of measures to improve the thermal insulation level of households as well as set up The National Registry building with high aseismic capacity. The reduced target of achieving 25% reduction in emissions by 2020 to 3.8% reduction of fiscal year 2005 emissions by COP19 was also announced (Kuramochi, 2014).

- **Continuous revision and recalculation of data:** After every inventory submission, the data, such as emission factor, activity data, etc., is continuously reviewed by the QAWG group. This resulted in changes in data of many subsectors like emission factors of LPG, gasoline passenger vehicle, manure management, changes in carbon stock of forest land, crop, etc. Even changes in activity data were noticed like the amount of crop residue, rice cultivation showing the constant betterment in fuel quality and estimation methods over the years. This continuous revision has also helped in progress of major sectors into Tier II and Tier III methodologies and will help sectors following Tier I approach to move forward to higher tiers (Japan Ministry of the Environment, 2017).

Conclusion: Since the beginning, the country of Japan has been self-sufficient in terms of its financial funds. Using its own resources and knowledge, the country was able to become one of the leading nuclear powers. The world saw the power of Japan when it was the only country to announce the reduction of its emissions by 25% till 2020 at COP15. Until the two major disasters struck Japan's core, its ambiguity was on a rise. The Great Japan Earthquake and Fukushima Nuclear Disaster created a major hole in the nuclear plans which the country has been trying to mitigate ever since. The Government of Japan improvised its target to reducing emissions up to 3.8% of the fiscal year 2005 by COP19 and implemented the 4th Basic Environmental Plan modifying the first one (Basic Environmental Plan) and incorporating the needs of the 21st century people as well as the national greenhouse gas inventory system.

The country of Japan has been able to become strong and developed in its GHG Inventory system due to its mitigation strategies, awareness campaigns, urge to create a networked institutional framework, and its moderately uncategorized information to the public. Although it has taken multiple steps to ensure its success, yet it needs more work in order to have less data uncertainty. The sub-sectors estimated through Tier I approach need to move to Tier II methodological approaches if not Tier III soon and ways need to be figured out for training new people who enter the inventory programme. The country also needs to construct buildings keeping in mind its highly prone nature to natural disasters such as earthquakes. With its resources, knowledge, and international associations, the country would do well in replacing its nuclear strength and rebounding from the impact much faster and much stronger than before.

References:

Academic Library. 2018. Responsibility of Developing Countries, The Role of Greenhouse Gas Inventory Office of Japan (GIO), One Part of the National System - Enabling Asia to Stabilise the Climate - Academic library - free online college textbooks. Available at <https://ebrary.net/15313/environment/responsibility_developing_countries#930>.

CGER; NIES; GIO. 2013. 'Proceedings of the 11 th Workshop on Greenhouse Gas Inventories in Asia -Capacity building for measurability, reportability and verifiability'. Available at <http://www-gio.nies.go.jp>, last accessed on April 19, 2018.

CGER; NIES; GIO; MOE. 2010. 'National Greenhouse Gas Inventory Report of JAPAN'.

Enoki, T. 2008. Takeshi Enoki Greenhouse Gas Inventory Office of Japan (GIO) National Institute for Environmental Studies (NIES) Conference on Climate Change, Development. - ppt download. Available at <http://slideplayer.com/slide/7619903/>.

Government of Japan. 1994. 'Japan's Action Report on Climate Change'.

Government of Japan. 1997. 'Japan's Second National Communication Under the United Nations Framework Convention on Climate Change', pp. 1–139. Available at <http://unfccc.int/resource/docs/natc/japnc2.pdf>.

Government of Japan. 2002. 'Japan's Third National Communication Under the United Nations Framework Convention on Climate Change', p. 188.

Government of Japan. 2006. 'Japan's Fourth National Communication'.

Government of Japan. 2010. 'Japan's Fifth National Communication'.

Government of Japan. 2013. 'Japan's First Biennial Report', (December). Available at <http://unfccc.int/files/national_reports/biennial_reports_and_iar/submitted_biennial_reports/application/pdf/br1_jpn_resubmission_v02.pdf>.

Government of Japan. 2017. 'Japan's Seventh National Communication under the Nations Nations Framework Convention on Climate Change'.

Japan Ministry of the Environment. 2017. 'National Greenhouse Gas Inventory Report of Japan 2017'.

Kato, S. 2007. '5th Workshop on GHG Inventories in Asia Japan's Institutional Arrangement for Preparation of National GHG Inventory'. Available at <http://www-gio.nies.go.jp/wgia/wg5/pdf/20. Sei Kato-Japan.pdf>, last accessed on April 20, 2018.

Kosaka, N. 2016. 'Japan ' s National Greenhouse Gas Inventory'.

Kuramochi, T. 2014. 'An Overview of the Current Policy Landscape', GHG Mitigation in Japan, (June), pp. 1–40. Available at <wri.org/publication/ ghg-mitigation-policy-japan>.

Mitsubishi UFJ Research and Consulting. 2014. 'Supporting Materials for preparing GHG Inventories, Biennial Update Reports, and National Communications'. Available at <https://www.env.go.jp/earth/coop/lowcarbon-asia/tools/data/supporting_materials.pdf>, last accessed on April 20, 2018.

Government of Japan. 2013. 'Japan's Sixth National Communication under the United Nations Framework Convention on Climate Change'.

United Nations. 2018. KP Introduction | UNFCCC. Available at <https://unfccc.int/process/the-kyoto-protocol>.

REPUBLIC OF CHILE

Background: On 21 March 1994, the United Nations Framework Convention on Climate Change (UNFCCC), ratified by Chile, came into force with the objective of achieving stabilization of greenhouse gas (GHG) concentrations in the atmosphere to a level that would prevent dangerous anthropogenic interference with the climate system.

Chile's national greenhouse gas inventories (NGHGI) is compiled according *to the 2006 IPCC Guidelines for national greenhouse gas inventories*, and including emissions and removals of GHGs; carbon dioxide (CO_2) and emission of methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6) in a series of time from 1990 to 2013.

Chile's first NGHGI was prepared by the National Environmental Commission (CONAMA) and submitted to the Convention in 2000 as part of the First National Communication of Chile and included information on GHG emissions for 1993 and 1994. The second official NGHGI was prepared by the Ministry of the Environment (MMA) and submitted in 2011 as part of the Second National Communication of Chile. This inventory included time series data from 1984 to 2006. The third NGHGI of Chile submitted to the UNFCCC included time series data from 1990 to 2010.

Chile's National GHG Inventory, 1990-2013 is the Fourth National Greenhouse Gas Inventory (NGHGI) submitted by Chile to UNFCCC in fulfillment of Article 4, paragraph 1(a) and Article 12, paragraph 1(a) of the UNFCCC and decision 1/ CP.16 of the 16th Conference of the Parties (Cancun, 2010).

According to the United Nations Development Program (UNDP, 2005), the preparation and presentation of NGHGI can provide a number of other benefits for a country, including: GHGs included in NGHGIs in developing countries, such as Chile, are CO_2, CH_4, N_2O, HFCs, PFCs, and SF6.

In 2013, Chile's total GHG emissions (excluding *FOLU*) amounted to 109,908.8 Gg CO_2 eq, an increase of 113.4% since 1990 and of 19.3% since 2010. The main GHG emitted by Chile was CO_2 (78.4%), followed by CH_4 (10.7%), N_2O (10.0%), and fluorinated gases (0.9%). The *energy* sector is the largest GHG emitter in Chile (77.4%), mainly due to the consumption of coal and diesel for electricity generation and consumption of diesel in road transport. The *agriculture, forestry, and other land uses (AFOLU)* sector is the only sector that consistently removes CO_2 in the country, and remains as a sink for the entire time series.

Institutional arrangement: The GHG Inventory of the Department of Climate Change of the Ministry of Environment has been designing, implementing, and coordinating, since 2012, the National Greenhouse Gas Inventory System of Chile (SNICHILE), which includes institutional, legal, and procedural measures for the biennial updating of Chile's NGHGI, thereby ensuring the sustainable preparation of GHG inventories in the country.

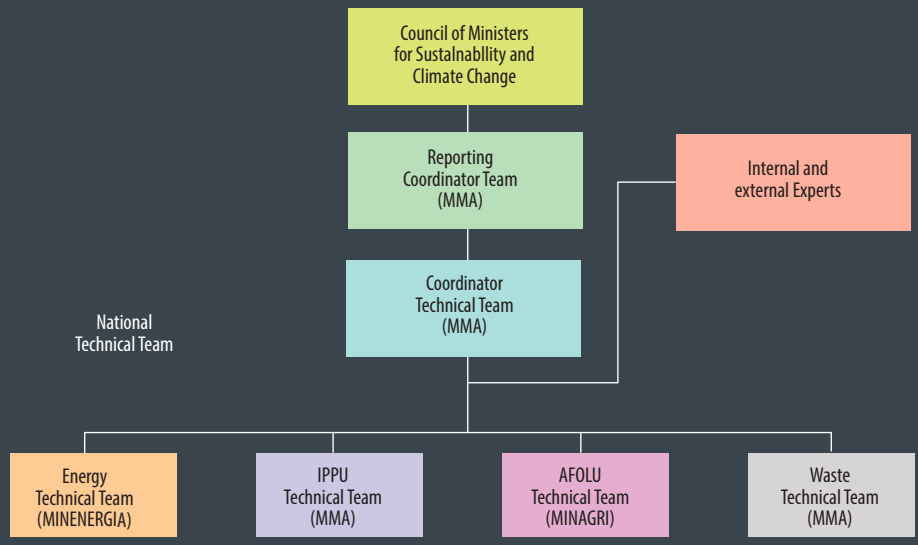
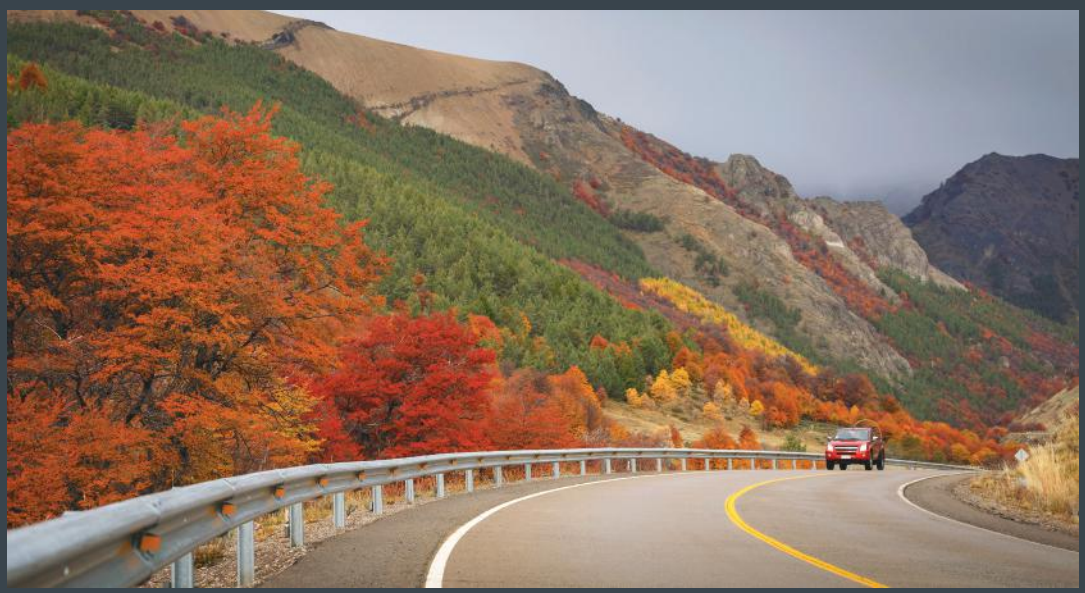


Figure 1 Organizational structure of SNICHILE (National Greenhouse Gas Inventory System of Chile)

Updating process of Chile's NGHGI

The process for the elaboration of this Chile's NGHGI began the first half of 2015 and concluded in the middle of 2016. Each Sectorial Technical Team develops the GHG inventory of its own sector. The Coordinating Technical Team then compiles the GHGSECI (Greenhouse Gas Sectorial Inventory) and develops the crosscutting theme. Subsequently, each Sectorial Technical Team approves the final report.

The following Chile's NGHGI, series 1990–2013, is the result of the compilation of GHGSECIs elaborated following 2006 IPCC Guidelines for national greenhouse gas inventories and applying IPCC software.



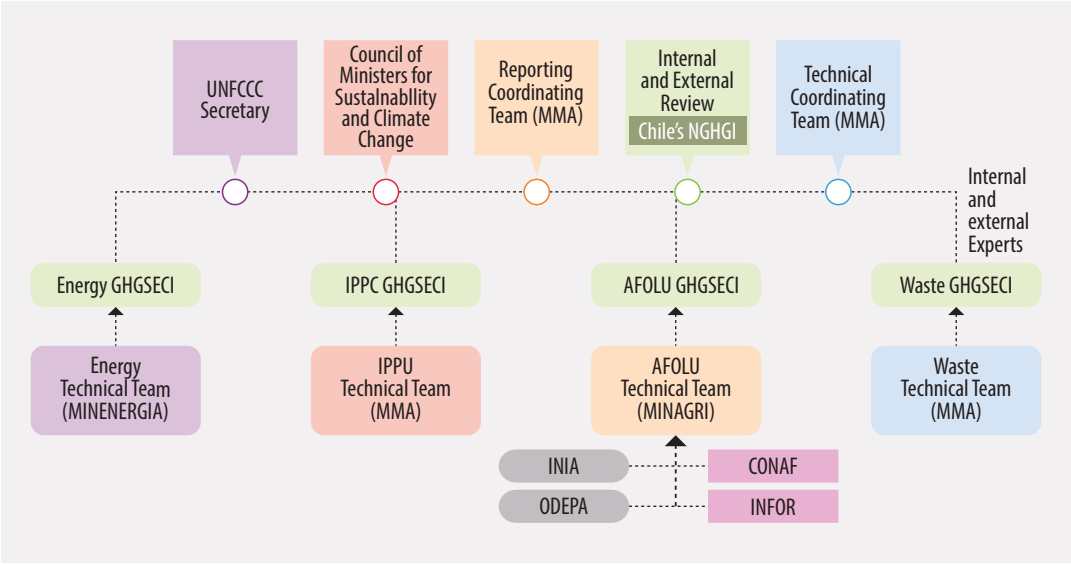


Figure 2 Updating process of Chile's NGHGI

Key categories: In 2013, GHG emissions and removals in Chile amounted to 70,054.4 Gg CO_2 eq while total GHG emissions in the country amounted to 109,908.8 Gg CO_2 eq, an increase of 113.4% since 1990 and of 19.3% since 2010. The key drivers of this trend in the GHG were the *energy* and the *AFOLU* sectors. The values observed that fall outside of the trend are primarily the consequence of forest fires accounted for in the *AFOLU* sector. In 2013, the total GHG emissions were dominated by CO_2, accounting for 78.4%, followed by CH_4 (10.7%) and N_2O (10.0%). Fluorinated gases collectively accounted for 0.9% of total GHG emissions in the country.

Table 1 Chile's NGHGI: GHG emissions and removals (Gg CO_2 eq) by sector, 1990-2013

Sector	1990	2000	2010	2011	2012	2013
Energy	33,219.5	52,122.9	69,423.7	78,527.0	82,076.6	85,075.4
IPPU	3,127.5	6,449.6	6,008.1	6,868.3	7,214.9	6,619.4
AFOLU	-30,866.3	-32,819.2	-30,514.4	-24,339.9	-18,410.7	-26,119.2
Agriculture	12,633.5	13,580.7	12,879.8	12,741.7	13,285.0	12,735.2
FOLU	-43,499.8	-46,399.9	-43,394.2	-37,081.6	-31,695.8	-39,854.4
Waste	2,526.1	3,348.3	3,802.6	3,939.8	4,019.2	4,478.8
Balance (with FOLU)	8,006.8	29,101.5	48,719.9	64,995.1	74,899.9	70,054.4
Total (without FOLU)	51,506.6	75,501.4	92,114.2	102,076.7	106,595.6	109,908.8

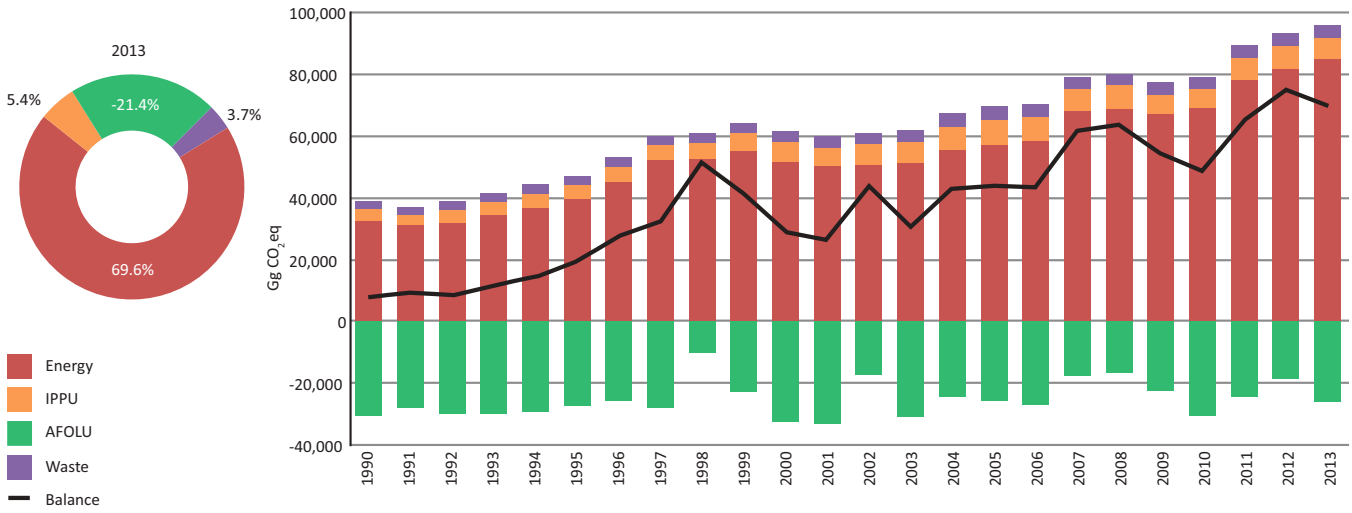


Figure 3 Chile's NGHGI: emissions and removals of GHG (Gg CO_2eq) by sector, series 1990–20130 2000 2010 2011 2012 2013

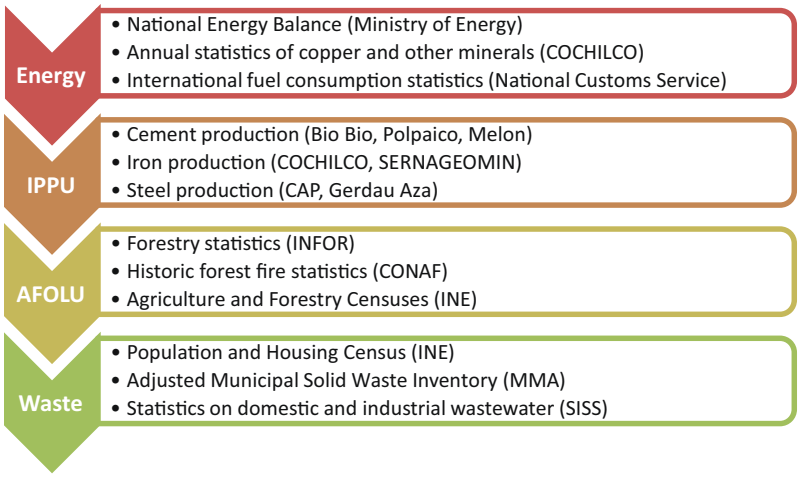


Figure 4 Main sources of information of the Chile's NGHGI, series 1990–2013

Sector-wise emission details:

Energy Sector

Leading GHG emitter in Chile,accounting for 77.4% of total GHG emissions in 2013.

- GHG emissions from the sector amounted to 85,075.4 Gg CO_2 eq an increase of 156.1% since 1990 and of 22.5% since 2010.
- Increased emission is due to increased energy consumption in the country, including the consumption of coal and natural gas for electricity generation and consumption of liquid fuels, mostly diesel and gasoline, for road transportation.

IPPU Sector

- Accounts for 6.0% of total GHG emission.
- The sector amounted to 6,619.4 Gg CO_2 eq, an increase of 111.7% since 1990 and of 10.2% since 2010.
- Emissions increased due to increase in production of iron and steel, lime, nitric acid, and cement.
- With regard to categories, 37.7% of GHG emissions from the sector correspond to the *mineral industry*, followed by 23.9% from the m*etal industry*, 21.2% from the *chemical industry*, 10.4% from *product use as substitutes for ozone depleting substances*, 4.7% from *other product manufacture and use*, and, finally, 2.1% from *non-energy products from fuels and solvent use*.

AFOLU Sector

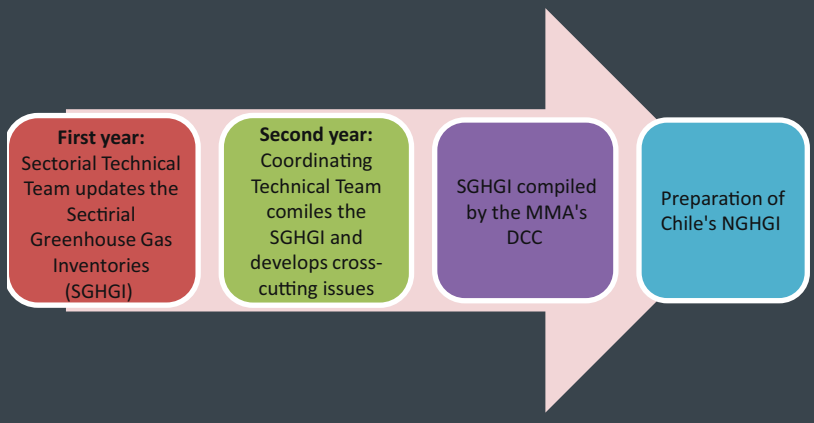
- This is the only sector which consistently removes CO_2 in the country.
- In 2013, the GHG balance from the sector amounted to -26,119.2 Gg CO_2 eq, reducing its sink condition by 15.4% since 1990 and by 14.4% since 2010.
- This reduction is due to the *land* category decreased their removals while GHG emissions from categories associated with agricultural activities (*livestock* and *aggregate sources and non-CO_2 emissions sources on land*) have remained stable during the 1990–2013 series.

Waste Sector

- This sector accounted for 4.1% of total GHG emissions in 2013.
- In the same year, GHG emissions from the sector amounted to 4,478.8 Gg CO_2 eq, an increase of 77.3% since 1990 and of 17.8% since 2010.
- The key driver is the sustained increase in solid waste generation.
- With regard to categories, 72.0% of GHG emissions from the sector correspond to *solid waste disposal*, followed by 26.7% from *wastewater treatment and discharge*, 1.3% from *biological treatment of solid waste* and, finally, 0.01% from *incineration and open burning of waste*.

Inventory preparation:

- GHG Inventories of the Ministry of the Environment's Department of Climate Change (DCC) designed, implemented, and maintained the National Greenhouse Gas Inventory System of Chile (SNICHILE), which contains the institutional, legal, and procedural steps for the biennial update of Chile's NGHGI, thus ensuring the sustainability of the preparation of GHG inventories in the country. SNICHILE's ongoing work is divided into five lines of action:
  - Operation of SNICHILE
  - Updating Chile's NGHGI
  - Quality assurance and quality
  - control system
  - Capacity building
  - Archiving and dissemination
- SNICHILE's work plan is organized in a **two-year cycle** of activities -



In conclusion, Chile's NGHGI is the result of the collective and continuous efforts of the Ministries of Agriculture, Energy, and Environment, which have worked in coordination under the framework of SNICHILE. This work has strengthened the preparation of Chile's NGHGI by adding expert knowledge from the various sectorial ministries involved.

Challenges in the inventory preparation:

- Lack of stable technical teams to ensure sustainable and the quality of GHG estimates.
- No country-specific emission factors in order to reflect the national situation more
- accurately in terms of GHG emissions and removals.
- No permanent national funding for hiring new professionals for the different technical teams as well as permanent funding for scientific research.

Overcoming the challenges:

- The main need is to expand the current negotiating team in the country and establish permanent teams in the relevant sectorial ministries
- There should be adequate financial and technical capacity for the preparation and full strategic monitoring of the negotiations and appropriate coordination mechanisms.
- Capacity-building to assess technological requirements relating to data collection for the BUR and the implementation of MRV systems.

Conclusion: National greenhouse gas inventories (NGHGI) consist of an exhaustive list of the quantities of each anthropogenic GHG emitted into or removed from the atmosphere in a given area over a specific period of time. These NGHGIs are intended to determine the magnitude of national GHG emissions and removals that are directly attributable to human activity and thereby establish a country's particular contribution to the phenomenon of climate change.

For Chile the key mechanisms for reporting NGHGIs to the Convention have been National Communications (NCs) and, as of 2014, Biennial Update Reports (BURs).

The country has been benefitted by the GHG inventory in many ways, such as, identifying sectors from which there is maximum emission; assessing options for mitigating GHGs; providing foundation of emission trading schemes, etc.

In 2013, the balance of GHG emissions and removals in Chile amounted to 70,054.4 Gg CO_2 eq, while total GHG emissions in the country amounted to 109,908.8 Gg CO_2 eq, an increase of 113.4% since 1990 and of 19.3% since 2010. The key drivers of this trend in the GHG balance were the *energy* and *AFOLU* sectors. The values observed that fall outside of the trend are primarily the consequence of forest fires accounted for in the *AFOLU* sector.

In 2013, the total GHG emissions were dominated by CO_2, accounting for 78.4%, followed by CH_4 (10.7%) and N_2O (10.0%). Fluorinated gases collectively accounted for 0.9% of total GHG emissions in the country.

References:

Chile's National Greenhouse Gas Inventory, 1990-2010 (Climate Change Office Ministry of the Environment of Chile)
Chile's First Biennial Update Report (Submitted to UNFCCC)
Chile's Second Biennial Update Report (Submitted to UNFCCC)

Project title
A Transparency Framework for Implementing Indcs in India: Setting Commonly Accepted Monitoring and Verification System

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