GHANA

Ministry of Environment, Science, Technology and Innovation

Sectoral Report

Sectoral Monitoring Reporting and Verification System in Ghana

November 2019

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ABBREVIATIONS AND ACRONYMS

AD	Activity Data
AFOLU	Agriculture, Forestry and Other Land Use
BAP	Bali Action Plan
BAU	Business-as-usual
BRRI	Building and Road Research Institute
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CC	Conditional target
CERs	Certified Emission Reductions
CERSGIS	Centre for Remote Sensing and Geographic Information Services
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
DVLA	Driver Vehicle Licensing Authority
EF	Emission Factors
EPA	Environmental Protection Agency
ERP	Emission Reduction Potential
ETF	Enhanced Transparency Framework
FSV	Facilitative Sharing of Views
GCNet	Ghana Community Network System
GDP	Gross Domestic Products
GEF	Global Environment Facility
GHGI	Greenhouse Gas Inventory
GLSS	Ghana Living Standard Survey
GSS	Ghana Statistical Service
GWP	Global Warming Potential
ICA	International Consultation and Analysis
ICAT	Initiative for Climate Action Transparency
IPCC	Inter-governmental Panel on Climate Change
IPPU	Industrial Process and Product Use
ITMOs	Internationally Transferred Mitigation Outcomes
KCA	Key Category Analysis
KP	Kyoto Protocol
MESTI	Ministry of Environment Science Technology and Innovation
MRV	Monitoring Reporting and Verification
MRV	Monitoring Reporting Verification
MW	Megawatt
NAP	Non-Annex Parties
NC	National Communications
NDC	Nationally Determined Contributions
NDPC	National Development Planning Commission
NIR	National Inventory Report
PA	Paris Agreement
QA/QC	Quality Assurance/Quality Control
RAC	Refrigeration and Air-condition
REDD+	Reducing Emissions from Deforestation and Forest Degradation
UC	Unconditional target
UNFCCC	United Nations Framework Convention on Climate Change

1 INTRODUCTION TO THE ASSIGNMENT

1.1 INTRODUCTION TO THE INTERNATIONAL MONITORING REPORTING AND VERIFICATION SYSTEM

The Parties to the United Nations Framework Convention on Climate Change (UNFCCC) must regularly publish their national communications (NCs). The NCs are to carry information on national greenhouse gas emission inventory, steps taken to implement the UNFCCC in-country, and any other information relevant to the objective of the Convention. Under the reporting arrangements, the Annex 1 Parties reported their NCs every four years, while the Non-Annex 1 Parties (NAP) had no reporting timelines. Reporting under the UNFCCC has been reformed significantly. When the 34 industrialised nations adopted the Kyoto Protocol (KP), strict annual reporting and technical review were introduced to evaluate progress towards achieving their emission reduction targets and ensured continued participation in the KP.

The Bali Action Plan (BAP) established a global monitoring, reporting, and verification (MRV) system, which sought to enhance the Parties' climate reporting. The international MRV scheme introduced enhanced reporting (four years for national communication and two years for the Biennial Update Report, BUR) and report review through two-step technical and multilateral reviews under the international consultation and analysis (ICA) process. Countries were required to establish an enhanced domestic MRV system to enable them to participate effectively in the international climate regime. Under the changes, countries had to set up functional national arrangements so that they could compile and publish credible and timely climate reports and participate effectively in the ICA. In addition to rationalising the NC reporting timelines and adding NAP's BUR, the content was also changed. The reporting elements in the NCs remained mostly unchanged, but the BUR now includes new items such as mitigation action and effects, domestic MRV, and support needed and received. The enhanced MRV regime will continue until 2024 when it is replaced by the enhanced transparency framework under the Paris Agreement (PA). Therefore, developing countries must prepare for a smooth shift to the enhanced transparency framework (ETF). This transition will undoubtedly require consistent efforts to strengthen the existing MRV arrangements.

1.2 EVOLUTION OF THE GHANA MRV SYSTEM

The purpose of establishing the domestic MRV system is to localise international reporting and incorporate it as an integral part of the government structure. In practice, this is a national arrangement that guides the systematic steps to regularly collect and process data and publish information on GHG emissions, mitigation actions, and their effects and support. The objective is to increase the transparency of mitigation actions that the country implements and to build confidence among all countries[1]. Ghana produces updated national greenhouse gas estimates every two years. The estimates are generated based on greenhouse gas emissions (CO2, CH4, N2O and PFCs) from the energy, industrial process, agriculture, forestry, and other land use and waste sectors, using the 2006 IPCC methodology. The energy and transport sectors are key contributors to economic growth and GHG emission in Ghana. The energy sector is the second-leading source of emissions currently, contributing 15.02 $MtCO_2e$ (35.6 percent) of national emissions, behind AFOLU (agriculture, forestry and other land use)[2]. Within the energy sector, transportation accounts for most emissions. Its 7.2 $MtCO_2e$ emissions in 2016 are responsible for 48 percent of total energy emissions and 17 percent of overall national emissions[3].

However, quantifying energy and transport sector emissions is more challenging due to the lack of accurate data and the difficulties associated with the data collection system. By 2024, countries that are Parties to the UNFCCC and the Paris Agreement will report on national communications and through the Biennial Transparency Report (BTR). UNFCCC-compliant nations will submit their national communications every four years. Since Ghana is a party to both UNFCCC and the PA, it would continue to report the NC every four years and begin compiling BRT in 2024, when the last BUR is published. Ghana thus needs to sustain its efforts to strengthen the existing national MRV system so that it responds to the EFT. Consequently, facilitating the development of workable sector-specific MRV systems for the energy and the transport sectors would be important steps towards establishing a functional climate reporting system in the country.

1 UNFCCC, 2011
2 EPA, 2019: Ghana's Fourth National Greenhouse Gas Inventory Report
3 EPA, 2019: Ghana's Fourth National Greenhouse Gas Inventory Report

This report is the culmination of a joint effort to evaluate the current state of Ghana's MRV system and propose practical ways to institutionalise it in the energy and transport sectors. The assignment was originally focused on designing energy and transport sector-specific MRV, but the team has developed an MRV tool that applies to all NDC sectors. However, the team has used energy and transport case examples throughout this document to illustrate salient concepts of MRV. The document's purpose is to understand MRV practices and suggest concrete methods to strengthen the accuracy of GHG estimates and mitigation actions to achieve its national targets, as well as to ensure accountability in terms of support received. The aim is to develop a tailor-made MRV tool across all NDC sectors, including energy and transport. The tool will help the Government of Ghana to report on the progress of all NDC mitigation actions in all sectors.

1.3 APPROACH TO DESIGNING SECTORAL MONITORING, REPORTING AND VERIFICATION

In line with the objectives outlined in the TOR, the consultants approached the assignment in three main stages. The first involved conducting a comprehensive review of the National Greenhouse Gas Inventory (GHGI) and Biennial Update reports to UNFCCC, policy documents on Ghana's MRVs, Ghana's NDC and other international MRV tracking systems. The review produced the National MRV Assessment Report of Ghana, submitted to the Ministry of Environment, Science, Technology and Innovation (MESTI) within the framework of this work. The assessment helped the team to understand how Ghana's national MRV system operates and identify gaps, challenges and efforts to address them to enhance the transparency and tracking of NDC targets and progress. The second stage involved consulting with MESTI/Environmental Protection Agency (EPA) and other key stakeholders to develop an in-depth understanding of the challenges of MRV tracking in Ghana. In the third stage, the consultants worked closely with the EPA to develop an MRV tool that can be used to monitor and report progress on the NDC and shared the draft with the UNDP for review and inputs. The fourth stage involved holding a stakeholder consultative workshop to test the suitability of the MRV tool and solicit their input for integration into the final version.

1.4 STRUCTURE OF THE REPORT

This document includes seven chapters:

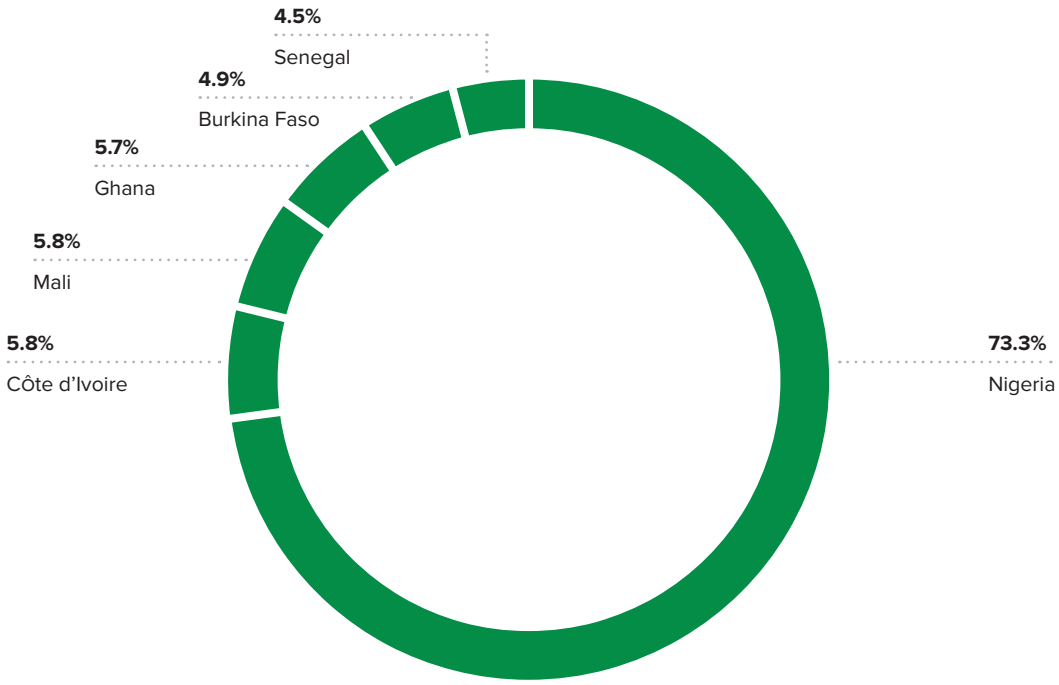
- Chapter 1 introduces the report. It provides background information on the broad elements of MRV, highlighting the need for sector-specific MRV for the energy and transport sectors.
- Chapter 2 presents an overview of Ghana's mitigation potential and the existing MRV system. It reviews the existing MRV system, challenges encountered and the gaps identified, which informed the development of the energy and transport sector-specific MRV.
- Chapter 3 discusses the tracking of Ghana's nationally determined contributions. It presents an overview of ETF, the NDC to national and sector-level GHG inventory, institutional arrangements, MRV reforms and challenges.
- Chapter 4 presents the MRV for the energy and transport sectors. It covers the national accounting system, requirements of the national NDC accounting system, data requirements and methodologies. This includes the institutional arrangements for implementing the sector-specific MRV system and for coordinating MRV related aspects. It also defines the role and responsibility of each institution, including for measuring and reporting the various parameters, managing the data management system, aggregating data, and conducting verification.
- Chapter 5 covers GHG accounting for NDC under the ETF regime. It describes the NDC accounting steps and requirements of the national NDC accounting system. This includes the data requirements and methodology for computing achievement of NDC targets. The chapter also describes the methods for calculating achievement of NDC and assessing NDC impacts.
- Chapter 6 presents an Excel-based tool developed to facilitate calculation of the achievement of NDC targets. It details the NDC accounting tool calculation options for tracking the NDC, features and steps and how they are linked in a worksheet. It also describes the five main elements required to determine NDC progress. These include business-as-usual emissions, national NDC targets, GHG inventory-based tracking, measure-based tracking and the NDC tracking dashboard.
- Last, Chapter 7 offers conclusions and recommendations for successful implementation of the tool.

2 GHG MITIGATION POTENTIAL AND THE EXISTING DOMESTIC MRV SYSTEM

2.1 OVERVIEW OF GHG MITIGATION POTENTIAL IN GHANA

Ghana's 42 million tonnes of greenhouse gas is just a small fraction of Africa's 4 percent of contributions to global emissions (Figure 1). However, the country is among the top six largest GHG emitters in the ECOWAS subregion[4]. Its total national emissions have increased by 66 percent over the period 1990-2016 and are projected to nearly double to 74 $MtCO_2e$ by 2030 along the BAU trajectory. Given this trend, it is quite likely that emissions will exceed their allowable limits if concrete steps are not taken to reduce them. If the current economic structure is not modified, emissions will continue to increase and, even, worsen beyond 2030. Ghana's rising emissions trend correlates positively with observed GDP and population growth[5].

Figure 1: Share of 2014 greenhouse gas emissions among the top five emitters in the ECOWAS Sub-region



Controlling increasing emissions in the future would require implementing cost-effective mitigations, using a wide array of fiscal, regulatory and technological measures. The country's GHG mitigation potential varies by economic sector because it is based on costs and available technology. Mitigation strategies entail both the question of the extent of cost-effective GHG emissions reduction in a given period and the ability to make the correct policy choices to achieve the targets set. Several factors thus come into play when countries or entities develop mitigation targets and the accompanying strategies to achieve them. One key factor is determining a country's ability to achieve its goal based on its economic circumstances. While some influential industrial countries have committed to a net-zero target[6], other emerging or developing nations have adopted a medium-term mitigation goal that is below business-as-usual or base year emissions. Another major step involves selecting a suitable mitigation accounting metric based on a transparent and robust methodology. The accounting metric a country selects is usually used to systematically assess GHG baselines and ex-ante impacts of the mitigation action and to track progress towards and achievement of the stated target. Ghana has adopted a BAU deviation emission target approach. Its overall BAU emissions target is 74 $MtCO_2e$ by 2030, projected from 2010 historical emissions of 20 $MtCO_2e$, and a corresponding target of 45 percent emission reduction (33 $MtCO_2e$) below the BAU emissions.

4 **https://www.climatewatchdata.org/data-explorer/historical-emissions?historical-emissions-data-sources=42&historical-emissions-gases=177&historical-emissions-regions=BFA%2CCIV%2CGHA%2CNGA%2CSEN%2CMLI&historical-emissions-sectors=509&page=1**

5 **https://unfccc.int/sites/default/files/resource/gh_nir4-1.pdf**

6 In June 2019, the UK Government announced a new net-zero carbon commitment by 2050 to replace the existing 80% emission cut by the same year as found in the 2008 Climate Change Act. **https://www.bbc.com/news/science-environment-48596775**

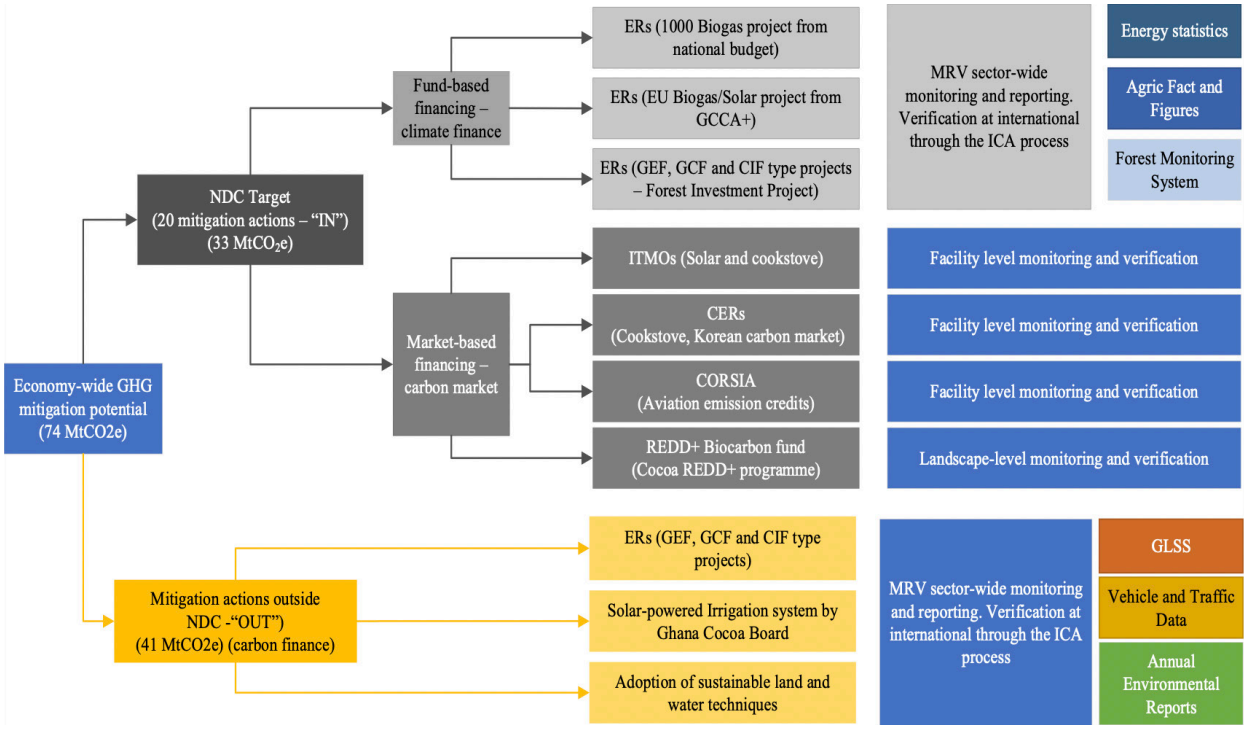
This means that by 2030, Ghana is expected to reduce its total national greenhouse gas emissions from the projected 74 $MtCO_2e$ to 41$MtCO_2e$ when all 20 mitigation measures in the NDC are fully implemented. This translates roughly into 33$MtCO_2e$ emission reductions over the 10 years. The remaining 41 $MtCO_2e$ are potential reductions that could be achieved with the mitigation actions outside the scope of the NDC (Figure 2). Ghana has identified two categories of mitigation measures. The 20 mitigation measures were originally captured in the NDC and labelled "IN," whereas all the other measures that fall outside the NDC are classified as "OUT" (Figure 2). Financing for the IN mitigation actions may come from multiple fund-based (climate finance) and market-based (carbon market mechanism) sources[7] or a mixture of them. The same financing arrangements may apply to the OUT mitigation actions. However, the MRV arrangement for IN and OUT measures would differ for the two financing tracks.

Typically, MRV for market-based mitigation measures tends to be stricter because the resulting GHG emission reductions may be exchanged for cash payments or other financial instruments. Therefore, market-based mitigation units must meet higher verification standards before emission reduction credits are issued to the intended owner with legal entitlement. This, in turn, means that the units generated must have been subject to rigorous monitoring, reporting and verification at the facility level before payments is issued. The facility operator performs monitoring and reporting at the project level before third-party verification. The bottom line is that all NDC mitigation actions funded through carbon finance schemes (such as CERs, ITMOs, CORSIA and REDD+) with a view to exchanging units for payment must comply with the funding conditions.

The NDC mitigation measures under non-market funding may not necessarily be subject to the strict MRV system in the same way as the market-based ones. This is because the mitigation outcomes from implementation are of limited use or may not be used in commercial transactions for payments. Thus, most mitigation units from non-market funding may be used to comply with or meet the national emission reduction targets. Nevertheless, they could be converted to market-grade units when they satisfy compliance conditions. The importance of distinguishing between the MRV schemes for the IN and OUT mitigation measures is to inform the design of the MRV scheme. It is important to understand the two MRV requirements to avoid any potential double-counting of mitigation outcomes for the IN and OUT measures. It is also important to recognise the important differences in the reporting lines for climate finance and carbon market projects.

For instance, while most carbon finance measures are reported under the BUR chapter that deals with mitigation actions and their effects and the mitigation assessment chapters in NC, the carbon market initiative falls primarily under the international carbon market section of the biennial update report. A much more detailed monitoring report is prepared as part of the third-party project verification (Figure 2).

Figure 2: Ghana's economy-wide mitigation potentials, linkages with NDC targets and corresponding MRV requirements for the respective mitigation measures



7 Articles 5 (REDD+), 6 (Carbon Markets) and 9 (Carbon Finance) of the Paris Agreement contain a suite of international cooperation instruments for financing mitigation action in countries and globally.

2.2 DESCRIPTION OF GHANA'S DOMESTIC MRV SYSTEM

The domestic MRV system covers MRV of GHG, actions and support. Monitoring of the actions is performed within the sectors and reported via the BURs. Next, the BUR is subject to ICA at the consideration stage to verify the information reported. In keeping with Article 13 of the Paris Agreement, the BTR will replace the BUR in 2024 and every two years afterwards. The BTR will add more elements to the information currently reported in the BUR. The primary information in the BURs includes: (a) national greenhouse gas inventory; (b) mitigation actions and their effects; and (c) support needed. The BTR will add specific information on adaptation and NDC progress, with some flexibility for developing countries in terms of reporting on those matters.

Ghana prepared two BURs between 2015 and 2019. Preparation of the third BUR is about to begin within the year. After BUR1 was submitted, ICA followed in two parts. Part 1 consisted of a technical analysis conducted by a multi-national expert review team. Part 2 involved a multilateral assessment, during which other countries may ask questions and obtain answers in a facilitative sharing of views (FSV) workshop. The ICA process focuses on identifying potential areas for capacity building, with a view to improving the quality of the BUR over time. Ghana is scheduled to join four other countries in the second FSV workshop in December 2019. Preparing the two BURs and subsequent participation in the ICA have contributed immensely to strengthening the functionality of the domestic MRV system, helping to improve technical capacities in the country and identifying key technical areas that need major improvements.

Compiling a credible and timely BUR also depends on seamless access to high-quality national data. Generally, the GHG inventory component of the domestic MRV is more advanced in terms of accessing data. Existing public institutions mandated to collect and publish administrative data for specific sectors supply activity data. However, the emission factors are mostly default figures from the IPCC database, except in the land category, where country-specific factors exist. Going forward, priority will be given to conducting scientific studies to collect country-specific emission factors, starting with the key categories (KCs). The KCs in fossil fuel power plants, transport, manufacturing industry and liquid and solid waste will receive immediate attention. In addition to the KCs, more data-related work remains to be done in specific emerging areas, such as residential cooking, fugitive emissions from the oil and gas industry, and open burning.

Data on mitigation actions are collected from multiple sources at the project level before they are aggregated into the sector and nationally. Bits and pieces of this mitigation data exist within the sector and require considerable effort to assemble. The major issues relate to establishing a consistent baseline and to the uncertainties associated with aggregating the effects of individual mitigation actions.

Another important aspect is reporting data on the sustainable development impacts of climate mitigation actions. Many reasons explain the difficulties of reporting on the sustainable development benefits of such actions; the key ones relate to the inability to collect sufficient data at different levels and the absence of a reliable methodology to assess the impacts. Nonetheless, an emerging literature can be useful in this regard. For instance, DTU-Partnership's ICAT project[8] recently published a guidance document on qualitative and quantitative approaches to assessing the sustainable development benefits of climate action. This work is an important element that Ghana will adopt to guide the subsequent reporting of socioeconomic impacts of mitigation actions in the BUR. Saudi Araba has also reported comprehensively on such impacts in its BUR1.[9] Ghana should consider some of these approaches in future BURs.

The BURs also include information on support needed and received. Ghana currently publishes information in the BURs on monetary and non-monetary support received. The monetary support data is collected by surveying donors and recipient organizations. Ghana also reports information on international financial inflows in the latest BUR, but very little on national climate inflows. Ghana intends to include climate finance data from the national government in the next BUR to enhance the completeness of reporting. Currently, Ghana's BUR reports on "committed climate funds" but not on expenditures because of the difficulties in collating spending data. When the data from both international and domestic climate finance inflows are eventually incorporated, this will further enhance the transparency of the BUR. Ghana also faces a challenge in terms of its inability to collect climate finance inflows from all formal and informal sources. Most informal sources are rarely captured in government data. Preparation of the two BURs has helped to assemble some mitigation data at a central location. The data are added at every reporting cycle. Those with major quality issues are either replaced with new ones or excluded from the database. Preparing the BURs will also allow

8 https://climateactiontransparency.org/icat-guidance/sustainable-development/
9 https://unfccc.int/sites/default/files/resource/18734625_Saudi%20Arabia-BUR1-1-BUR1-Kingdom%20of%20Saudi%20Arabia.pdf

for proper documentation of mitigation data for easy retrieval by future BUR teams. Data for preparing the BUR are obtained from six existing platforms in the line ministries. An overview of the data flows, institutions, data type and challenges is presented in the table below:

Table 1: Existing data sources used for the Biennial Update Report and National Communication in Ghana

NAME	INSTITUTION	DATA TYPE	LINK TO BUR REPORTING	REMARKS
Energy statistics http://www.energycom.gov.gh/planning/energy-statistics	Energy Commission	Fuel consumption Electricity generation	GHG inventory	Published every year in April. The metadata is unavailable, making it difficult to estimate uncertainty levels. Statistics are sourced primarily from the sector's upstream and downstream entities. Some of the data are obtained from surveys and market monitoring. Sectoral or industrial sectors' fuel consumption share figures are based on previous field survey data and projections are based on expert judgments. There are no sector-specific emission factor figures.
Energy Access Tool Kit http://167.114.144.200/Energydatabase		Energy project updates	Energy mitigation actions and their effects in the BUR	No timeline for regular updates. Metadata not published. Data not updated regularly. The data collection system needs to be strengthened.
Ghana Living Standard Surveys (GLSS) http://www.statsghana.gov.gh/nationalaccount_macros.php?Stats=MjM3NTIyNzgzLjM4ODU=/webstats/8ppr2r245p	Ghana Statistical Service (GSS)	Household energy consumption and share of waste disposal	GHG inventory	Published every five years; the latest version is GLLS 7. Metadata and regional disaggregation data are available on request.
Ghana Open Data Initiative https://data.gov.gh/search/type/dataset		Socioeconomic data	GHG inventory Energy mitigation actions and their effects in the BUR	Published online. References to the data source are also published. There is no clear schedule for updates. This is a new initiative led by the GSS, involving most government institutions that provide environmental, economic, social, energy, forestry and other data.
Agric Facts and Figures http://agricinghana.com/wp-content/uploads/2017/07/AGRICULTURE-IN-GHANA-Facts-and-Figures-2012.pdf	Ministry of Food and Agriculture	Food balance and livestock information	AFOLU GHG inventory and some mitigation-related data	PDF of the facts and figures are published online, but not on an annual basis. The latest publication online is from 2016. Metadata is available on request. It uses a vertical data structure, linking from the districts to the regional and national levels.
Forest Monitoring System	Forestry Commission	REDD+ Land-use change information	AFOLU GHG inventory	The forest monitoring system is at the planning stage. Dataset is available offline. Biomass, areas of land use categories and changes in them, fire spots and biomass (timber and wood fuel) harvest are available offline.
Environmental Management Plans and Annual Environmental Report	Environmental Protection Agency	Industry performance data	GHG inventory Manufacturing mitigation actions and their effects	Industry environmental performance data is published offline; data is inconsistent and incomplete. Industry supplies data on air emission, industrial effluent, water use, energy use and other.

NAME		INSTITUTION	DATA TYPE	LINK TO BUR REPORTING	REMARKS
Vehicle data	Vehicle imports	Customs – GCNet	Number and classes (technology, fuel types) of vehicle imports	GHG inventory	Import figures not published online. Available on request.
	Registration and roadworthiness data	DVLA and private garages	Annual vehicle registration per region Vehicle emissions testing data	GHG inventory Transport mitigation actions and their effects	Vehicle physical inspection data from private garages, odometer readings not recorded, fuel economy gauge and odometer in most commercial or old vehicles do not work. Emissions testing at the garage is voluntary and conducted on request. Results of the emission testing are not included in determining whether to issue the roadworthiness certification.
	Traffic data	Ministry of Transport	Vehicle average speed and distances on different road classes (highway, urban and feeder roads)	GHG inventory	Data do not exist at the national level. The Ministry of Transport has conducted some studies on BRT routes in Accra. EPA did a country-wide study on vehicle emission estimates in 2006 using the COPERT model.
Annual Progress Report (APR) http://ndpc-cms.herokuapp.com/downloads/33/	Sector/Districts	All line ministries and districts, including NDC sectors	Tracking achievement of policy targets at the sector level, including NDC actions	Mitigation actions (NDC mitigation actions and their effects)	Line ministries and the NDPC have not started reporting the progress of NDC in the sector and national APRs. Initial work has been done to develop indicators to track each NDC action and the target. The report is published annually. Existing reports cover the years 2003 to 2017.
	National	NDPC	Tracking achievement of national policies and the SDGs		
Sanitation data		Major district assemblies and the Ministry of Sanitation and Water Resources	Municipal solid waste and liquid disposal, landfill gas, incineration, open burning, compost, etc.	GHG inventory Waste mitigation actions and their effects	Complete waste data is not available in a central location, but do exist in various locations. Most are published through studies and project reports.

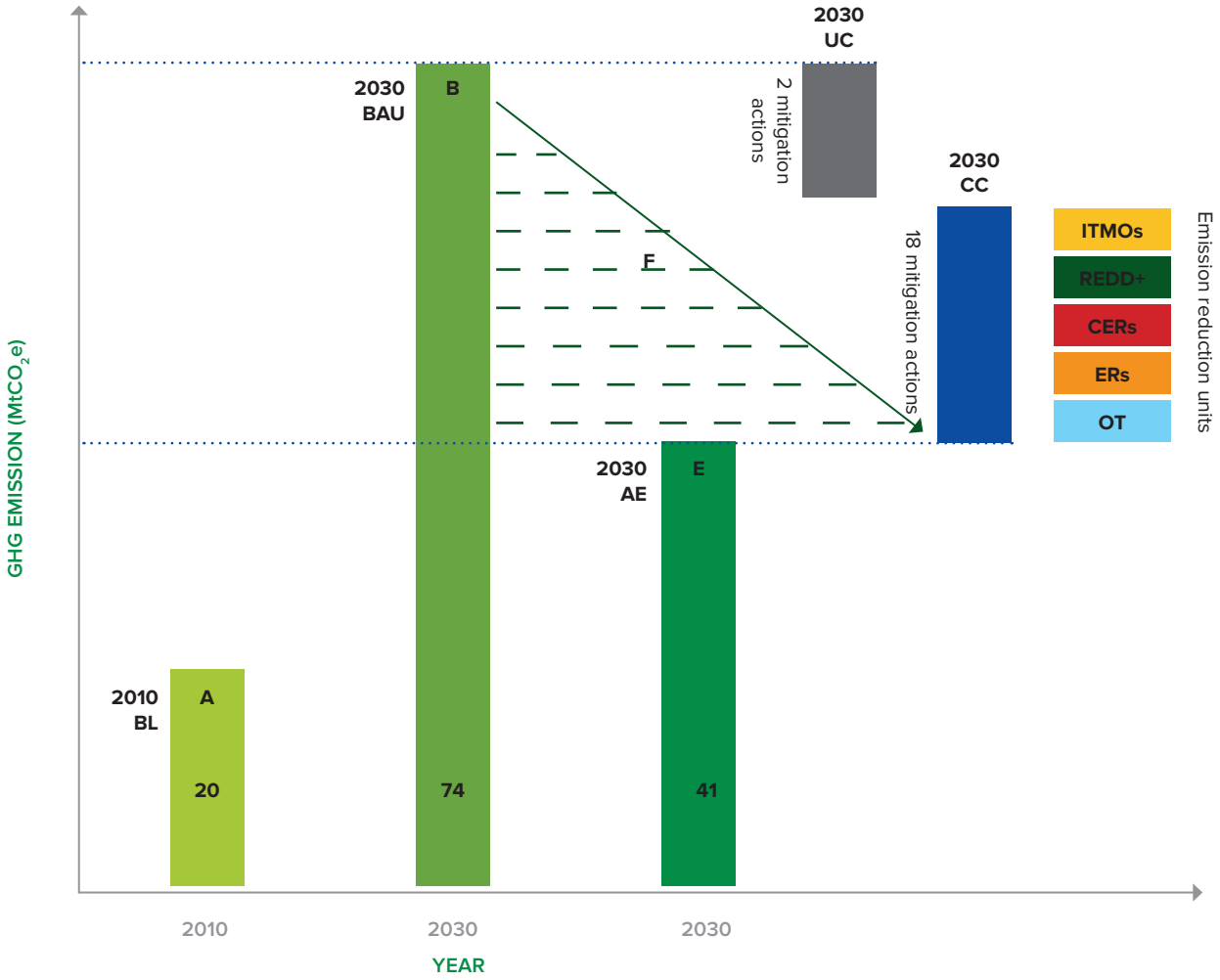
2.3 ELEMENTS OF GHANA'S NDC BASELINE AND MITIGATION TARGET

In 2015, Ghana adopted a voluntary GHG mitigation goal in the Nationally Determined Contributions under the Paris Climate Agreement. The NDC goal was set as a baseline scenario[10] with single-year (2030), two-tier (unconditional and conditional) and economy-wide (all gases and all sector activities) targets. In the NDC, Ghana has committed to a 45 percent reduction in GHG emissions below the projected business-as-usual emissions of 74 million tonnes of carbon dioxide equivalent ($MtCO_2e$) by 2030. Of the 45 percent overall target, 15 percent is an unconditional commitment and the remaining 30 percent is conditional. The 45 percent target totals to 33 $MtCO_2e$ in absolute terms; 11 $MtCO_2e$ of which are expected through the mitigation outcomes for the unconditional actions and 22 $MtCO_2e$ for the conditional actions (Figure 3).

10 This approach makes it possible to calculate the expected emission reductions by a given amount below a projected emissions baseline scenario. A baseline emissions scenario depicts a likely situation in future without steps taken to achieve the mitigation goal. Countries use different types of mitigation goals (baseline targets, intensity target, intensity and non-GHG target and trajectory and fixed level targets) depending on national circumstances. The choice of the type of goal is informed primarily by technical and political concerns.

Figure 3: Overview of Ghana's NDC mitigation commitment.

The emission reduction trajectory has been represented from A to F. A refers to 2010 baseline emissions, covering all IPCC sectors and direct greenhouse gas obtained from the national GHG inventory. Point B is the BAU emissions derived from historic economic performance and the scenario under which the status quo of the existing policies will remain unchanged in 2030. C and D represent the total 45 percent emission reduction target below the 2030 BAU emissions in two tiers. C depicts the mitigation pathway resulting from full attainment of the 15 percent unconditional commitment. D shows the additional 30 percent emissions cut trajectory resulting from implementation of the conditional mitigation actions. E is the projected assigned emissions threshold instead of B, following full implementation of all 20 mitigation measures. This will be the level of allowable national emissions threshold by 2030 under the scenario of achieving a 45 percent national target. Progress at any point toward achieving the 2030 45 percent target against the BAU emission will be tracked as indicated in F.



Baseline – BL (A): The starting year for the NDC baseline is 2010. The baseline included all direct greenhouse gas emissions that occur in Ghana and are inventoried in the recent national greenhouse gas inventory report. These gases include carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and fluorinated-gases (HFC-22 and HFC-410), excluding SF6 because of lack of inventory data. In terms of scope, the baseline captured primarily the major emissions/removals categories from the IPCC sectors (energy, industrial process and product use (IPPU), AFOLU, and waste). The baseline emission of 20 $MtCO_2e$ represented 66 percent of the 2010 total national emissions. The emissions were mainly from key categories that were considered cost-effective to mitigate GHG within the NDC period. Emissions from extractive industries and agriculture were strategically excluded from the baseline. The NDC document includes explanations of Ghana's intentions to revise the baseline to include emissions from extractive resources as the government commits to the policy to utilise the bauxite or oil resources in the country.

This approach - focusing on high GHG-polluting categories - seems to be the most practical way to deal with the policy uncertainties surrounding natural resource utilisation. It was also the surest way to prevent the possibility of constraining economic development at the expense of emission reductions. The NDC document also does not address the treatment of agricultural emissions in future revisions of the baseline. Based on the literature the team reviewed, emissions from livestock, rice cultivation and fertiliser application on croplands were excluded from the baseline. Agriculture emissions have been removed for reasons of materiality relative to the baseline emissions.

As Ghana plans to review the baseline emission next year, the national team should resolve the following outstanding issues:

- Shifting the base year: The team must weigh the option of keeping the 2010 base year or shifting it to a more recent year. In evaluating the options, the team must answer some fundamental questions, including which base year (2010, historical or recent) is most suitable to represent the country's current socioeconomic circumstances and the factors that would drive future GHG emissions trends. Would changing the base year (to the past or future) contribute to a more aggressive goal?
- Including or excluding IPCC categories: The current baseline covers 66 percent of total national emissions in the five IPCC sectors. Not all sources/sinks have been covered. The team must decide which category to add to the baseline and justify the inclusion. Agriculture- and industry-related emissions should be included in the baseline, but the team should determine which activities must be incorporated within a given time frame. The SF6 is not part of the baseline due to a lack of data. It was also not reported in the recent inventory for the same reason. Unless activity data are made available on the inventory side, it would be difficult to include them in the revised baseline.
- Defining the policy scope: The team must also objectively evaluate which government policy to include in the baseline. This is an important link to the emission projections under the BAU emissions.

Business-as-usual emissions: BAU (B). The timeline for the NDC baseline covered 2010-2030 and was subdivided into periods: pre-2020, a 2020-2025 window and a 2025-2030 window, with two updates in 2020 and 2025. The 20 $MtCO_2e$ base year emissions have been projected to rise to 74 $MtCO_2e$ by 2030 along the BAU trajectory. The baseline was assumed to be static and that any likely changes would require revising the dataset. To keep the baseline simple and transparent, individual sector emissions were aggregated into an economy-wide scale. This approach has advantages and disadvantages. The major advantage is that it made it possible to simplify the subtle details of the influences of individual drivers on BAU emissions without losing sight of the central message. On the other hand, simplifying the BAU methodology did not allow for elaborating on the refined details of the baseline at the category level. Regardless of which BAU option is selected (simple or complex), the most important feature that should not be compromised is the ability to maintain an "honest" baseline, ensuring that the correct policy drivers are included to the extent possible. The explanatory notes attached to the baseline emission also suggest that the trends in terms of socioeconomic variables, such as GDP and population, were considered to be the main drivers of BAU emissions. Changes in the GDP and population trends over the NDC period were based on conservative assumptions that the economy, policy and the demography will grow with in line with the moderate changes observed in the past.

Further, sectors for which specific projection figures were available were incorporated into the NDC baselines to ensure consistency. However, not all sectors have such figures. The classic example is the energy sector, where existing model data from long-range energy planning was adopted in the NDC. Furthermore, the data on baseline projections for national forest reference levels for REDD+ was also used in the NDC baseline. Although it is good practice to use existing data projections for the baseline sectors, this can introduce or, even, compound errors in the baseline. Uncertainties in emission projections are a major concern in terms of transparency. This involves both pinpointing the sources of the errors to be able to estimate its overall effects and managing the errors. The baseline calculation methodology must be assessed to identify areas that require further work. Priority should be given to minimising the error effect of areas characterized by the greatest uncertainties. For instance, the team should review the use of activity data, emission factors, emission forecast rates, underlying assumptions and emissions' policy drivers.

National targets (C and D): The NDC have set a single-year target by 2030. This involves a 10-year "commitment period" from 2020 and may be updated every five years. Emission reductions from the pre-2020 mitigation action may be carried over or extended to the 2020-2030 period insofar as they fall within the BAU trajectory. The projected cumulative mitigation outcome has been pegged at a 45 percent reduction relative to BAU emissions of 74 $MtCO_2e$ over the entire period (pre-2020 or 2020-2030). The 45 percent mitigation target is broken down into 15 percent unconditional (UC)

and 30 percent conditional (CC) targets. The unconditional mitigation measures are expected to generate 11 $MtCO_2e$ as a benchmark over the BAU trajectory. The emission reduction units from the unconditional mitigation actions will flow into the national reserve account to retire on the national commitment. Any surplus volumes from the unconditional measures may be banked into the conditional target, transferred into ITMOs or made fungible on a seniority basis.

When the NDC are revised in the coming months, the team must consider this issue and provide additional guidance on how to operationalise them. This will be an important issue in any future corresponding adjustment exercise, regardless of when or how it is triggered. When the NDC target is tracked, leading to the conclusion that the minimum benchmark volume is unlikely to be reached, Ghana can choose among several policy options.

The team must evaluate the pros and cons of each option before making a final decision on the cost-effective course of action. One option could be to reallocate emission reductions from conditional emission units where it is legally permissible or borrow on the account of Ghana's carried interest. Another option may be to acquire emission transfers (ITMOs or permissible CERs) from mitigation actions outside the NDC or from another country. Ghana must establish an emission registry system to implement the options above. The registry will host the database of emission reductions and transactions involving allocation and transfers. At the time this document was being prepared, Ghana had begun working on a national registry system for the NDC. Hopefully, it will be ready before the official accounting period begins, prior to the end of 2020.

Emission reductions from the 18 conditional commitments are estimated at 22 $MtCO_2e$ below the emissions associated with the BAU trajectory (D). The level of emission reduction flows will be determined by the scale and type of support received for implementation of the mitigation measures. The scale or flow will depend on Ghana's ability to mobilise climate finance across the spectrum of traditional and new sources. Given the real possibility of entering into a wide variety of support arrangements (including bilateral, commercial, 100 percent gratis, multilateral, voluntary, compliance and market), emission reductions from the conditional commitment will take different forms, such as ITMOs, REDD+ (a form of RMUs), and extended form of CERs.

The key issue here is that the team must consider the possibility of double-counting (a double issue or double claim). Because Ghana has not adopted a carbon-neutral or zero-carbon target, there will still be emissions at the end of the NDC period (see end-year inventory estimates A-E in Figure 3), although the level would be lower than the alternative worse case under the BAU trajectory. The NDC figures (Figure 3) suggest that Ghana's net emissions would hover around 41 $MtCO_2e$ when the 45 percent mitigation commitment is fully achieved. By comparison, the 41 $MtCO_2e$ year-end emission would be better than the projected 74 $MtCO_2e$ BAU emissions. The overall emission reduction accounting position will be determined based on the terminal national GHG inventory and the corresponding adjustments.

Assigned emissions (E): Point E in Figure 3 refers to the likely net emissions that will remain after emission reductions associated with the 45 percent mitigation commitment are realised. The final assigned emissions will be estimated during the true-up period just before the official end of the NDC commitment period. The final GHG inventory and the NDC accounting will include the assigned emission estimates after applying the corresponding annual adjustment formulae. In the end, net national inventory GHG emission estimates must hover around the 41 $MtCO_2e$ thresholds. The annual GHG inventory results would be a critical source of data for NDC accounting. They would serve as the basis for measuring relative changes in BAU emissions over the accounting period. Any substantial changes (additional or recalculated) are likely to affect the corresponding absolute value of the 45 percent emission reduction target.

NDC accounting must also incorporate the individual or aggregate effects of NDC mitigation measures relative to the BAU emissions. The balance of BAU emissions and mitigation units with annual corresponding adjustments (adding transferred emission reductions to the total emission reduction) would be classified as the assigned emissions. Assigned emissions may be managed in several ways to ensure that they remain within limits that the Ghanaian economy can manage without compromising the country's industrialisation goals. Two main factors affect the levels of the assigned emissions at any point: the choice of accounting metrics and/or the goal of mitigation policies. The selection of the kind of accounting metric[11] for the NDC is more technical than whether a given metric suits the country's conditions. Ghana's efforts must focus on selecting the appropriate methodology that fits the country's circumstances and, simultaneously, can produce reliable results. Given the global call for countries to step up the goals of their mitigation actions in the NDC, Ghana must give priority to policy measures that seek to reduce the net assigned emission levels.

11 An accounting metric is a broad suite of the technical scope and assumptions that determine emission estimates calculation, types of gases covered, global warming potentials range of gases, coverage of emission/removal activities, scoping of emission baselines, emissions target setting, evaluation of mitigation outcomes etc.

This approach has two policy implications. On one hand, Ghana could achieve ambitious goals if it can mobilise the necessary financial and technological support to fully implement the 20 mitigation commitments leading to a 45 percent emission reduction by 2030. In reality, it will be difficult to achieve such a high level of implementation, given the country's current funding constraints. This may very well mean that Ghana would adopt another strategy, giving priority to the 15 percent unconditional commitment and leveraging this to raise funding for the 30 percent conditional target. Regardless of how the strategy works, the net assigned emissions at the end of the period may be greater than the projected 41 $MtCO_2e$. Another important aspect is that the level of assigned emissions at the end of the true-up period would be determined by the extent to which Ghana has achieved the NDC target, as well as the transition stage of decarbonisation of its economy.

The annual GHG inventory would serve as the main source of information to evaluate the status of assigned emissions, to be prepared every two years under the BTR. If Ghana opts to perform biannual corresponding adjustments, then once this is done, the remaining emissions would be considered as the assigned emissions. Although the ETF regime does not require Ghana to report on the assigned emissions, it would be useful to incorporate them into NDC accounting. One important step Ghana needs to take is to train its key experts on how to perform the corresponding adjustment of emission reduction units that would be accrued from carbon finance projects. This is crucial because it will ensure environmental integrity (primarily avoiding double-counting of emission reduction units – double claim or double issuance or using the same emission reduction for different purposes).

Track NDC target (F): NDC target tracking is one of the new elements in the enhanced transparency framework. The Article 13 rulebook provides general guidance on technical considerations for tracking NDC targets at any given time: simply, it involves measuring progress toward achieving the 45 percent emission reductions below 74 $MtCO_2e$ BAU emissions by 2030. Tracking the NDC targets will depend on the accounting of individual and aggregate effects of mitigation actions and the rate of deviation from the adjusted BAU emissions. Reporting on the achievements of the NDC target is one of the elements in the newly introduced biennial transparency report. Thus, every two years, Ghana should be able to determine its progress toward achieving the NDC target and report on it in the BTR. Adding these new elements has implications for future UNFCCC reporting. Under the existing BUR reporting regime, countries do not have the option of tracking NDC targets to determine how and when to report. On the other hand, the BURs already capture mitigation actions and their effects. Ghana may thus have obtained some experience in reporting on mitigation actions and their effect, but not on the entire spectrum of NDC accounting. Therefore, going forward into the ETF, Ghana must build on the existing MRV system for reporting mitigation actions and their effects. The following steps could be taken to build on the existing national arrangement for the BUR report:

- Revise and update THE existing mitigation data collection template to include the new reporting elements for individual and aggregate mitigation actions;
- Expand the list of mitigation actions reported to include all those covered under the NDC and label them as IN;
- Include information on any other mitigation actions that are not part of the NDC and label them as OUT;
- Collect information from the national emission registry and the associated emission reduction unit and their exchanges for the two mitigation categories;
- Train key stakeholders on NDC accounting and target tracking; and,
- Use the NDPC's Annual Progress Report as a reliable source for the line ministries to report NDC implementation progress NDC in their respective sectors.

2.4 BROAD CLASSIFICATION OF MITIGATION MEASURES IN THE NDC

The NDC identified 20 mitigation measures in nine priority areas in the energy, transport, forestry, industry and waste sectors. Emission reductions would be generated by implementing the measures through the adoption of green technology, financial incentives, standards and regulations, and removing barriers. Agriculture-specific mitigation measures have been excluded from the NDC because of the sensitive nature of the sector. It is the backbone of the economy and livelihood for most rural households. In addition, most agricultural sources are not in the key categories, so are not significant sources of GHG emissions. Generally, the mitigation measures may be classified into the following broad categories:

- Scale-up renewable energy;
- Promote clean cooking and lighting;
- Decarbonise electricity supply;
- Double energy efficiency in households and industry;
- Promote sustainable urban transportation;
- Lower deforestation;
- Promote plantation development;
- Phase down high-GWP HFCs; and,
- Adopt innovative waste management.

Implementation of these measures began in 2016 and is scheduled to end by 2030. Implementation is expected to lead to sustainable development and climate protection outcomes at multiple levels. The benefits include GHG emission reductions, which would enable Ghana to meet unconditional and conditional commitments under the Paris Agreement. Low-carbon electricity and forest plantation make up the unconditional commitment and are expected to generate 11 $MtCO_2e$ in emission reductions. The remaining 18 measures cut across technologies in the energy sector (including mini-hydro, wind, solar, mini-grid, solar lanterns, improved cookstoves, LPG stoves and power factor correction devices), forestry (REDD+, forest plantation and enrichment planting), climate-friendly and energy-efficient air conditioning, bus-based transit, railway transit, landfill gas management, compost and biogas. They are expected to generate an additional 22 $MtCO_2e$ in emission reductions over the same period to achieve the conditional target (Table 2).

Table 2: Breakdown of NDC mitigation measures by sector and their emission reduction potential (ERP) between 2016 and 2030

TYPES OF NDC MEASURES		NO. OF MITIGATION MEASURES	EMISSION REDUCTION TARGETS	
			2016-2030	ANNUALLY
Categories	NDC commitments	20	34 $MtCO_2e$	2.4 $MtCO_2e$
	Unconditional commitments	2	11 $MtCO_2e$	0.8 $MtCO_2e$
	Conditional commitments	18	23 $MtCO_2e$	1.6 $MtCO_2e$
Sector breakdown	Energy	12	14 $MtCO_2e$	1 $MtCO_2e$
	Forestry	2	10 $MtCO_2e$	0.7 $MtCO_2e$
	IPPU	1	1 $MtCO_2e$	0.1 $MtCO_2e$
	Transport	2	5 $MtCO_2e$	0.4 $MtCO_2e$
	Waste	3	4 $MtCO_2e$	0.3 $MtCO_2e$

The various line ministries are responsible for implementing the 20 measures (Table 3). This involves public and private investments in projects that will lead to mitigation and sustainable development outcomes. The line ministries are to oversee the NDC projects and capture them in their sector annual progress reports and official publications. Several organizations have invested in some of the NDC-related projects. Ghana's second biennial update report to the UNFCCC reports that 20 mitigation actions have been implemented consistently between 2011 and 2017[12]. Of those, 16 are in the energy sector and the remaining four are in the forestry (three) and waste (one) sectors.

12 https://unfccc.int/sites/default/files/resource/gh_bur2_rev-2.pdf

The energy sector projects focus primarily on grid-connected renewables, clean cooking, low-carbon electricity, energy efficiency and avoidance of gas flaring. The forestry mitigation action focuses on forest carbon stock enhancement through tree plantation development. Overall, the mitigation actions have led to annual average GHG emission savings of 2 $MtCO_2e$. This result suggests that implementation of the NDC mitigation measures began at different points and, as a result, the level of progress also varies. While implementation has begun in most areas (including solar PV, clean stove, fuel switch, natural gas flaring avoided, tree plantation and compost projects), progress is generally slow. The efforts could be stepped up to achieve the desired pace. A few measures have not yet been implemented, but are in the financial closing or procurement stage (e.g. wind and mini-hydro projects). The remaining actions have not begun due to technological, fiscal or financial barriers that require immediate policy attention.

Table 3: Twenty mitigation measures, targets and emission reduction potential (ERP)

NO.	MITIGATION MEASURES	TARGET	UNIT	2016	2020	2025	ERP BY 2030
POA1	Increase small-medium hydro installed capacity to 150-300MW	300	MW				
POA2	Achieve utility-scale wind power capacity to 50-150MW	150	MW				
POA3	Achieve utility-scale solar electricity installed capacity to 150-250 MW	250	MW				
POA4	Scale up the 200,000 solar systems for lighting in residential and non-residential buildings	200,000	500W				
POA5	Establish 55 mini-grids with an average 40kW capacity	55	40kW				
POA6	Increase solar lantern penetration in rural non-electrified households to 2 million	2,000	1,000 lamps				
POA7	Scale up adoption of LPG to at least 50% of households for cooking	134	1000 LPG stoves				
POA8	Scale up access to and adoption of 2 million efficient stoves	2,000	1,000 efficient stoves				
POA9	Fuel switch from heavy fuel oil to natural gas in existing electric power plants	50	100 TJ fuel use/year				
POA10	Improve thermal power plant efficiency by converting single-cycle power plants to combined cycle	3.3	100 MW increase				
POA11	Recover and use associated gas from Jubilee and Tein oil fields	120	1 MMSCF/day				
POA12	Scale up installation of power factor correction devices in 1,000 commercial and industrial facilities (capacitor banks)	1,000	1 facility				
POA13	Ghana Cocoa REDD+ Programme	270	Avoided deforestation 1,000 ha				
POA14	National Forest Plantation Development Programme (including enrichment planting)	660	Reforestation of 1,000 ha				
POA15	HFC reduction in the RAC sector (scale up market share of climate-friendly and energy-efficient air conditioning)	70%	Market share of green and energy-efficient air conditioners				
POA16	Expand intracity transportation modes (Bus Rapid Transit)	200	1 km BRT line				
POA17	Expand inter and intra-city transportation modes (Railway Transit System)	TBD	TBD				
POA18	Improve effectiveness of urban solid waste collection to 70-90% and build engineered landfill for methane recovery	14	200 t/day plant				
POA19	Increase waste-to-compost capacity from current 200 t/day to 500 t/day	0.5	1,000 t/day plant				
POA20	Scale up to 200 biogas facilities in schools, hospitals, prisons and other facilities	1	1,000 t/year plant				

POA: Programmes of Action

3 ACCOUNTING FOR NDC PROGRESS

3.1 TOOL FOR NDC ACCOUNTING IN GHANA

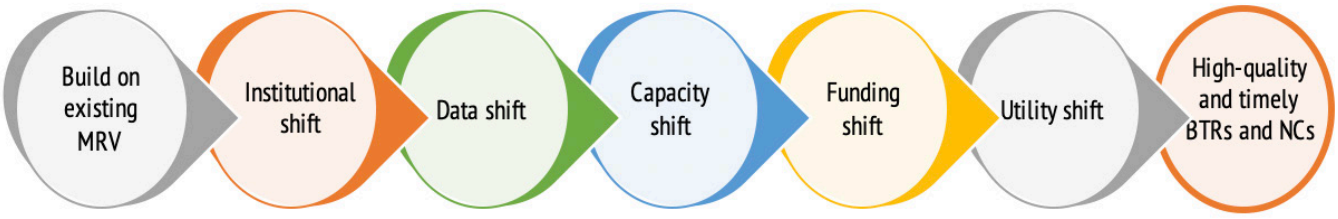
Currently, mitigation actions and their effects and national greenhouse gas inventory results are regularly reported to the UNFCCC in the BURs and the NCs. Current reporting guidelines do not include specific NDC-related elements, so most developing countries make their own decisions regarding how much information to provide in the reports. Ultimately, the existing international climate reporting regime does not provide a way to report NDC accounting information officially. Thus, the emerging ETF regime provides for NDC accounting and builds on the current MRV system. The general ETF architecture does not represent a significant departure from the MRV regime, but may include stricter submission timelines, in-depth content and more rigorous post-submission considerations.

As noted above, the BTR will replace the BUR by 2024, while the NC will remain unchanged. The ETF rulebook includes a broad range of information that countries must report in the BTR (GHG inventory, NDC accounting, adaptation and support). Countries must thus begin preparations to participate in the ETF regime. The readiness efforts should ensure that a functional national arrangement is in place and can produce timely, credible reports on a sustainable basis. As pointed out earlier, Ghana's long-term climate change reporting strategy must focus on consolidating the existing MRV structures. It must also give priority to strengthening areas such as continuous capability building, data management, institutional collaboration and tools/methodology, with a view to integrating them into government structures.

Incorporating the ETF regime into the culture of reporting within the public service can be an arduous task. Consistent effort is required to embed it in government programs and, above all, to make the results more useful to domestic audiences. Typically, line ministries can use GHG inventory results when formulating sectoral climate change mitigation policies. ETF data can also be valuable in assessing policy performance, helping to identify policy areas that require revision to ensure that broader objectives are achieved. However, the potential value of the ETF cannot be realised without a functional national arrangement that clearly defines, among other things, the roles and responsibilities of institutions involved and data management approaches. Thus, the strategy for preparing to participate in the ETF effectively must be holistic. In general, the priority should be to build on existing structures across sectors and national levels. The focus should be on strengthening those aspects of existing MRV structures that already work fairly well, addressing those areas that are not functioning at all and expanding the scope to cover the newly introduced reporting elements, such as NDC measures and tracking progress and achievements. If the transition is to lead to successful participation in the ETF on a timely basis and if it is to bring meaningful reforms, the government needs to lead major shifts, to occur as soon as practicable, in the following areas (Figure 4):

- Institutional shift – make ETF institutional involvement a routine practice and create ownership;
- Data shift – ensure a continuous supply of reliable data;
- Funding shift – explore funding options beyond current donors;
- Capacity shift – identify a sustainable way to develop capable institutions and individuals at all levels; and,
- Utility shift – add value to the usefulness of the ETF results.

Figure 4: Components of the shift required for Ghana to participate effectively in the enhanced transparency framework introduced under Article 13 of the Paris Agreement



These shifts must not be a one-off event, but must occur as part of a carefully planned process. Significant additional, consistent work is needed to create awareness and stimulate key stakeholders' interest and buy-in. The key message on the shift must resonate, to the extent possible, with most government climate agendas, especially those related to the NDC. For example, given the government's intent to update the NDC next year, the importance of the shift should be emphasized and, above all, made integral to all NDC programming in the coming years. Based on Ghana's circumstances, this approach seems to be the surest way to maintain the line ministries' interest in supporting a robust sector transparency system underlying their respective NDC.

3.2 OVERVIEW OF ENHANCED TRANSPARENCY FRAMEWORK REPORTING

By 2024, countries that are Parties to the Convention and the Paris Agreement will report on national communications and submit biennial transparency reports. The countries that are Parties to the Convention will report national communications every four years. However, those that are Parties to both the Convention and the PA would report on national communication every four years and submit biennial transparency report every two years. They would also participate in the technical expert reviews, multilateral consideration and the global stocktake (GST) exercises[13] starting in 2023 and every five years thereafter. Table 4 presents an overview of climate change reporting elements under the current MRV and future ETF regimes.

Table 4: Overview of climate change reporting elements under the current MRV and future ETF regimes

ITEMS	UNFCCC REPORTING			PARIS AGREEMENT REPORTING
Type of report	NATCOM	BUR	REDD+ National Reference Level	BTR
Frequency	Every four years	Every two years		
Status	On-going	On-going	On-going	2023
Achievements	Third NATCOM submitted; fourth NATCOM underway	Second BUR submitted; third BUR about to start	First national REDD+ FRL submitted	
Reporting elements	National GHG Inventory			
	GHG mitigation assessments	Mitigation actions and effects		NDC Progress
	Vulnerability and adaptation assessment			Climate impacts and adaptation
		Domestic MRV		
	Financial, technical and capacity needs	Support needed and received		Support needed and received
	Information on technology transfer, education, and awareness		Technical Annex to BURs	
Report consideration	No reviews or analysis	Technical analysis	Technical assessment of FREL	Technical reviews
	No multilateral consideration	Facilitative sharing of views workshop		Multilateral, facilitative, consideration of progress
Post-report utility				Implementation and compliance
				Global stocktaking

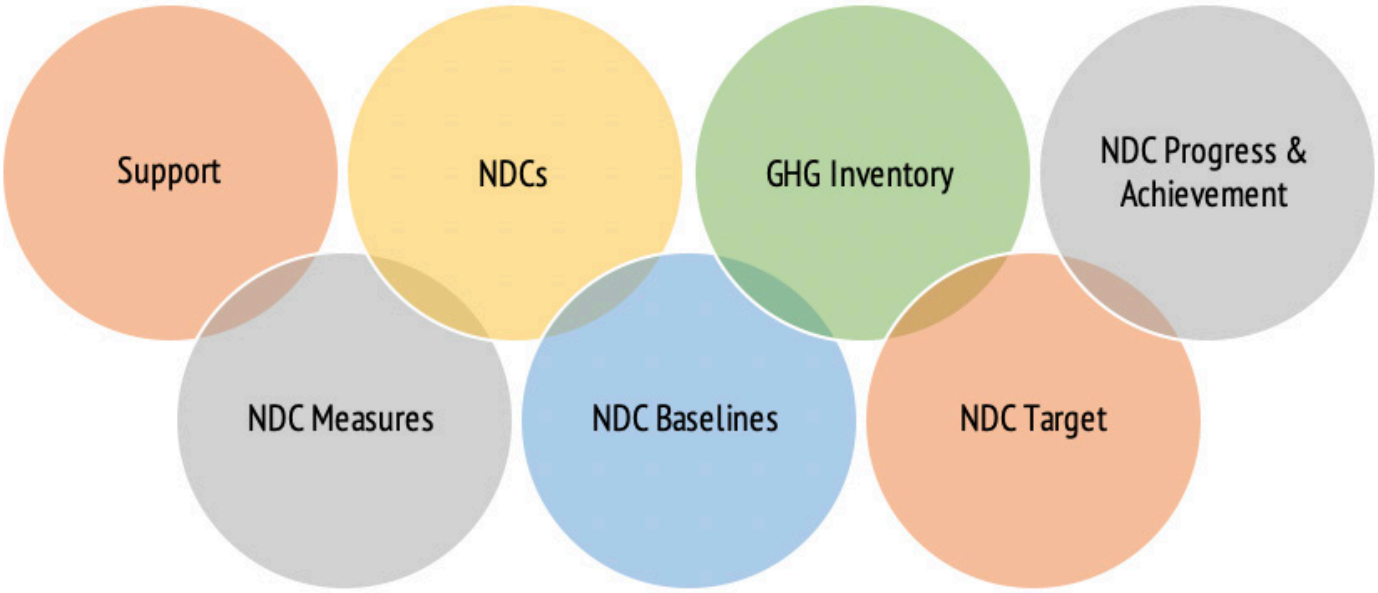
NB: Grey shaded cell: text applicable to light blue cell. Empty cells: N/A

Table 4 highlights the interlinkages among the elements of the UNFCCC reports under the current MRV and the future ETF regimes. While reporting timelines will remain largely unchanged, the content will be modified slightly, with a greater focus on NDC progress and related underlying information on greenhouse inventory, support and adaptation. The new ETF arrangement will build on the considerations in the existing report, for a relatively more intense technical and peer

13 The aim of GST is to assess collective progress towards achieving the Agreement and its long-term goals.

review process. On the basis of the report, a party may self-trigger or another country may trigger the compliance process. With a clear understanding of the existing reporting regime and expectations for the ETF at the international level, Ghana must now address how it will improve the functionality of the existing domestic MRV system to respond to any future reporting requirement.

Figure 5: Key elements of the enhanced transparency framework (adaptation is not included because this focuses on mitigation action)



In general, ETF emphasizes the NDC, GHG inventories, support and their inter-relationship (Figure 5). In terms of the NDC, Ghana shall report information on NDC progress. The information must thus include the implementation status of the individual NDC measures and a comparison of the aggregate effects to the NDC baselines to evaluate the extent of progress and achievement of the NDC targets. In this regard, Ghana would also be required to relate information on NDC progress and achievements to the national greenhouse gas inventory. The national NDC accounting methodology must be the basis for the entire assessment process. The determination of the accounting approach is based on cost, data and baseline uncertainty to achieve robustness and environmental integrity.

3.3 LINKING THE NDC ACCOUNTING SYSTEM TO THE NATIONAL AND SECTOR-LEVEL GHG INVENTORY

For the first time, Ghana must report GHG estimates together with information on NDC progress in the BTR in the NDC accounting framework. The BTR will thus include the following:

- GHG estimate updates;
- NDC baselines;
- Individual and aggregate effects of NDC measures;
- Assessment of the effects of NDC measures on achieving NDC targets;
- Effects of NDC measures on national GHG estimates; and,
- Effects of corresponding adjustments on national GHG estimates.

Therefore, the GHG inventory and NDC accounting system must produce consistent data to ensure the credibility of the national transparency arrangement. First, a national dashboard will be needed to capture information on GHG emission estimates, NDC baselines and targets, NDC progress, and achievement at any given time within the NDC period. Second, institutional structures must be strengthened to support the timely preparation of the UNFCCC reports on an ongoing basis.

3.3.1 INSTITUTIONAL ARRANGEMENTS

The EPA coordinates preparation of the national GHG inventory estimation in collaboration with the institutions responsible for the respective sector inventories and supply of data. As the coordinating institution, the EPA ensures that inventory is delivered efficiently, performs generalist functions (QA/QC, Uncertainty Assessment, Key Category Analysis) and leads the report consideration process, such as the ICA. The Energy Commission oversees the energy inventory for the various sectors, while Forestry and the Directorate of Crop Services of the Ministry of Food and Agriculture are responsible for the AFOLU inventory. The manufacturing industry and EPA's built environment departments handle IPPU and the waste sectors. The sector leads compile the respective sector inventory reports and estimates, which the EPA uses to prepare the national GHG estimates and reports. Table 5 presents the institutional arrangements for GHG inventory in Ghana.

Table 5: Institutional arrangement for Ghana's national greenhouse gas inventory

INVENTORY SECTOR	SUB-CATEGORIES	ORGANIZATIONS INVOLVED	DATA SOURCES	PRIORITY ISSUE TO ADDRESS
Energy	Electricity generation Refinery Manufacture of solid fuels Manufacturing and construction Transport Residential Services/Commerce Fugitive emissions	• Energy Commission • Ministry of Transport • Environmental Protection Agency • Volta River Authority	• Energy Statistics • International Energy Agency statistics • Vehicle data from DVLA • Fuel data from NPS	Sector allocation of fuel shares and biomass Use of default emission factors
IPPU	Mineral products Chemical industry Metal production Non-energy products from fuels and solvent use Electronics industry Product uses as substitutes for Ozone-depleting substances	• Environmental Protection Agency • Ministry of Trade and Industry	Aluminium production figures from VALCO National survey data on HFC consumption Industry annual environmental reports	Missing category (SF6 sources)
AFOLU	Livestock	• Ministry of Food and Agriculture • Animal Research Institute	Agric facts and figures FAO Country Statistics	Use of expert judgment to estimate manure management practices Refinement of livestock classification
	Land	• Forestry Commission • Renewable Natural Resource Faculty, KNUST • Forestry Research Institute • UNU-INRA • CERSGIS	Forest Monitoring System under REDD+ [14] National Plantation Development Statistics Timber harvesting data	Refinement of the land use categories
	Other sources	• Ministry of Food and Agriculture • Forestry Commission	Forest Monitoring System under REDD+	Improvement of burnt-out areas

14 https://redd.unfccc.int/files/ghana__modified_frl_november_10_2017_clean.pdf

INVENTORY SECTOR	SUB-CATEGORIES	ORGANIZATIONS INVOLVED	DATA SOURCES	PRIORITY ISSUE TO ADDRESS
Waste	Municipal solid waste treatment • Composting • Open burning • Domestic wastewater	• Environmental Protection Agency • Zoomlion Ghana Limited • Ministry of Sanitation and Water Resources	• District assemblies' waste data • Scientific research publications • Ghana Living Standards Survey • Multiples Indicator Cluster Survey[15]	Expert judgment to estimate waste composted or openly burned
	Industrial wastewater	Environmental Protection Agency	Annual Environmental Report for industries	Wastewater quantity data cover some percentage of industries

3.4 REFORMS IN THE DOMESTIC MRV SYSTEM

The current state of the national greenhouse gas inventory improves on the version that existed a few years ago. Today, more institutions are involved in the inventory than previously, when consultants led the process. With new institutions allowed to join the inventory system, the task of inventorying was decentralized to the sector lead institutions. This move has both helped to strengthen participation and resulted in a high degree of consistency on the team. The team has also improved its capacities in various aspects of GHG inventories. The emphasis in future years must be on consolidating institutional governance and focusing on facility operators. The reforms touched on data management, but much more work remains. Through the reforms, the EPA introduced an online climate data hub to host all GHG inventory data. The hub has been used to archive inventory data (activity data, emission factors and GHG estimates) and aid easy retrieval[16]. The major challenge facing the data hub is EPA's inability to update the website regularly with current information. Data management improvements have also involved updating the list of data sources and developing data collection templates. The hub serves as an essential utility for the entire inventory, particularly when it covers most of the data sources. Going forward, the focus must be on strengthening the functionality of the existing data system to improve how the dataset is collected and to consistently supply those compiling the inventory.

Through the reforms, the country also adopted the 2006 IPCC guidelines as the GHG inventory methodology. As a result, all inventory sectors in the 2018 National Inventory Report (NIR) used the methodology in the 2006 guidelines to estimate GHG emissions and removals and assess uncertainty and QA/QC activities. Though some progress has been made in overall inventory management, other areas still need to be addressed, including, for example, uncertainty assessment. In the latest inventory, uncertainty estimates were not adequately reported for the sectors, except the "Land category" under the AFOLU sector. In an effort to improve inventory management, a QA/QC and uncertainty management plan was adopted when the recent national inventory report was prepared.

3.5 CHALLENGES OF CURRENT MRV AND GAPS

Improvements in the last 10 years in the GHG inventory's national system should also be noted. As a result of these improvements, Ghana has been able to provide four standalone NIRs that provide comprehensive and reliable information on emission estimates and methodology. Having acknowledged the improvements in the national system's performance, the key critical issues below still need to be resolved across all sectors.

- Slow policy uptake of inventory results;
- Inadequate funding for the inventory;
- Slow processes for mainstreaming;
- Non-existent or missing activity data;
- Predominant use of default emission factors;
- Use of tier 1 methodology for key categories;
- Incomplete uncertainty assessment; and,
- Missing sub-categories.

15 https://www.unicef.org/ghana/reports/ghana-multiple-indicator-cluster-survey
16 http://climatedatahubgh.com/

Slow policy uptake of inventory results: Ghana is among the first few developing countries to publish standalone national inventory reports, although the UNFCCC does not require this. The NIR provides comprehensive information on the end-to-end steps for compiling GHG inventory estimates at the national and sector levels. Internationally, Ghana is seen as a forerunner, producing reliable inventories, but the extent to which the information is used in climate policy, investments and research is not clear. Ghana's climate change community is familiar with the inventory process, but it is not popular broadly among the general population and, in particular, decision makers.

Increasing the visibility of the inventory process and results within the government and among major stakeholders thus deserves considerable attention. One way to address this is to prepare three-page summaries of the NIR (typically, 300 pages) for policymakers. The summary must present the key findings and policy messages from the inventory results that require further action. The general public should also be targeted by efforts to create awareness of the inventory results. The Ghana team can consider preparing educational materials (including policy briefs and brochures) and share the content on social media.

The new focus will be to facilitate adoption of the key findings from the inventory. Factors that can aid in the adoption of these results could include:

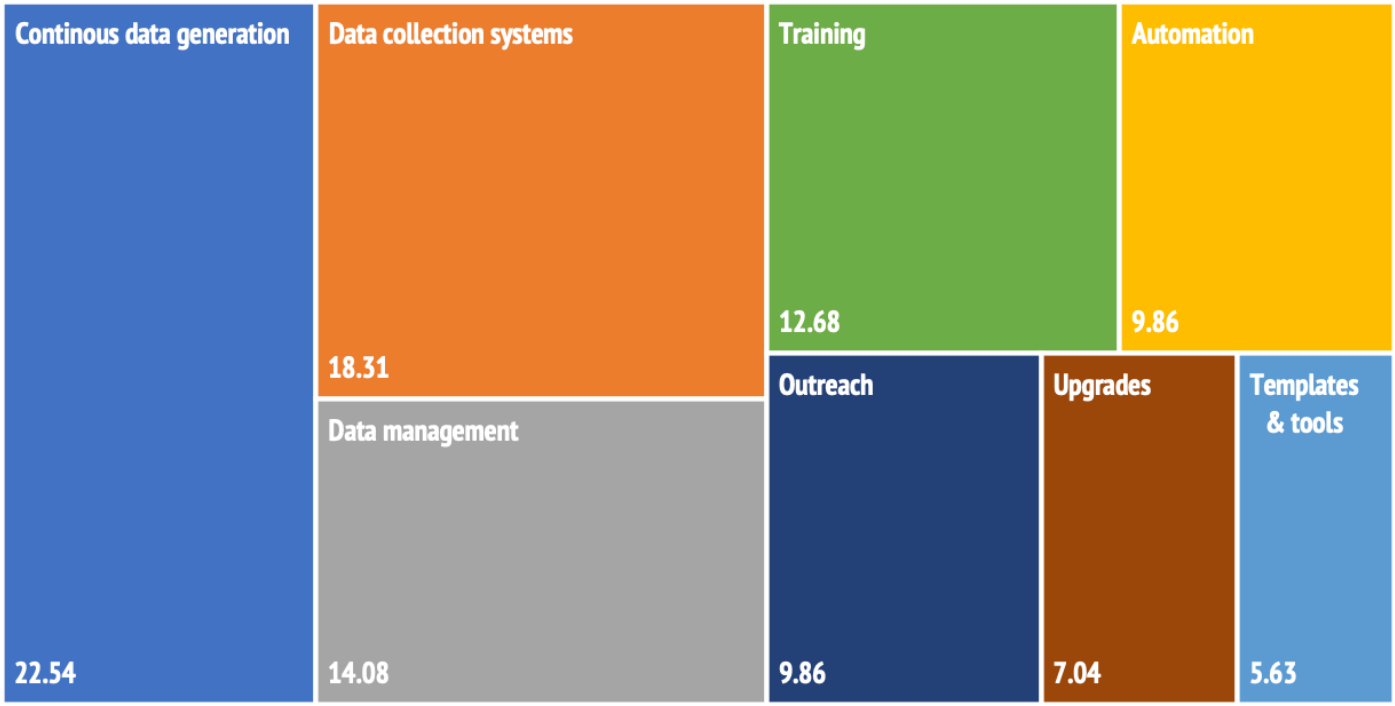
- Ensuring high confidence in the inventory results by adopting a robust methodology that complies with the TCCCA (Transparency, Completeness, Consistency, Comparable and Accuracy) principle;
- To the extent possible, using country-specific or plant-level activity data and emission factors with a view to increasing the credibility of the inventory results; and,
- Identifying key persons or groups of persons in the line ministries who can facilitate adoption of key inventory findings. The strategy for each ministry must differ based on its unique circumstances. The approach must not be a "one-size-fits-all," but must be tailor-made to suit each ministry's special needs.

Inadequate funding for the inventory: The national GHG inventory is 100 percent donor-funded. To date, the Global Environment Facility (GEF) is the inventory's largest funder, with a few grants from bilateral donors. Current funding levels do not cover the full cost of preparing the inventory on a regular basis. And given that under the ETF, the frequency of reporting will increase and the level of scrutiny of the national reports will become intense, it is important to mobilise additional funding from national and international sources. The GEF's terms prohibit using funds to collect primary data in the field, even if this is a key investment need. Thus, additional funding from sources beyond the GEF must be explored.

The Ghana team must look beyond GEF funding for future inventories and explore emerging funding sources, the private sector and the national budget. When identifying strategies to mobilise funding, the unique features of the funding sources identified should thus be considered. Priority should be given to accessing additional funding from the national budget as the government is a lead partner, which will require the line ministries to incorporate the GHG inventory into the sector plan and annual plans so that they can budget for them. This is a critical source of funding for sustainable GHG inventory. However, it will not be easy to convince the line ministries to incorporate the GHG inventory into their strategic programming. First, the ministries must appreciate the importance of the inventory results and the value-added that can be obtained by incorporating the inventory into the sector programme.

In addition, even if the line ministries agree to fully budget the GHG inventory work in their sector, cost rollover must be gradual over a given period. This approach would lessen the cost burden on the line ministries and avoid potential pushback. Private sector involvement in raising long-term funding to support future GHG inventory is crucial, particularly because Ghana has initiated processes to engage the facility operators in the national system. In this regard, the Ghana team should develop a clear fundraising strategy from the three sources. Once a strong system has been established, the investment needed over time will not be as large. The inventory's major cost points include data generation and management, automation, acquisition of analysis tools, training and awareness-raising (Figure 6).

Figure 6: Cost points of GHG inventory preparation (in %).
The length and width of each box indicate the relative importance of the areas that need consistent funding to support the long-term sustainability of the national system.



Slow mainstreaming of the inventory into the national structures: Mainstreaming the national GHG inventory into the line ministries' routines will be important in achieving a functional, relevant and durable inventory in the long term. The mainstreaming process - to incorporate the steps in the inventory into governmental structures - was part of initial reforms in the national system. This began almost a decade ago, but has not yet reached the desired level. The primary goal of mainstreaming is to ensure that the inventory is considered a useful source of information to aid climate change policy. This was to be achieved by systematically integrating the inventory tasks into the line ministries' work and allocate budget resources to cover them.

In the last 10 years, the EPA has taken steps to facilitate the mainstreaming process by, first, decentralising the inventory tasks to relevant organizations under the ministries. The purpose was to let the ministries play a greater role in the inventory, develop capacities, create awareness, encourage ownership of the inventory results and, ultimately, create stability or permanence for the inventory's institutional arrangements. Decentralisation - or transferring the frontline inventory tasks to the line ministries - has been largely successful to date, but some administrative issues need to be addressed. The EPA has oversight of the inventory and still performs most of the general activities that cut across the sectors, such as data requests, QA/QC protocol, recalculations and key category analysis, while inventory planning, preparation and management have been assigned to the line ministries.

As part of transferring the inventory task, the EPA prepared a memorandum of understanding (MoU) to guide the relationship with the institutions involved. Certain aspects of the MoU have not been fully operationalised, which continues to pose an obstacle to the mainstreaming process. Although the inventory task has been transferred to the ministries, it has not been fully embedded into their respective work programmes. Take, for example, an expert working on the inventory in the sector. That person's time spent on inventory work is not included in the staff performance appraisal, although the institutions officially nominated them as inventory schedule officers. As a result, the officer may prioritise other tasks from his/her own institution over the inventory tasks assigned. As Ghana prepares to participate in the ETF regime, it would be very useful to have capable institutions as part of the national arrangement that could drive the transparency functions.

Continuous training for line ministry staff was included in the mainstreaming package. To date, six experts from four organizations have received training through the UNFCCC training of experts to participate in the review of annual GHG inventories for the Annex 1 parties in the areas of energy, IPPU, waste, agriculture, and LULUCF. In addition, seven more will receive online GHG inventory training this year to strengthen expertise in the country. As far as we can judge, this strategy has been effective, based on its achievements, and should continue in coming years. If Ghana is to derive maximum benefits, the team must consider increasing the number of people who are trained annually through the UNFCCC training and certification programmes. However,

due to funding constraints, the UNFCCC usually limits the number of trainees to one from each country. If Ghana wishes to train more people in the inventory, it could consider budgeting for that activity and pay to train additional experts. Another viable option would be to collaborate on training with the University of Ghana's Sustainability and Climate Change Studies programme. This approach is viable because it may be less expensive and sustainable in the long term.

Therefore, the team should consider the following suggestions to speed the mainstreaming process:

- Continue to train experts from the line ministries as an incentive to sustain their interest and add value to career development;
- If funding is available, sponsor more people to be trained through the UNFCCC training programme;
- Explore the option of collaborating with the University of Ghana to train students on GHG inventory and management;
- Revise the existing MoU so that the line ministries commit more resources to support the inventory;
- Collaborate with the inventory institutions to ensure that the experts' time spent on the GHG inventory is included in staff appraisals; and,
- Encourage the line ministries to add one or two persons to support the work of the inventory sector inventory expert as a backup.

Predominant use of tier 1 method and default emission factors: The use of tier 1 methods and default coefficients dominate in Ghana's inventory estimate. While the land, aluminium production and solid waste sectors use higher tier methods and country-specific factors to estimate GHGs, the relatively large proportion of the remaining inventory relies on tier 1 and default factors. Although it is not wrong to use tier 1 and default factors, this can introduce significant uncertainties in the inventory estimates which, in turn, can affect confidence in the inventory, particularly the key categories that contribute most to the overall estimates. Ultimately, this results in a lack of access to credible country-specific data in Ghana. Investing in continuous data collection is one of the surest ways to resolve this methodological issue. The consultations conducted as part of this work reveal that the inventory team has already identified some of the tasks that must be completed, but all require funding before implementation can begin. They include:

- Collection of activity data on the consumption of F-gases, particularly SF6;
- Collection of activity data and emission factors to support the development of a tier 2 method for road transport;
- Support to expand the current facility-level carbon accounting programme, taking into account lessons learned from the public electric utility's current voluntary carbon accounting programme;
- Development of solid waste and wastewater balances to better understand the flow of solid waste and wastewater from the point of generation to the end site (e.g. solid waste disposal sites in the case of solid waste, or seas, rivers or lakes in the case of wastewater); and,
- Data collection to improve current expert judgment regarding the allocation of manure to various manure management systems.

Incomplete uncertainty assessment: Uncertainty assessment for the GHG inventory has been implemented partially in the current inventory. According to the NIR4, uncertainty assessment was conducted only for the inventory's land category. The primary reason was that because the data (activity data and emission factors) for the inventory are obtained from secondary sources that do not publish the accompanying metadata, it is difficult to estimate uncertainty levels. Going forward, the focus must thus be on developing concrete category-level plans to collect the necessary uncertainty values for AD, EFs and parameters.

4 SECTORAL MRV FOR ENERGY AND TRANSPORT

4.1 OVERVIEW OF MRV ISSUES IN THE ENERGY AND TRANSPORT SECTORS

The IPCC 2006 guideline uses the tree hierarchy approach to cluster common GHG emission sources and removals for the sectoral inventory. The category level in the energy sector includes three classes: energy combustion, fugitive emissions and carbon capture, and storage. Each category has sub-divisions based on a common set of energy production and consumption activities. For example, the "energy combustion category" has been divided further into stationary combustion (including energy industry, manufacturing, construction and residential, commerce, agriculture/forestry/fishing) and mobile combustion (road transport, aviation and inland navigation).

The sector-level inventory focuses on accounting for GHG emissions from relevant sources and removals. Direct GHG emissions/removals in each sector are calculated at the category and subcategory levels, using activity data and emission factors. The sector leads obtain the best available activity data and emission factors in the country and estimate emissions in line with the IPCC methodology. The sector inventory also includes key category analysis and recalculations, where applicable. In general, the activity data is obtained from secondary and administrative data sources. If secondary data are unavailable, the missing data are generated to fill the gaps, using IPCC-recommended methods, or default data are used.

4.2 DATA AND METHODOLOGICAL ISSUES IN THE ENERGY AND TRANSPORT SECTORS

Most sector inventories rely on a tier 1 approach to estimate emissions/removal except in land, solid waste disposal and metal industry, where a higher tier has been applied. Thus, as the country prepares to participate in the future ETF regime, priority should be given to synchronise the schedules for publishing country data from the existing data platforms. For example, the Energy Commission publishes national energy statistics every April. The energy section of GHG emissions should be published with energy statistics annually, together with metadata. The format of the administrative data must be improved so that they are more useful to the inventory. Fuel allocation is another important data issue that must be addressed.

4.2.1 FUEL ALLOCATION IN INDUSTRY

In the GHG inventory and mitigation assessment, fuel use in industry falls under the energy sector, while emissions associated with process fall under the IPPU sector. The current fuel allocation formulae for the sector and industry sub-sector are outdated. In practice, the formulae are used to calculate the amount of fuel that the industrial sector consumes in a year. Industrial sectors' fuel shares (such as food processing, mining and quarrying and iron and steel) are computed from industry's total fuel consumption, based on outputs. The entire fuel allocation approach and the shares should be updated. The team may choose among three options that can accurately capture fuel consumption in the sector cost effectively. They options are to: (a) conduct a fresh industrial survey; (b) build on the annual environmental report data at EPA; or (c) collaborate with the Ghana Association of Industries (AGI) or Ghana Statistics Service (GSS) to collect fuel cost data for the industry to compute the consumption figures.

Each option has advantages in terms of cost and sustainability. Conducting an industry survey to collect data on fuel consumption from the plant level is the preferred option, but can be very expensive. Although this will be a one-off exercise, it can serve as the basis for regular updates at given time intervals. The survey coverage will depend on the financial resources available. Given that Ghana is characterized by a wide range of operational types of industries, a one-size-fits-all method may not work to the team's satisfaction. If the team feels strongly about using this approach, it should consider collaborating with the GSS or Ministry of Trade or AGI to reduce the cost and develop strategies for regular updates. The cost can be reduced further if the fuel survey is built into a larger industry-wide data collection programme.

The second strategy involves working with the Manufacturing Industry Department (MID); its mandate is to collect annual environmental performance data, including fuel consumption, from companies. Although the regulator requires companies to supply the data, not all companies are able to do so on time. Some of the data submitted have gaps and are not current. This option is the most preferable because it will be less costly, sustainable and may cover the widest range of companies. It would require working with the MID to increase data collection and verification of annual environmental reports.

A similar data-sharing arrangement may be made with the AGI or GSS, but data is supplied to the business association on a voluntary basis. If the choice is to work with AGI, it would be appropriate to also work with MID in complement. Working with GSS can take two forms. Fuel data may be added to any major industry survey campaign. Under this option, the fuel data frequency will depend on when the GSS industry survey starts. The GSS usually conducts industry surveys when funding is available, so data will not be available on a regular basis.

The last option involves deriving fuel consumption data from the fuel sales or cost data that GSS uses to compute the national accounts. The fuel data from this approach could be available on a regular basis, but may not be available at the facility scale. Going forward, the national team must explore the issue further to better understand the nuances before determining the preferred option for fuel allocation for the industrial sectors.

4.2.2 TRANSPORT DATA

Data on fuel use in transport and the collection of vehicle and traffic statistics also present a major challenge (Table 1). The current inventory for the transport sector is tier 1, using the fuel consumption approach. Road transport is a key category within the transport category, so tier 1 methods cannot continue to be used to estimate emissions, as stipulated in the Article 13 rulebook. Ghana must thus begin improving the inventory for the transport sector, giving serious emphasis to the road sector. Four important data points under road transport must be improved before the team adopts a high tier. These are activity data (vehicle information, fuel consumption data and traffic data), development of country-specific emission factors and the use of road transport emission models, such as the COPERT IV model.

4.2.2.1 VEHICLE DATA

Since the inventory is conducted yearly, annual vehicle figures are needed for the calculations. Computing the active total vehicles in the country for each year depends on total vehicle imports, the year's vehicles registered and total roadworthy vehicles. These data come from two main sources: the GCNet and DVLA. Vehicle import data is obtained from Customs through GCNet. GCNet vehicle imports are captured in Excel online, but access is restricted. The relevant information recorded for each car and that is useful for inventory purposes includes: engine type (fuel type); engine capacity (volume); engine technology (year of make); and, vehicle make. The inventory team receive the data via official requests from EPA, to the Ministry of Transport and then to Customs. The request response time may be improved if it is done on time and on schedule. If the data request is scheduled on time, Customs can make provisions to prepare and share the data in a relatively short time. The GCNet data format is generally suitable for the inventory, although the data require extensive cleaning to remove outliers. The EPA, Ministry of Transport and Customs must work together to find an effective way to improve the quality of the data and data-sharing channels.

The DVLA offers another source of vehicle data, supplying the inventory team with vehicle registration and roadworthiness data. DVLA policy allows private garages to take over vehicle inspections in Accra, Tema, Kumasi and other towns. Emissions testing at the garages is voluntary and performed on request. The test results are not considered in determining whether to issue the roadworthy certification. Private garages do not record odometer and fuel economy gauge readings and the fuel economy gauge and odometer in most commercial or old vehicles are not functional. It is thus difficult to capture distance or fuel economy data from vehicles with defective odometers. Even when private garages are asked to collect circulation data (distance and fuel economy), most commercial or old vehicles will be excluded because of a faulty odometer. However, odometer readings may not be the only option for collecting distance data. Another critical challenge is that the current form used by private garages to record information on vehicles that undergo registration or roadworthiness certification lacks space to record odometer and fuel economy gauge readings. The Ghana inventory team can partner with the DVLA and private garages to collect traffic and emission data. Recommendations are as follows:

- EPA and GSA have recently gazetted the motor emission standards and are awaiting legislation to support implementation. When the legislation is ready, private garages may then have cause to conduct emissions testing on every vehicle that undergoes registration or roadworthy certification and, subsequently, uses the results to determine roadworthiness. The inventory team can collect the real emissions testing data from the garages to validate emission estimates and compute the implied emission factors for different types of vehicles.
- The EPA should liaise with the Ministry of Transport, DVLA and private garages to begin recording vehicle odometer and fuel economy gauge readings annually. This data can be used to estimate the annual distance that vehicles cover. The main challenge the team is likely to face is obtaining consistent data for the same vehicles for year-on-year comparisons. Currently, vehicle owners are not required to visit the same private garage for roadworthiness certification. Thus, the odometer reading for the same vehicle in the subsequent year may not be available if the car owner decides to visit another garage. The solution would be to work with the DVLA and the garages to create a central database to house where all data from the different garages. Under this approach, a car's odometer can be filtered even if the inspection was not conducted at the same garage in subsequent years.

4.2.2.2 TRAFFIC DATA

Traffic data is an essential input into kilometre-based vehicle emission calculations. It measures speed on different road classes (urban, highways and feeder roads) and driving patterns. This data is used to estimate GHG emissions using a higher tier method in the road transport category. No comprehensive traffic data currently exist at the national level; only fragmented data is available in different locations in the country. For instance, the Ministry of Transport conducted a comprehensive traffic study on selected artery and BRT routes in Accra. The study provided useful information on traffic counts, average speed, average distances and the share of vehicle class on the study routes. In 2006, the EPA conducted a nationwide vehicular emission estimate exercise. It provided country-specific emission factors for different greenhouse gases based on data obtained from the field surveys on fuel consumption, vehicle pattern, vehicle technology and traffic information (speed and distances). The Accra data is not representative of the country and the 2006 vehicle emission estimate data is obsolete.

Given the current state of the road transport inventory and that emissions from road transport are a key category source, it would be worthwhile to come up with an effective way to strengthen the traffic data management system. It may be appropriate to build on the 2006 vehicle emission estimate work conducted by the EPA, as it will be less expensive to update the 2006 data than to start over. Using this approach, the EPA and the Ministry of Transport can develop a joint proposal to international transport research agencies that may be interested in partnering with Ghana. The least-cost option could be to work through the University and the CSIR-Building and Road Research Institute (BRRI) to support student research in the relevant areas where data gaps exist.

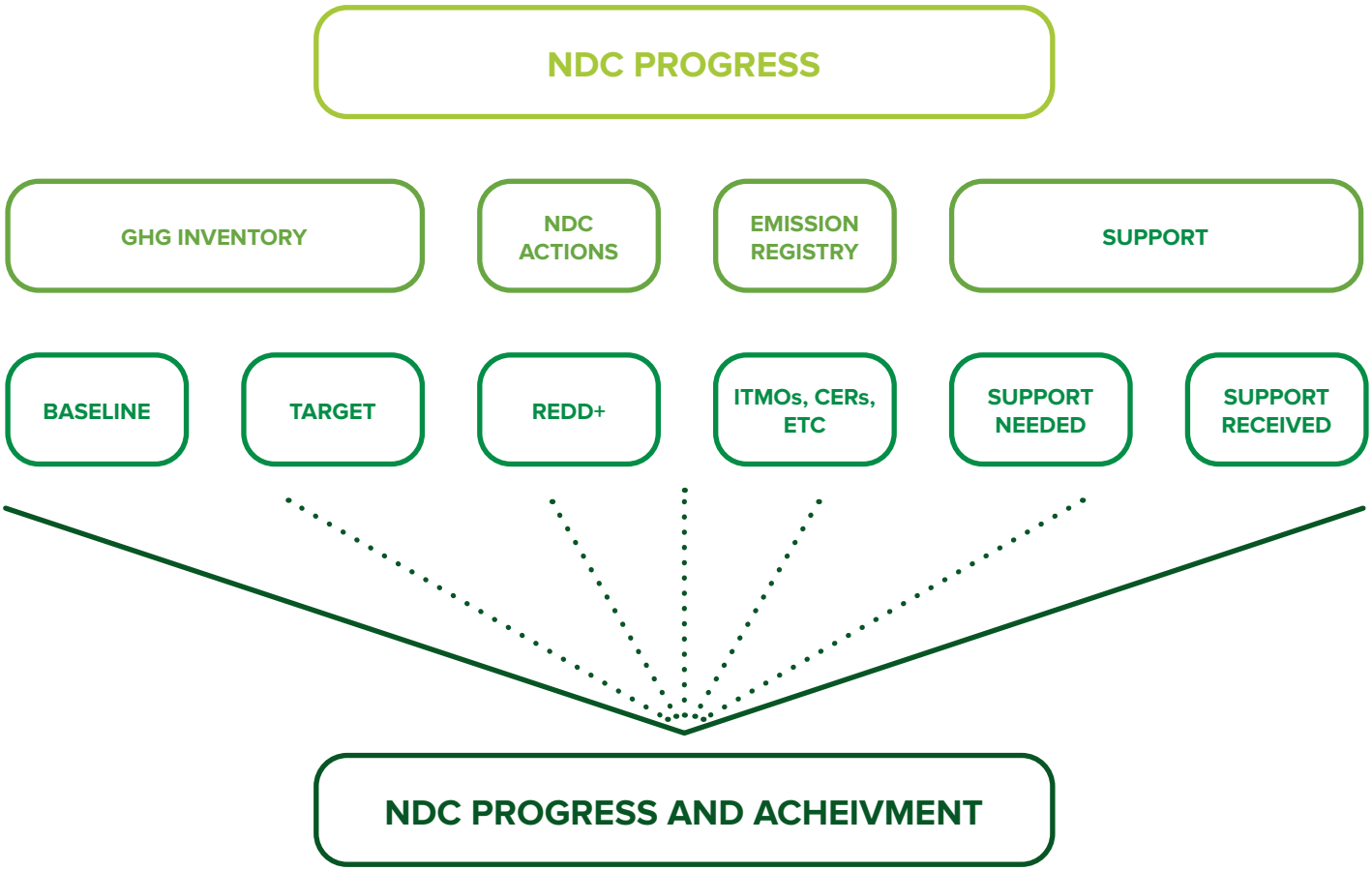
5 GHG ACCOUNTING FOR NATIONALLY DETERMINED CONTRIBUTIONS

5.1 BRIEF DESCRIPTION OF THE NDC ACCOUNTING STEPS

The new national accounting system is more detailed than the national arrangement anticipated for the GHG inventory. It brings together all the strands of NDC, climate finance, carbon market and transparency in a single dashboard. This suggests that the accounting system will build further on institutional arrangements and methodological choices for the biennial update report and, in particular, ensure that strong synergies exist among them. The national arrangement is not expected to change significantly in terms of efforts to operationalise the national accounting. The institutions that are already responsible to conduct the GHG inventory, monitor implementation of climate actions and track climate support will continue to perform similar functions. The only new addition is the mitigation outcome accounting, which can be tracked using inventory-based or measure-based approaches.

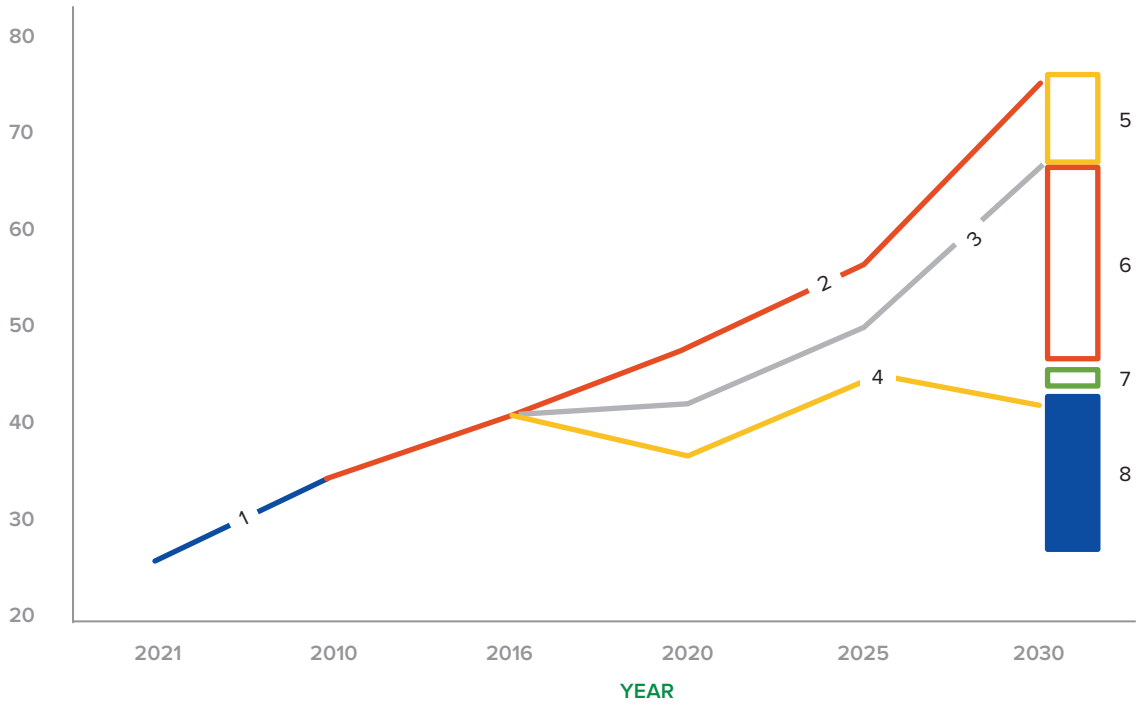
The data required for the accounting system will remain largely the same, although the frequency with which they are generated and the level of detail may change considerably. Selecting the methodology for calculating the baselines and tracking targets is also crucial to determine the type of national or sectoral accounting system established. The accounting system will seek to harmonise the work on GHG inventory, setting baseline scenarios and NDC targets, monitoring NDC actions (including REDD+), tracking support and establishing a national registry to monitor carbon credit to communicate NDC progress (Figure 7).

Figure 7: Overview of the proposed national NDC accounting system



Information on NDC progress constitutes a new biennial reporting requirement in the BTR under the enhanced transparency framework. Thus, at any given time within the NDC period, Ghana should be able to monitor progress and achievements of the NDC targets relative to the effects of collective and individual NDC on greenhouse gas inventory results and projected business-as-usual emissions (Figure 8).

Figure 8: Relationship among GHG inventory, BAU emissions, unconditional and conditional targets, NDC actions and the assigned emissions: 1 represents historical emissions obtained from the national GHG inventory; 2 represents projected BAU emissions under the status quo emission trajectory; 3 and 4 depict the unconditional and conditional emission reduction targets; 5 and 6 represent emission reductions from implementation of the two unconditional and the 18 conditional NDC mitigation actions, respectively; 7 is associated with emission reductions from mitigation action outside the NDC; and 8 refers to remaining GHG emissions generated from the national GHG inventory.



To monitor and report effectively on NDC progress, the national accounting system must be based on credible data, a functional institutional arrangement, and a suitable accounting methodology and metric. In operationalising the national NDC accounting system, success factors must be anticipated from the start and addressed directly. Those factors include: (a) determining the operational scope of the NDC accounting system (project, sector and national levels); (b) institutional mandate and capacity needs; (d) cost-effectiveness (cost associated with means and frequency of data collection and management); and, (e) data management (data access and data sharing).

5.2 REQUIREMENTS OF THE NATIONAL NDC ACCOUNTING SYSTEM

Under the BRT, Ghana would be required to report on NDC progress. This information would include GHG inventory results, baseline emissions and changes in them, and the mitigation outcomes of the NDC actions. The combined data on the annual GHG inventory, mitigation outcomes and baseline emissions will be used as inputs in the NDC progress. This means that whenever Ghana reports on NDC progress in the BTR, the GHGI, NDC actions and their effects, and baseline emissions must be updated to reflect any changes in the reporting period. The updates would require revisions and additions of new inventory data and the NDC that were implemented within the reporting timeline. Ghana's ability to comply with BTR reporting will depend on how well the national NDC accounting system works. It must be able to produce credible data continuously to compile the BRT biennially. Three main elements are key to the effective functioning of the accounting system: access to reliable data; appropriate methodology; and, a tool to track NDC progress. The essential requirements for the NDC accounting system are described below.

5.2.1 DATA REQUIREMENTS

5.2.1.1 GHG INVENTORY RESULTS

EPA normally prepares the GHG inventory every two years using the IPCC guidelines and actual administrative or field data. The GHGI does not make projections in estimating the emissions. Rather, it is a compilation and uses activity data and an emissions coefficient to estimate GHG emissions from four IPCC sectors, which correspond to six national sectors (Ministry of Energy, Transport, Lands and Natural Resources, Ministry of Trade, Ministry of Food and Agriculture, and Ministry of Sanitation and Water Resources). The dataset is usually collected from national and international sources and covers more than 20 years. The latest GHGI spans the period 1990-2016 and is expected to be updated every two years. It can serve two main purposes: first, it forms the basis for computing the business-as-usual emission trajectory; and, second, the biennial updates provide an indication of the overall sector-wide and economy-wide effect of the NDC actions.

5.2.1.2 BASELINE (BUSINESS-AS-USUAL SCENARIO)

Ghana has already developed a national business-as-usual baseline extending to 2030. It would be used to assess the impacts of NDC implementation and evaluate progress in achieving the NDC targets. The baseline was established using historical GHG emissions and the drivers affecting the trends over the 26 years. The baseline is dynamic and will be updated every five years to reflect the country's socioeconomic realities. For example, as Ghana prepares to update its NDC in 2020, the team should consider incorporating new government policies into the baseline. This will produce a 2020-2025 baseline emission that differs from the previous 2016 baseline. This update should be performed because it supports a more robust baseline that is relevant to the policy of the government of the day. The baseline is normally based on assumptions that will always involve certain uncertainties, in both ex-ante and ex-post projections. The typical inputs to a GHG emissions projection are GDP development, population growth, energy efficiency, introduction of eco-technologies, deforestation levels and fuel prices.

5.2.2 METHODOLOGY FOR COMPUTING ACHIEVEMENT OF NDC TARGETS

5.2.2.1 DESCRIPTION OF METHODS FOR CALCULATING NDC ACHIEVEMENT

Three main methods are used to compute achievement of the NDC target, which includes degree of achievement and tonnes of CO2 reduced. The NDC target is based on the following accounting variables: GHGI, BAU, NDC actions, and their impacts. The three methodologies are:

- GHGI reduction against BAU;
- GHG impact of NDC against GHGI; and,
- GHG impact of NDC against BAU.

GHGI reduction against BAU: This approach uses GHG emissions results and BAU emissions data for the IPCC and national category and sectors. Both data variables can also constitute additional categories in accordance with national sectors, which correspond to the line ministries. Under this approach, the NDC target is calculated based on the ratio of BAU and GHG emissions, using the formula below:

$$\text{NDC emission reductions (Er)} = \frac{\text{BAU emisssions (t)-GHGI emissions (t)}}{\text{BAU emisisons (t)}}$$

Where:
t = time
BAU = business as usual
GHGI = greenhouse gas inventory

The team recommends that Ghana consider using this approach because it is simple, easy to implement and has been evaluated by the IPCC. In addition, the literature provides extensive experience and knowledge and it is consistent with Ghana's NDC accounting framework. Its advantages include that it is less data-intensive and would not require extensive on-the-ground data collection. It will rely on regular data collection for conducting the GHG inventory as baseline emissions are locked in for five years. Thus, the GHGI result would reflect the effects of NDC implementation after a given time period at the sector and national levels. Under this approach, it will not be feasible to spend resources to monitor individual NDC, but it is reasonable to monitor the aggregate effects of a group of NDCs on sector and national emissions compared to the baseline.

GHG impact of NDC against GHGI: Under this approach, the focus is to compute the NDC targets using the GHG impacts of individual, or group of NDC and/or aggregate and GHGI figures for the IPCC category, sector or national. It uses the following formula:

$$\text{NDC emission reduction (Er)} = \frac{\text{GHG impact NDC (t)}}{\text{GHGI emissions(t)} + \text{GHG impact NDC(t)}}$$

Where:
t= time
GHGI-= greenhouse gas inventory
GHG Impact NDC= greenhouse gas impact of nationally determined contributions

5.2.2.2 ASSESSING NDC IMPACTS

NDC assessment can be complex because the impact of each must be calculated using a separate methodology. No accepted control and verification standard exists. Data are often collected based on the boundary of the NDC actions, which can affect the cost of these data sources. The WRI's Policy and Action Standard is a suggested guideline to assess the impact of NDCs. That is, no universal methodologies exist to quantify aggregate NDC impacts (in a country); rather, the compilation of individual project methods are assessed only at the level of typical actions (for example, the Clean Development Mechanism (CDM)). In this regard, the team will decide to develop a generic Excel-based tool that the Ghanaian MRV team can use for NDC accounting.

6 TOOL TO CALCULATE NDC IMPACTS

6.1 OVERVIEW OF THE NDC GHG ACCOUNTING TOOL

As part of this exercise, an Excel-based tool was developed to facilitate calculation of the achievement of NDC targets. This is the first time Ghana has created such a comprehensive tool. It seeks to help target users implement the NDC accounting steps in orderly fashion, using the data listed above. Although the scope of this assignment covers the energy and transport sectors, the team made an additional effort to develop a tool that covers all NDC sectors, which offers greater value than one limited to just two. The team thought it wise to expand the tool's scope to all NDC mitigation sectors because an expanded tool can serve as a one-stop dashboard for all 20 mitigation actions and highlight their interlinkages. It has wider utility and enables technical and non-technical users to estimate the GHG emission reductions of the NDCs and compare them to the NDC target on the fly. It can also be used to compare the actual GHG inventory estimates to projected BAU emissions to evaluate the extent to which the NDC target is being achieved at any given time.

6.2 FEATURES OF THE NDC ACCOUNTING TOOL

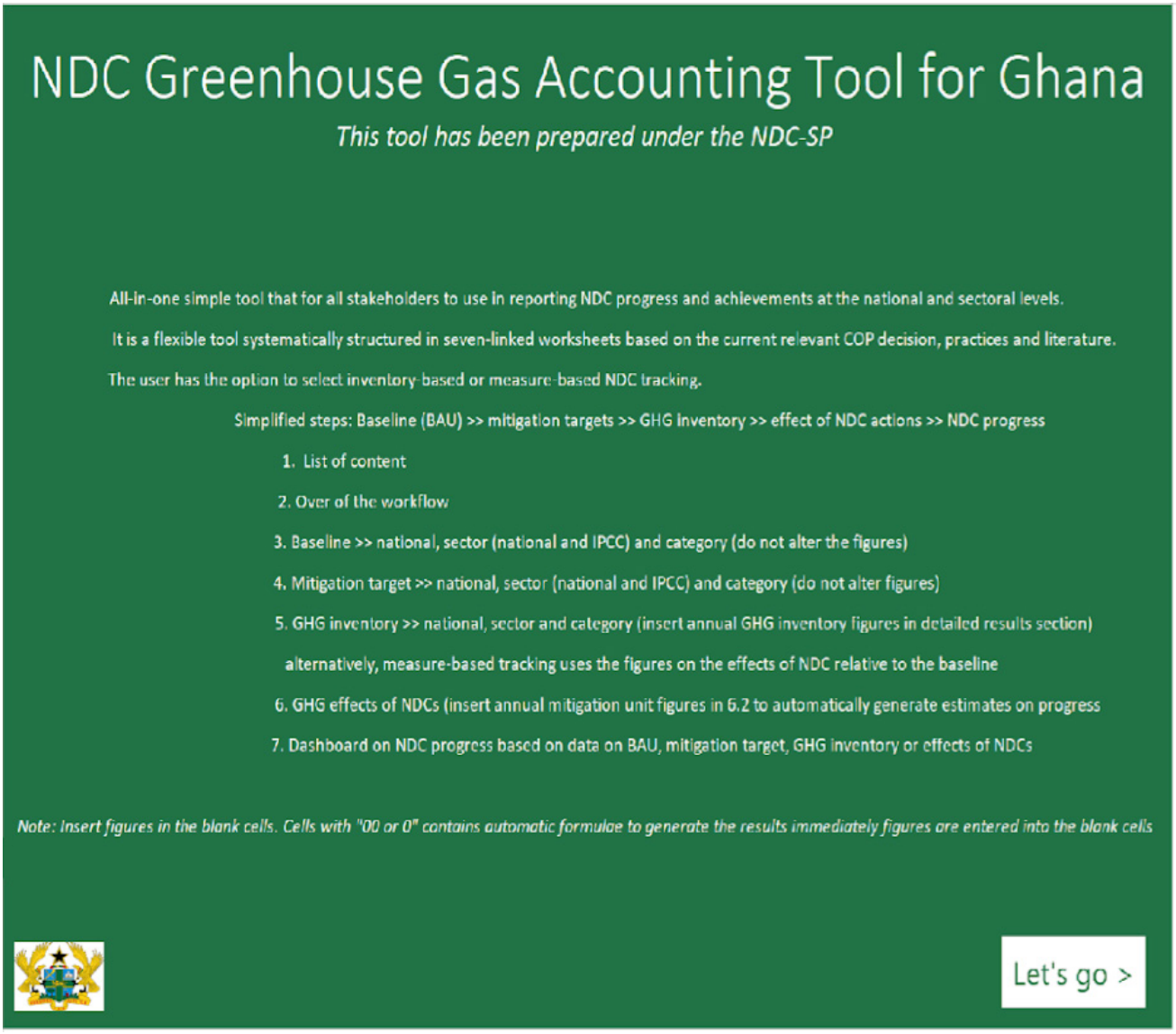
The tool is based on the Excel spreadsheet and makes it possible to estimate the NDC actions and effects quickly. It is a flexible tool that has structured the NDC accounting steps in seven linked worksheets, based on the current relevant COP decision, practices and literature. The user may select inventory-based or measure-based NDC tracking. The tool uses five main elements to determine NDC progress: (a) projected BAU emissions up to 2030; (b) original NDC targets; (c) annual GHG inventory; (d) NDC effects; and, (e) corresponding adjustment. With data on these five elements, NDC progress can be evaluated on a yearly basis.

The two calculation options for tracking the NDCs are inventory-based and measure-based tracking. Under the former, annual GHG inventory figures at the sector or category level are compared with BAU emissions for the same year to evaluate the extent of deviation. The relative differences between the two figures provide a conservative estimate of NDC progress. This option is favoured because it is consistent with IPCC guidelines and developed countries have used it regularly. The latter option presents fewer uncertainties in aggregating the impact results from the category to the national levels. To avoid double counting, it is always important to adjust emission reduction transfers that would have taken place over the same period. The inventory-based tracking methodology has been incorporated in the tool in sheet 5.

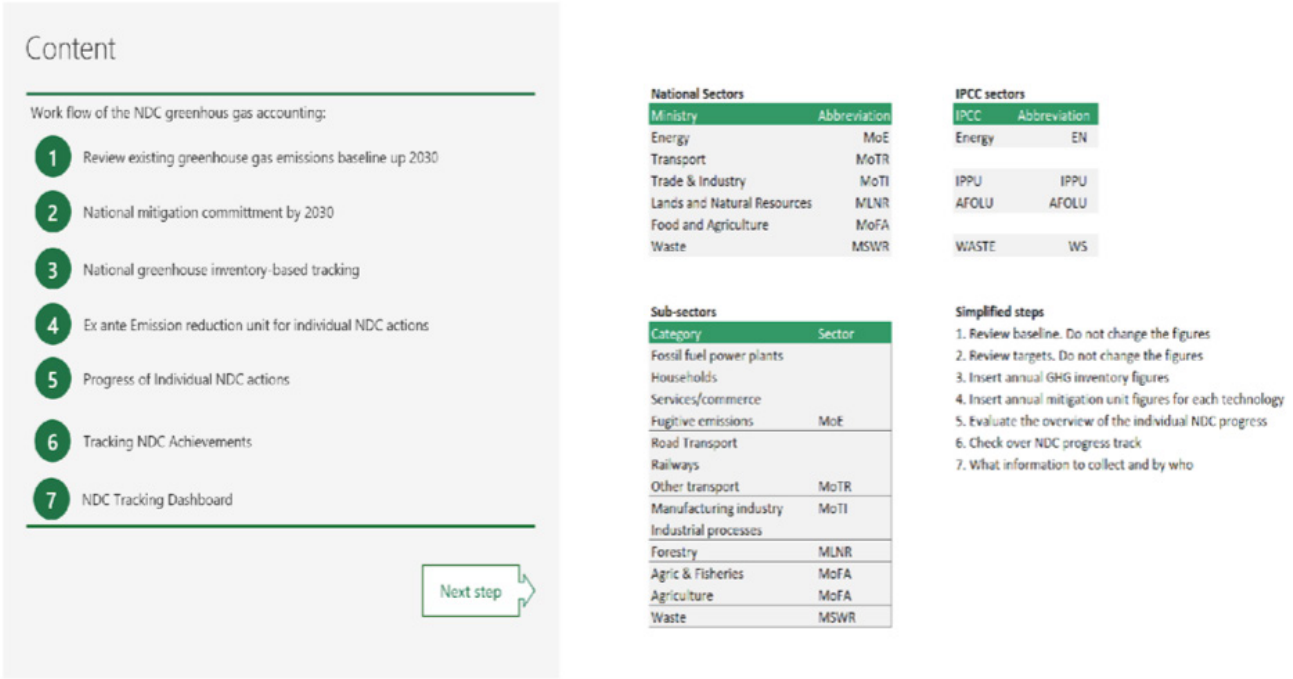
Measure-based tracking pools data on individual NDC actions and effects into an aggregate category or sectoral or national figures and compares them to projected BAU emissions or actual GHG inventory for a given year. The primary challenge of this approach is the uncertainties associated with aggregating GHG effects of individual NDC actions into category, sectoral or national figures. If, for some reason, the national or sectoral prefer to use the measure-based inventory, it would be important to note the data requirements for individual NDC actions. Variations in scope must be considered when setting out the accounting framework. Nevertheless, the team recognises that both options can be used when necessary. When using both approaches simultaneously, double-counting must be avoided. If users intend to use both approaches, they would be required to populate the GHG inventory sheet and the relevant individual NDC measures sheet. When both are completed, the remaining sheets would be generated automatically in the overall NDC progress dashboard. A brief description of the sheets is provided below.

6.2.1 INTRODUCTION SHEETS

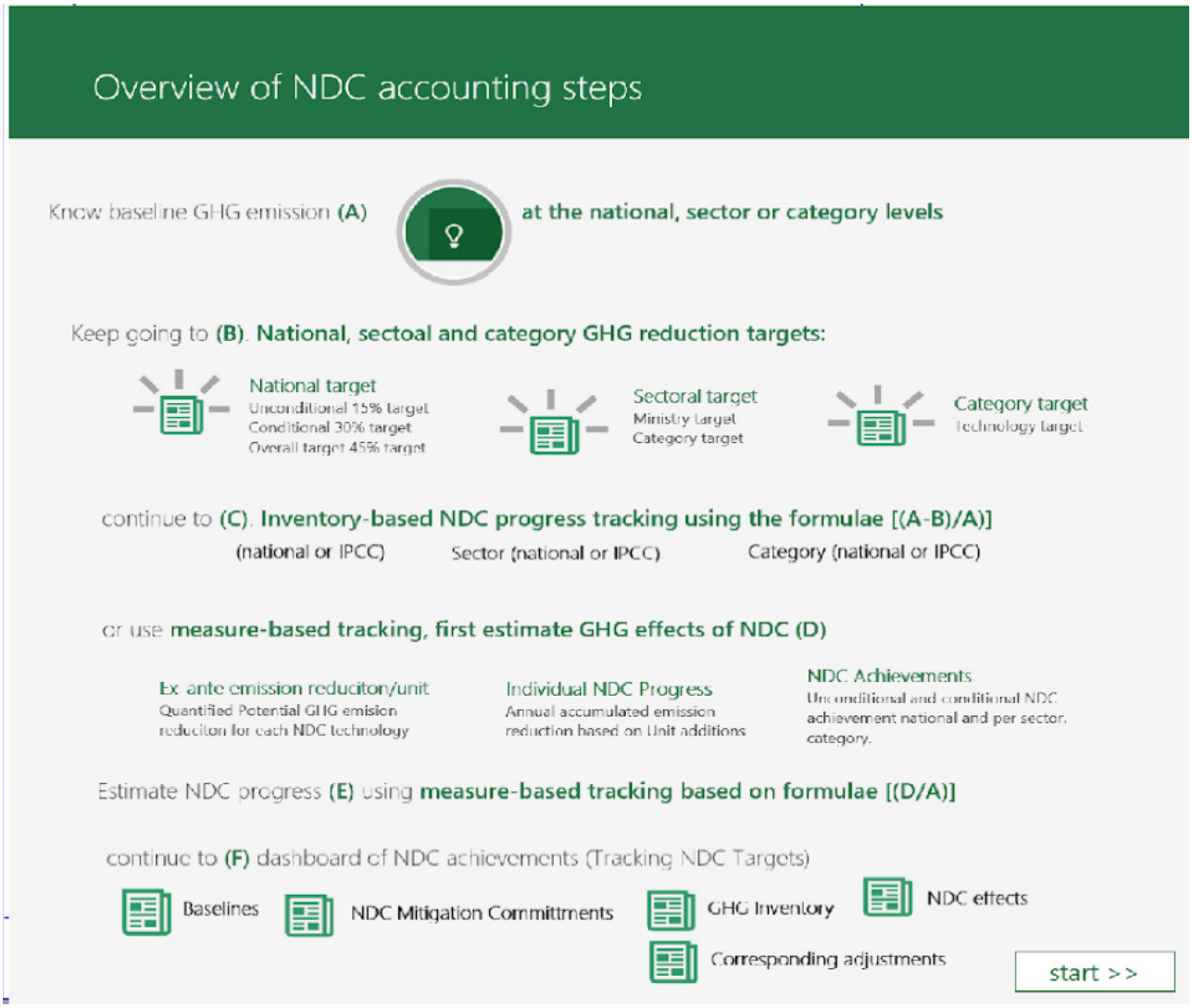
The tool has several spreadsheets linked together via formulae. The first three sheets compose the introductory sheet, which provides an overview of the tool and its uses. The title page includes the name of the tool and a brief overview of the calculation steps a user will follow to use it.



The tool also has a table of contents that outlines the end-to-end steps of NDC accounting and how the sectoral data have been arranged in the tool.

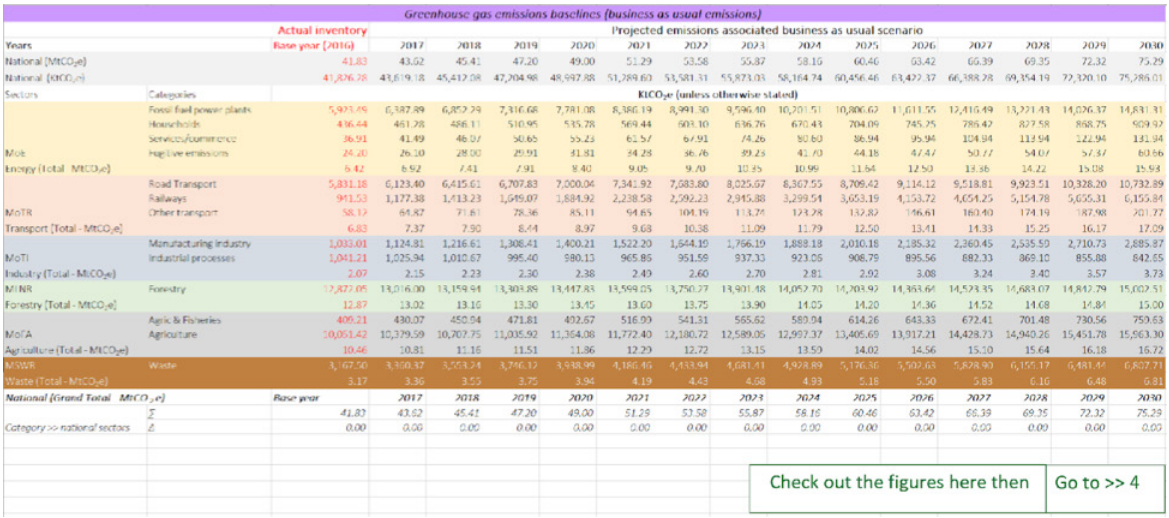


The final introductory sheet presents a summary of the NDC accounting approach.



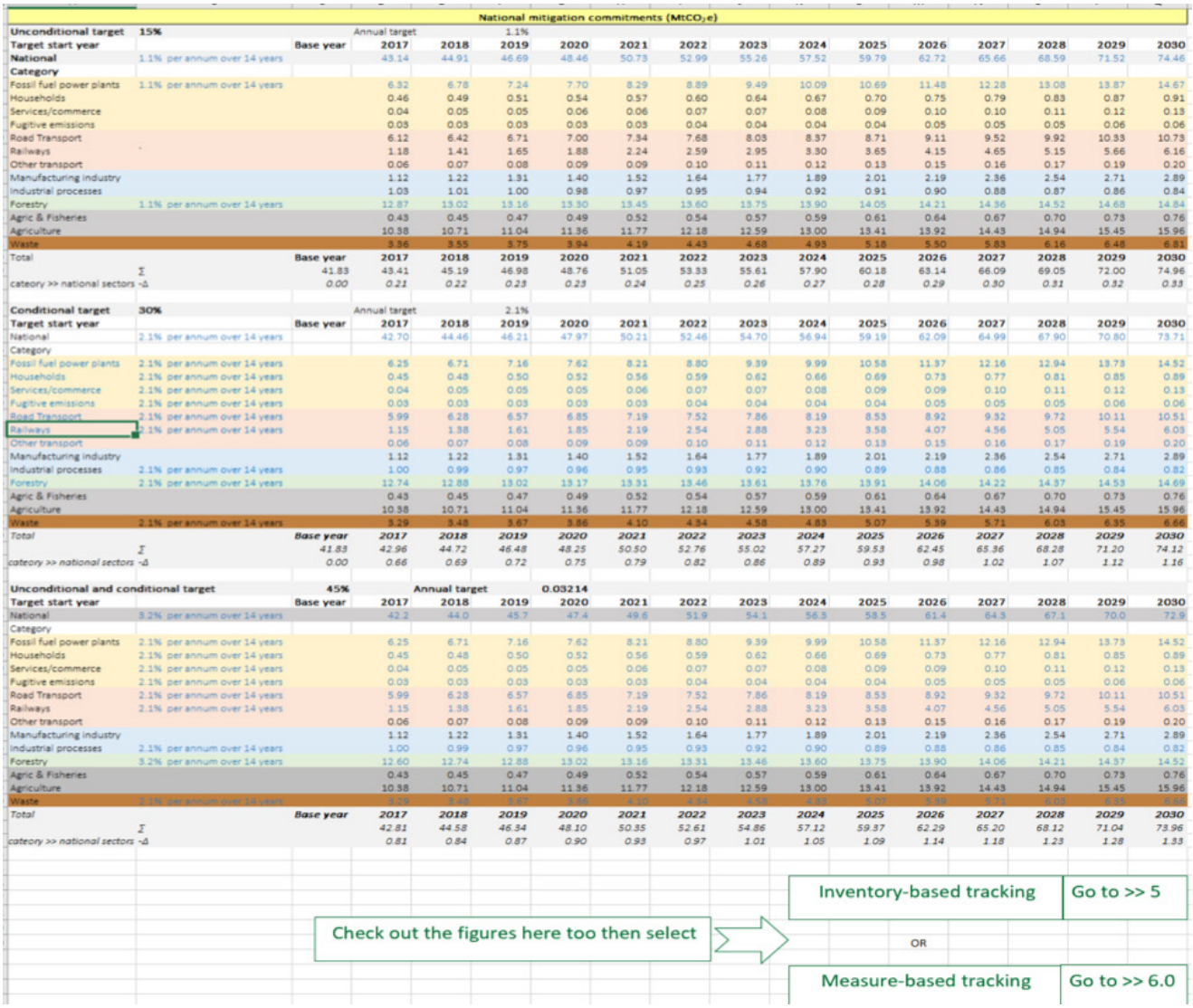
6.2.2 BUSINESS-AS-USUAL EMISSION SHEET

This sheet contains BAU emissions data from 2016 to 2030. These data were originally generated by the national NDC team and accompanied the official submission of the NDC to the UNFCCC. The BAU emission figures are at the national, sectoral and category levels. The national figures are the sum of all individual projected sector emissions from 2016 to 2030. Similarly, the national figures have been disaggregated into sectoral figures. The sectoral figures have been categorised based on the national ministries and according to the IPCC sectors. The sectoral BAU emission figures have been further classified into technology-based categories. Users are not to change the BAU emissions in the tool because that figure has already been officially accepted as part of the NDC submission. Changes may be made only when the NDC baseline is officially updated in 2020.



6.2.3 NATIONAL NDC TARGETS

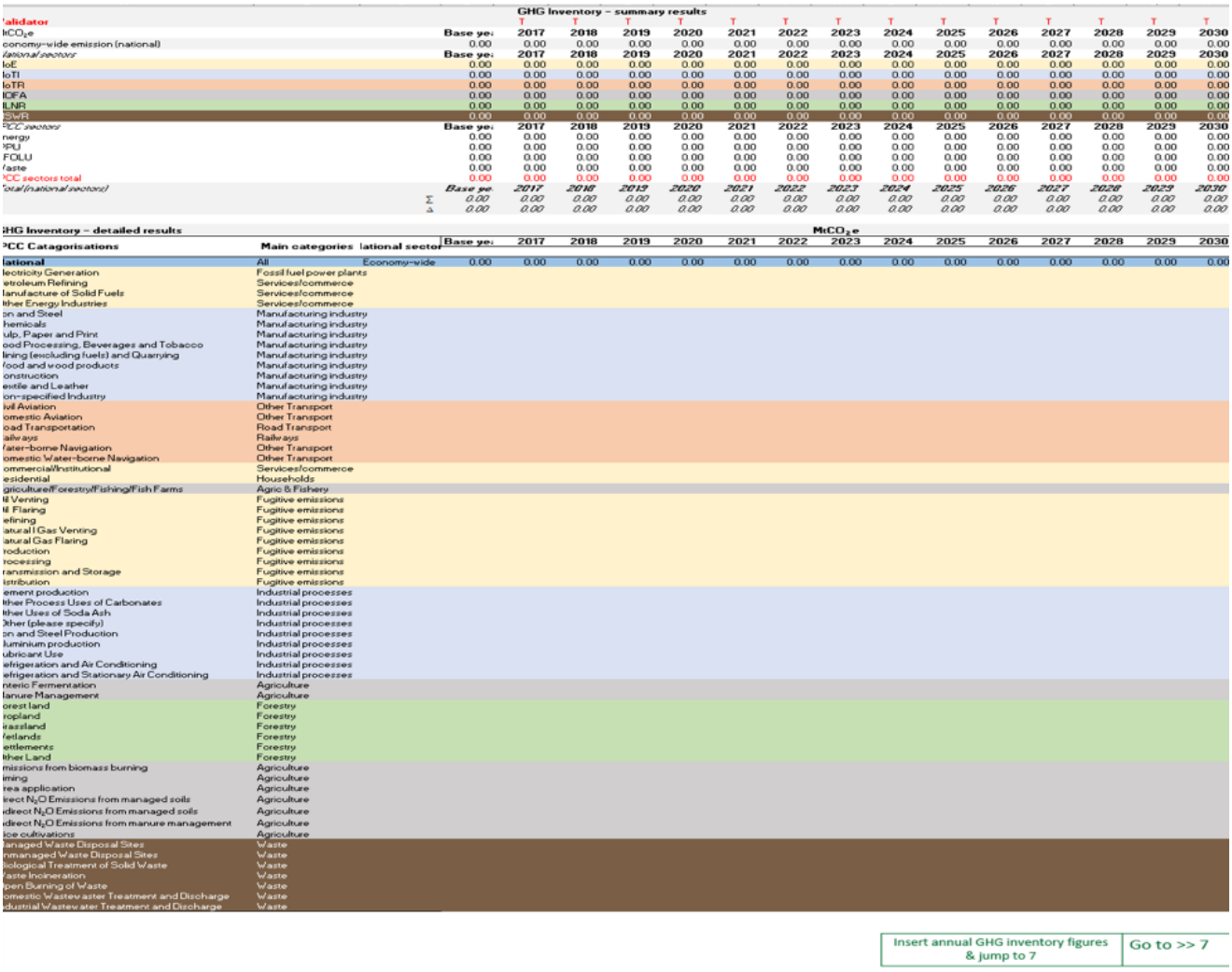
The NDC target figures were derived from the BAU emissions, based on the 15 and 30 percent unconditional and conditional commitments. As with the BAU emission figures, the tool's users are not permitted to change the figures. The NDC target figures have also been captured at the national, sectoral and category levels. The unconditional and conditional targets have been applied to the relevant section for each level. At the national level, both the 15 percent and 30 percent unconditional and conditional targets have been applied to the BAU emissions and expressed on an annual basis. For example, the 15 percent target has been divided into annual 1.1 percent targets for 14 years. Similarly, the 30 percent target has been broken down into a 2.1 percent annual target. It is instructive to note that the yearly targets are applicable only to the sector where emission reduction commitments exist. For example, the unconditional 15 percent emission reduction target applies only to fossil fuel power stations and forest plantations. The tool thus divides the 15 percent target into a 1.1 percent annual target, applied to the appropriate categories and highlighted in blue, indicating remaining emissions. The same approach has been used for the 30 percent conditional. First, the 30 percent target was divided by 14 years to derive the 2.1 percent annual conditional target. Next, the 2.1 percent reduction was applied to applicable mitigation actions in households, services, industrial processes and forestry sectors. However, the annual reduction target increases to 3.2 percent in sectors with both unconditional and conditional mitigation actions, such as the forest sector.



Users are not to change the figures because they are official and were generated to accompany the NDC. They may be changed only when the NDC is updated. Once users are conversant with the figures under the mitigation commitment, they have the option to use inventory-based tracking or measure-based tracking in assessing NDC progress. As already indicated, we recommend that the team select inventory-based tracking because it is consistent with the IPCC methodology and international best practices.

6.2.4 GHG INVENTORY-BASED TRACKING

Inventory-based tracking is preferred because it is simple and largely transparent. This is the sheet on which the users are expected to input annual greenhouse gas inventory data from the category, sectoral to the national levels. Whenever the EPA publishes national GHG inventory figures, the user simply populates the relevant categories. The system will then automatically generate total national GHG emissions and for each category and aggregate them further into national and IPCC sectors. Next, the total national GHG emission figures will be compared to projected BAU emissions to evaluate the extent of deviation to estimate the percentage of NDC target achievement. To avoid exceeding projected BAU emissions, an emission constraint formula has been inserted into the sheet as a validator. It will ensure that annual GHG inventory figures do not exceed projected BAU emissions. The validator will prompt the user whenever GHG inventory figures are higher than BAU emissions.



GHG Inventory – summary results

alidator		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
tCO_2e	Base ye:	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
conomy-wide emission (national)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ational sectors	Base ye:	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
loE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loTI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
loTR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OFA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
LNR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SWR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCC sectors	Base ye:	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
nergy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PPU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FOLU	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
/aste	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
PCC sectors total	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
otal (national sectors)	*Base ye:*	*2017*	*2018*	*2019*	*2020*	*2021*	*2022*	*2023*	*2024*	*2025*	*2026*	*2027*	*2028*	*2029*	*2030*
Σ	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*
Δ	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

GHG Inventory – detailed results

$MtCO_2e$

PCC Catagorisations	Main categories	lational sector	Base ye:	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
ational	All	Economy-wide	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
lectricity Generation	Fossil fuel power plants																
etroleum Refining	Services/commerce																
anufacture of Solid Fuels	Services/commerce																
ther Energy Industries	Services/commerce																
on and Steel	Manufacturing industry																
hemicals	Manufacturing industry																
ulp, Paper and Print	Manufacturing industry																
ood Processing, Beverages and Tobacco	Manufacturing industry																
ining (excluding fuels) and Quarrying	Manufacturing industry																
ood and wood products	Manufacturing industry																
onstruction	Manufacturing industry																
extile and Leather	Manufacturing industry																
on-specified Industry	Manufacturing industry																
ivil Aviation	Other Transport																
omestic Aviation	Other Transport																
oad Transportation	Road Transport																
ailways	Railways																
/ater-borne Navigation	Other Transport																
omestic Water-borne Navigation	Other Transport																
ommercial/Institutional	Services/commerce																
esidential	Households																
griculture/Forestry/Fishing/Fish Farms	Agric & Fishery																
l Venting	Fugitive emissions																
l Flaring	Fugitive emissions																
efining	Fugitive emissions																
atural l Gas Venting	Fugitive emissions																
atural Gas Flaring	Fugitive emissions																
roduction	Fugitive emissions																
rocessing	Fugitive emissions																
ransmission and Storage	Fugitive emissions																
istribution	Fugitive emissions																
ement production	Industrial processes																
ther Process Uses of Carbonates	Industrial processes																
ther Uses of Soda Ash	Industrial processes																
Other (please specify)	Industrial processes																
on and Steel Production	Industrial processes																
luminium production	Industrial processes																
ubricant Use	Industrial processes																
efrigeration and Air Conditioning	Industrial processes																
efrigeration and Stationary Air Conditioning	Industrial processes																
ntetic Fermentation	Agriculture																
anure Management	Agriculture																
orest land	Forestry																
ropland	Forestry																
rassland	Forestry																
/etlands	Forestry																
ettlements	Forestry																
ther Land	Forestry																
missions from biomass burning	Agriculture																
iming	Agriculture																
rea application	Agriculture																
irect N_2O Emissions from managed soils	Agriculture																
ndirect N_2O Emissions from managed soils	Agriculture																
ndirect N_2O Emissions from manure management	Agriculture																
ice cultivations	Agriculture																
anaged Waste Disposal Sites	Waste																
nmanaged Waste Disposal Sites	Waste																
iological Treatment of Solid Waste	Waste																
/aste Incineration	Waste																
pen Burning of Waste	Waste																
omestic Wastewater Treatment and Discharge	Waste																
ndustrial Wastewater Treatment and Discharge	Waste																

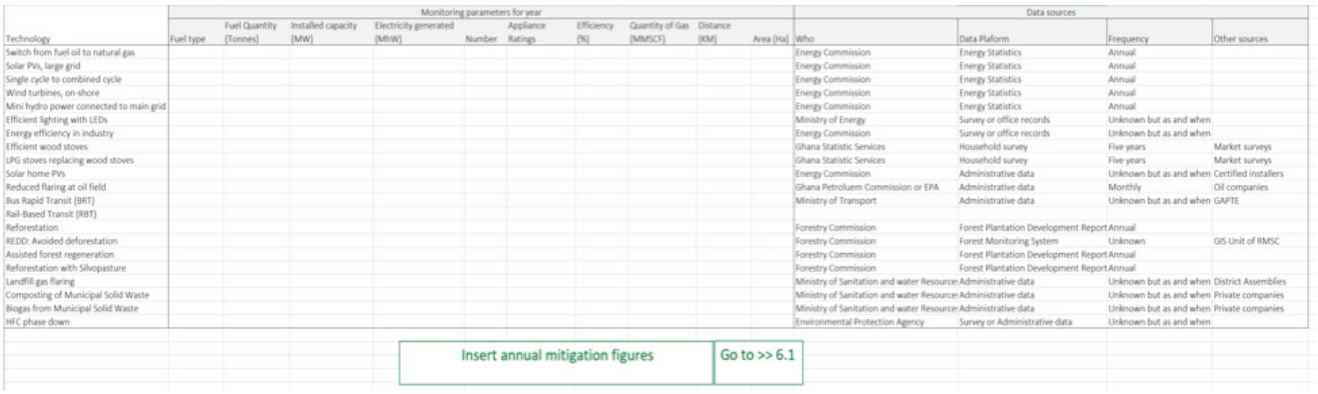
Insert annual GHG inventory figures & jump to 7 | Go to >> 7

This allows the user to ensure that total GHG emissions do not exceed projected emissions under the BAU scenario. If annual inventory estimates exceed BAU emissions for any given year, the validator shows that Ghana is not achieving its NDC target. The current version of the tool performs the BAU and GHGI emission comparison at the national level, but not at the sectoral or category levels. However, the tool may be refined further to allow comparison at the sector or category level. Users must also input data on total emission reductions that have been transferred offshore or involved cancellation and use in the corresponding adjustment. This simply means that any emission reductions transferred offshore would be counted as emissions and added to overall total national emissions.

6.2.5 MEASURE-BASED TRACKING

Information on NDC progress can also be generated using the measure-based tracking approach. Under this approach, the assessment focuses on individual NDC measures and then aggregates to the sector and, further, to the national. Information on individual NDC action monitoring must be collected via a set of indicators. The data gathered is then used to estimate GHG emission reductions from implementation of the actions relative to the baseline. In this regard, four sub-

sheets have been developed for measure-based tracking. The first is the data collection template, which includes the core indicators for the 20 NDC actions. Parameters have been developed for the core indicators so that GHG emission reductions can be estimated quickly, based on an ex-ante emission reduction (already calculated) for each unit of NDC actions. The data collection sheet also identifies which institution is responsible to monitor the individual NDC actions, the platform on which data will be published and reporting frequency. The responsible ministries are asked to use this template to collect annual data on NDC implementation, using the core indicators noted.



	Monitoring parameters for year									Data sources			
Technology	Fuel type	Fuel Quantity (Tonnes)	Installed capacity (MW)	Electricity generated (MWH)	Number	Appliance Ratings	Efficiency (%)	Quantity of Gas (MMSCF)	Distance (KM)	Area (Ha)	Who	Data Plaform	Frequency	Other sources
Switch from fuel oil to natural gas											Energy Commission	Energy Statistics	Annual	
Solar PVs, large grid											Energy Commission	Energy Statistics	Annual	
Single cycle to combined cycle											Energy Commission	Energy Statistics	Annual	
Wind turbines, on-shore											Energy Commission	Energy Statistics	Annual	
Mini hydro power connected to main grid											Energy Commission	Energy Statistics	Annual	
Efficient lighting with LEDs											Ministry of Energy	Survey or office records	Unknown but as and when	
Energy efficiency in industry											Energy Commission	Survey or office records	Unknown but as and when	
Efficient wood stoves											Ghana Statistic Services	Household survey	Five years	Market surveys
LPG stoves replacing wood stoves											Ghana Statistic Services	Household survey	Five years	Market surveys
Solar home PVs											Energy Commission	Administrative data	Unknown but as and when	Certified installers
Reduced flaring at oil field											Ghana Petroluem Commission or EPA	Administrative data	Monthly	Oil companies
Bus Rapid Transit (BRT)											Ministry of Transport	Administrative data	Unknown but as and when	GAPTE
Rail-Based Transit (RBT)														
Reforestation											Forestry Commission	Forest Plantation Development Report	Annual	
REDD: Avoided deforestation											Forestry Commission	Forest Monitoring System	Unknown	GIS Unit of RMSC
Assisted forest regeneration											Forestry Commission	Forest Plantation Development Report	Annual	
Reforestation with Silvopasture											Forestry Commission	Forest Plantation Development Report	Annual	
Landfill gas flaring											Ministry of Sanitation and water Resource	Administrative data	Unknown but as and when	District Assemblies
Composting of Municipal Solid Waste											Ministry of Sanitation and water Resource	Administrative data	Unknown but as and when	Private companies
Biogas from Municipal Solid Waste											Ministry of Sanitation and water Resource	Administrative data	Unknown but as and when	Private companies
HFC phase down											Environmental Protection Agency	Survey or Administrative data	Unknown but as and when	

Insert annual mitigation figures | Go to >> 6.1

The next sub-sheet is the ex-ante emission reduction unit. It contains pre-calculated emission reduction potential (ERP) figures for each unit of the individual NDCs. The figures from the data collection sheet and the ex-ante emission reduction units may be used to derive individual and overall NDC progress. The ex-ante emission reductions for each unit of NDC core indicators using the approved CDM methodologies applicable to the individual NDC actions are presented in another spreadsheet.

Review the ERP per GHG mitigation technology

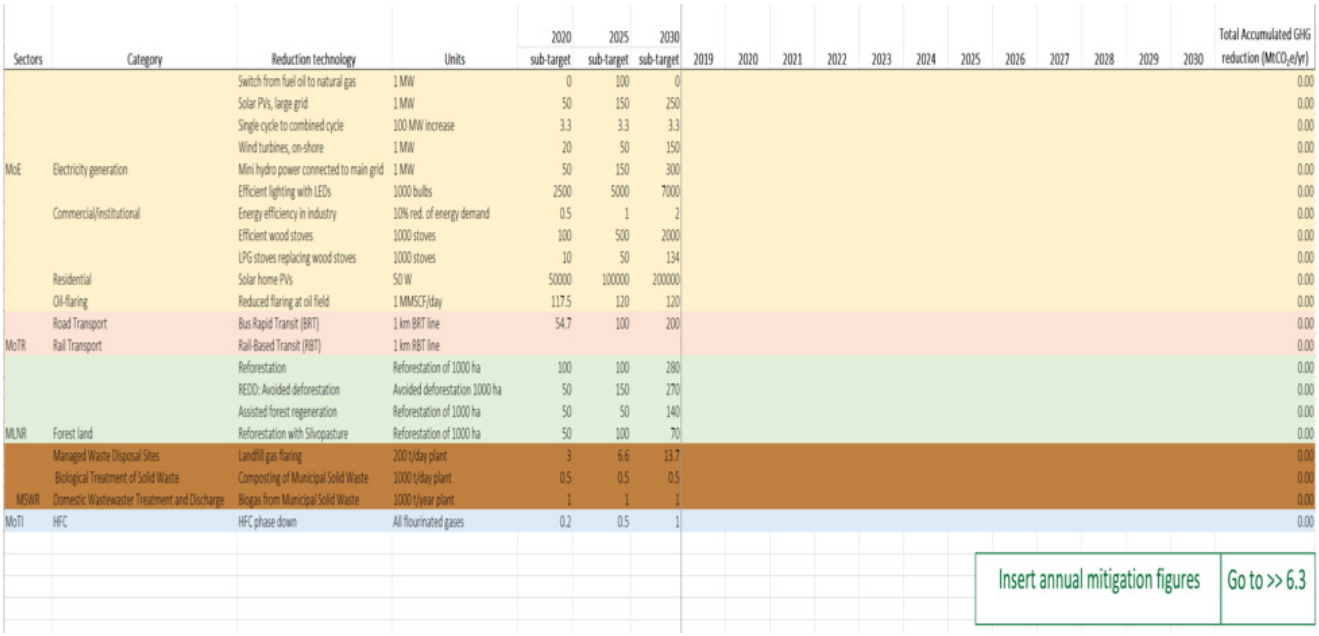
Reduction technology	Emission reduction Potential (ERP) (tCO_2/unit)	Measuring units	Unit targets 2020	2025	2030
Switch from fuel oil to natural gas	1,454.4	1 MW	-	100	-
Solar PVs, large grid	711.8	1 MW	50.0	150.0	250.0
Single cycle to combined cycle	120,744.0	100 MW increase	3.3	3.3	3.3
Wind turbines, on-shore	975.0	1 MW	20	50	150
Mini hydro power connected to main gric	1,720.0	1 MW	50	150	300
Efficient lighting with LEDs	78.9	1000 bulbs	2,500	5,000	7,000
Energy efficiency in industry	16,397.1	10% red. of energy demand	0.5	1.0	2.0
Efficient wood stoves	7,298.3	1000 stoves	100	500	2,000
LPG stoves replacing wood stoves	8,680.7	1000 stoves	10	50	133.5
Solar home PVs	0.3	50 W	50,000	100,000	200,000
Reduced flaring at oil field	22,613.5	1 MMSCF/day	117.5	120	120
Bus Rapid Transit (BRT)	1,975.5	1 km BRT line	54.7	100	200
Rail-Based Transit (RBT)		1 km RBT line	-	-	-
Reforestation	5,238.1	Reforestation of 1000 ha	100	100	280
REDD: Avoided deforestation	5,238.1	Avoided deforestation 1000 h	50	150	270
Assisted forest regeneration	5,238.1	Reforestation of 1000 ha	50	50	140
Reforestation with Silvopasture	3,666.7	Reforestation of 1000 ha	50	100	70
Landfill gas flaring	124,415.2	200 t/day plant	3.0	6.6	13.7
Composting of Municipal Solid Waste	3,558,522.2	1000 t/day plant	0.5	0.5	0.5
Biogas from Municipal Solid Waste	12,186.7	1000 t/year plant	0.6	0.6	0.6
HFC phase down	613.0	All flourinated gases	0.2	0.5	1

NB: ERP has been calculated based on the reference and alternative reduction technology penetration in another excelsheet. This sheet must be used in together with the technology sheet if the user wishes to revise the ERP figures

Review ERP Figures | Go to >> 6.2

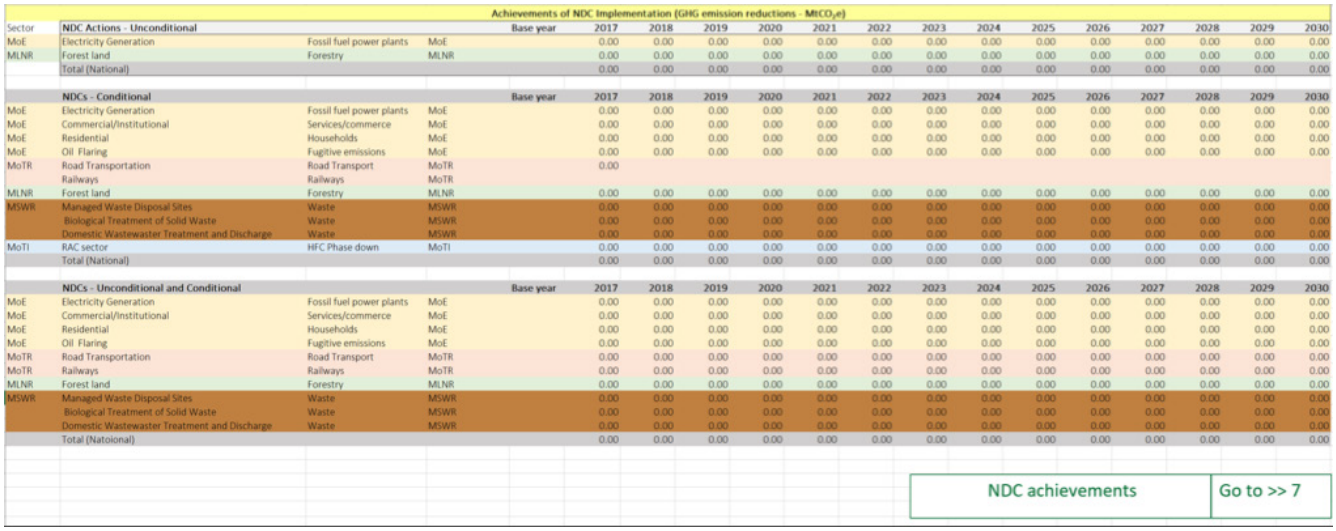
If the user would like to learn more about how emission reductions for each unit were determined, both spreadsheets may be used together. This can offer a deeper insight into the assumptions and explanations of the calculation. Here, too, users are not to change the pre-calculated ERP figures for each unit measure of the NDC.

Annual implementation achievements should be recorded in the individual NDC progress record sheet. Users may add figures on NDC implementation status using the core indicators per unit. For example, “Mini hydropower connected to main grid” has a target of 300 MW by 2030.The annual rate for achieving the 300 MW of mini-hydro between 2017 and 2030 may thus be recorded on this sheet. If 50 MW of mini-hydro capacity was added in 2018, then the user may insert this figure in the sheet. The tool will automatically calculate the corresponding greenhouse emission savings for that intervention. The calculation uses the unit ERP for the mini-hydro technology and multiplies it by the capacity addition, thereby deriving total emission savings for that year. The tool has also been designed to calculate cumulative emission savings for the number of years the mini-hydro capacities have been added. When working on this sheet, users must be sure to select the proper measurement indicators, end-year targets and the corresponding ERP factor for the applicable NDCs.



Sectors	Category	Reduction technology	Units	2020 sub-target	2025 sub-target	2030 sub-target	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total Accumulated GHG reduction ($MtCO_2e/yr$)
		Switch from fuel oil to natural gas	1 MW	0	100	0													0.00
		Solar PVs, large grid	1 MW	50	150	250													0.00
		Single cycle to combined cycle	100 MW increase	3.3	3.3	3.3													0.00
		Wind turbines, on-shore	1 MW	20	50	150													0.00
MoE	Electricity generation	Mini hydro power connected to main grid	1 MW	50	150	300													0.00
		Efficient lighting with LEDs	1000 bulbs	2500	5000	7000													0.00
	Commercial/Institutional	Energy efficiency in industry	10% red. of energy demand	0.5	1	2													0.00
		Efficient wood stoves	1000 stoves	100	500	2000													0.00
		LPG stoves replacing wood stoves	1000 stoves	10	50	134													0.00
	Residential	Solar home PVs	50 W	50000	100000	200000													0.00
	Oil-flaring	Reduced flaring at oil field	1 MMSCF/day	117.5	120	120													0.00
	Road Transport	Bus Rapid Transit (BRT)	1 km BRT line	54.7	100	200													0.00
MoTR	Rail Transport	Rail-Based Transit (RBT)	1 km RBT line																0.00
		Reforestation	Reforestation of 1000 ha	100	100	280													0.00
		REDD: Avoided deforestation	Avoided deforestation 1000 ha	50	150	270													0.00
		Assisted forest regeneration	Reforestation of 1000 ha	50	50	140													0.00
MLNR	Forest land	Reforestation with Silvopasture	Reforestation of 1000 ha	50	100	70													0.00
	Managed Waste Disposal Sites	Landfill gas flaring	200 t/day plant	3	6.6	13.7													0.00
	Biological Treatment of Solid Waste	Composting of Municipal Solid Waste	1000 t/day plant	0.5	0.5	0.5													0.00
MSWR	Domestic Wastewaster Treatment and Discharge	Biogas from Municipal Solid Waste	1000 t/year plant	1	1	1													0.00
MoTI	HFC	HFC phase down	All flourinated gases	0.2	0.5	1													0.00

The last item for measure-based tracking is the sheet that address the overall effect of NDCs. Users do not add data to this sheet. The figures will be generated automatically from the previous individual NDC progress sheet. This sheet is designed to present a summary of overall NDC actions. The summary has been organized into category, sector and national level.



Achievements of NDC Implementation (GHG emission reductions - $MtCO_2e$)

Sector	NDC Actions - Unconditional			Base year	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
MoE	Electricity Generation	Fossil fuel power plants	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MLNR	Forest land	Forestry	MLNR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total (National)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	NDCs - Conditional			**Base year**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
MoE	Electricity Generation	Fossil fuel power plants	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoE	Commercial/Institutional	Services/commerce	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoE	Residential	Households	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoE	Oil Flaring	Fugitive emissions	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoTR	Road Transportation	Road Transport	MoTR		0.00													
	Railways	Railways	MoTR															
MLNR	Forest land	Forestry	MLNR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MSWR	Managed Waste Disposal Sites	Waste	MSWR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Biological Treatment of Solid Waste	Waste	MSWR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Domestic Wastewaster Treatment and Discharge	Waste	MSWR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoTI	RAC sector	HFC Phase down	MoTI		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total (National)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	NDCs - Unconditional and Conditional			**Base year**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
MoE	Electricity Generation	Fossil fuel power plants	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoE	Commercial/Institutional	Services/commerce	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoE	Residential	Households	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoE	Oil Flaring	Fugitive emissions	MoE		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoTR	Road Transportation	Road Transport	MoTR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MoTR	Railways	Railways	MoTR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MLNR	Forest land	Forestry	MLNR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
MSWR	Managed Waste Disposal Sites	Waste	MSWR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Biological Treatment of Solid Waste	Waste	MSWR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Domestic Wastewaster Treatment and Discharge	Waste	MSWR		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Total (Natoional)				0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

6.2.6 NDC TRACKING DASHBOARD

The NDC tracking dashboard gathers all NDC accounting information in one window and establishes the linkages to evaluate overall NDC progress. Here again, users will not add much data, other than to indicate how much emission reductions have been transferred to a third party under the tool's corresponding adjustment column. First, this sheet captures BAU emissions (A) for the period 2016-2030, generated automatically from the BAU sheet. Second, the NDC mitigation (B) target (unconditional, conditional or both) expressed as yearly targets over the same period will also appear automatically in the dashboard. The third dashboard item is the annual GHG inventory estimates (C) for each sector. This is followed by GHG emission reductions (D) for the individual NDC actions. The fifth item is the corresponding adjustment data (E). Information on NDC progress achievement is calculated automatically based on A and C and E, or individual NDC actions expressed in absolute terms or relative to A or C.

Dashboard																
Years	**Variable**	**Base year**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
Validator			F	F	F	F	F	F	F	F	F	F	F	F	F	F
National baseline (BAU emissions) (MtCO2e)		**41.83**	**43.62**	**45.41**	**47.20**	**49.00**	**51.29**	**53.58**	**55.87**	**58.16**	**60.46**	**63.42**	**66.39**	**69.35**	**72.32**	**75.29**
Energy (Total - MtCO2e)			6.92	7.41	7.91	8.40	9.05	9.70	10.35	10.99	11.64	12.50	13.36	14.22	15.08	15.93
MoTR (Total - MtCO2e)			7.37	7.90	8.44	8.97	9.68	10.38	11.09	11.79	12.50	13.41	14.33	15.25	16.17	17.09
MoTI (ToTal - MtCO2e)			2.15	2.23	2.30	2.38	2.49	2.60	2.70	2.81	2.92	3.08	3.24	3.40	3.57	3.73
MLNR (Total - MtCO2e)			13.02	13.16	13.30	13.45	13.60	13.75	13.90	14.05	14.20	14.36	14.52	14.68	14.84	15.00
MoFA (Total - MtCO2e)			10.81	11.16	11.51	11.86	12.29	12.72	13.15	13.59	14.02	14.56	15.10	15.64	16.18	16.72
MSWR (Total - MtCO2e)			3.36	3.55	3.75	3.94	4.19	4.43	4.68	4.93	5.18	5.50	5.83	6.16	6.48	6.81
Nataional target (unconditional) (MtCO2e)	-1.1%	per annum	43.14	44.91	46.69	48.46	50.73	52.99	55.26	57.52	59.79	62.72	65.66	68.59	71.52	74.46
National target (conditional) (MtCO2e)	-2.1%	per annum	42.70	44.46	46.21	47.97	50.21	52.46	54.70	56.94	59.19	62.09	64.99	67.90	70.80	73.71
National target(unconditional & conditional) (MtCO2e)	-3.2%	per annum	42.22	43.96	45.69	47.43	49.65	51.87	54.09	56.30	58.52	61.39	64.26	67.13	70.01	72.88
Actual GHG Inventory results- national (MtCO2e)			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Actual GHG Inventory results- MoE (MtCO2e)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual GHG Inventory results- MoTI (MtCO2e)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual GHG Inventory results- MoTR (MtCO2e)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual GHG Inventory results- MoFA (MtCO2e)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual GHG Inventory results- MLNR (MtCO2e)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Actual GHG Inventory results- MSWR (MtCO2e)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Corresponding Adjustment (MtCO2e) - variables																
Total outflows			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
Annual ITMOs transfers (outflow: +) - track 1			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
REDD+ ER (outflow: +) - track 2			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CERS (outflow: +) - track 3			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CORSIA (outflow: +) - track 4)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GHG Reductions (MtCO2e)																
NDC Impacts (Unconditional)- (national - absolute)			**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**	**0.00**
NDC Impacts (Unconditional)- (national - %)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electricity Generation (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electricity Generation (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NDC Impacts (Conditional)- (national-absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NDC Impacts (Conditonal) - (Adjusted)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NDC Impacts (Conditional)- (national-%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electricity Generation (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electricity Generation (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial/ Institutional (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial/ Institutional (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil Flaring (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil Flaring (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Road Transportation (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Road Transportation (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railways (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railways (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Managed Waste Disposal Sites (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Managed Waste Disposal Sites (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biological Treatment of Solid Waste (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biological Treatment of Solid Waste (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Wastewater Treatment and Discharge (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Wastewater Treatment and Discharge (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NDC Impacts (Conditional and Unconditional)- (national-absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NDC Impacts (Conditional and Unconditional)- (national-%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electricity Generation (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Electricity Generation (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial/ Institutional (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Commercial/ Institutional (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Residential (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil Flaring (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oil Flaring (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Road Transportation (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Road Transportation (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railways (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railways (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Forest land (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Managed Waste Disposal Sites (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Managed Waste Disposal Sites (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biological Treatment of Solid Waste (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Biological Treatment of Solid Waste (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Wastewater Treatment and Discharge (absolute)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Domestic Wastewater Treatment and Discharge (%)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Achievements																
NDC Impacts ((BAU-GHG)/ BAU) - option 1 - recommended (%)	Inventory-based		100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Compare to 15% unconditional target			Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
Compare to 30% Conditional target			Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
Compare to 45% unconditional and conditional target			Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved	Achieved
NDC Impacts (NDC/ (NDC+GHG) - option 2 (%)	measure-based		#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
NDC Impacts (NDC/ BAU) - option 3 (%)	measure-based		0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Corresponding adjustments																
Annual emission levels covered by NDC (18/ CMA. 77.d.i)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total emission reduction outflows:+			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emission balance (as per 18/ CMA 1 para 77.d.ii)			0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

7 CONCLUSIONS AND RECOMMENDATIONS

7.1 CONCLUSIONS

The MRV for the energy and transport sectors form an integral part of the national transparency arrangement for the NDCs, which is why the newly developed tool covered all NDC mitigation sectors. To evaluate NDC progress, the tool uses data on annual greenhouse inventory, baseline emissions, NDC mitigation targets, and NDC actions and their effects. This tool makes it possible to determine NDC progress on the fly every year, provided the basic data are available. The tool is suitable for analysis at the national, sectoral and category levels. The user may select the preferred level of analysis from the start to the end of the accounting. The NDC accounting tool was developed based on decisions in the Article 13 rulebook and the elements discussed under Article 6 of the Paris Agreement. It also draws lessons from the good practices from Annex 1 reporting under the Convention and the Kyoto Protocol. This component of the tool is an Excel spreadsheet that presents a step-by-step approach to assessing NDC progress. It does so by evaluating the impacts of NDC implementation and comparing the degree of deviation relative to the BAU emissions established.

The NDC accounting tool may be used in several ways. First, it offers national-level users a broad overview of progress towards achieving the NDC target at any time. Second, when baseline emissions or mitigation commitments are revised, the tool facilitates those changes without affecting the structure. In addition, the sector should consider providing additional information to the activity level. Such refinements may be necessary when project levels are made available. Additional graph tabs can also be incorporated to enhance visualisation of the results (the tool is portable and can be linked to other spreadsheet programmes). Another important feature is the inbuilt data collection sheet that users may use to populate data on NDC implementation. Overall, the tool's use is expected to significantly improve efficiency and transparency in NDC accounting and reporting. It will provide a single tool for assembling the MRV-related dataset to evaluate NDC progress every year.

7.2 RECOMMENDATIONS

The success of this tool will depend on the number of people who understand its concept and can apply it to different accounting situations. The team thus recommends that the EPA:

- conduct a full-fledged trial of the tool, using real-life data, and obtain feedback to improve its functionality;
- hold training for different stakeholders on the tool's structure and utility;
- distribute the NDC accounting tool to NDC sector contact points for use in regular reporting on sector NDCs; and,
- officially upload the password-protected version of the tool online.

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GLOSSARY

Assigned emissions: The difference between baseline emissions and emission reductions resulting from implementation of NDC mitigation actions.

Bali Action Plan: A comprehensive process to enable the full, effective and sustained implementation of the UNFCCC through long-term cooperative action, now, up to and beyond 2012, in order to reach an agreed outcome and adopt a decision.

Biennial Transparency Report: Reports to be submitted by the Parties to the Paris Agreement containing national greenhouse gas inventories and the "information necessary to track progress made in implementing and achieving" their NDCs.

Biennial Update Reports (BURs): Reports to be submitted by non-Annex I Parties, containing updates of national Greenhouse Gas (GHG) inventories, including a national inventory report and information on mitigation actions, needs and support received.

Conditional NDCs: Conditional targets NDC actions that require external support for their fulfilment.

Corresponding adjustments: Adjustments add up to zero to ensure environmental integrity, so that the atmosphere sees no extra ton of GHG after the transfer of an internationally transferred mitigation outcome (TMO).

Facilitative Sharing of Views (FSVs): One of the two steps defined under the international consultation and analysis (ICA) process for Parties not included in Annex I to the Convention (non-Annex I Parties). FSVs are usually organized as a workshop, where participants present an overview of the BUR followed by a question and answer session.

Global Stocktake: A process established under Article 14 of the Paris Agreement for taking stock of collective progress toward achieving the purpose of the Agreement and its long-term goals. It takes place every five years.

'IN" and "OUT" NDCs: "IN" denotes all country actions that have been put forward in the nationally determined contributions. Those outside the NDCs fall in the "OUT" category.

International Consultation and Analysis: A process adopted at the 16th session of the Conference of the Parties as part of the measurement, reporting and verification arrangements under the Cancun Agreements.

Inventory-based NDC tracking: Tracking NDC progress based on the measure of relative deviation of annual GHG inventory results of projected baseline emissions.

Kyoto Protocol: An international treaty that extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC). It commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that global warming is occurring and that it is extremely likely that human-made CO2 emissions are primarily responsible for it.

Measure-based NDC tracking: Measuring NDC progress using the aggregate effect of individual NDC actions relative to baseline emissions.

Monitoring Reporting and Verification (MRV): A term used to describe all measures that countries take to collect data on emissions, mitigation actions and support. Monitoring means direct measurement or estimated calculations of emission and emission reductions following strict guidance and protocols, such as the IPCC Guidelines and CDM Methods. This can include direct measurement using devices or estimation using simple methods or complex models. Reporting means documentation intended to inform all interested parties. This includes information on methodologies, assumptions and data. Reporting starts from standardized reporting templates, protocols and procedures that are used to feed into National GHG Inventory, NC and BUR. Verification means specific procedures or expert reviews used to verify the quality of the data and estimates. Verification can be internal or external.

National Communications: A type of report submitted, every four years, by the countries that have ratified the United Nations Framework Convention on Climate Change (UNFCCC).

Nationally Determined Contributions: National climate actions to reduce greenhouse gas emissions under the UNFCCC.

NDC accounting: A constant check on the pulse of the Paris Agreement to see how countries are performing. Countries are currently developing guidance for NDC accounting of mitigation components, including an array of GHG targets, non-GHG targets, and policies and actions.

Net-zero (target): Any emissions are balanced by absorbing an equivalent amount from the atmosphere. In order to meet the global warming target in the Paris Agreement, global carbon emissions should reach net zero around mid-century.

Unconditional NDCs: Unconditional NDC actions that are to be implemented without explicit external support.

United Nations Framework Convention on Climate Change (UNFCCC): An international environmental treaty adopted on 9 May 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992. It then entered into force on 21 March 1994, after a sufficient number of countries had ratified it.

UNDP NDC SUPPORT PROGRAMME

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