



Thai-German Climate Programme (TGCP): National Measurement, Reporting and Verification System

Review and Analysis of Thailand's MRV System



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Since 2008, the International Climate Initiative (IKI) of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) has been financing climate and biodiversity projects in developing and newly industrialising countries, as well as in countries in transition. Based on a decision taken by the German parliament (Bundestag), a sum of at least 120 million euros is available for use by the initiative annually. The Initiative places clear emphasis on climate change mitigation, adaptation to the impacts of climate change and the protection of biological diversity. These efforts provide various co-benefits, particularly the improvement of living conditions in partner countries. The IKI cooperates closely with partner countries and supports consensus building for a comprehensive international climate agreement and the implementation of the Convention on Biological Diversity. Moreover, it is the goal of the IKI to create as many synergies as possible between climate protection and biodiversity conservation.

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Acronyms

AWD	Alternate Wet and Drying
BAU	Business as Usual
BEC	Building Energy Code
BERC	Bureau of Energy Regulation and Conservation
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CAAT	The Civil Aviation Authority of Thailand
CCMP	Climate Change Master Plan
CMA	Conference of the Parties serving as the meeting of the Parties to the Paris Agreement
COP	Conference of the Parties (of the Convention)
DEB	Department of Energy Business
DEDE	Department of Alternative Energy Development and Efficiency
DEQP	Department of Environmental Quality Promotion
DIW	Department of Industrial Works
DLA	Department of Local Administration
DLD	Department of Livestock Development
DMCR	Department of Marine and Coastal Resources
DMF	Department of Mineral Fuels
DNP	Department of National Parks, Wildlife and Plant Conservation
DOA	Department of Agriculture
DOAE	Department of Agriculture Extension
DOC	Department of Customs
DOH	Department of Health
DPIM	Department of Primary Industries and Mines
DWR	Department for Water Resources
EbA	Eco-system based Adaptation
ECP Act	Energy Conservation and Promotion Act
EGAT	Electricity Generating Authority of Thailand
EPPO	Energy Policy and Planning Office
ERC	Office of Energy Regulatory Commission
ETF	Enhanced Transparency Framework
FGD	Focus Group Discussion
GAP	Good Agricultural Practices

GHG	Greenhouse Gas
GISTDA	Geo-Informatics and Space Technology Development Agency
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GWP	Global Warming Potential
ICA	International Consultation and Analysis
IETA	Industrial Estate Authority of Thailand
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Processes and Product Use
ISIT	Iron and Steel Institute of Thailand
IT	Information Technology
LDD	Land Development Department
LULUCF	Land Use, Land Use Change and Forestry
M&E	Measurement and Evaluation
MNRE	Ministry of Natural Resources and Environment
MoAC	Ministry of Agriculture and Cooperatives
MOI	Means of Implementation
MPGs	Modalities, Procedures, and Guidelines for the transparency framework
MRV	Measurement, Reporting and Verification
MSW	Municipal Solid Waste
MSWM	Municipal Solid Waste Management
NAMA	Nationally Appropriate Mitigation Action
NAP	National Adaptation Plan
NC	National Communication
NCCC	National Committee on Climate Change Policy
NDC / INDC	Nationally Determined Contribution / Intended Nationally Determined Contribution
NESDC	Office of the National Economic and Social Development Council
12 th NESDP	National Economic and Social Development Plan 2017-2021
NIR	National Inventory Report
NWRC	National Water Resources Committee
OAE	Office of Agriculture Economics
OIE	Office of Industrial Economics
ONEP	Office of Natural Resources and Environmental Policy and Planning
ONWR	Office of the National Water Resources
OTP	Office of Transport and Traffic Policy and Planning
PA	Paris Agreement
PAT	Port Authority of Thailand

PCD	Pollution Control Department
PEA	Provincial Electricity Authority
PSO	Office of the Permanent Secretary of Energy, Policy and Strategy Coordination Office
PTIT	Petroleum Institute of Thailand
QA/QC	Quality Assurance and Quality Control
QA	Quality Assurance
QC	Quality Control
RAOT	Rubber Authority of Thailand
RD	Rice Department
RFD	Royal Forest Department
RID	Royal Irrigation Department
SPP	Small Power Producers
SRT	State Railway Authority of Thailand
SSNM	Site-specific Nutrient Management
TA	Technical Analysis
TNC	Third National Communication
TGEIS	Thailand GHG Emissions Inventory System
TGCP	Thai-German Climate Programme
WWT	Wastewater treatment
UNFCCC	United Nations Framework Convention on Climate Change
VSP	Very Small Power Producer

Executive Summary

The Thai-German Climate Programme (TGCP) supports the Office of Natural Resources and Environmental Policy and Planning (ONEP)'s aim to improve the framework conditions for implementing the Nationally Determined Contribution (NDC) of Thailand in a sustainable and nationally appropriate manner. Whereupon, the TGCP targets five sectors relevant for NDC implementation in emission mitigation and climate change adaptation: national climate policy, renewable energy, waste management, agriculture and water (including Ecosystem-based Adaptation, EbA). The programme support for MRV focuses on the need to enhance the current national Measurement, Reporting and Verification (MRV) system for GHG emissions and mitigation, and the Monitoring and Evaluation (M&E) system for adaptation, so that they will comply with future UNFCCC reporting requirements under the Modalities, Procedures, and Guidelines (MPGs) for the Enhanced Transparency Framework (ETF) of the Paris Agreement (PA). Enhancing national MRV capacities will enable on a routine basis the compilation of data and information for tracking progress of national climate policies, e.g. the implementation of the NDC and National adaptation Plan, as well as on the national GHG inventory and reporting on the technical progress towards reaching the NDC targets.

There are three separate components which an MRV system for developing countries such as Thailand should track under the MPGs, and these are GHG emissions, actions, and support. The approach for this review and analyses focuses on the above three components, at both the national level and within the applicable sectors (e.g. energy, waste, agriculture, and water). This approach includes three methods for addressing information needed for this review and analysis, a desk review of relevant information, Focus Group Discussions (FGDs) for the applicable sectors, and outputs from two training sessions on GHG baselines and QA/QC practices for GHG emissions, respectively. This information is then used to determine the most critical gaps between current practices and the relevant needs for MRV under the MPGs, and concludes with recommended actions which can be taken by Thailand to fill the identified MRV gaps.

The UNFCCC requires the submission of National Communications (NCs) and Biennial Update Reports (BURs) in accordance with specific rules and provided guidance by the bodies under the UNFCCC process. In accordance with this, Thailand has submitted to date three NCs (1st - 2000, 2nd - 2011 and 3rd - 2018) and two BURs (1st - 2015 and 2nd - 2017). At the Katowice Climate Change Conference (COP 24) in December 2018, the Modalities, Procedures and Guidelines (MPGs) for the Enhanced Transparency Framework (ETF) for action and support referred to in Article 13 of the PA, were agreed upon¹. The reporting requirements under the ETF of the PA require that a Biennial Transparency Report (BTR) and a National Inventory Report (NIR) to be submitted as a stand-alone report by all countries, or as a component of a BTR. It is important to note that the majority of information to be reported under the BTR and NIR, are already within the reporting requirements for NCs and BURs, and in some areas enhance these established reporting requirements. The main difference is that the BTR shall provide all information necessary to track progress made in implementing and achieving the NDCs under Article 4 of the PA. Accordingly, information on mitigation actions and baselines are required to be presented in a transparent manner, along with the impacts of adaptation actions. In general, the ETF of the PA adds an extra request of information for reporting of developing countries but allows for consideration of the capacities of the developing country in reporting.

Thailand has established an institutional arrangement for an MRV system to report on the GHG inventory, NCs and BURs. In this context, Thailand has formed a National Committee on Climate Change Policy (NCCC) chaired by the Prime Minister. Under the NCCC, there are four sub-committees including the Subcommittee on Climate Change Knowledge and Database. To support the work of this sub-committee, there are then five sectoral Working Groups (i.e. Energy, Industrial Process and Product

¹ Decision -/CMA.1 (Advance unedited version)

Use, Agriculture, LULUCF and Waste). The Working Groups review the GHG inventory, NCs and BURs, and provide recommendations on improvement of the existing Measurement, Reporting, and Verification (MRV) for future national requirements.

The MRV system on GHG inventory, NCs and BURs also involves local governments and private entities, and other data owners at the ministerial level. At present, the upstream data collection and reporting is performed manually for sectors such as energy, waste and agriculture through spreadsheets and documents, and inventory is developed based on revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the 2003 Good Practice Guidance for LULUCF and partly. the 2006 IPCC guidelines. However, the country is in the process of implementing an IT based tool called the Thailand GHG Emissions Inventory System (TGEIS). The TGEIS is based on 2006 IPCC Guidelines and it will facilitate the collection of information for the inventory report, quality control and information exchanges between relevant agencies throughout the inventory process.

Thailand's NDC baseline was prepared as a part of the development of the iNDC in 2015, and takes an ex-ante top-down approach to modelling and is based on a computable general equilibrium model called AIM/ExSS. The main inputs to the baseline were the GHG Inventory with the base year 2005 to project GHG emissions into the future on a BAU scenario of the economic-wide target of -20%. During the Baseline training, participants highlighted future planning considerations and new sectoral data that should be addressed while reviewing the NDC baseline. Participants in the baseline training indicated a general preference for the continued use of an ex-ante approach, with a combination of top-down and bottom-up modelling. In the context of future requirements under the ETF, the NDC baseline and GHG mitigation scenarios will need to have complimentary boundaries, and for ease of transparency preferably use similar activity data and methodology where applicable.

Thailand does not have yet a comprehensive MRV system for tracking mitigation actions across sectors. However, Thailand has developed a sector based MRV system to monitor progress in the implementation of domestic NAMAs in the transport and energy sector. The current MRV system for these NAMAs tracks mitigation action results of GHG emissions and energy generated / converted / saved (incl. biofuels). It does not track other benefits or outcomes and Means of Implementation (MOI).

In the process for completing the GHG inventory, the Quality Control (QC) is carried out by ONEP, and by ministerial data owners and at the Working Group level for each sector. The overall Quality Assurance (QA) occurs at the national subcommittee level. The current QA/QC system is process oriented and needs to systematically address the quality of information relating to mitigation and adaptation actions, or MOI. In addition, there is currently a separate QA/QC process for each sector in terms of data collection and review in the GHG inventory process.

Within the energy sector, Thailand has a robust MRV system for determining GHG emissions from electricity generation, and for energy efficiency in large buildings and industry. This MRV system is being strengthened and includes data collection and reporting frameworks from various organizations such as power plants (for Electricity Generation and Renewable Energy), Large Building & Factories (for Energy Efficiency), EGAT, ERC, Energy Working Group (under the Ministry of Energy), DEDE, EPPO, Energy Working Group (under the Ministry of Energy) and ONEP. The QC of the electricity generation data is being carried out at three levels - EGAT, EPPO and ONEP while Energy Working Group is responsible for overall QA of information. The scope of the MRV arrangement to track progress of mitigation actions under the sector is currently limited to the NAMA roadmap which focuses on renewable energy and energy efficiency in electricity and heat generation, biofuels in transport², and energy efficiency in appliances. Though the MRV of support within the sector meets minimum

² A MRV system with a larger boundary for transport is on the process of finalizing development and gaining approvals.

requirements, it needs to be strengthened to meet the MPGs. The electricity generation sub-sector does need to improve the overall QA/QC of data at the bottom level as part of the GHG emissions inventory process, and corresponding QA/QC for mitigation under energy efficiency can be strengthened. This strengthening can be achieved through the use of common QA/QC guidelines and standardised templates.

The current MRV system for the waste sector only focuses on the GHG inventory and does not cover mitigation measures and MOI in a complete manner. The Pollution Control Department (PCD) is an important entity in handling data on municipal solid waste and domestic waste water, which is transferred to ONEP for the GHG inventory. PCD publishes related data also in the form of the Thailand State of Pollution Report. However, data collection including QA/QC and uncertainty assessment at the local level involved in waste handling and treatment including the private sector requires further improvement. This improvement should include capacity building for data collection but also could introduce reporting obligations for the private sector. Generally, Activity Data such as total solid waste generation is often estimated based on population data instead of direct real measurements and is partially incomplete. Furthermore, key data and parameters, e.g. the composition of municipal solid waste, are outdated and would need an update. For wastewater, the information provided to PCD mainly relates to municipal and industrial wastewater treatment, and there is missing information needed to future GHG inventories, such effluent bodies. However, what is most significant is that the current boundary for MRV in wastewater treatment does not include on-site treatment, which is expected to be the majority of wastewater generated in Thailand.

In the agriculture sector, a basic MRV system for determining GHG emissions was established by ONEP to prepare the BURs in 2015, which supported the preparation of 2nd BUR and TNC. This MRV system covers the sources of GHG emissions, the activity data for different sub-sectors, description of the Tiered approaches used for sub-sectors (Tier 1 or 2), the determination of GHG emissions factors, and the institutions responsible for data collection. However, within existing practices there is duplicity of data collection efforts by different government offices and departments leading to data redundancy. For determination of GHG emissions, default IPCC 2006 emissions factor values are used. There are few exceptions, for example with rice cultivation where Tier 2 country specific emissions factor values were developed. In terms of MRV of mitigation actions, there is progress to develop and implement MRV for a NAMA in the rice sub-sector, but there is no tracking of mitigation actions for other agricultural sub-sectors such as fertilisers, livestock and other cash crops. In addition, baseline GHG emissions scenarios for mitigation actions are yet to be developed for all agriculture sub-sectors. For the Monitoring and Evaluation (M&E) framework for adaptation actions in agriculture, a basic system is yet to be developed for Thailand. While the MRV for support for the sector is currently limited.

In the water management sector, the M&E system for adaptation action is yet to be developed. The National Adaptation Plan (NAP) identifies flooding as a critical risk and proposes different flood risk management strategies as a means of adaptation. In order to develop a basic M&E, the climate change risks and adaptation measures may be identified based on individual river basins to start with. Subsequently, qualitative and quantitative goals and performance indicators on outcomes & impacts may be defined for identified adaptation actions and activity data may be generated. The M&E for adaptation actions and support in this sector is currently very limited, but Thailand is working to begin strengthening both adaptation planning and M&E for this sector.

This review and analysis focus on the need to enhance the current MRV system to comply with future UNFCCC reporting requirements under the ETF of the PA. Since the MRV system is comprehensive, the following figure offers a pathway highlighting the most vital of the recommendations from this review and analysis, and is not an exhaustive, but is meant to offer strategic direction in a temporal approach of what to strengthen and when.

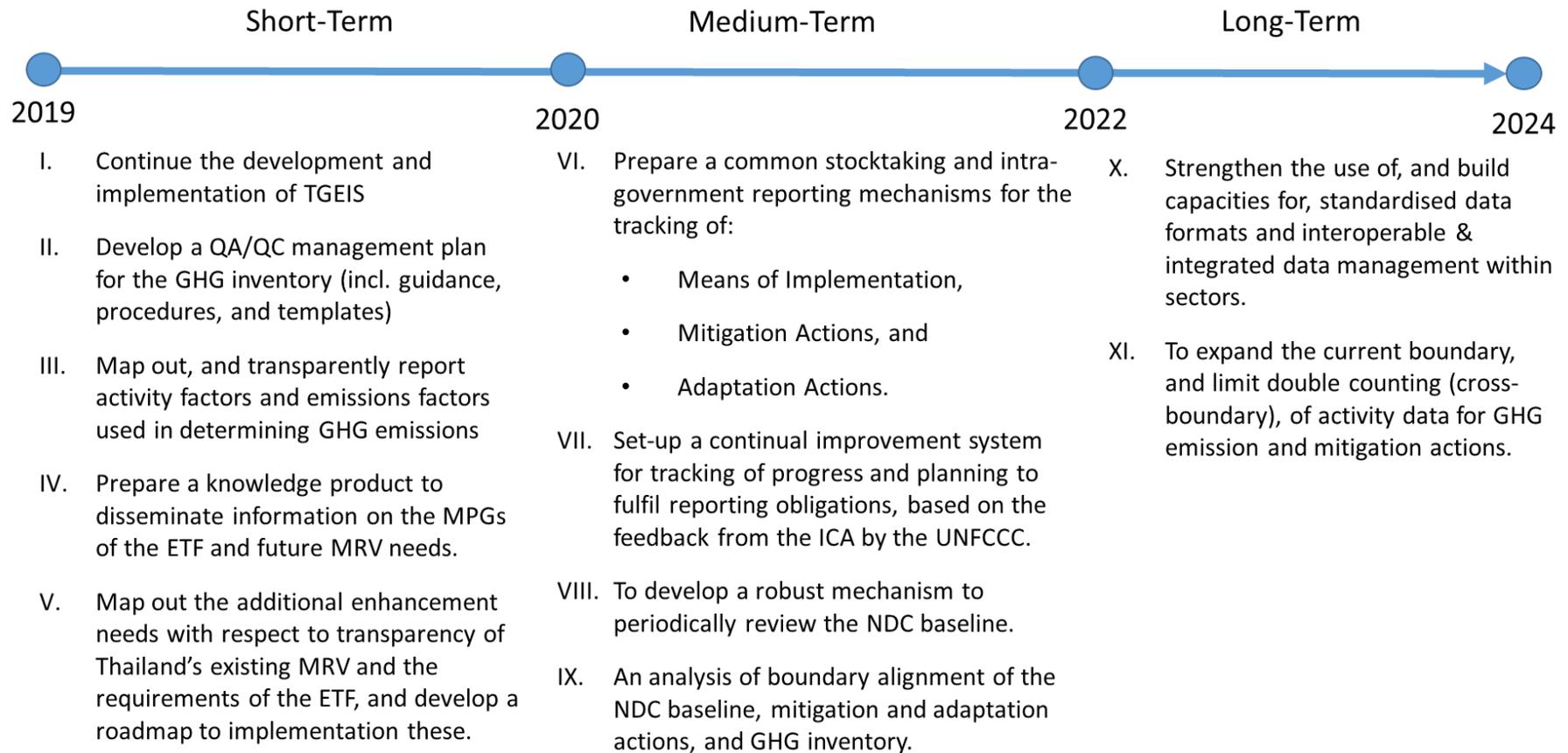


Figure 1: Summary of recommended pathway for strengthening the MRV system

1 Background of the Thai-German Climate Programme

The Thai Ministry of Natural Resources and Environment (MNRE) together with its subordinate authority, the Office of Natural Resources and Environmental Policy and Planning (ONEP), is responsible for the development and implementation of the Nationally Determined Contribution (NDC) in Thailand. At ONEP, the Climate Change Management and Coordination Division (CCMC) was established in 2008. It functions as the secretariat to Thailand's National Committee on Climate Change Policy (NCCC) and its relevant sub-committees, and also acts as the National Focal Point (NFP) for the United Framework Convention on Climate Change (UNFCCC), the Nationally Designated Authority (NDA) for the Green Climate Fund (GCF), the focal point for the Adaptation Fund (AF), the focal point of Thailand's Nationally Appropriate Mitigation Action (NAMA) and the national focal point for the ASEAN Working Group on Climate Change (AWGCC).

GIZ has worked in Thailand on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) since 2009. In the frame of the International Climate Initiative (IKI), GIZ supports MNRE to reduce greenhouse gas (GHG) emissions and improve the capacity for adaptation to climate change in Thailand.

The Thai-German Climate Programme (TGCP) brings in expertise to build a strong institutional architecture for the successful NDC implementation in the agriculture, energy, waste, and water sectors. Supports are provided in 5 key fields of work:

- National Policy Development
- Sub-national Implementation
- Measurement, Reporting, and Verification (MRV) and Monitoring & Evaluation (M&E)
- Financing
- International Cooperation

Acknowledging the crucial role sector level actor can play, the programme closely work with MNRE and ONEP for the climate policy component, the Pollution Control Department (PCD) for issues related to waste, the Office of the National Water Resources (ONWR) and the Department for Water Resources (DWR) for the water issues, the Office of the Permanent Secretary of Energy, Policy and Strategy Coordination Office (PSO) for renewable energy matters, and Ministry of Agriculture and Cooperatives (MoAC) and the Rice Department (RD) concerning the agriculture sector. Implementation runs from 2018-2021.

This review and analysis report is part of the focus of the first task in the key field of work No. 3 of the TGCP, which is to help ensure that Thailand has an appropriate MRV system to report to the UNFCCC in the future. Thus, focusing on the need to enhance the current national measurement, reporting and verification (MRV) system to comply with future UNFCCC reporting requirements under the Enhanced Transparency Framework (ETF) of the Paris Agreement (PA). This includes enhancing national MRV capacities to enable Thailand to routinely compile relevant of data and information on GHG emissions, support needed and received, and on the progress made towards achieving Thailand's NDC targets.

2 Existing and Expected MRV Requirements under the UNFCCC and Paris Agreement

The UNFCCC (the “Convention”) has the objective to achieve the stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous threats to ecosystems and mankind. To achieve this objective, the Convention requires reliable, transparent and comprehensive information on GHG emissions, climate actions, and support provided and received. Accordingly, all Parties are obliged to communicate information relevant to the implementation of the Convention as detailed in Article 12 of the Convention text. The requirements for developing country parties communication are further described in the *Handbook on Measurement, Reporting and Verification for Developing Country Parties*³ (UNFCCC 2014a).

According to this handbook, **Measurement** occurs at the national level and refers to the measurement of GHG emissions by sources and removals by sinks through the national GHG inventories. Non-Annex I Parties (e.g. developing countries) also need to measure the specific effects of national mitigation actions as well as the support needed and received. **Reporting** is implemented through the National Communications (NCs) since 1996 and Biennial Update Reports (BURs) since 2013. Parties are required to report on their actions to address climate change in their NCs, which include information on the GHG inventories, mitigation actions and their effects, adaptation to climate change, constraints and gaps, support needed and received, and other information considered relevant to the achievement of the objective of the Convention. NCs are to be submitted every four years, and BURs are to be submitted every two years. Where BURs shall provide an update of the information presented in NCs, with focus on mitigation and actions, support needed and received. **Verification** is addressed at the international level through International Consultation and Analysis (ICA) of BURs, which is a process to increase the transparency of mitigation actions and their effects, and support needed and received while being non-intrusive, non-punitive and respectful of national sovereignty⁴. In this respect NCs are not subject to ICA. At the national level, verification is implemented through national MRV mechanisms to be established by each Party, and in this respect a wealth of guidance is provided in Convention decision's, as well as Convention and third-party publications for best practice. Provisions for verification at the national level that are part of the national MRV framework are to be reported in the BURs (UNFCCC 2014a). Verification at both the international and national levels can for example include ascertaining the source of information reported in BURs, as well as the information's integrity and level of accuracy.

In accordance with the Convention, Thailand has submitted to date three NCs (in 1st - 2000, 2nd - 2011 and 3rd - 2018) and two BURs (in 1st - 2015 and 2nd - 2017). In the ICA technical analysis of the 2nd BUR, Thailand was commended with regards to several components on its completeness of reporting, and clarifications during the technical analysis. This technical analysis pointed out further actions to strengthen further NCs / BURs, and related capacity building needs (UNFCCC 2018a).

Within the Convention, all parties to the PA are requested to define their NDCs to the global response to climate change, for which the accumulative response has the global goal of “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels” (UNFCCC 2015). This includes under Article 13 that all parties to the PA report regularly on their anthropogenic emissions by sources and removals by sinks of greenhouse gases and information on progress made in implementing and achieving its NDC, under the ETF.

³ Also referred to as non-Annex I Parties

⁴ (UNFCCC 2012) and (UNFCCC 2014b)

In accordance with the Modalities, Procedures, and Guidelines (MPGs) for the ETF this information should be reported through Biennial Transparency Reports (BTRs) and National Inventory Reports (NIRs) which may be standalone. Whereupon, the first BTR / NIR reports shall be delivered at the latest 31st December 2024 (UNFCCC 2018b). Generally, the reporting requirements under the ETF are the same for developed and developing countries, however, the MPGs offer flexibility to developing country Parties who need such in light of their current capacities. In making use of this flexibility provisioned to developing country Parties, they are requiring to provide an identification of support needed to ensure further improvement of their reporting and transparency over time.

It is important to note that most of the information to be reported under the ETF's BTRs and NIRs, are already within the reporting requirements for NCs and BURs. There are some differences for developing countries, and these relate mainly to more detailed M&E of adaptation and MRV of mitigation actions and support needs and received, and progress to achieving NDCs, but taking into consideration national capacities as mentioned above. Table 1 below gives a general depiction of the similar and different reporting requirements of NC, BUR, and BTR reports. This table identifies both what information shall / should / may be included in the different types of reports, but also what is enhanced in terms of greater definition of what information is provided.

Reporting Elements for non-Annex 1 Parties	<input type="checkbox"/> Included <input checked="" type="checkbox"/> Enhanced		Under the "Convention"		Under the ETF of the PA	
	NCs	BURs (can be part of NCs)	BTR	NIR (optional stand- alone)		
National circumstances and institutional arrangements for reporting	✓	✓	☑	☑		
National GHG inventory	✓	✓		☑		
GHG accounting methodologies, parameters and data used, and rationale for use	✓	✓		✓		
Estimate uncertainty, assessed completeness, and QA/QC implementation	✓	✓		✓		
Description of the Nationally Determined Contribution			✓			
Mitigation policies and measures, actions and plans actions	✓	✓	☑			
Projections of GHG emissions and removals			✓			
Progress in implementing and achieving the NDC: approaches, methodologies, and assumptions			✓			
Constraints and gaps in finance, technology, and capacity	✓	✓	☑			
Description of financial, technology, and capacity building support needed and received	✓	✓	☑			
Description of support needed and received to enhance transparency			✓			
Information on the national/domestic MRV system	✓	✓	☑			
Climate Change impacts, risks, and vulnerabilities	✓		✓			
Adaptation policies and measures, actions and plans actions	✓		☑			
Progress on the implementation of adaptation and results, including approaches and methodologies	✓		☑			
Information related to averting, minimizing and addressing loss and damage			✓			
Research and systematic observations	✓					
Education, training and public awareness	✓					
Cooperation, good practices, experience and lessons learned for adaptation			✓			
Technical expert review		✓	☑			
International consultation and analysis (ICA) & Facilitative, multilateral consideration of progress		✓	☑			

Common

Inventory

NDC/
Mitigation

Adaptation

Table 1: general depiction of the similar and different reporting requirements of NCs, BURs, and ETF reports

3 Approach used to Review and Analyse MRV / M&E Practices

This review and analyse focuses on the three components GHG emissions, Actions and Support. In each component, MRV needs to be applied: **Measurement** of GHG emissions through GHG Inventory, achieved mitigation through measures of actions as well as the assessment of support needs and received. **Reporting** of GHG emissions is implemented through reporting to the UNFCCC in NC and BURs and domestic reports, the same for achieved mitigation and adaptation and support received and needed. **Verification** of GHG Emission measurement can be applied through four-eyes principle, third party review by national and/ or international experts, as well as Quality Control and Quality Assurance system. Reporting of the verification are documents and minutes of these applied verification tools and methods as well as through international processes of climate reports, e.g. the ICA process.

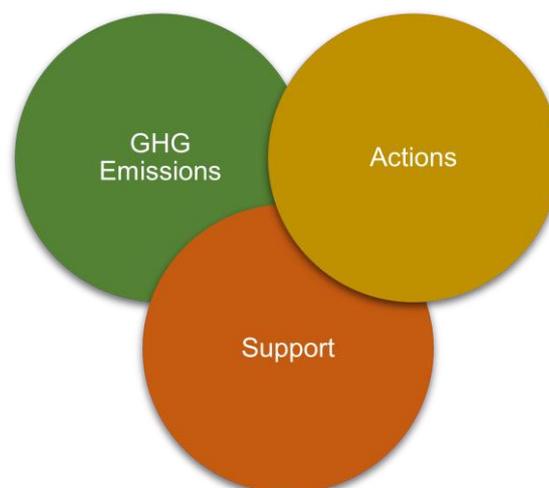


Figure 2: The three components an MRV system should track

The report covers within both the national level and the applicable sectors defined in the boundary of the TGCP assignment to support MRV and M&E (e.g. energy, waste, agriculture, and water management). The approach agreed to with ONEP and GIZ and used for this review and analyse in October and November 2018 is depicted in Figure 3. This approach includes three methods for addressing information on the collection and management of data relevant to the current status of MRV in Thailand: 1) a desk review of relevant documentation provided by ONEP and GIZ, 2) Focus Group Discussions (FGDs) for the applicable sectors, and 3) outputs from two training sessions on GHG baselines and QA/QC practices for GHG emissions, respectively. This information is then used to determine the most critical gaps between current practices and the relevant needs for MRV under the MPGs. Then this review and analyse concludes with recommended actions which can be taken by Thailand to fill the identified gaps.

This approach allows for a review of information on the current collection and management of MRV related data at the national level. Due to past reporting requirements of Thailand under the UNFCCC, most of such information focuses on GHG emissions and a minor portion on actions and support. Given the limitations of the approach used, gaps in information, and the extent of current practice, the review of sectoral MRV systems was not comprehensive (e.g. full information mapping was not possible).

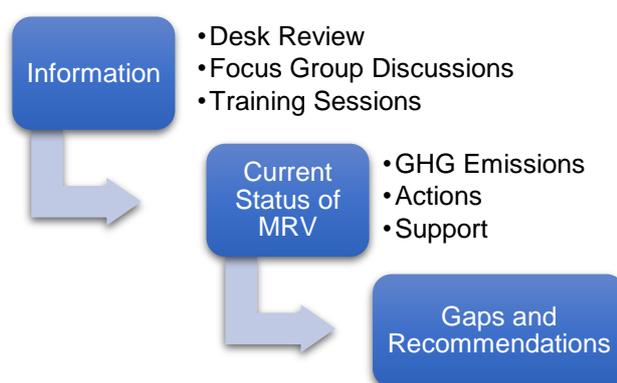


Figure 3: Approach to determining the current status of MRV in the sectors, then gaps and recommendations

All activities were facilitated by the staff of ONEP and GIZ's experts / consultants. The FGDs and training session were attended by scores of representatives of both national and sub-national government departments, offices, and agencies appropriate to the applicable sectors. It is noted that the private sector (outside of state-owned enterprise) was not included in the review and analysis processes.

4 Status of the National System for GHG, Mitigation Reporting in Thailand

Thailand established institutional arrangement and MRV systems specific to the preparation of the national GHG inventories, NCs and BURs in 2015. The structure of this institutional arrangement is depicted in Figure 4, and was used in the development of the Third National Communication (TNC) in 2018 and 2nd BUR in 2017. In this context, Thailand has established the National Committee on Climate Change Policy (NCCC), chaired by the Prime Minister. The NCCC looks after (i) national climate change policy and strategy; (ii) determination of national positions in international negotiations under the UNFCCC and any relevant international agreements; and (iii) monitoring and evaluation of implementation results of government agencies, as stated in the national policy and strategy. Under NCCC, there are four subcommittees, viz. the Subcommittee on Climate Change Policy and Planning Integration, the Subcommittee on Climate Change Knowledge and Database, the Subcommittee on Climate Change Negotiation and International Cooperation, and the Subcommittee on Action for Climate Empowerment and Public Relations.

Under the subcommittee on Climate Change Knowledge and Database, five sectoral working groups (i.e. Energy, Industrial Process and Product Use, Agriculture, LULUCF and Waste) have been set up to review the GHG inventory, NCs and BURs, and provide recommendations on improvement of the existing MRV for future national requirements.

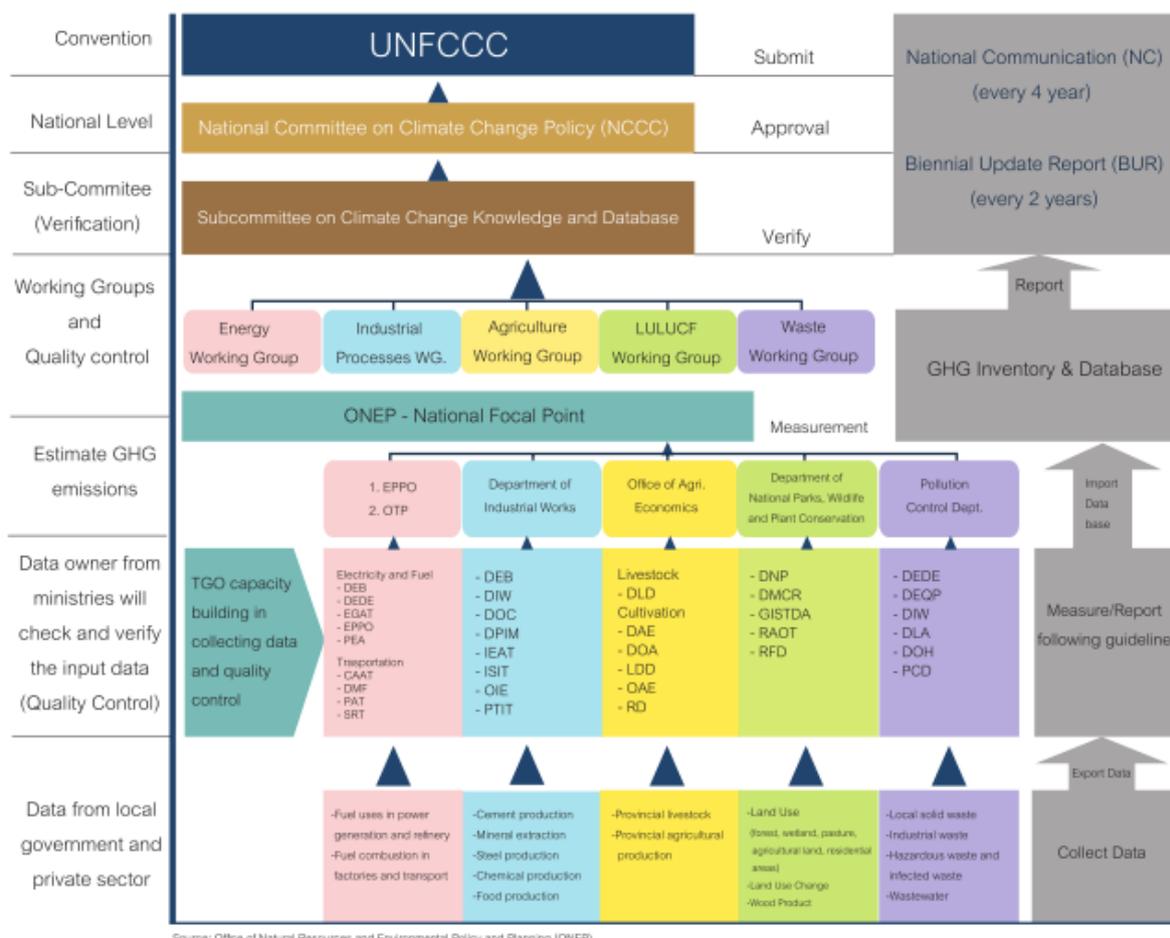


Figure 4: Preparation Structure of NC and BUR (Thailand 2018b)

4.1 National System for GHG Reporting

Thailand's latest GHG inventory given in the TNC and 2nd BUR, showing GHG emissions for the years 2000 to 2013, was prepared to the extent of the country's capabilities using the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, the 2000 Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories and the 2003 Good Practice Guidance for LULUCF. This inventory report presents Thailand's national GHG emissions by sources and GHG emissions removal by sinks and include GHG emissions (CO₂, CH₄, and N₂O) and emissions of other radiatively active substances (NO_x, CO, NMVOCs, and SO₂). The process for developing the GHG inventory consists of following steps regarding data, information flow, and is also depicted in Figure 4.

1. Local government and private sector entities of different sectors (namely Energy, Industrial Processes and Product Use, Agriculture, LULUCF, and Waste) report data to respective data owners from ministries.
2. These ministry data owners then submit the data to sectoral focal point which has been assigned to be collecting the activity data viz. Energy Policy and Planning Office (EPPO), Office of Transport and Traffic Policy and Planning (OTP) for energy sector, Department of Industrial Works (DIW) for IPPU sector, Office of Agricultural Economics (OAE) for agricultural sector, Department of National Parks, Wildlife and Plants Conservation (DNP) for LULUCF sector, and Pollution Control Department (PCD) for waste sector will check and verify data from local government and private sector.
3. ONEP and expert team estimate GHG emissions for all sectors based on the data provided by the sectoral focal point or lead agencies.
4. The results of this GHG emission estimation are submitted to the sectoral working groups. Each working group of relevant sectors reviews the Activity Data and Emission Factor methodology, process, and results of the GHG emission estimation.
5. After the approval from the sectoral working groups, GHG inventories of the sectors are submitted as part of the BUR/NC to the Subcommittee on Climate Change Knowledge and Database for verification.
6. In the final step, as secretariat of the NCCC, ONEP submit the BUR/NC to the NCCC for approval before submitting it to the UNFCCC. It is noted, that with most recent GHG inventory, much of the upstream data in the development process is captured manually for sectors like energy, agriculture, waste etc. through MS Excel or Word. The information is transferred into the TGEIS (see below) to compile the GHG Inventory and identify uncertainties and errors in the submitted data sets. In addition, Thailand has the goal of transition methodology used for emission estimation from the revised 1996 IPCC guidelines to the 2006 guidelines for all sectors, as well as from Tier 1 to 2 in some sectors.

Currently Thailand is implementing an IT based tool called the Thailand GHG Emissions Inventory System (TGEIS) that facilitates the collection of activity data and estimation information for the GHG inventory report, quality control, and information exchanges between relevant agencies throughout the GHG inventory development process. The TGEIS has as a bases the 2006 IPCC Guidelines and gives Thailand a faster and more efficient manner to compile GHG accounting data. As part of the TGEIS system, Thailand has developed activity data archiving process as well as various templates for data collection. Included within the work of implementing TGEIS, Thailand has also prepared MRV Handbooks for GHG emissions, for five sectors: Energy, Industrial Process and Product Use,

Agriculture, Forestry and LULUCF. These handbooks address Activity Data collection systems and QA/QC processes for the respective sectors in terms of developing the GHG inventory.

4.2 NDC GHG Emissions Baseline

Thailand's NDC baseline was prepared as a part of the development of the iNDC in 2015 (Thailand 2015a). Thailand used NDC baseline takes an ex-ante top-down approach to modelling and is based on a computable general equilibrium model called AIM/ExSS, which is also used by other countries in Asia. The main inputs to the baseline were historic data from the various sectors within the NDC boundary, and chosen socio-economic values were used to project GHG emissions into the future on a Business-As-Usual (BAU) scenario. Thailand used the GHG Inventory with the base year 2005 to estimate the emission development until 2030 for the (i)NDC and the economic-wide goal of -20% unconditional emission reduction. The NDC baseline is an emission projection into the future (ex-ante) as the data of the GHG Inventory and the time series shows actual past GHG emissions (ex-post).

It is recommended in the context of future requirements under the ETF, the NDC baseline and sectoral GHG mitigation scenarios should have, if possible and applicable, the closest or same goal, used data and framework. This means that Thailand has several options on how to address the NDC baseline in the future, with regards to reporting on progress in achieving NDC targets.

The baseline training session addressed the different options for applying an NDC baseline under a BAU scenario, and examples of how baselines are applied on two NDC sectors: energy and waste. There were also breakout sessions addressing the modelling preference, and the context of baselines in the agriculture, energy, and waste sectors. These breakout sessions pinpointed the uncertainty regarding the boundary of the NDC baseline during the development in 2015, in terms of what sub-sectors are included, and new planning considerations and sectoral data that should be addressed while developing or reviewing NDC baseline. There was a general preference for the continued use of an ex-ante approach, and a combination of top-down and bottom-up modelling among the participants, but the approach used in the future will need to follow the reporting needs under the ETF (TGCP 2018b).

4.3 System for Reporting of Mitigation Actions

Thailand has developed a national MRV system to monitor progress in the implementation of domestic NAMAs in the energy and transport sector within the NAMA roadmap. The robust national MRV system for tracking mitigation actions across all mitigation sectors can build upon experience. The figure below depicts the process of NAMA tracking along with the institutional agencies involved in the reporting of the actions. The steps are:

1. First, the "Working group on GHG inventory and Mitigation measure" prepares the goal to reduce GHG emissions and select appropriate measures and policies by setting the criteria for evaluation of measures and policies.
2. After selection of measures and policies, the "Working group on GHG inventory and Mitigation measure" develops methods for calculating GHG reduction along with selection of emission factor and develop MRV process for activity data collection and reporting. Based on this, the working group develops the GHG emission reduction report for the selected mitigation measures, including a QA/QC process.
3. The working group then submit the result to the relevant ministry for their verification and approval. The Ministry shall form ministerial level working group to verify the report. The report is verified based on following: 1) Appropriate GHG emission reduction measures / policies, 2)

appropriate GHG reduction methodology, 3) MRV process and activity data and 4) GHG reduction by measures.

4. Based on the above-mentioned verification process, the relevant ministry can either approve the report or can propose modifications.
5. When the ministry approves the report, it is then sent to the Subcommittee on Climate Change Knowledge and Database. The Subcommittee on Climate Change Knowledge and Database verifies the report on GHG estimation methodology and amount of GHG emission reduction (under a QA process).
6. When the Subcommittee approve the report, it is presented to the NCCC to consider the greenhouse gas reduction results to be included in the NC and BUR.

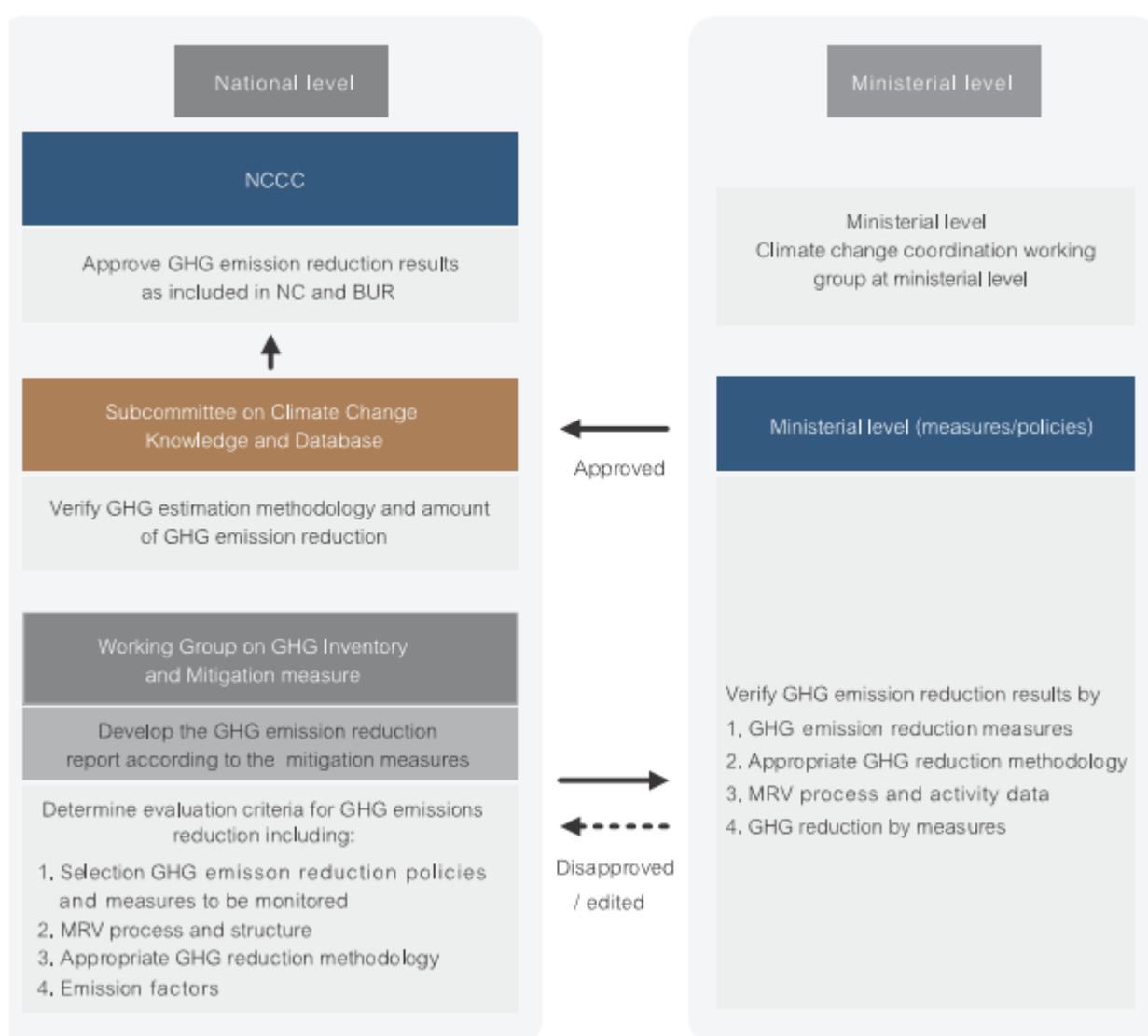


Figure 5: Structure of National MRV system for NAMAs (Thailand 2017)

The national MRV system can build upon the existing MRV system for domestic NAMAs and include more information. Therefore, the siting MRV system for domestic NAMAs are characterised as follows:

1. The boundary of this MRV is based on the boundary of the NAMAs included: (i) Development of renewable and alternative energy sources, (ii) Improvement of energy efficiency in power generation, industries, buildings, and transportation, (iii) Substitution of bio-fuels for fossil fuels in the transport sector; and (iv) Advancement of the transport infrastructure development plan for Thailand. Therefore, the MRV system for Actions does not yet collect more information of other measures.
2. The MRV only tracks mitigation action results of GHG emissions and energy generated / converted / saved (incl. biofuels). It does not track other benefits or outcomes, e.g. co-benefits or support needed and received. The support information can include also domestic sources for the implementation of the measures, needs for Capacity Building or used/ needed technologies.

4.4 QA/QC System under GHG Reporting

As previously indicated in Section 4.1, Thailand has established a basic QA/QC system within the process of developing the national GHG inventory. It is important to note that the current QA/QC system does not systematically address quality of information relating to mitigation and adaptation actions, or MOI. The current QA/QC system is process oriented, consisting of a system of assigned QA/QC roles, with each role taker defining their procedures and recording. Where information is being checked for quality in a bottom-up approach, which is depicted in Figure 4. Briefly the current QA/QC process includes the following steps (ONEP 2018a) :

1. Raw data is collected from the local government and the private sector, where it is assumed that data is gained following quality practices (e.g. metering follows quality standards, and data studies follow standard quality procedures);
2. Then ministry data owners, who are various Thai offices and departments in a sector, receive the data and should perform QC checks on the data;
3. Data is then compiled by lead agencies, and delivered to sectoral working groups who should perform a QA check;
4. ONEP compiles the data and performs GHG calculations based on IPCC methodologies, and performs a comparative QC check on the data used in the methodologies and GHG outcomes;
5. The Subcommittee on Climate Change Knowledge and Database then performs a QA on the draft reporting from ONEP.

As identified by ONEP (ONEP 2018a) and within the FGDs (TGCP 2018b), there is in practice a separate QA/QC process for the data collection and review for each sector in the GHG inventory. For example, a QC process for data collection is available for agriculture sector for the review of several forms of data by different government agencies (DOA for crops, Department of Livestock for livestock). There also exists a QA process for an annual review by a Joint Committee at OAE for sector level. QC at ONEP level is the comparison of data from year to year and in some cases between imports and exports. A series of surveys and field checks are also conducted for certain data at the activity level.

For energy sector, the QC process for the data collection under the electricity generation (on-grid electricity generation) sub-sector includes various organisations such as EGAT, DEDE, Energy Working Group (under the Ministry of Energy), EPPO and ONEP. The QC of the electricity generation data is

being carried out at three levels - EGAT, EPPO and ONEP, while Energy Working Group is responsible for overall QA of the data.

Within the waste sector QC of raw data is assumed at the activity level, where a QA review of complied data is performed by different government agencies (Pollution Control Department (PCD), Department of Local Administration etc.). Then another QA process at PCD and the Waste Working group before it is submitted to ONEP. ONEP then does a QC of GHG inventory data and results,

A more systemic oriented management of QA/QC can be implemented (e.g. where there are standardized ed procedures and forms for recording the QA/QC completed), as there is currently no clear guidance and standards in the QA/QC process and no related documentation specific to the process. In many cases this also includes the issues of data uncertainly, which should be a part of the QA/QC system. Within Thailand, this means that departments and office who are downstream in the QA/QC process are not aware the extent of actual QA/QC performed upstream.

4.5 Gaps between the Current National MRV System and Future Requirements

Under this review and analysis several national level gaps and capacity development needs have been observed between the existing national MRV system and the expected future requirements for MRV under the ETF, as well as the Thailand's desire to strengthen the existing GHG inventory system. In terms of the GHG inventory estimation and compilation gaps predominantly relate to the transition from the revised 1996 to 2006 IPCC guidelines, as well as from Tier 1 to 2 in some sectors, and the need for a systematic QA/QC management. With regards to the NDC GHG baseline, a greater level of transparency is needed as to both the development of the original BAU scenario and the future periodic determination of the BAU scenario over time. The MRV of mitigation and adaptation actions must be expanded the respective actions under the NDC and include the MRV other benefits or outcomes and MOI. There is need for a more transparent description of bottom-up information flows in most sectors, and at a minimum the need for a systematic QA/QC management system (at least of the GHG inventory and later the BAU scenario).

Information on the key gaps and capacity development needs identified in this review and analysis at the national level, along with recommended actions which can be taken, are highlighted in the table below:

No.	Gaps and Capacity Development Needs	Recommended Actions
Institutional Arrangement		
1	A more streamlined information flow is needed from the bottom level to ONEP. There is a lack of standardised data formats to collect activity data at the bottom level. This leaves risks for redundant effort, and diverse data sets can lead to greater uncertainty.	Strengthen information management plan from top to bottom with: 1) Clarified of roles for each party in each sector / sub-sector, 2) defined set of guidelines and information templates as per the requirements of the guidelines for NCs, BURs, and ETF, including MOI, co-benefits, QA/QC, etc. 3) address new additions / improvements for sub-sectors (new industry, F-gases,. etc.). These should first focus on GHG inventory (and TGEIS inputs), then on MOI and mitigation/adaptation. Note that these roles, guidelines, and templates will assist in cross verification of the data (under the QA/QC guideline).

MRV of GHG Inventory		
2	Gradual transition to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories in all sectors is expected due to implementation of TGEIS. Thus, there is need to enhance the professional capacities of national experts on 2006 IPCC involved in the inventory process.	Conduct technical training session for the technical staff and national experts to use the 2006 IPCC Guidelines, and TGEIS inputs, with focus on LULUCF and Agriculture/ AFOLU.
3	Currently data is being captured manually for sectors like energy, agriculture etc. through spreadsheets and documents. Consequently, there is potential for human error in data validation, verification and compilation.	An information technology (IT) based system that collect and assess the data and information can be developed to eliminate the human errors. Implementation of the TGEIS is expected to improve the data quality, and this can be strengthened by greater digitalization of data bottom-up.
4	There needs to be QA/QC management plan ensure the quality of data and transparency of processes for GHG inventory development and reporting on MOI and mitigation/adaptation.	To strengthen the overall QA/QC process through development of guidelines and standardised templates for QA/QC. Including capacity building sessions on the QA/QC guidelines and templates should be conducted.
MRV of Actions		
5	The existing national MRV system is GHG inventory centric and does not include provision for tracking the progress and impacts of actions under the NDC.	The national MRV system needs to be enhanced to include the reporting all requirements under the PA and MPGs. This includes, inter alia, a systematic method for tracking MOI and the progress and other outcomes of MRV of mitigation and M&E of adaptation actions. Also, additional requirements for more transparent reporting needs to be included into the regular reporting.
6	The current NDC baseline was developed as a one-time effort to conclude on the commitments in the NDC. The Thailand will need a robust NDC baseline methodology and tool for the future tracking of progress and institutionalise the data archiving for baseline development. (Noting that the NDC baseline and GHG inventory may not have similar boundaries)	A robust and fully transparent NDC baseline methodology and tool should be developed following the BAU approach, so that the Thailand can track progress towards NDC targets on at least a biennial basis. It is recommended that boundary shall fit the mitigation actions planned, to use as much data gained in the GHG inventory process, and to use an open tool or set of tools.
7	The scope of the MRV for mitigation actions is currently limited to the domestic NAMA roadmap, in the 2 nd BUR this tracks only GHG emissions, and energy generation / savings.	The development a robust MRV components for tracking all MRV of mitigation and M&E of adaption actions, including elements of no. 6 above, but also a clear set of methodologies which are developed on an action specific basis or on a sub-sector specific basis. This should include adequate

		capacity building and technical supports needed to be operationalise these elements into the national MRV system.
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Table 2: GHG and Mitigation Action Reporting – identified gaps and capacity development needs and recommended actions

5 Status of National MRV / M&E in the Different Sectors

At the sectoral level, this review and analyse focused on the four previously mention sectors defined in the boundary of the TGCP assignment to support MRV and M&E (e.g. energy, waste, agriculture, and water), and is depicted in Figure 6. In the context of GHG mitigation, the energy, waste, and agriculture sectors were reviewed under an MRV framework. While the water management sector, and to a smaller extend agriculture sector, were reviewed under a M&E framework for adaptation.

The desk review of current MRV in the applicable sectors focused on the three components of GHG Emissions, Actions, and Support, as well as on the M&E of Actions and Support in the applicable sectors for adaptation. The FGDs and training sessions for GHG baseline and QA/QC predominantly focused on information for GHG emissions only, in the context of gaining sector specific information from participants from the energy, waste, agriculture sectors. Where a single FGD allowed for gaining sector specific M&E information from participants from water management sector.

For the most part, Thailand has a hybrid top-down / bottom-up system for MRV and M&E of sectors. Currently, this consists of a top-down approach to gaining information required for reporting under NCs and BURs (e.g. national circumstances, GHG emissions, mitigation & adaptation actions, gaps, and support needs) as described in Chapter 3. For example, with regards to GHG emissions, ONEP defines in a top-down approach, the specific GHG information based on IPCC methodologies required from ministerial offices & departments in a sector. Whereupon, these key ministerial government offices & departments gain the information under a bottom-up approach from national and sub-national line offices & departments, and the private sector, who typically already report the results through existing practices to the key ministerial offices & departments. This MRV process incorporates the basic QA/QC system described in Section 4.4, at the different levels.

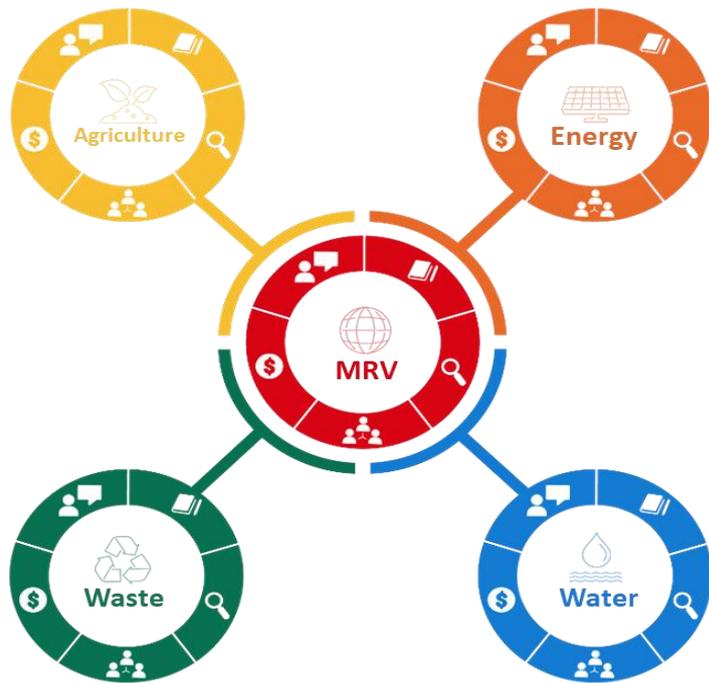


Figure 6: Sectors addressed for MRV under the Thai-German Climate Programme

5.1 MRV in Energy (Electricity and Large Energy Consumers Sub-Sector)

A robust energy sector MRV system for establishing greenhouse gas inventory in the electricity and other energy from large consumers (large buildings & industry) sub-sector exists in Thailand. Where the data is available at the bottom level, the quality of data and GHG Inventory is similar to leading developed countries. However, gaps have been observed in tracking mitigation actions, and the MOI within these sub-sectors. Where the GHG inventory process needs improvements in terms of QA/QC of data at the bottom (upstream) level for these different sub-sectors.

An adequate data collection and reporting mechanism exists for electricity generation sub-sector (fossil fuels and renewable energy). The primary data measured and reported under this sub-sector are: 1) Electricity generation from on-grid power plant (by Fuel type including electricity generation from Renewable Energy) 2) Electricity transmission from on-grid power plant 3) Electricity distribution and 4) Fuel consumption by the on-grid power plants (by fuel type). Although a real-time based data reporting process for each installation to authorities is still under development, the present recording and reporting process is being carried out using MS excel in most cases.

The current MRV data reporting framework and QA/QC process includes various organizations such as power plants, EGAT, ERC, Energy Working Group (under the Ministry of Energy), EPPO and ONEP. The Quality control (QC) of the electricity generation data is being carried out at three levels - EGAT, EPPO and ONEP while Energy Working Group is responsible for overall quality assurance (QA) of the data.

Under large energy consumers (for energy efficiency) sub-sector, current focus is on energy efficiency measures in large buildings and factories. The energy efficiency activities in buildings and factories in Thailand is within the purview of Energy Conservation and Promotion Act (ECP Act) and a few downstream regulations such as decree on designated buildings, decree on designates factories and Building Energy Code (BEC). Within the mandate of BEC, the estimated energy consumption of large buildings (exceeding 2,000 m²)⁵ at design stage is being reported based on the building design by the building owner to the Bureau of Energy Regulation and Conservation (BERC), under DEDE.⁶

The actual energy consumption (both electricity and fuel consumption) is being recorded and reported based on electricity and fuel bills. For large factories, the actual energy consumption data (both electricity and fuel consumption) is being reported as per national requirement under energy management regulation, which requires large factories to provide annual energy management reports audited by the Energy Management Auditors.⁷ The actual annual energy consumption data for both large buildings and factories are reported by the building/factory owner to the BERC through an E-Forum on an annual basis.⁸ This upstream data process means that data is available to determine energy savings, but the level of participation is unconfirmed under the review and analysis. For the energy efficiency sub-sector, the overall QA/QC process could not be determined fully under the review and analysis but has as its basis energy management audits (due to regulations). Information on the key gaps and capacity development needs identified in this review and analysis for these sub-sectors, along with recommended actions which can be taken, are highlighted in the table below.

⁵ The information can be accessed at the following weblink - <http://bec.dede.go.th/becdb/>

⁶ Guidelines for reporting of energy in large buildings are found in the E-Forum here <https://eform.dede.go.th/report/xmain.php>

⁷ Guidelines for energy auditing are found in the E-Forum here <https://eform.dede.go.th/report/documents/e-Audit.pdf>

⁸ Guidelines for reporting of energy in factories are found in the E-Forum here <https://eform.dede.go.th/report/documents/e-Factory.pdf>

No.	Gaps and Capacity Development Needs	Recommended Actions
Institutional Arrangement		
1	Off-grid electricity generation and thermal energy generation (heat energy) is currently not covered under the MRV system for inventory and the same will not be included in the real-time based reporting mechanism, which is under development. The extent (%) of this component in total energy was not identified in this review and analysis.	To develop a mechanism to capture off-grid electricity and thermal heat generation data. Recommended actions may include mandatory data reporting through amendment of existing regulation or under a new regulation on installed capacity, or survey information.
2	Delay in data reporting from on-grid power plants to EGAT is not clearly defined.	Align the reporting mechanism from plants to EGAT with the new developing real time mechanism to avoid delay in reporting. There is a need to understand further the cause of reporting delays. If the cause is related to capacity, it is recommended to conduct appropriate capacity building session for stakeholders on data reporting.
3	Though Very Small Power Producers (VSPPs) and Small Power Producers (SPPs) are either directly selling power to industrial customers or using it for captive consumption (selling the excess power to MEA and PEA at the rate based on feed in tariff system), data/information flow from VSPPs and SPPs to ONEP is very limited. There are no mandatory reporting obligations for VSPPs and SPPs to report on electricity generation.	Capture the energy generated through VSPPs and SPPs through a mandatory reporting mechanism.
4	Current regulations mandates energy use and energy efficiency activities for buildings and factories is applicable only for large installations. Medium and small facilities are not included in the system.	Development of a mechanism/regulation to capture medium and small facilities to get a holistic picture of the data.
MRV of GHG Inventory		
5	Quality control (QC) of the data at ONEP level is adequate, although the determination of uncertainty is limited. There is a need for further review the QC at the bottom level (i.e. Power plant, EGAT and ERC) as it includes uncertainty from meters and calorific values of the fuels.	There is a need to improve the overall QA/QC process through development of guidelines and standardised templates for QA/QC. Which should include components for determining uncertainty in energy data. Capacity building sessions on the QA/QC guidelines and templates should be conducted for parties participating in the different levels of QA/QC.
6	As current data reporting is excel based, human error in data recording likely.	An information technology (IT) based system that collects and assess the data and information can be developed to eliminate the human errors. Alignment of data reporting

		through real-time based mechanism is a possible solution. It is reported that such an IT system is in the process of development and implementation for fossil fuel power plants.
7	There may be a possibility that double counting occurs in connection with other sub-sectors, within energy. There is no process to address potential double counting.	Process of cross verification of the data (under the QA/QC guidelines) may be developed to address double counting issue.
8	There seems to be gaps between DEDE and ONEP data on energy savings.	There is need to improve the overall QA/QC process through development of guidelines and standardised templates for QA/QC. Capacity building sessions on the QA/QC guidelines and templates should be conducted for DEDE.

Table 3: Energy sector – identified gaps and capacity development needs and recommended actions

5.2 MRV in Waste

The current MRV system for the waste sector only focuses on the GHG inventory, and the key entities involved in this MRV process are the following (Please refer to Annex B: Summary of Focus Group Discussion – Waste for further details):

- Local government organizations (LGOs) at municipal level are the primary source of data collection related to waste and wastewater management. For Bangkok, the Bangkok Metropolitan Administration (BMA) has a key role in initial data collection, while for wastewater the Water Management Authority (WMA) as it is now under the Ministry for Interior⁹ is relevant. Beside the government agencies, private companies as operators of waste or wastewater treatment plants are requested to provide required data, however lack of regulatory obligations for data collection and reporting is observed resulting in incomplete data collection.
- Mid-level government agencies such as the Provincial Office for Local Administration (POLA), the Provincial Office for Natural Resources and Environment (PONRE), the Department of Local Administration (DLA), the Department of Environment Quality Promotion (DEQP), the Department of Industrial Works (DIW), the Department of Health (DOH), Regional Environment Office (REO) and the Industrial Estate Authority of Thailand (IEAT) handle data and information relevant for the waste sector.
- A special role is with the Pollution Control Department (PCD) acting as the central agency responsible for collecting waste data and information at the national/central level. PCD issues also the Thailand State of Pollution Report. However, since 2017, the overall responsibility for Municipal Solid Waste Management (MSWM) was transferred from MNRE to Ministry of

⁹ Royal Decree volume 135, section 38 Kor, announced on 22nd November 2018, - as attached (TH version)

Interior. DLA became key institution responsible for the implementation of MSWM. Hence, DLA has taken over responsibility for the Municipal Solid Waste (MSW) data management from PCD. Problem, DLA lacks capacity to manage data properly, as well as, no systematic coordination between DLA and PCD on QC/QA takes place resulting in data gaps and inaccuracy.

- Office of Natural Resources and Environmental Policy and Planning (ONEP) will use the available data to prepare the GHG inventory. Oversight is provided by a “working group for waste” and the Subcommittee on Climate Change Knowledge and Database and the National Committee on Climate Change Policy (NCCC).

Generally, it is observed that QA/QC procedures can be found in some of the entities involved but a comprehensive approach covering the entire waste sector is missing. However, TGEIS is expected to provide some functionality regarding QC at the national level. In addition, uncertainty assessment appears to be applied based on a top-down approach, which can lead to significant inaccuracy. It should be noted that ONEP has already taken the first step towards the application of IPCC 2006 guidelines in form of an MRV Manual Greenhouse Gas Inventory - waste sector and the development of the TGEIS.

This review and analyse determined that the MRV related to mitigation measures in this sector remains unclear. However, according to Thailand's NDC Roadmap 2030, the waste sector can contribute to the NDC target by up to 2.0 MtCO₂eq by implementation of mitigation measures such as 3R (Reduce, Reuse and Recycle) campaign, methane recovery from industrial wastewater treatment, improvement of municipal wastewater treatment, and clean technology promotion (Thailand 2018b).

The MRV related to MOI in this sector also remains unclear at this stage. However, TNC provides an overview of constraints, gaps, and support needed and received comprising technology transfer (e.g. related to Waste-to-Energy) and capacity building.

One very important outcome of the FGDs is that it is known by Thai authorities that the currently available data for solid waste and waste water in Thailand does not comprehensively cover the whole country and population, and this relates to boundary of both the GHG inventory and BAU scenario, and achieved mitigation, hence a high level of uncertainty due to bias.

Information on the key gaps and capacity development needs identified in this review and analysis for the waste sector, along with recommended actions which can be taken, are highlighted in the table below:

No.	Gaps and Capacity Development Needs	Recommended Actions
Institutional Arrangement		
1	<i>Solid waste</i> : Capacity building needed for LGOs was identified to enable better data collection	Develop and conduct a capacity building programme for strengthening data collection by LGOs
2	<i>Wastewater central treatment plants (WWTP)</i> : Missing data parameters at WWTPs: Effluent bodies, sludge disposed Missing demographic data: Number of populations connected to the dairy wastewater	New regulation needs to be developed to required reporting of additional information to be compliant with IPCC 2006 guidelines

3	<p><i>Wastewater central treatment plants:</i></p> <p>Streamlined information flow is needed, as there are different data collection forms (ONEP, PCD, WMA), and a possibility for double counting from different sources of information, and there needs to be QA/QC structure to ensure the data quality and transparency of processes.</p>	<p>A more detailed mapping of data / information flow is needed for Wastewater central treatment plants, to ensure the type of need and to prevent double counting.</p>
MRV for GHG Inventory		
4	<p><i>Solid waste:</i> GHG emission calculations using solid waste quantities generated, treated, and subject to disposal are not always based on direct measurements but based on estimations related to the registered number of populations, and do not considering migrant workers or tourists for example.</p>	<p>Engage in a transition to mandatory measurements (e.g. based on certain thresholds related to waste generation / treatment quantities). This may include measures related to enforcement combined with capacity building and support.</p> <p>Alternative, to determine / update solid waste generation data by demographic regions through studies.</p>
5	<p><i>Solid waste and Wastewater central treatment plants:</i> there is a lack of demographic information on the migrant and tourist population.</p>	<p>To determine the number of migrant workers or tourists within demographic regions via national statistics (immigration data), to improve accuracy.</p>
6	<p><i>Solid waste:</i> There is a larger share of solid waste not properly collected and treated. There is no information available on details of the related quantities and types of treatment.</p>	<p>Initiate a survey to get a better understanding of these unaccounted for solid waste quantities and types of treatment.</p>
7	<p><i>Solid waste:</i> Specific treatment options such as recycling and reuse are not monitored in detail but based on a generic calculation approach.</p>	<p>Elaborate measurement and data collection procedures and a related guideline for determining the extent of recycling and reuse of solid waste.</p>
8	<p><i>Solid waste:</i> Generally, very limited information on historical disposal at landfills or dump sites is available.</p>	<p>Engage into extrapolation of data where possible, based on information from point no.1,</p>
9	<p><i>Solid waste:</i> Limited data collection from solid waste treatment / disposal operated by private sector</p>	<p>Elaborate possibilities to make data reporting mandatory and engage in measures to enforce the same, as with point no. 1.</p>
10	<p><i>Solid waste:</i> Limited information on landfill or dump sites regarding their characteristic (depth of waste body, etc.)</p>	<p>Initiate a survey to collect required data which is currently missing.</p>
11	<p><i>Solid waste:</i> Waste composition data is currently only for the national level and is outdated, and but regional is needed and</p>	<p>Conduct waste composition analysis at the regional level to derive regional data and update national values</p>

	should be determined to reflect the current situation.	
12	<i>Wastewater on-site treatment (WWT)</i> : On-site WWT is relatively unaccounted for, though it is expected to make up the majority of disposed wastewater.	To define a methodology and data needs for the determination of quality, composition, and treatment in on-site WWT, preferably applied at the regional level.
13	<i>Solid waste treatment and waste incineration</i> : ONEP identified gaps and corresponding capacity development needs as part of adoption of a higher tier approach following IPCC 2006 guidelines (e.g. dry matter content of waste for the calculation of GHG emissions from waste incineration, which is based on default values under Tier1 and Tier 2a, country-specific data under Tier 2b and plant-/management-specific under Tier 3).	Generally, using a higher tier approach for the determination of GHG emissions from the waste sector can be expected to improve the quality of Thailand's GHG inventory. However, under a situation of limited resources to prepare the national GHG inventory, it is recommended to follow IPCC 2006 guidelines with regard to the analysis of key categories (see Volume 1 Chapter 4). As a result, Thailand should focus on a transition to a higher tier approach for the key categories identified as a priority. Followed by an optional adoption to a higher tier approach for non-key categories as per available resources. Based on the outcome of the key category analysis, Thailand can start elaboration of country parameters (e.g. through measurement campaigns/surveys) or include plant-/management-specific data collection under the MRV system.

Table 4: Waste sector – identified gaps and capacity development needs and recommended actions

5.3 MRV in Agriculture

Thailand's latest GHG Inventory from the 2nd BUR and TNC and the MRV Manual for the Agriculture published by ONEP in 2018 include comprehensive processes for determination of GHG emissions in the agriculture sector in line with IPCC 2006 guidelines. However, it is understood that the MRV Manual prepared by ONEP is meant for use by all relevant stakeholders in the country for all current and future purposes. Hence this report has referred to the manual to assess the coverage of GHG emission sources that the manual has identified for the agriculture sector. The table below provides a synopsis on the coverage as per the manual (ONEP 2017).

	Source of Emissions	Gases Covered
3A	Livestock	
3A1	Enteric fermentation	CH ₄
3A2	Manure management	CH ₄ , N ₂ O
3C	Aggregate Sources and Non-CO₂ Emission Sources on Land	

3C1b	Biomass Burning (Cropland)	CH ₄ , N ₂ O, CO, Oxides of Nitrogen
3C2	Liming	CO ₂
3C3	Urea Fertilization	CO ₂
3C4	Direct N ₂ O emissions from managed soils	N ₂ O
3C5	Indirect N ₂ O emissions from managed soils	N ₂ O
3C6	Indirect N ₂ O emissions from manure management	N ₂ O
3C7	Rice cultivation	CH ₄

Table 5: Sub-sectors and gases covered in agriculture inventory

For each of the sources of emissions listed in the above table, the MRV manual identifies i) the requirements of activity data and emission factors ii) frequency of data collection iii) protocols for data measurement, reporting and verification and iv) responsible agencies for data collection, reporting and verification. The manual also provides data record forms for the activity and emission factor data.

However, it was understood from the FGDs that none of the stakeholders i.e., OAE, RD, DLD, LDD, DOAE are currently using the MRV protocols and data record forms as prescribed in MRV manual. There are multiple templates and multiple organisations (OAE, RD, and DOAE) who are involved in the activity of data collection and collation. Sample surveys (OAE) as well as population survey (DOAE) of farmer households are being carried out simultaneously by both the organizations and the data are being collected manually in hand written forms from the farmers during the surveys before entering it into MS Excel or Word formats (TGCP 2018a). This may be happening owing to lack of awareness amongst the stakeholders on the use of MRV manual and partly due to lack of clarity on the collection procedure of the activity data that will feed into the data record forms in the MRV manual.

In terms of emission factors, Thailand is currently at an advanced stage of experimenting country specific emission factors for enteric fermentation (cattle and buffalo), manure management (CH₄: cattle, buffalo and swine) and rice cultivation. Supporting data for estimating Tier 2 emission factors are being acquired from the published data and expert judgment in the country and from the IPCC defaults. Tier 2 approach is being experimented for dairy cattle, beef cattle, and buffalo under sub-sectors enteric fermentation and the manure management system. The supporting data for estimating Tier 2 emission factors are animal and feed characteristics, daily volatile solids excreted, methane producing potentials of manure, fraction of manure handled in manure management system, etc. These data are obtained from literature reviews (more than 15 national journal articles and handbooks), expert judgment, and IPCC defaults.

Tier 2 approach is being tested for swine under subsector manure management. The supporting data for estimating Tier 2 emission factors are animal and feed characteristics, daily volatile solids excreted, methane producing potentials of manure, fraction of manure handled in manure management system, etc. These data are being obtained from literature reviews (more than 15 national journal articles and handbooks), expert judgment, and IPCC defaults.

With regard to data collection, reporting, and QA/QC with the GHG inventory process, the MRV Manual classifies the institutions into 3 groups:

- 1) Main agencies who are responsible for collection of Activity Data e.g., rice harvesting area, animal population, agricultural product quantities etc.
- 2) Supporting agencies who are responsible for acquisition of data that are supportive in nature e.g., emission factors.
- 3) Agriculture coordination centre at Office of Agriculture Economics who is responsible for collection of data from main and supporting agencies, validation and preparation of data in the

data recording forms, pre-calculation of data and submitting the data to ONEP for inserting the same into TGEIS.

Agency	Main	Supporting
Ministry of Agriculture and Cooperatives		
Agriculture Coordination Centre at Office of Agriculture Economics (OAE)	√	
Department of Livestock Development (DLD)	√	
Land Development Department (LDD)	√	
Rice Department (RD)		√
Department of Agriculture Extension (DOAE)		√
Ministry of Science and Technology		
Geo Informatics and Space Technology Development Agency		√

Table 6: MRV roles of agencies in agriculture

It is noted from the table that RD plays a supporting role for rice the sub-sector. The MRV manual also provides a responsibility flow chart for activity data reporting under the category, 3C7 i.e, Rice Cultivation, which is presented in the figure below. It may be noted from the figure that there are overlaps amongst OAE, RD and DOAE in terms of data collection and reporting under 3C7.

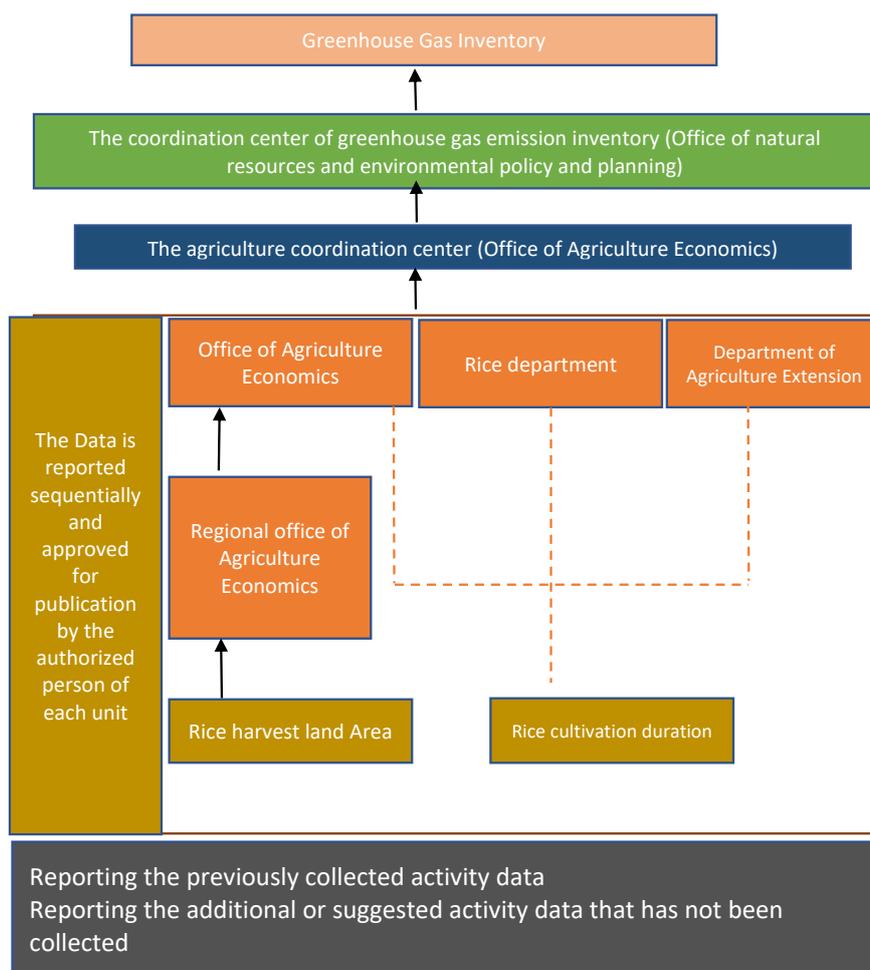


Figure 7: Flow chart of 3C7 activity data report: Rice cultivation

The TNC of Thailand lists down 8 mitigation strategies for the agriculture sector based on national and sectoral climate change action plans and other planning documents such as 20-Year Agriculture and Cooperatives Strategy (2017-2036) and the 12th National Economic and Social Development Plan 2017-2021 (NESDP). The strategies are on 1) improving animal breeding for higher productivity 2) promoting biogas production from animal waste 3) alternative wetting and drying in paddy of rice fields 4) improving production efficiency by rice variety and agricultural zoning/agri-map 5) improving fertilizer application according to Good Agricultural Practices and site-specific nutrient management 6) avoiding burning of crop residues in the field 7) promoting utilization of crop residue for alternative energy purposes and 8) enhancing carbon sequestration in tree and soil.

So far there is no tracking of the mitigation actions and the emission reductions from these actions in the agriculture sub-sectors other than rice. In addition, mitigation actions in the agriculture sector also do not form a part of the country's NDC as yet although the actions have significant emission reduction potential¹⁰.

¹⁰ Currently, on pilot project-based level Thailand develops with international support a data collection system for rice cultivation that will contribute to a national MRV system for reporting to UNFCCC. The pilot project is being developed under the GIZ TGCP-Agri and Thai Rice NAMA. International Rice Research Institute (IRRI), the

Thailand has developed the National Adaptation Plan (NAP) to provide a strategic implementation plan at the national and local levels in 6 prioritized areas which includes agriculture and food security. It is understood that the NAP will include a framework for M&E for adaptation actions in the agriculture sector¹¹.

No.	Gaps and Capacity Development Needs	Recommended Actions	Recommended entity for implementation
1. Observations on the MRV Manual for Agriculture			
1 a.	<p>Roles and responsibilities:</p> <p>In the existing version of the MRV manual Rice Department has a supporting role even for the rice sub-sector. As per the manual RD is responsible for researching and proposing policies and technologies for development of the rice sector. OAE is the main agency and is responsible for collection of activity data.</p> <p>Against activity data for 3C7 (Rice Cultivation), all agencies (OAE, RD, DOAE) are listed without any segregation of responsibility on who will do what and when</p> <p>However, there is a discrepancy in the roles being performed by RD vis-à-vis the ones prescribed in the MRV manual. Presently RD collects all relevant activity data and develops measurement and calculation methods for development of Tier 2 emission factors.</p>	<p>Rice being a very important sub-sector in terms of GHG emission mitigation potential, and considering the fact that there has been substantial effort in this sector in terms of implementation of mitigation actions, the needs segregation of roles and responsibilities for the rice sub-sector.</p> <p>MRV manual may be further strengthened to assign Rice Department as the main agency for collection, validation and preparation of activity data and development of Tier 2 emission factors. This is also in line with what RD does.</p> <p>Similarly, DOAE may do the same for other cash crops and LDD for livestock related data.</p> <p>All these data (for rice, other cash crops and livestock) may be compiled and verified bi-annually by OAE and annually</p>	<p>Within Thailand's agricultures sectors, the lead agencies may develop recommendation for the implementation of the MRV handbook align with the mandates of OAE, RD and DOAE. This may also strengthen the roles and responsibilities of each agency.</p> <p>Experts can assist in the process of revision.</p>

co-implementing agency (along with the Rice Department) of the Rice NAMA is tasked with the responsibility of development of the data collection system, including guidance on the field measurement of GHG emissions (N₂O, CH₄, CO₂). The MRV system is designed for the mitigation action on rice cultivation which aims at introducing low-emission rice farming in irrigated rice in 6 provinces (100,000 farm households) of the Central Plains of the country. The MRV developed includes 4 steps which are 1) Recording GHG emission rates (field and lab measurements), 2) Determining Emission Factors (seasons/spatial units), 3) collecting Activity Data (area, crop management), and 4) Entering Emission Factors and Activity Data into GHG Calculator. A new GHG Calculator called SECTOR (Source-selective and Emission-adjusted GHG CalculaTOR for Cropland) was also developed for the Thai Rice NAMA Project. (IRRI 2018)

¹¹ Other than NAP, Thailand Development Research Institute (TDRI) published a report on Stocktaking Climate Change Adaptation activities for the Agriculture Sectors in Thailand in 2017 that lists out 17 thematic projects in climate change adaptation and provides a draft action plan for implementation of the thematic projects. However, the report does not contain any information on input, output and outcome parameters and progress indicators for the identified thematic projects that could serve as the basis for an M&E framework. (TDRI 2017)

No.	Gaps and Capacity Development Needs	Recommended Actions	Recommended entity for implementation
		by ONEP before inputting the data to TGEIS.	
1 b.	<p>Data Adequacy:</p> <p>The MRV manual mostly replicates the Tier 1 methodologies from the IPCC 2006 Guidelines. For some categories like enteric fermentation and manure management, Tier 2 methodology is discussed. However, no country specific guidance is provided in the manual on how tier 2 methodology will be applied. The manual also does not specify the choice of estimation method (Tier 1 or Tier 2) and the rationale behind the choice for different categories given the country context.</p>	<p>The MRV manual may be further strengthened to include a discussion on the choice of estimation method (Tier 1 or Tier 2) and the rationale behind it.</p> <p>Decision trees provided in the IPCC 2006 Guidelines may be used along with key category analysis to decide on the choice of the method.</p>	<p>Within Thailand's agricultures sectors, the lead agencies may develop recommendation for the implementation of the MRV handbook align with the mandates of OAE, RD and DOAE. This may include guidance on the choice of estimation method (Tier 1 or Tier 2) and the rationale behind it in close consultation with ONEP as coordination agencies for Thailand's GHG Inventory.</p> <p>Experts can assist in the process of revision.</p>
1 c.	<p>Data record formats:</p> <p>The MRV manual prescribes data record forms for all activity data under the emission categories of 3A and 3C. These forms are helpful for compilation of the activity data once they are collected. However, the manual does not include any guidance or template for data collection. Consequently, there is a need to distinguish between data collection and data record and address both the aspects adequately in the manual. It was understood during the FGD discussions that different stakeholders (OAE, RD, and DOAE) are using different data</p>	<p>The data record forms in the MRV manual may be further reviewed and strengthened in the light of IPCC 2006 and ETF of Paris Agreement. A brief guidance note on collection procedure (who will collect what data when and how) for each activity data under 3A and 3C may be included in the manual.</p> <p>Further, capacity building sessions for the stakeholders OAE, RD, LDD, DLD and DOAE on "who will use what forms, how and when" may be rolled out systematically over the next 1 – 1.5 years.</p>	<p>In close consultation with ONEP and entities in charge for data collection, experts can assist in developing the training programme, manuals, and presentation.</p> <p>Experts will assist in strengthening the data formats of the MRV manual for the transition from 1996 IPCC guidelines to 2006 IPCC guidelines and ETF of Paris Agreement.</p>

No.	Gaps and Capacity Development Needs	Recommended Actions	Recommended entity for implementation
	collection forms to collect the same set of data. This leads to duplication of efforts and data redundancy.		
1cd.	QA / QC The Manual provides an example of QA/QC checklist.	Detailed QA/QC guidelines and checklists may be developed and included in the MRV Manual and capacity building on the use of guidelines and templates may be undertaken.	In close consultation with ONEP and entities in charge for data collection, experts can assist in developing of the QA/QC guidelines and checklist.
3. <u>Other observations</u>			
2 a.	<i>MRV of mitigation actions</i> - In the existing MRV of mitigation actions, the focus is more on rice cultivation and significantly less on other cash crops and livestock.	Collation of information on existing and planned mitigation actions in other cash crops and livestock. Development of basic MRV for mitigation actions for sub-sectors other than rice. If no mitigation action is undertaken in any of the sub-sectors other than rice, then there may be a separate study commissioned for identification of mitigation actions.	DOAE may undertake collation of information on mitigation actions for other cash crops. Collation of information on mitigation actions for livestock maybe undertaken by DLD. OAE may undertake the development of basic MRV of mitigation actions for sub-sectors other than rice by OAE. In close consultation with ONEP and depending on the own resources, the lead agencies may develop the appropriate emission factors for the sub-sectors. Experts may review the collation of information on mitigation actions and suggest an overall MRV framework.

No.	Gaps and Capacity Development Needs	Recommended Actions	Recommended entity for implementation
2 b.	<p><i>Baseline scenarios:</i> Currently, the agriculture sector does not have a fully developed specific baseline of emissions (beyond the general GHG inventory).</p>	<p>The existing MRV is based on the GHG inventory and it does not determine the baseline scenarios for specific mitigation actions. Baseline scenarios may be developed for agricultural sub-sectors that contribute materially to the country's GHG emissions inventory</p> <p>Since the rice sub-sector contributes significantly to the country's emission reductions, it is of utmost importance to develop the baseline scenarios for rice sector against each of the mitigation action in the 6-targeted provinces.</p>	<p>OAE may undertake development and revision of the baseline</p> <p>TGO in close consultation with ONEP may be undertaken by verification of baseline</p> <p>Experts may review the baseline scenarios and suggest strengthening of the baseline in the light of ETF requirements under the Paris Agreement.</p>
2 c.	<p><i>Tier 2 emission factor:</i> Application of Tier 2 emission factors is limited to a few sub-sectors. Even within rice sub-sector where the laboratory infrastructure is available with the rice department application of country specific emission factor is being done on an experimental basis and not at larger scale.</p>	<p>Development of the mechanisms, and funding, for determining additional Tier 2 emission factors in the sub-sectors, other than rice sub-sector.</p>	<p>OAE may have the responsibility of development of infrastructure.</p> <p>RD may undertake the responsibility of application of Tier 2 methods for Rice.</p> <p>DOAE may undertake the responsibility of application of Tier 2 methods for other cash crops.</p> <p>DLD may undertake the responsibility application of Tier 2 methods for livestock.</p> <p>Experts may assist in choice of emission factors (Tier 1 or Tier 2) for the emission categories (3 A, 3C) sub-sectors identified under the MRV manual.</p>

No.	Gaps and Capacity Development Needs	Recommended Actions	Recommended entity for implementation
2 d.	<p><i>Adaptation data:</i> Though the country's NDC has a component for adaptation in agriculture and there have been efforts to list out the thematic adaptation projects but currently there is very limited information available on adaptation centric data such as:</p> <ul style="list-style-type: none"> - types and number of agro-ecological zones, climate change risks (hazard, exposure, vulnerability), climate variables (annual rainfall, temperature cavitation) of different river basins. - Input, output and outcome parameters for the thematic projects and the progress indicators. - Project level M&E for the 17 thematic projects identified in the TDRI stocktaking report 	<p>An overall M&E framework for adaptation actions in the agriculture sector may be developed indicating the generic input, output and outcome parameters based on good practices and international experiences.</p> <p>A case study may be developed for 1-2 selected thematic projects in consultation with ONEP to show how the M&E framework will be applied to develop project specific M&E systems.</p> <p>In addition, an IT based database may be developed to capture climate change risk data for the existing agro-ecological zones of the country. The database may also contain the details of coping mechanisms/ adaptation activities already undertaken by different farmer groups in the country. The database may serve as a basis for decision making on identification of adaptation measures in different agro-ecological zones of the country and develop M&E actions.</p>	<p>OAE may have the responsibility of development and maintenance of the database.</p> <p>Based on the National Adaptation Plan (NAP), the lead agencies in the agriculture sectors may decide on the appropriate measures, M&E for the measures as well as the data collection and storage.</p> <p>Experts may assist in design of the overall M&E framework for adaptation actions in the agriculture and the case study that OAE or RD may replicate in future for project specific requirements.</p>
2 e.	<p><i>Data entry and analysis:</i> At the bottom level currently, data are being captured manually through answers from questionnaires provided to farmers. There are hand-written notes, which are then compiled in MS Excel or Word. Consequently, there is potential for human error in data validation, verification and compilation.</p>	<p>Once standardised data templates are in place (as discussed in point 1), an IT based system may be developed based on those templates that will have a bottom up architecture so that DOAE / RD can enter data into the system at the local level and the same may be validated against standard values/ outliers by OAE and ONEP at regional and national level. This will also reduce the</p>	<p>RD may undertake data entry for Rice.</p> <p>DOAE may undertake data entry for other crops.</p> <p>OAE may undertake data validation.</p> <p>ONEP supports the process with standardised Quality Control templates for the data entry in line with the national GHG</p>

No.	Gaps and Capacity Development Needs	Recommended Actions	Recommended entity for implementation
		existing over-dependency on TGEIS.	Inventory IT system TGEIS..

Table 7: Agriculture sector – identified gaps and capacity development needs and recommended actions

5.4 M&E in Water Sector

Adaptation is in comparison to mitigation depending on national circumstances, and therefore highly country-driven. Thailand revises the country's first National Adaptation Plan, which identified priority areas including water management. For mitigation, countries can conduct the data collection based on e.g. 2006 IPCC guidelines and carry out a comprehensive MRV system. For Monitoring and Evaluation (M&E) of adaptation actions, guidance for reporting on adaptation by the UNFCCC negotiations exists and gives countries flexibility to adapt the guidance to the national circumstances and in the light of their capacities. Adaptation is also part of Thailand's NDC, and therefore a tailor-made M&E system for adaptation is needed as well as building capacities for regular reporting to the UNFCCC.

In terms of setting up a comprehensive M&E framework for adaptation actions, Article 7 of the Paris Agreement plays a very significant role by providing the initial set of guidelines on what the countries should report on adaptation actions. Given the level of preparedness of the countries and the constraints related to the availability of financial resources, these requirements are recommended and not mandated. Paragraph 10 of Article 7 expects the countries to include national priorities, plans, actions, implementation status and support needs as a part of their adaptation communications and paragraph 11 states that the adaptation communications be made in alignment with the country's NAP and NDC. (UNFCCC 2015) The expectation is to have a national M&E framework that will form a part of the overall progress and policy goals of the country and not a stand-alone activity.

The modalities, procedures and guidelines (MPGs) of the Enhanced Transparency Framework (ETF, adopted at COP 24, Katowice, Poland) provides guidance on reporting and reviewing progress towards their climate mitigation and adaptation targets (NDCs). The following guidelines serve as the basis for a country-level adaptation M&E framework. (UNFCCC 2018b)

Elements for adaptation M&E from the Paris Rulebook (guidelines)	How to address the requirements in the M&E framework
National circumstances, institutional arrangements and legal frameworks	Give a clear understanding of the national context and priorities and alignment of the adaptation actions accordingly
Impacts, risks and vulnerabilities, as appropriate	Carry out comprehensive climate change risk and vulnerability assessments and developing adaptation actions aligned with the climate change risks and impacts identified
National adaptation priorities, strategies, policies, plans, goals and action	Streamline of the M&E with national policies, plans and actions

Implementation and support needs	Identify, justify and quantify the technical assistance, financial assistance needed for the adaptation actions
Implementation of adaptation actions and plans, including: <ul style="list-style-type: none"> • Progress and results achieved • Adaptation efforts • Cooperation on enhancing adaptation at the national, regional and international level • Barriers, challenges and gaps related to the implementation of adaptation • Good practices, lessons learned and information-sharing 	<p>The M&E is expected to be based on a robust set of indicators that would help in clearly quantifying the progress of the adaptation actions, the efforts required to achieve the results.</p> <p>This also requires development of a collaborative institutional framework to streamline the efforts made in the regional, sectoral and national level.</p>
Adaptation actions and/or economic diversification plans, including those that result in mitigation co-benefits	List out all adaptation actions with its co-benefits at the outset will be key to formation of a comprehensive and effective M&E
Information on how adaptation actions contribute to other international frameworks and/or conventions; gender-responsive adaptation action, indigenous people	While developing the progress indicators for the M&E of the adaptation actions, there needs alignment with other significant international conventions e.g., Sustainable Development Goals

Table 8: Guidelines for adaptation M&E from the Paris Rulebook and implications for Thailand

The Adaptation Committee of the UNFCCC also develops more guidance for countries to communicate their adaptation actions and impact through reliable M&E system:

- Use of data analytics (e.g. big data) to resolve issues around lack of sufficient, or sufficiently high quality, data to build a reliable M&E system.
- Communication of M&E results in a comprehensible manner to different stakeholders (Government, businesses) so that adequate responses may be prepared to combat the impacts of climate change.
- Measuring adaptation progress in vulnerable groups, communities and ecosystems with some specific case studies.

The Adaptation Committee will be continuing its work in the future and support countries in their reporting on adaptation.

Keeping in mind the international requirements, the first step towards developing an M&E framework for climate change adaptation actions in the water sector in Thailand is to identify the policies, actions and sub-activities in the sector and thereafter listing out the data parameters for each sub-activity that will be monitored, evaluated and reported. There are three main policies under the Climate Change Master Plan 2015-2050 around 1) Integrated Water Resources Management, 2) flood and drought mitigation and adaptation and 3) flood and drought risk management, which may serve as the basis of designing an M&E system for adaptation actions in the water sector¹².

Thailand has also formulated a Strategic Plan for Natural Water Resources Management (2015-2026) and the updated 20-Year Water Resources Master Plan (2018-2037) setting forth 6 key strategies for

¹² Please refer to Annex H for detailed narration on constituent policy goals and its sub-activities.

the water sector that include water management for domestic use, building water security for production sector (agriculture and industry), flood management, water quality management, upstream forest rehabilitation and soil erosion prevention and administrative management. This will also be a key policy based on which the M&E framework will be built.

Most importantly, Thailand is currently developing the NAP that provides a strategic implementation plan for climate change adaptation at the national and local levels and that includes water management as one of its prioritized areas. The NAP will include two water-related goals that could provide an entry point for an M&E system for adaptation actions in the water sector. The goals are:

- 1) To increase water sector security (Water Security Index), and
- 2) To reduce costs of loss and damage from water-related disasters.

Related to the goals, the NAP also includes respective work plans that ideally would play a very critical role in designing an M&E for adaptation actions in the country with a focus on the water sector. The work plans are summarized and explained below: (ONEP 2018b)

<i>Workplan 1.1: The integrated and balanced water management in river basin systems</i>	<i>Workplan 1.2: The creation of readiness for tackling and reducing damages caused by droughts and floods</i>
<ul style="list-style-type: none"> • Formulate/improve database system regarding the amount of water supply and water demand in all sectors • Assess/foresee the climate change impacts on water quantity and the possibility of changes in water flow and the distribution of water sources • Promote/support the participatory process in determining water management plans and policies with climate change considered • Manage 22 main river basins¹³ systematically; the main river basins linking to Chao Phraya River are considered the first priority. 	<ul style="list-style-type: none"> • Restore catchment forest areas to help slow down water flow and increase water absorption • Provide additional water supply and develop water diversion projects as well as water grid • Formulate master plan on water resources infrastructure to promote conjunctive use

It is to be noted here that Workplan 1.1. focuses on systematic assessment of climate change impacts for all river basins. Ideally, an adaptation M&E should contain all climate change risks and impacts (that the adaptation action addresses) as input parameters. This workplan, once in place, will generate the input parameters (i.e., list of all climate change risks and impacts) for each project level M&E, and also feed into the national M&E. Whereas, the database (which is to be further strengthened) as a part of workplan 1.1. may be utilized to archive and report all parameters required to build the M&E at the national level. It may also be useful to utilize the database to archive M&E data from the project level.

It is understood from above that the Workplan 1.2. has its focus on the actual adaptation actions. It is to be kept in mind that the basis for all output and outcome indicators of an M&E will be these adaptation

¹³ A study by ONWR introduces a revision of 25 river basins to 22 river basins according to its geography, geopolitics, hydrology, demography and culture.

actions. However, all sub-actions need to be spelt out properly either in the NAP document or they need to be linked to the sub-actions already listed in the Climate Change Master Plan¹⁴.

It is worthwhile to state here that an M&E framework is data intensive and data driven. Based on the FGD discussions carried out in November 2018, we understand that there is no existing data to build on when it comes to adaptation actions in the water sector. While Thailand comprehensively tracks data on water resources management, the data is not aligned with the climate change drivers (e.g., climate change risks and impacts, benefits and co-benefits of adaptation actions) and they are available in scattered manner without concrete linkages to adaptation actions and sub-activities. Consequently, there is a need for aligning the existing data with the climate change indicators to be defined as a part of an M&E framework.

In terms of the institutional framework, since 2017, the Office of the National Water Resources (ONWR) under the Prime Minister's office is constituted as the lead agency for the Thai water sector with the mandate to formulate policies, master plans, and measures in water resources management and coordinate the implementation as well as to prepare proposals and plans on integrated national water resources management to the National Water Resources Committee (NWRC). Most importantly with regards to M&E, ONWR also is the responsible agency to monitor and evaluate outcomes of water resources management in Thailand.

Beyond ONWR, a wide range of departments and agencies under the Ministry of Natural Resource and Environment, Ministry of Agriculture and Cooperatives, Ministry of Science and Technology, Ministry of Interior, Ministry of Digital Economy and Society, Ministry of Industry, Ministry of Energy, Ministry of Foreign Affairs, and Ministry of Defence are performing different water-related functions, including monitoring, data gathering and analysis (Thailand 2015b). Due to its leading regulatory role and its mandate for the establishment of a water resources management database ONWR may be the nodal agency for activities such as M&E framework design, data verification, and reporting. The roles of the other actors at the national (e.g. HII, GISTDA) and sub-national level (e.g. River Basin Committees, RBCs) need to be discussed at length with ONWR and other stakeholders and a M&E specific institutional mechanism that links river basin planning and implementation of adaptation measures at the river basin level (under the responsibility of the respective RBCs) to the national level needs to be developed.

The organigram shown below (Fig. 9) depicts the support structure of different institutions towards the implementation of different mandates of ONWR¹⁵.

¹⁴ Refer to Annex H for details on the sub-actions.

¹⁵ Support to integrate adaptation M&E into the process of the development of River Basin Master Plans and how to link this to national level adaptation will be provided to Thai water-related agencies by TGCP-Water with its Supporting Framework for Subnational Implementation as presented and agreed at the Working Group 2 meeting on 14 February 2019.

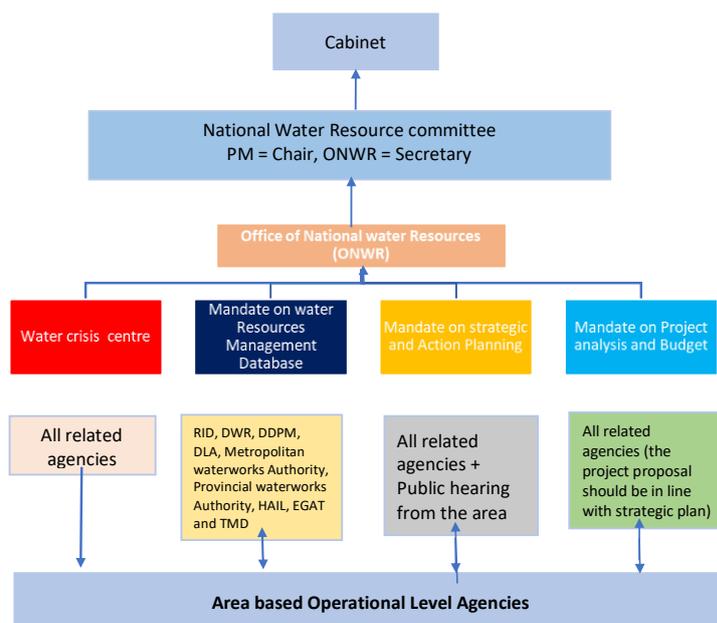


Figure 8: Institutional Structure for Thailand's Water Management (Thailand n.d.)

It is to be noted here that this organigram is meant for water management and not for M&E activities. Depending on project level/sectoral level/national level indicators to be decided for M&E, the institutions to be involved for M&E might be very different from this structure.

The way forward:

No.	Gaps and Capacity Development Needs	Recommended Actions
1	Develop a comprehensive M&E framework for the water sector	<p>The country currently does not have an M&E framework for adaptation actions in the water sector. The steps to develop a robust M&E framework as integral part of the countries' overall water monitoring and data management processes linking national and subnational (river basin) level would be as follows:</p> <ol style="list-style-type: none"> i. Carry out climate change risks and impact assessments at river basin level ii. List out policies, goals, actions, sub-actions/projects to address the climate change risks iii. List out input, output, outcome indicators for each adaptation action /sub-actions iv. Identify the measurement/data collection, collation, recording methods for each parameter v. Identify institutions responsible for the measurement/data collection, collation, recording vi. Identify institutions for sectoral/national level collation, verification vii. Identify institutions for sectoral /national level reporting

No.	Gaps and Capacity Development Needs	Recommended Actions
		<p>Out of these tasks only for point no. 2 there are some existing activities in the country. For the rest of the steps, ONWR may be the responsible agency and under the cooperation with TGCP-Water guidance based on international good practices on how an M&E framework should look like, what would be the indicators to be monitored and who will do what and when may be provided.</p>
2	<p>Establish linkages amongst policies, actions and sub – activities</p>	<p>The country has comprehensive policies around climate change actions in the water sector in three forms, the Climate Change Master Plan 2015 – 2050, the 20-Year Water Resources Master Plan (2018-2037) and the National Adaptation Plan. However, the immediate requirement is to link the actions and sub-activities identified under the first two policies with the work plans prepared under the NAP. Streamlining of policies with actions and sub-activities in the NAP document will serve as the basis for developing an M&E for adaptation actions in the country. This will ensure that the M&E thus developed is a not standalone activity but is deeply interlinked with the country's overall policy goals.</p>
3	<p>Systemic identification of data requirements for each input, output, outcome indicators under the M&E and updating the existing database</p>	<p>As acknowledged above, there is no lack of water management related data in Thailand, data is available in different forms with different institutions. Consequently, it is important to make use of the available data in the M&E framework to be built. However, it is also noted that the data in the current scenario is not streamlined with climate change indicators. Hence, once the actions and sub-actions are aligned in NAP, there requires systemic identification of input, output, and outcome indicators for each adaptation activity. Once the indicators are identified, available data needs to be aligned with the indicators and it is to be seen if additional data needs to be generated (i.e. collected or measured or calculated).</p> <p>The database/data warehouse referred to in the NAP (work plan 1.1) needs strengthening in terms of alignment of the existing data with climate change indicators and also adding further data relevant to climate change adaptation M&E.</p>

4	Institutional arrangements specific to M&E	<p>Once all the actions, sub-activities related to adaptation are listed and indicators identified, the task will be to identify the relevant institutions for each of the following:</p> <table border="1" data-bbox="568 405 1385 808"> <thead> <tr> <th data-bbox="568 405 679 703">Action</th> <th data-bbox="679 405 823 703">Indicator</th> <th data-bbox="823 405 983 703">How to collect data for the indicator?</th> <th data-bbox="983 405 1118 703">Who will collect the data on ground?</th> <th data-bbox="1118 405 1254 703">Who will collate and validate at regional level?</th> <th data-bbox="1254 405 1385 703">Who will review and report at national level?</th> </tr> </thead> <tbody> <tr> <td data-bbox="568 703 679 757"></td> <td data-bbox="679 703 823 757"></td> <td data-bbox="823 703 983 757"></td> <td data-bbox="983 703 1118 757"></td> <td data-bbox="1118 703 1254 757"></td> <td data-bbox="1254 703 1385 757"></td> </tr> <tr> <td data-bbox="568 757 679 808"></td> <td data-bbox="679 757 823 808"></td> <td data-bbox="823 757 983 808"></td> <td data-bbox="983 757 1118 808"></td> <td data-bbox="1118 757 1254 808"></td> <td data-bbox="1254 757 1385 808"></td> </tr> </tbody> </table> <p>In addition, at an overall level, there is a need to identify the responsible institutions for policy making, policy decisions, technology support and financial support.</p>	Action	Indicator	How to collect data for the indicator?	Who will collect the data on ground?	Who will collate and validate at regional level?	Who will review and report at national level?												
Action	Indicator	How to collect data for the indicator?	Who will collect the data on ground?	Who will collate and validate at regional level?	Who will review and report at national level?															

Table 9: Water sector – identified gaps, capacity development needs and recommended actions

6 Recommended Pathway for Strengthening the MRV System

This review and analysis report highlights the current status of the MRV system and M&E system for water management in Thailand, in both the national context and the context of several sectors, with a focus on interlinking items such as GHG inventory, NDC baseline, QA/QC, mitigation & adaptation actions, and MOI. The current MRV system in Thailand is predominately based around the GHG inventory and the reporting requirements for NCs and BURs and takes advantage of strong data availability in some sectors and robust organizational support from government departments and offices at the national and sub-national levels. Where evidence of strengths within the current MRV system is emphasized through several commendations in the technical analysis of the 2nd BURs by the UNFCCC reviewers (UNFCCC 2018a).

The purpose of this review and analysis is to continue the process of ensuring that Thailand has an appropriate MRV system to report to the UNFCCC in the future. Thus, focusing on the need to enhance the current MRV system to comply with future UNFCCC reporting requirements under the ETF under the PA. The previous chapters of this review and analysis report highlight several identified gaps and capacity building needs in key areas of the MRV system and offers some general recommended actions for filling the gaps and needs. Since the MRV system is comprehensive, the following pathway consolidates the most vital of these recommendations and is not an exhaustive list, but is meant to offer some strategic direction in a temporal approach of what to strengthen and when.

Short-term (2019)

- To continue the good work in the development and implementation of TGEIS, and the integration of the 2006 IPCC guidelines and Tier 2 approach in sectors where currently possible.
- To prepare a QA/QC management plan for information required for the GHG inventory, to include guidance, procedures, and templates to transparently document the quality processes and uncertainties to be used by ONEP and sector ministries in the development of the GHG inventory (and potential use for the NDC baseline).
- To map out, and transparently report, activity factors and emissions factors used in the methodologies for determining GHG emissions in the energy, waste, and agriculture sectors, and to highlight which factors can be updated and / or strengthened by development of national or regional values.¹⁶
- To prepare a knowledge product for the use of Thailand to disseminate information on the MPGs of the ETF, and related future needs to reach a more transparent MRV under the PA (incl. tracking progress and MOI).
- To map out and identify additional elements to enhance the transparency of Thailand's existing MRV system, reflective of the ETF under the PA and other UNFCCC requirements, and to develop a roadmap in close consultation with the sectors for the implementation of the enhancements.

Medium-term (2020 - 2021)

¹⁶ Activity factors and emissions factors, and those fixed factors which are used to determine GHG emissions, often by multiplying the factors by measured activity data.

- To prepare a common stocktaking and intra-government reporting mechanism for the tracking of MOI based on the MPGs and reporting requirements under the ETF.
- To prepare a common stocktaking and intra-government reporting mechanism for the tracking of mitigation actions and their impacts (including and beyond reduced GHG emissions) based on the MPGs and reporting requirements for progress in meeting the national NDC targets. This can start with a listing of current active and planned mitigation actions in the energy, waste, and agriculture sectors in the short, medium and long term along with the GHG emission reduction potential of each measure, capacity building needs and support required for their implementation.
- To set-up a continual improvement system for tracking progress and planning to fulfil the reporting obligations, based on the feedback from the ICA by the UNFCCC. Including the documentation of methodology changes and improvements for the GHG Inventory, mitigation and adaptation actions, NDC implementation and progress, and MOI.
- To perform a stocktaking of current and planned adaptation actions in the agriculture and water management sectors under the NAP and updated NDC, and to prepare an M&E methodology for determining the qualitative and quantitation impacts of these adaptation actions.
- To develop a robust mechanism (process, methodology, and tools) for the periodic review of the NDC baseline in the context of the business-as-usual scenario.
- To prepare a review and analysis of the boundaries of the NDC baseline, mitigation and adaptation actions, and GHG inventory, to ensure boundary alignment within applicable sectors, the use of common data, MRV of progress, and the MOI.

Longer-term (2022 - 2024)

- Strengthen the use of, and build capacities for, standardised data formats and interoperable & integrated data management to collect activity data within and from sectors, including bottom-up approach if appropriate, to prevent the duplication of data gathering and to allow for direct data inputs rather than the current system of inputs and transfer from spreadsheets and documents.
- To expand the current boundary, and limit double counting (cross-boundary), of activity data gathering for GHG emissions and mitigation actions (e.g. small producers in the energy sector, reuse / recycle and on-site treatment in waste, other cash crops in agriculture, etc.).

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Annex A: Summary of Focus Group Discussion - Energy

The purpose of the Focus Group Discussion (FGD) on the energy sector in Thailand was to further the common understanding of key Thai stakeholders for measurement, reporting, and verification (MRV) of national GHG emissions and climate change mitigation actions under the Paris Agreement (PA). In this context, the scope of the FGD was to address the following:

1. To share the current practice of Thailand in the MRV for GHG emissions in energy in Thailand, including means of reporting mitigation actions, boundaries of current MRV, and the roles of Thailand's stakeholders;
2. To share planning for mitigation actions within the various energy sub-sectors;
3. Introduce the basic requirements of MRV within the context of the PA, to include boundary, GHG emissions, actions (progress in the implementation of GHG mitigation, other impacts, alignment to global frameworks), and support (means of implementation: capacity building, technology transfer, and finance);
4. To discuss in breakout sessions information pathways for the MRV of GHG emissions in the various energy sub-sectors and to identify gaps and potential solutions for filling those gaps.

The FGD was held on 12th November 2018 at The Quarter Ari at Ari Hills in Bangkok, and attended by the following groups:

Department	Roles
Office of Natural Resources and Environmental Policy and Planning (ONEP)	Amongst other responsibilities, is responsible for coordinating national level climate change mitigation as well as national level reporting on climate change.
GIZ Thailand	Responsible for the implementation of the Thai-German Climate Programme (TGCP).
TGCP consultants	Responsible for providing the technical assistance & training to the Government of Thailand for the development of a national MRV system focusing on select sectors, under the TGCP.
Department of Alternative Energy Development and Efficiency (DEDE)	Responsible for energy efficiency promotion, energy conservation regulation, energy sources provision, alternative development of integrated energy uses and energy technology dissemination. The organization is also responsible for regulation, supervision, promotion and assistance provision to the designated factories and buildings to comply with laws and regulations for efficient use of energy and savings.
Energy Policy and Planning Office (EPPO)	Responsible for recommending national energy policies and plan to ensure well-proportioned, adequate and efficient supply of energy.
Policy and Strategy Office (PSO), Office of Permanent Secretary, MoEN	Responsible for national energy policy and strategy.

Department of Mineral Fuels (DMF)	Responsible to promote and accelerate domestic petroleum exploration and production.
Energy Regulatory Commission (ERC)	Responsible for regulating energy industry operations in compliance with the policy framework of the government. The organization is empowered to issue regulations, rules, announcements or criteria, procedures and conditions in order to regulate various issues in the energy industry as prescribed by law.
Department of Energy Business	Responsible for promoting the use of natural gas and energy efficiency to reduce the imports from abroad, and the development system of the clean energy and environment
Department of Industrial Works (DIW)	Thailand's state-owned power utility under the Ministry of Energy, responsible for electric power generation and transmission for the whole country as well as bulk electric energy sales.
Electricity Generating Authority of Thailand (EGAT)	Thailand's state-owned power utility, responsible for electric power generation and as well as bulk electric energy sales.
Provincial Electricity Authority (PEA)	PEA is a government enterprise under the Ministry of Interior, responsible for the provision of standardized electricity services and related business.
Metropolitan Electricity Authority (MEA)	Thai state-owned oil and gas company and is involved in electricity generation, petrochemical products, oil and gas exploration and production, and gasoline retailing businesses
PTT Public Company Limited	Thai energy company having core business in petroleum refining.
Bangchak Corp.	Thailand's state-owned power utility under the Ministry of Energy, responsible for electric power generation and transmission for the whole country as well as bulk electric energy sales.

The FGD included a mixture of presentations (incl. case studies) and breakout sessions. The agenda for the FGD included five presentations from GIZ, ONEP, PSO, EPPO, and the TGCP consultants, respectively. The subject and a general short summary of the presentations is provided in the table below.

Introduction to participants, GIZ project and MRV assignments - GIZ

GIZ introduced the agenda for the day, and the GIZ Thailand Climate and Environment programme, and specifically the Thai-German Climate Programme (TGCP). Highlighting that the current focus group discussion was to address the energy sector and specifically MRV within the sector.

Thailand MRV for Energy sector - ONEP

ONEP highlighted the importance of the need or transparency under the Paris Agreement, and provided Thailand's approach on achieving the NDC target in the energy sector and discussed the MRV system requirements under the Paris Agreement. Potential changes in the preparation of BUR and National Communications (NC) under the Paris Agreement, where also highlighted.

ONEP explained the different levels of data collection and QA/QC process for the energy sector under the GHG inventory development. Then presented the Thailand GHG Emissions Inventory System (TGEIS) that facilitates the collection of data and information for the GHG inventory report, data archiving and quality control. TGEIS is supported by the Australian Government and use the 2006 IPCC Guidelines for GHG Inventories

National Energy Policy and Plan - EPPO

The presentation initiated with the explanation on energy use statistics of Thailand, which reached a mark of 80.752 ktoe in the year 2017. The presentation then steered towards Thailand Integrated Energy Blueprint (TIEB) that includes five individual national energy plans, which are aligned under the same timeframe (2015-2036) and focuses on suitable energy balance. The plans have defined target such as:

- Power Development Plan (PDP) has a target to reduce the use of natural gas in electricity consumption by 30-40% by 2036.
- Energy Efficiency Plan (EEP) aims to reduce energy intensity by 30% by the year 2030 from the base line year 2010.
- Alternative Energy Development Plan (AEDP) targets to increase the share of renewable energy by 2036 to 30% compared to total energy consumption.

It was indicated that Thailand's NDC target for mitigation was formulated based on the above-mentioned plans and achieving targets under the NDC will be dependent of the successful implementation of these plans. This was then followed by a detailed discussion on NDC roadmap for the energy sector.

Provincial Energy Plan - PSO

The presentation provided an understanding of the current energy usage in the country and developing strategies for providing modern energy to all. The initial part of the presentation focussed on providing a detailed insight of the energy utilisation by various regions of Thailand along with fuel type. Following this, a brief introduction of the Spatial Energy Plan of Thailand that consists of national strategies and direction of energy sector development with focus on energy security, energy supply and infrastructure development. Further to this, an overview of the 17 energy reform issues and a roadmap to the success of the energy plan.

PSO presented a brief background on the existing energy information system for MRV, and that it consists of primary and secondary data collection mechanism. Finally, the importance of a full-fledged geo-database system and spatial planning tool that can capture data and help in formation of energy development programme was suggested.

Domestic Measurement, Reporting and Verification System ("MRV") - TGCP consultants

The TGCP consultants highlighted that a national MRV system is built upon existing efforts for monitoring and reporting in a sector. Under the Paris Agreement (Enhanced Transparency

Framework) the MRV system should not only track GHG emissions, but also progress made towards the targets defined in the NDC in the form of actions, and the use and results of support in the form of Means of Implementation (e.g. capacity building, technology transfer, and finance).

Two case studies were presented, one focused on MRV system for RE Electrification and Off-grid electricity generation from Fiji, and the other MRV for on-grid electricity generation from Indonesia. TGCP consultants and GIZ introduced the breakouts of the FGD which where to focused on specific gaps in MRV.

The breakout sessions of the FGD were divided into two groups, with one group focusing on electricity generation and renewable energy, and the other focusing on energy efficiency. The objective of the breakout sessions was to identify the complexities/gaps in the current energy sector MRV system and possibilities for improvement. The participants were requested to discuss and address the following in relation to MRV in the energy sector:

- WHAT action(s) and data are to track?
- WHERE within the information system do we measure, monitor, evaluate and report action(s)?
- HOW to measure, monitor, evaluate and report on the action(s)?
- WHO will do the measuring, monitoring, evaluation and reporting of the action(s)?
- WHEN or how often will measuring, monitoring, evaluation and reporting of the action(s) take place?

With the focus on the above points, the table below highlights some of the main results of the breakout sessions.

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
Electricity generation from on-grid power plant (by Fuel type including electricity generation from Renewable Energy)	The data is measured at the Power plant and it is recorded by EGAT	An excel based tool is used for data gathering, recording and reporting. However, the real-time based reporting tool is under development.	Reporting framework includes the organizations EGAT, ERC, EPPO and ONEP, the data recorded at EGAT is being reported to ERC. ERC reports the same data to EPPO. EPPO does a QA/QC check on the data reported by ERC. Finally, EPPO reports the final set of data to ONEP.	The power plants report data to EGAT on monthly basis. However, the data flows from EGAT to EPPO to ONEP on annual basis.
Electricity transmission from on-grid power plant	The data is recorded by EGAT	An excel based tool is used for data gathering, recording and reporting. However, the real-time based reporting tool is under development.	Reporting framework includes the organizations EGAT, ERC, EPPO and ONEP. The data recorded at EGAT is being reported to ERC. ERC reports the same data to EPPO. EPPO does a QA/QC check on the data reported by ERC. Finally, EPPO reports the final set of data to ONEP.	The power plants report data to EGAT on monthly basis. However, the data flows from EGAT to EPPO to ONEP on annual basis.
Electricity distribution	The distribution data is measured and recorded by the distribution companies PEA and MEA.	An excel based tool is used for data gathering, recording and reporting.	Reporting framework includes the organizations of distribution companies (i.e. PEA and MEA), ERC, EPPO and ONEP. The data recorded at PEA/MEA is being reported to ERC. ERC reports the same data to EPPO. EPPO does a QA/QC check on the data reported by ERC. Finally, EPPO reports the final set of data to ONEP.	The distribution companies report data to ERC on monthly basis. However, the data flows from ERC to EPPO to ONEP on annual basis.
Fuel consumption by the on-grid power plants (by fuel type)	The data is measured at the Power plant and it is recoded by EGAT	An excel based tool is used for data gathering, recording and reporting. However, the real-	Reporting framework includes the organizations EGAT, ERC, EPPO and ONEP, the data recorded at EGAT is being	The power plants report data to EGAT on monthly basis. However, the data flows from

		time based reporting tool is under development.	reported to ERC. ERC reports the same data to EPPO. EPPO does a QA/QC check on the data reported by ERC. Finally, EPPO reports the final set of data to ONEP.	EGAT to EPPO to ONEP on annual basis.
Electricity and fuel consumption in large buildings (exceeding 10,000 m ²)	The energy efficiency activities in buildings is within the purview of Energy Conservation and Promotion Act (ECP Act) and downstream regulations such as Decree on designated buildings and Building Energy Code (BEC). The estimated energy consumption at design stage is being reported based on the building design by the building owner. The actual energy consumption is being recorded based on electricity and fuel bills.	The design is verified to check the building energy code compliance. The actual annual energy consumption data is to be provided to the ePortal by the building owner. DEDE has the oversight of ePortal.	The building owner reports the data to DEDE through the ePortal. Finally, DEDE reports the data to ONEP.	The data is being reported on annual basis.
Electricity and fuel consumption in large factories	The energy efficiency activities in factories is within the purview of Energy Conservation and Promotion Act (ECP Act) and downstream regulations such as	The actual energy consumption data (both electricity and fuel consumption) is being reported as per national requirement under Energy management in designated factories that require large factories to prepare annual energy management report audited by	The actual annual energy consumption data is reported to DEDE by the factory owner through an ePortal on an annual basis. Finally, DEDE reports the data to ONEP.	The data is being reported on annual basis.

	<p>Decree on designated factories and Energy management in designated factories. The actual annual energy consumption data are collected by the factory owner and shared with DEDE through an ePortal on an annual basis.</p>	<p>the Energy Management Auditors.</p>		
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The outcome of the breakout session reveals that a robust energy sector MRV system for establishing greenhouse gas inventory report in the context of the UNFCCC exists in Thailand. However, gaps have been observed in tracking the mitigation actions and means of implementations (Supports and capacity building) under the various sub-sectors of the sector. The process also needs improvements in terms of QA/QC of data being gathered at the bottom level as part of the GHG inventory process.

Under the electricity generation and renewable energy sub-sector, an adequate data collection and reporting mechanism has been observed. The primary data measured and reported under the sub-sector is electricity generation from on-grid power plants, electricity distribution, and fuel consumption by the on-grid power plants (by fuel type). Although a real-time based data reporting process is under development, the present recording and reporting process is being carried out using MS excel.

Under the energy efficiency, measurement and reporting focuses on large buildings and factories. The energy efficiency activities in buildings and factories in Thailand is within the purview of Energy Conservation and Promotion Act (ECP Act) and a few downstream regulations such as Decree on designated buildings, decree on designates factories and Building Energy Code (BEC). The actual energy consumption in large buildings (both electricity and fuel consumption) is being recorded and reported based on electricity and fuel bills. For large factories, the actual energy consumption data (both electricity and fuel consumption) is being reported as per national requirement under energy management reporting audited by the Energy Management Auditors. The actual annual energy consumption data for both large buildings and factories are reported by the building/factory owner to DEDE through an ePortal on an annual basis. The ePortal is under the purview of DEDE.

The below are identified gaps and capacity development needs, and recommended actions for MRV within the sector.

No.	Gaps and Capacity Development Needs	Recommended Actions
1	Off-grid electricity generation and thermal energy generation (Heat energy) is currently not covered under the MRV system for inventory and the same will not be included in the real time-based reporting mechanism, which is under development.	There is a need to develop a mechanism to capture off-grid electricity generation data. Recommended actions may include mandatory data reporting through amendment of existing regulation or under a new regulation. A provision under the real time data reporting mechanism, which is under development needs to be evaluated to capture off-grid electricity generation data.
2	Delay in data reporting from on-grid power plants to EGAT is not clearly defined.	Align the reporting mechanism from plants to EGAT with the new developing real time mechanism to avoid delay in reporting. There is a need to understand further the cause of delay. If the cause is related to capacity, it is recommended to conduct appropriate capacity building session for stakeholders on data reporting.
3	Quality control (QC) of the data at ONEP level is adequate, although uncertainty processes to be implemented. There is a need for further review the QC at bottom level (i.e. Power plant, EGAT and ERC) as	There is a need to improve the overall QA/QC process through development of guidelines and standardised templates for QA/QC. Capacity building sessions on the QA/QC guidelines and templates should be conducted.

	it includes uncertainty from meters and calorific values of the fuels.	
4	As current data reporting is excel based, human error in data recording is common.	An information technology (IT) based system that collect and assess the data and information can be developed to eliminate the human errors. Alignment of data reporting through real time-based mechanism can be the possible solution.
5	Though Very Small Power Producers (VSPPs) and Small Power Producers (SPPs) are either directly selling power to industrial customers or using it for captive consumption (with sell the excess power to MEA and PEA at the rate based on feed in tariff system), data/information flow from VSPPs and SPPs to ONEP is very limited. There are no mandatory reporting obligations for VSPPs and SPPs to report on electricity generation.	Capture the energy generated through VSPPs and SPPs through a mandatory reporting mechanism.
6	Current regulations mandate MRV of energy efficiency activities for building and factories is applicable only for large installations. Medium and small facilities are not included in the system.	Development of a mechanism/regulation to capture medium and small facilities to get a holistic picture of the data (and total GHG emissions).
7	There may be a possibility that double counting occurs in connection with other sub-sectors, within energy. There is no process to address potential double counting.	Process of cross verification of the data (under the QA/QC guideline) may be developed to address double counting issue.
8	There seems to be gaps between DEDE and ONEP data on energy savings.	There is need to improve the overall QA/QC process through development of guidelines and standardised templates for QA/QC. Capacity building sessions on the QA/QC guidelines and templates should be conducted for DEDE.

In order to address the gaps and develop a more effective MRV system, the following steps can be undertaken through support:

1. To assist Thailand in designing an information pathway on data collection and reporting for off-grid electricity generation since the market for off-grid energy is expected to increase in short to medium term. Inclusion of off-grid energy generation data will provide a holistic picture on tracking the NDC progress (noting that this may expand the baseline of the NDC).
2. To design an enabling environment for capturing the energy generation data from SPPs and VSPPs to develop a holistic picture of the energy generation data.
3. To assist in developing a guideline, standard templates, and training for QA/QC process to be followed at various data points in either one or both of the on-grid electricity generation and

large energy consumption sub-sectors. This will reduce errors, omissions and maximize consistency within information.

4. To assist in developing a guideline, standard templates, and training for the MRV of means of implementation within the on-grid electricity generation and large energy consumption sub-sectors.

Annex B: Summary of Focus Group Discussion – Waste

The purpose of the Focus Group Discussion (FGD) on the waste sector in Thailand was to further the common understanding of key Thai stakeholders of measurement, reporting, and verification of national GHG emissions and climate change mitigation actions under the Paris Agreement (PA). In this context, the scope of the FGD was to address the following:

1. To share the current practice of Thailand in the MRV for GHG emissions in waste in Thailand, including means of reporting mitigation actions, boundaries of current MRV, and the roles of Thailand's stakeholders;
2. To share planning for mitigation actions within the various waste sub-sectors;
3. Introduce the basic requirements of MRV within the context of the PA, to include boundary, GHG emissions, actions (progress in the implementation of GHG mitigation, other impacts, alignment to global frameworks), and support (means of implementation: capacity building, technology transfer, and finance);
4. To discuss in breakout sessions information pathways for the MRV of GHG emissions in the waste sub-sectors and to identify gaps and potential solutions for filling those gaps.

It should be noted, that the waste sector comprises of solid waste management and wastewater management sub-sectors.

The FGD was held on 9th November 2018 at Ari Hills in Bangkok, and attended by the following groups:

Department	Roles
Office of Natural Resources and Environmental Policy and Planning (ONEP)	Amongst other responsibilities, is responsible for coordinating national level climate change mitigation as well as national level reporting on climate change.
GIZ Thailand	Responsible for the implementation of the Thai-German Climate Programme (TGCP).
TGCP consultants	Responsible for providing the technical assistance & training to the Government of Thailand for the development of a national MRV system focusing on select sectors, under the TGCP.

Pollution Control Department (PCD)	Responsible for the prevention and control of pollution throughout the country and helps define environmental quality standards.
Bangkok Metropolitan Administration (BMA)	Is the local government of Bangkok, response for operating solid waste and wastewater in the city.
Department of Environment Quality Promotion (DEQP)	Is responsible for promotion sustainability on natural resources and environment through awareness raising and readiness development.
Wastewater Management Authority (WMA)	Manages centralised wastewater treatment plants in Thailand.
Representatives from various (14) Regional Environmental Offices (REO)	Is responsible for regulating pollutions prevention activities are the sub-national level in Thailand.
Industrial Estate Authority of Thailand (IEAT)	Is responsible for regulating industrial estates in Thailand.
Department of Industrial Works (DIW)	Monitor and supervise industries within the framework of local laws and international regulations.
Department of Health, Ministry of Public Health	Oversight related to clinical waste.
Kasetsart University (KU)	Provides advisory service for GHG calculation for waste sector.

The FGD included a mixture of presentations (incl. case studies) and breakout sessions. The agenda for the FGD included five presentations from GIZ, ONEP, PCD (wastewater and solid waste), and the TGCP consultants, respectively. There was strong participation in the questions and answers sessions after to the presentations during the first part of the FGD. The subject and a general short summary of the presentations is provided in the table below.

Introduction to participants, GIZ project and MRV assignments – GIZ and TGCP consultants

GIZ introduced the agenda for the day, and the GIZ Thailand Climate and Environment programme, and specifically the Thai-German Climate Programme (TGCP). Highlighting that the current focus group discussion was to address the waste sector and specifically MRV within the waste sector.

MRV on GHG inventory and Mitigation: Group Discussions of waste sector - ONEP

Thailand is currently in the transition from 1996 to 2006 guidelines. Under this process, an MRV handbook and related reporting templates have been developed. In 2013, total emissions in the waste sector were determined to be 11.8 MtCO₂eq based on IPCC 1996 guidelines, where solid waste disposal contributed by 5.3 MtCO₂eq (i.e. 45.19 %) wastewater management contributed by 6.4 MtCO₂eq (i.e. 53.9 %) and waste incineration by 0.1 MtCO₂eq (i.e. 0.91 %). The emission

reduction targets for the year 2030 related to the sub-sectors solid waste management and wastewater management were reported to be 1.3 and 0.7 MtCO₂eq respectively.

Regarding the reporting structure, data is initially collected at the local government agencies and the private sector where engaged in waste management. The data is then exported to the related ministries and agencies (also referred to as data owners) where a first check of the data should be done. The following agencies are relevant for the waste sector: DEDE, DEQP, DIW, DLA, DOH and PCD, with PCD acting as the central agency in the waste sector. ONEP, as the national focal point builds upon the data provided by PCD running the GHG inventory database. Furthermore, the working group for waste is responsible for checking of the data collected so far. Via the Subcommittee on Climate Change Knowledge and Database and the National Committee on Climate Change Policy (NCCC), Thailand is reporting to UNFCCC in form of the National Communications (NCs) and the Biennial Update Reports (BURs).

Measurement, Reporting and Verification of Wastewater Management in Thailand - PCD

The presentation provided an overview of wastewater management in Thailand, the related reporting structure and potential measures to improve wastewater treatment, and thus reduce GHG emissions. The total quantity of wastewater generated is calculated based on the total population (66 Million) and an average wastewater generation rate of 150 litres per person and day resulting in 9.9 million m³ of wastewater per day. About 1.6 million m³ per day are treated in connected centralized wastewater treatment plants while 8.3 million m³ per day are collected and treated "onsite". Centralized treatment plants utilize stabilization ponds (46%), aerated lagoons (16%) and activated sludge systems (38%). Where more comprehensive wastewater management shall contribute to achieving the target under the NDC by a combination of measures including measures to reduce wastewater generation and improved wastewater treatment.

Measurement, Reporting and Verification of Municipal Solid Waste Management in Thailand - PCD

The presentation provided an overview of the (municipal) solid waste management, related national policies to improve waste management, and the general reporting structure on solid waste and involved stakeholders. The key linking policies are the road map on waste and hazardous waste management (2014), the national solid waste management master plan for the period 2016 to 2021, and the Action plan "Thailand zero waste" (2016). Under the new reporting system, the local administrations (LGOs) report via the Provincial Department of Local Administration (PDLA) followed by the Department of Local Administration (DLA) towards the Ministry of Interior (MoI) and the Pollution Control Department (PCD). PCD releases the Thailand State Pollution Report based on the received data.

Domestic Measurement, Reporting and Verification System ("MRV") - TGCP consultants

The TGCP consultants highlighted that a national MRV system is built upon existing efforts for monitoring and reporting in a sector. Under the Paris Agreement (Enhanced Transparency Framework) the MRV system should not only track GHG emissions, but also progress made towards the targets defined in the NDC in the form of actions, and the use and results of support in the form of Means of Implementation (e.g. capacity building, technology transfer, and finance). The presentation gave a short example of the broad level needs for the EU requirements for MRV in the

waste sector. In order to facilitate the discussions in the breakout groups, the MRV process was presented in steps and with elements including reference to the waste database by PCD and the TGEIS system for GHG inventory currently under implementation.

After the presentations, interactive breakout sessions were facilitated to identify the complexities/gaps in the current waste sector MRV system and possibilities for improvement. During the session, all participants were asked to divide into two groups focusing on solid waste management and wastewater management, respectively. The participants were requested to discuss and address the following for their sub-sectors:

- WHAT action(s) and data are to track?
- WHERE within the information system do we measure, monitor, evaluate and report action(s)?
- HOW to measure, monitor, evaluate and report on the action(s)?
- WHO will do the measuring, monitoring, evaluation and reporting of the action(s)?
- WHEN or how often will measuring, monitoring, evaluation and reporting of the action(s) take place?

With the focus on the above points, the tables below highlight some of the main results of the breakout sessions.

Municipal Solid Waste (key activity data discussed during the breakout group discussion)

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
Waste generation at source	LGO	<ol style="list-style-type: none"> LGO uses default value investigated by PCD to estimate waste generation at different sources LGO surveys and collects info data or PONRE/Regional Environment Office (REO) estimate number 	LGO > POLA/PONRE > REO > PCD (verification) > ONEP	Annually
Waste collection (the amount of waste being collected and transferred to disposal sites)	<p>Option A: Waste disposal sites</p> <p>Option B: At waste transfer stations before sending to waste disposal sites</p>	LGO weighs the amount of waste collected (when they have weighing facilities) or PONRE/Regional Environment Office (REO) estimate number from waste collection truck	LGO > POLA/PONRE > REO > PCD (verification) > ONEP	Annually, (Remark: monthly data supposedly collected by LGO, but in the reality, some LGO doesn't perform data collection every single month.)
Waste disposal (open dump, improperly treated waste)	Waste disposal sites	Estimation at sites by REO	LGO > POLA > REO > PONRE > PCD	Annually

Wastewater (connected to central treatment plants discussed during the breakout group discussion)

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
Operated by LGOs				
Parameters: BOD5, pH, SS, TP, TN, Oil & Grease	CASE A: LGO's DWW plant, received fund from provincial action plan.	REOs (collecting data) >> sharing data with ONEP/PCD (depends on funding sources)	REOs >> trusted by ONEP/PCD	Annually

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
	<p>Data being collected by REOs, cost of data collection funded by ONEP.</p> <p>CASE B: other LGO's DWW plants, data collection will be performed by LGO officials / staffs</p>		<p>REOs lab are certified by Department of Science Services (DSS)</p> <p>ONEP/PCD will check received data and random asked for re-verification of questioned data</p>	
Operated by WMA				
<p>Parameters: BOD, COD, SS, Temperature, Nitrogen (N), Total Nitrogen (TN), Influent flow, Effluent flow, Fat Oil and Grease (FOG)</p>	<p>WMA performs data collection themselves and report back to MoNRE every month</p> <p>WMA report has been addressed as WMA's KIP</p>	<p>WMA (collecting data) >> verify by third party>> reporting to MoNRE</p>		<p>Monthly</p>
Operated by BMA				
<p>Parameters: BOD, SS, NH₄⁺, TN, TP, NO₃⁻, Flow (Influent & Effluent) , Excess sludge (m³/day)</p>	<p>BMA perform data collection themselves</p> <p>Data is shared with PCD on yearly basis</p>	<p>Each BMA's DWW plant (8 in total) will submit report to Water Quality Management (WQM) Division of BMA</p> <p>Complied report later shared with PCD</p>		<p>Annually</p>

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
Industry located outside IEAT (Industrial Estate Authority of Thailand)				
Parameters: COD, SS, TDS, Oil and Grease, Volume (additional parameters according to industry types)	Influent and Effluent	Reporting template Industry 1-2 (Ror-Ngor 1-2) only regulated industries	Industry perform data collection themselves base on provided template >> submit to DIW (Department of Industrial Works) for further verification of data	Twice a year
Industry located inside IEAT				
	Pre-treatment inside each factory before sending to the IEAT central wastewater treatment plant			

The outcome of the breakout session reveals that a data collection system for the development of the GHG inventory in the context of IPCC guidelines is established in Thailand. Under the current transition from IPCC 1996 towards IPCC 2006 guidelines, an MRV handbook for the waste sector was developed and is now available for the involved agencies also at the local level.

Generally, it was reported that the data at local level is sometimes not yet derived from “measurements” (e.g. weighing of waste at treatment or disposal sites) but via calculation based on the registered population and a default waste generation rate. Due to regional differences and, also not reflecting for example migrant workers or tourists, this approach is expected to generate less precise results. A second key issue was raised with regard to the solid waste composition, as this was not recently reviewed and as such may result in another uncertainty.

The process also needs improvements in terms of QA/QC of data being gathered at the bottom level as part of the data collection process to establish the GHG inventory.

With the focus on the above points, the following gaps and capacity development needs are identified, and recommendations are made to improve MRV.

No.	Gaps and Capacity Development Needs	Recommended Actions
1	<i>Solid waste:</i> Calculations instead of direct measurement. Solid waste quantities generated, treated and subject to disposal are not always based on direct measurements but based on estimations related to the registered number of population not considering migrant workers or tourists for example.	Engage in a transition to mandatory measurements (e.g. based on certain thresholds related to waste generation / treatment quantities). This may include measures related to enforcement combined with capacity building and support.
2	<i>Solid waste:</i> There is a larger share of solid waste not properly collected and treated. There is no information available on details of the related quantities and types of treatment.	Initiate a survey to get a better understanding of the waste quantities and types of treatment
3	<i>Solid waste:</i> Specific treatment options such as recycling and reuse is not monitored in detail but based on a generic calculation approach	Elaborate measurement and data collection procedures and a related guideline
4	<i>Solid waste:</i> Generally, very limited information on historical disposal at landfills or dump sites is available.	Engage into extrapolation of data where possible
5	<i>Solid waste:</i> Limited data collection from solid waste treatment / disposal operated by private sector	Elaborate possibilities to make data reporting mandatory and engage in measures to enforce the same

6	<i>Solid waste:</i> Limited information on landfill or dump sites regarding their characteristic (depth of waste body, etc.)	Initiate a survey to collect required data currently missing
7	<i>Solid waste:</i> Waste composition data is currently only for the national level and is outdated, and but regional is needed and should be determined to reflect the current situation	Conduct waste composition analysis at regional level to derive regional data and update national values
8	<i>Solid waste:</i> Capacity building need for LGOs was identified enable better data collection	Develop and conduct a capacity building programme for strengthening data collections
9	<i>Solid waste and Wastewater central treatment plants:</i> there is a lack of demographic information on the migrant and tourist population.	To use or develop national statistics on migrant and tourist population, by region.
9	<i>Wastewater central treatment plants:</i> Missing data parameters at WWTPs: Effluent bodies, sludge disposed Missing demographic data: Number of populations connected to the DWW	New regulation needs to be developed to required reporting of additional information to be compliant with IPCC 2006 guidelines
10	<i>Wastewater central treatment plants:</i> Streamlined information flow is needed, as there are different data collection forms (ONEP, PCD, WMA), and a possibility for double counting from different sources of information, and there needs to be QA/QC structure to ensure the data quality and transparency of processes.	A more detailed mapping of data / information flow is needed for Wastewater central treatment plants, to ensure the type of need and to prevent double counting.

In order to address the gaps and develop a more effective MRV system, the following steps can be undertaken through support:

1. In-depth review of the MRV guideline, and mapping of current data / information flow, for the waste sector to identify potential gaps and capacity building / training needs beyond the guideline (application of the guideline).
2. To prepare the statistically relevant survey requirements and methodology, and survey templates, for determining the common factors needed in calculating GHG emissions in the waste sector (e.g. regional solid waste generation and composition, household water use and wastewater composition).
3. Assistance in developing guidelines, standard templates, and training for QA/QC process to be followed at various data collection points to reduce errors, omissions and maximize consistency within the information.

4. Development of training materials and guidelines to address capacity building needs to strengthen data collection (for IPCC 2006 data) and reporting at the local level (e.g. LGOs, REOs, WMA...).
5. Develop a draft methodology for determining GHG emission at-site treatment facility based on different sites (e.g. households, residential buildings, residential buildings, small industry, etc.).

Annex C: Summary of Focus Group Discussion – Agriculture

The purpose of the Focus Group Discussion (FGD) on the agriculture sector in Thailand was to further the common understanding of key Thai stakeholders of measurement, reporting, and verification of national GHG emissions and climate change mitigation actions under the Paris Agreement (PA). In this context, the scope of the FGD was to address the following:

5. To share the current practice of Thailand in the MRV for GHG emissions and M&E of adaptation in agriculture in Thailand, including means of reporting mitigation and adaptation actions, boundaries of current MRV, and the roles of Thailand's stakeholders;
6. To share planning for mitigation and adaptation actions within agriculture;
7. Introduce the basic requirements of MRV within the context of the PA, to include boundary, GHG emissions, actions (progress in the implementation of GHG mitigation, other impacts, alignment to global frameworks), and support (means of implementation: capacity building, technology transfer, and finance);
8. To discuss in breakout sessions information pathways for the MRV of GHG emissions in the agriculture and to identify gaps and potential solutions for filling those gaps.

The FGD was held on 12th November 2018 at The Quarter Ari at Ari Hills in Bangkok, and attended by the following groups:

Department	Roles
Office of Natural Resources and Environmental Policy and Planning (ONEP)	Amongst other responsibilities, is responsible for coordinating national level climate change mitigation as well as national level reporting on climate change.
GIZ Thailand	Responsible for the implementation of the Thai-German Climate Programme (TGCP).
TGCP consultants	Responsible for providing the technical assistance & training to the Government of Thailand for the development of a national MRV system focusing on select sectors, under the TGCP.
Department of Livestock Development (DLD)	Responsible for livestock sub-sector development in Thailand, including resources, value chain, technology and information. DLD includes the Bureau of Livestock Standard and Certification, Bureau of Animal Husbandry

	and Genetic Improvement, Information and Communication Technology Centre.
Department of Agricultural Extension (DOAE)	Responsible for increasing agricultural production capacity, processing, increasing agricultural goods values, establishing measures and guidelines in agricultural promotion, controlling goods and product qualities, as well as transferring agricultural technology. DOAE includes the Bureau of Agricultural Commodities Promotion and Management, Information and Communication Technology Centre.
Office of Agricultural Economics (OAE)	Responsible for developing and formulating country's agricultural strategy as management tools for security, prosperity and sustainability, and to report on agricultural economics, and to prepare and provide agricultural data and information services. OAE includes Bureau of Agricultural Economic Research, Centre for Agricultural Information.
Land Development Department (LDD)	Responsible to conduct soil surveys and analyses as a basis for establishing land classification and utilization maps, land development, and to define land use areas, and soil and water conservation areas according to a land census. LDD includes the Planning Division, Office of Research and Development for Land Management, Policy and Land use Strategy
Ubon Ratchathani Rice Research Center, Rice Department	Responsible for the development and research on rice sector in order to support the local farmers

The FGD included a mixture of presentations (incl. case studies) and breakout sessions. The agenda for the FGD included five presentations from GIZ (for TGCP and GIZ-CIM), ONEP, OAE and the TGCP consultants. The presentation, though including adaptation, mainly focused on mitigation within the agriculture sector. The subject and a general short summary of the presentations is provided in the table below.

Introduction to participants, GIZ project and MRV assignments – GIZ and TGCP consultants

GIZ introduced the agenda for the day, and the GIZ Thailand Climate and Environment programme, and specifically the Thai-German Climate Programme (TGCP). Highlighting that the current focus group discussion was to address the agriculture sector and specifically MRV and M&E within the sector.

Recap from GHG Inventory Workshop in August 2018 - ONEP

Key findings from the workshop conducted in August on MRV systems to account for greenhouse gas in the agriculture sector was presented during the session. The presentation covered list of activity, data requirements and guidelines for data collection for Enteric Fermentation, Biomass burning, use of urea fertilizer, Use of chemical fertilizer, Agricultural waste, Agriculture soil, and Rice cultivation.

Current status of agricultural strategic plan on climate change, foreseen thematic or flagship projects/plans to mainstream four core strategies - OAE

This session covered status and plans on mitigation in the agriculture sector. The strategy for agriculture sector is to make agriculture climate resilient and the focus is more on adaptation, however mitigation actions have been identified. Currently there are five projects under mitigation which are 1) rice cultivation, 2) biomass burning, 3) fertilizer, 4) improvement of animal feed, and 5) biogas generation. The presentation also covered 4 sub strategies for agriculture sector and discussed the action plan developed for the sector and the gaps in data collection.

GHG Measurement and Data Collection for the Rice Sector: Introduction to SECTOR (Source-selective and Emission-adjusted GHG CalculaTOR for Cropland) - GIZ-CIM

In this session, information on data collection system for rice cultivation that can contribute to a national MRV system for reporting to UNFCCC developed by TGCP-Agri and Thai Rice NAMA was presented. The presentation focussed on the measurement aspect and detailed the 4 steps involved in the process which are 1) Recording GHG emission rates (field and lab measurements), 2) Determining Emission Factors (seasons/spatial units), 3) collecting Activity Data (area, crop management), and 4) Entering Emission Factors and Activity Data into GHG Calculator. The presentation also covers the New GHG Calculator used in NAMA Project and its important features.

Domestic Measurement, Reporting and Verification systems - TGCP consultants

In this session, an overview of MRV systems in general and specifically for the agriculture sector was discussed. The presentation covered an introduction to the national MRV framework, linkages between three pillars (GHG inventory, mitigation actions, support) as well IPCC guidelines with details of data parameters for two selected mitigation actions – rice cultivation and fertilizer use. The presentation also included examples of India's and Bangladesh's monitoring and evaluation (M&E) for agriculture and livestock sectors respectively.

After the presentations, interactive breakout sessions were facilitated to identify the complexities/gaps in the current agriculture sector MRV system and possibilities for improvement. The framework presented in the first part was used to guide the discussion. The FGD helped in gaining information on existing MRV systems and practices from the stakeholders. It also helped in strengthening the participant's understanding related to the components of MRV system as well as development and implementation of sectoral and national level MRV.

The FGD was structured as an interactive breakout session with the participants forming four groups. Each of the groups were assigned a sub-sector and were requested to discuss and answer the following questions:

- WHAT action(s) and data are to track?
- WHERE within the information system do we measure, monitor, evaluate and report action(s)?
- HOW to measure, monitor, evaluate and report on the action(s)?
- WHO will do the measuring, monitoring, evaluation and reporting of the action(s)?
- WHEN or how often will measuring, monitoring, evaluation and reporting of the action(s) take place?

For each of these points, Gaps and Possibilities were also discussed and recorded.

The sub-sectors chosen for the FGD were 1) Rice, 2) Other cash crops, 3) livestock, and 4) synthetic fertilizer & lime. These sub-sectors were chosen as they contribute most significantly to the emissions

inventory of the agriculture sector and have prominent roles to play in the country's overall economy. During the FGD, a list of parameters, which are being currently tracked, were shared by the participants. For each of the parameters, further information was collected from the group and recorded. A snapshot of data parameters collected is provided below.

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
Rice and other cash crops				
<ul style="list-style-type: none"> • Type and production of crops • Number of crop growing days • Number of flooding days • Fertiliser type & use 	Collected through surveys from farmers	Sample survey and population survey both are carried out to collect primary data from the farmers based on pre-fixed questionnaires.	Field level data collection on population is carried out by DOAE and Rice Department as per crop calendar. For validation of the data collected by DOAE, OAE conducts sample surveys (by calling farmers to their office). Then the data are compiled (mostly in excel) by OAE for all seasons annually. The annual, compiled data are reported by OAE to ONEP. ONEP then feeds the data to TGEIS.	Field level data collection is carried out as per crop calendar. The data are compiled by OAE and reported to ONEP annually.
<ul style="list-style-type: none"> • CH₄ / ha / year • Nitrogen percentage per unit volume of fertiliser 	These two data points are gathered mainly from international guidelines for emission factors such as the 2006 guidelines of Intergovernmental Panel on Climate Change (IPCC). In a few rice fields, the Rice Department is carrying out Glass Chromatograph analysis to assess seasonal and annual emissions of CH ₄ per ha of land.	<p>The data are gathered from two sources:</p> <ul style="list-style-type: none"> a) Mainly IPCC 2006 default values are used for emission factors of CH₄ and nitrogen b) Very limited laboratory analysis (glass chromatography) for some rice fields to obtain annual/seasonal CH₄ emissions data to calculate the emission factor per ha of land. 	<p>The default factors are applied for inventory calculation by ONEP directly.</p> <p>In case of laboratory analysis, rice department uses its own infrastructure (i.e., calibrated glass chromatograph) to obtain CH₄ emissions data.</p>	The laboratory analysis data for CH ₄ emissions are currently not being used generally at a country level to calculate the inventory by ONEP since it is at a very nascent stage. It is mostly the default emission factors prescribed by IPCC guidelines of 2006 that are
Livestock				

What data is gathered?	Where is it being gathered?	How is it being gathered?	Who is reporting it to ONEP?	When is it reported to ONEP?
<ul style="list-style-type: none"> Animal type and number Type and quantity of manure 	These two data points are collected round the year from the farmers.	The Livestock Department collects two data points based on pre-fixed questionnaires round the year as there is no seasonal variation.	Livestock Department compiles the data annually and shares the same with ONEP. There is no separate mechanism followed for data validation or verification.	Reporting to ONEP happens annually.
Synthetic Fertilizers				
<ul style="list-style-type: none"> Synthetic fertilizers 	Gathered by DOA from customs authority	Through a registry system for import / export of synthetic fertilizers	OAE receives synthetic fertilizer data from DOA, then OAE reports the data to ONEP (there is a quarterly working committee in the Min. of Agriculture who provides a review / QC of data on fertilizer)	Annually
Lime				
<ul style="list-style-type: none"> Lime 	Gathered by LDD	based on government purchases from state budget. LDD distributes to the region and then this is disturbed at the provincial level.	LDD is reporting to OAE and then OAE is reporting to ONEP (there currently seems to be no specific QC of data on lime)	Annually

It was understood from the discussions that the existing MRV system in the agriculture sector has more of a focus on GHG inventory, rather than a total MRV system. Emissions are being captured by the system; however, no specific baseline exists for emissions from the sector or sub-sectors (outside inventory data). Another concern regarding the current MRV system is that there are multiple templates and multiple organisations (OAE, Rice Department, DOAE) involved in data collection and collation. Sample surveys (OAE) as well as population survey (DOAE) are being carried out simultaneously by both the organizations. This leads to greater uncertainty regarding data and redundancy. There also appears to be leakages or incomplete data for fertilizer and lime use, specifically data on private sector production and distribution.

No.	Gaps and Capacity Development Needs	Recommended Actions	Responsibility
1	<p><i>Rice/Crops/Livestock Activity data:</i> Different departments (Rice department, DOAE, OAE) use different formats to collect field level activity data. This makes some of the data collected redundant. Also, diverse data sets lead to greater uncertainty. This duplication of efforts reflects the lack of clarity in terms of roles of each of the stakeholder in the MRV process and lack of coordinated efforts.</p>	<p>This concern needs to be addressed at two levels:</p> <p><i>a) Define clarity of roles for each actor in each sub-sector:</i></p> <ul style="list-style-type: none"> • Rice Department may be assigned the role of field level data collection for only rice crops based on sample surveys as per crop calendar. • Similarly, DOAE may do the same for other cash crops and livestock department for livestock related data. • All these data (for rice, other cash crops and livestock) may be compiled and verified bi-annually by OAE and annually by ONEP. <p><i>b) Define standard guidelines and templates:</i></p> <ul style="list-style-type: none"> • QA/QC guidelines and templates as per the requirements of UNFCCC may be developed as a part of TGCP for each sub-sector. • These standardised guidelines and templates may be used uniformly by all departments for data measurement and recording, verification and 	<ul style="list-style-type: none"> • Data collection for rice – Rice Department • Data collection for other cash crops- DOAE • Data collection for livestock- Livestock Department • Biennial data compilation and Verification- OAE • Annual data verification – ONEP

		compilation to ensure data consistency and accuracy.	
2	<i>Rice Emission Factor Data:</i> Laboratory analysis and third-party calibration for CH ₄ emissions data is limited. Mostly IPCC 2006 default values are being used for CH ₄ and nitrogen emissions.	<p>Thailand has initiated laboratory analysis of CH₄ emissions from rice cultivation on limited fields as a good practice. However, this practice needs to be scaled up so that the data may be used for calculation of sectoral emissions for the entire country. This is important as scaling up ensures that the sample size is an appropriate representation of the total number of rice fields.</p> <p>Also, it is of greatest importance that calibration of the laboratory instruments (e.g. glass chromatograph) is carried out annually by a third party (other than the Rice Department) who is internationally accredited (e.g. as per standards defined by IRR!) to increase reliability of the data.</p>	<ul style="list-style-type: none"> • Rice Department
3	<i>Rice/Crops/Livestock Baseline of emissions:</i> Currently, the agriculture sector does not have a fully developed specific baseline of emissions (beyond the general GHG inventory).	<p>Based on the discussions during the FGDs, to start with, a more specific GHG emissions baseline may be developed covering Rice, other cash crops and livestock as sub-sectors.</p> <p>The more specific GHG emissions baseline may be ex-post to accommodate revision of Tier 1 emission factor values (based on IPCC 2006) with Tier 2 values (based on laboratory analysis).</p> <p>ONEP and OAE are already aware of FAO's modelling tool and consequently may be used for more specific GHG emissions baseline projection.</p>	<ul style="list-style-type: none"> • Development and revision of the baseline - OAE • Verification of baseline – ONEP
4	<i>Rice Data validation and verification:</i> Currently data are being captured manually in the questionnaire from the farmers. There are handwritten notes, which are then	Once standardised data templates are in place (as discussed in point 1), an IT based system may be developed based on those templates that will have a bottom	<ul style="list-style-type: none"> • Data entry for Rice-Rice Department • Data entry for other crops – DOAE

	compiled in MS Excel or Word. Consequently, there is potential for human error in data validation, verification and compilation.	up architecture so that the DOAE/Rice Department can enter data into the system at the local level and the same may be validated against standard values/ outliers by OAE and ONEP at regional and national level. This will also reduce the existing over-dependency on TGEIS.	<ul style="list-style-type: none"> • Data validation – OAE • Data verification – ONEP
5.	<i>Adaptation data:</i> Though the country's NDC has a component for adaptation in agriculture, currently limited adaptation centric data such as types and number of agro-ecological zones, climate change risks (hazard, exposure, vulnerability), climate variables (annual rainfall, temperature cavitation) and adaptation measures are being captured at a national or regional level for the agriculture sector.	A database may be developed to capture climate change risk data for the existing agro-ecological zones of the country. The database may also contain the details of coping mechanisms/ adaptation activities already undertaken by different farmer groups in the country. The database may serve as a basis for decision making on identification of large-scale adaptation measures in different agro-ecological zones of the country.	<ul style="list-style-type: none"> • Development and maintenance of the database – OAE • Review of database and decision making on adaptation actions – ONEP
6.	<i>Synthetic Fertilizer and Lime Activity data:</i> Data regarding synthetic fertilizers is based on import/export data, and there is a possibility of leakage as domestic production of synthetic fertilizers is not clear. Lime activity data is based on purchase through the government but does not address purchase through the private sector.	Greater clarification needs to be taken on the potential for the domestic production of synthetic fertilizers, and any potential related leakages. More accurate data on lime use, may be gained by gathering data from lime distributors, including the existing data from government distribution but possible inclusion of private sector distributors.	

In order to address the gaps and develop effective a basic MRV of baseline scenario(s) and mitigation actions (against a baseline), the following steps can be addresses through support:

1. To assist in developing a comprehensive list of data points/indicators to be captured under the adaptation and mitigation actions that will have reference to the country's future NDC, National Adaptation Plan and the UNFCCC requirements, this will act as the basis for development of the M&E and MRV frameworks of the agriculture sector.
2. To assist in developing guidelines, standard templates for MRV mechanisms in mitigation actions and for M&E mechanisms in adaptation actions for the agriculture sub-sectors.

3. To assist in developing guidelines and templates for QA/QC process to be followed for various data points for both mitigation and adaptation activities in the agriculture sub-sectors.
4. To develop customised training programmes/materials for rice (Rice Department/DOAE), non-rice crops (DOAE, LDD) and livestock (Livestock department) as they handle different sets of data points including for agency act as the focal point (OAE).
5. To assist the government in identifying potential other sources of synthetic fertilizer and lime within the economy, and if significant, to determine means to track this activity and strengthen the MRV component of this data.

Annex D: Summary of Focus Group Discussion – Water Sector

The purpose of the Focus Group Discussion (FGD) on the water management sector in Thailand was to give a better understanding of the current situation of NDC and NAP processes and clarify expectations towards monitoring and reporting requirements on adaptation actions in the Thai water sector. Where the aim of the Working Group and Workshop was to discuss information governance, including conducting a SWOT (strengths, weaknesses, opportunities, threats) and gap analysis, the FGD provided the opportunity for related agencies in the water management sector to understand the current situation of NDC and NAP processes and clarify expectations towards monitoring and reporting requirements on adaptation actions in the Thai water management sector.

The FGD was held on 13th November 2018 at The Quarter Ari in Bangkok, a list of presentations given at the FGD is given below.

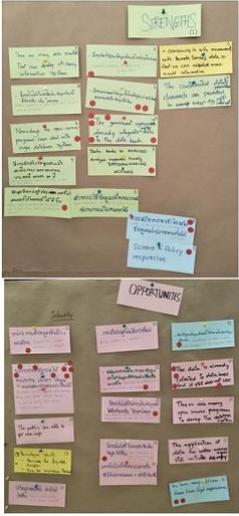
- Welcome and introduction to TGCP and MRV/M&E assignment presented by Ms Kirsten Orschulok, Thai German Climate Programme, Advisor
- Thailand's National Adaptation Plan: Water Resource Management presented by Mr Teerapong Laopongpith, Environmentalist, Policy and Strategy Section, Climate Change Management and Coordination Division, Nature: ONEP
- Case studies on flood management from other countries presented by TGCP-consultants Ms Madhura Mitra, Associate Director, PricewaterhouseCoopers Private Limited (PwC India)
- Road map of National Water Command Centre (NWCC) presented by Mr Attathapong Chantanumate, Expert in water crisis analysis, Office of The National Water Resources: ONWR

The presentation by the TGCP-consultant Ms Madhura Mitra, PwC India, was prepared with the objective of familiarising the audience with good practices on flood management implemented by other countries (Singapore, Netherlands). The examples of Singapore's storm water management and Holstebro city's Flood Management Plan were discussed. Using the example of Singapore stormwater management, possible monitoring & evaluation (M&E) indicators were discussed.

After the presentations the Focus Group Discussion on water management was held. It was facilitated by Ms Jutta May, Information & Knowledge Management Specialist and was based on the results of the Working Group meeting and SWOT (Strengths, Weakness, Opportunities, Threats) analysis and prioritisation of water information and data conducted with the participants during a preparatory M&E

working group meeting on information governance and data management in the Thai water sector the day before:

The highest priority was identified as the opportunity that government policies are supporting data and information sharing processes between different agencies including the verification of data. The second priority was a data warehouse while its status or lack is identified as a weakness. The third priority relates to capacity development and addressing the threat that user potentials are not updated in relation and response to continuously changing technology. The fourth priority reflects the strengths of existing government agencies efforts to integrate water data. The key results of this exercise are visualised in the figure below.



Strengths	Rank	Opportunities	Rank
The government agencies already integrate water data into the data bank	5	Government policies are supporting data and information sharing process between different agencies and can verify data between different agencies	8
Real time data dissemination and easy to access	3	Data is already collected to database but it still does not use	4
Creating of understanding about data for civil society	2	We have many officers with high experience	2
Weakness	Rank	Threat	Rank
Data warehouse	7	User potential are not updated on changing technology	6
No sharing policy, different data sources	4	One agency for topic/responsibility	4
There is incomplete primary data checking system	3	Data security	3

Figure: SWOT analysis – key results with ranking

Based on the discussions over the two days participants gave further recommendations regarding the following:

What information and data are needed for reporting on adaptation in the Thai water sector?

- Integration of data between organizations
- each organization follows their recognized mission
- data and information needs include hazards and risks (climate risk data), adaptation capacity index, socio economics, critical infrastructure, water use (flood and drought indicators), precipitation, institutional technical adaptive/capacity at the national and river basin level.
- possess information on capacity of infrastructure for coping with floods
- integration of remote sensing (satellite images) for monitoring the spatial distribution of flood/drought and land use
- identify lacking data, baseline studies

Which information and data are already collected? Which should be prioritized for collection?

- Existing reservoir storage data
- Conduct studies in pilot areas (e.g. Sakrakrang, provinces/flood prone areas)

What is needed to meet the requirements for M&E on adaption in the Thai water sector (people, governance, processes and technology)?

- Need more engagement/consultations for prioritizing monitoring
- Initiate in pilot area(s) to demonstrate M&E before scaling up
- Use bottom-up approach rather than top-down approach

For additional information please refer to the “**Summary of M&E/ MRV Working Group and Workshop 12 - 13 November 2018: Thai-German Climate Programme – Water, TGCP-Water**”.

Thai government agencies attending the workshops (M&E/MRV) on 12-13 November 2018:

- Office of the National Water Resources (ONWR)
- Department of Water Resources (DWR)
- Department of Public Works and Town & Country Planning (DPT)
- Royal Irrigation Department (RID)
- Office of Natural Resources and Environmental Policy and Planning (ONEP)
- Hydro and Agro Informatics Institute (HAI)
- Geo-Informatics and Space Technology Development Agency (Public Organization) -GISTDA
- Department of Ground Water Resources (DGR)
- Department of Disaster Prevention and Mitigation (DDPM)
- Royal Forest Department (RFD)

Annex E: Summary of Focus Group Discussion – Transport

The purpose of the Focus Group Discussion (FGD) on the transport sector in Thailand was to further the common understanding of key Thai stakeholders of measurement, reporting, and verification of national GHG emissions and climate change mitigation actions under the Paris Agreement (PA). In this context, the scope of the FGD was to address the following:

1. To share the current practice of Thailand in the MRV for GHG emissions in transport in Thailand, including means of reporting mitigation actions, boundaries of current MRV, and the roles of Thailand's stakeholders;
2. To share planning for mitigation actions within the various transport sub-sectors;
3. Introduce the basic requirements of MRV within the context of the PA, to include boundary, GHG emissions, actions (progress in the implementation of GHG mitigation, other impacts, alignment to global frameworks), and support (means of implementation: capacity building, technology transfer, and finance);
4. To discuss in breakout sessions information pathways for the MRV of GHG emissions in the various transport sub-sectors and to identify gaps and potential solutions for improvement of filling those gaps.

The FGD was held on 9th November 2018 at The Quarter Ari at Ari Hills in Bangkok, and attended by the following groups:

Department	Roles
Office of Natural Resources and Environmental Policy and Planning (ONEP)	Amongst other responsibilities, is responsible for coordinating national level climate change mitigation as well as national level reporting on climate change.
GIZ Thailand	Responsible for the implementation of the Thai-German Climate Programme (TGCP).
TGCP consultants	Responsible for providing the technical assistance & training to the Government of Thailand for the development of a national MRV system focusing on select sectors, under the TGCP.
Department of Land Transport (DLT)	Responsible for the regulation of the land transport sub-sector.
State Railway Thailand (SRT)	Responsible for the operation of the state rail system in Thailand.
Port Authority of Thailand (PAT)	Responsible for the operation of sea ports in Thailand
Civil Aviation Authority of Thailand (CAAT)	Responsible for the regulation of the civil aviation sub-sector
Office of Transport and Traffic Policy and Planning (OTP)	Responsible for submitting policies, formulating transport and traffic plans, and working out transport safety measures

The FGD included a mixture of presentations (incl. case studies) and breakout sessions. The agenda for the FGD included five presentations from GIZ, ONEP, OTP, CAAT, and the TGCP consultants, respectively. The subject and a general short summary of the presentations is provided in the table below.

Introduction to participants, GIZ project and MRV assignments - GIZ
GIZ introduced the agenda for the day, and the GIZ Thailand Climate and Environment programme, and specifically the Thai-German Climate Programme (TGCP). Highlighting that the current focus group discussion was to address the transport sector and specifically MRV within the transport sector.
Recap from GHG Inventory Workshop in August 2018: Transport - ONEP
ONEP presented the institutional arrangements for data and GHG determination under the GHG inventory preparation process for transport, and this includes the following modes of transport: rail, road vehicles, maritime, and aviation. Whereupon mainly fuel consumption is gathered by select departments with oversight by OTP, then delivery to ONEP. There are currently missing gaps in data to meet IPCC 2006 inventory guidelines and Tier 2 level, these include separating fuels use by vehicle type & size, and specific consumption by all types of vehicles, separation between international and national travel, conversion of fuel units by type of fuel.
Data Collection and MRV system in the Thai Transport sector - OTP
OTP presented the draft NDC Action Plan for Transport which as the goal to support the implementation of governments agencies work plans in the transport sector, improve legislation, establish and MRV system, and empower the reduction of GHG emissions. The process used to prepare the NDC Action Plan for Transport was presented dealing with existing mitigation projects/plans, recommended new mitigation projects/plans, and projects/plans where GHG emissions cannot currently be assessed. The approach used was to define means to avoid / reduce travel, change the way of travel, or improve the efficiency of travel. A high number of existing and potential actions was presented, with potential for mitigation. The future objective is to use the bottom-up method for GHG emissions determination ASIF (Activity-Structure-Intensity-Fuel) as a basis for data under MRV.
Activity Data Management for Thailand's Aviation Sector - CAAT
CAAT presented the current & planned process for MRV in the aviation sub-sector, which is divided between international aviation to be reported to ICAO under CORSIA (in future), and national aviation to be reported to ONEP for the GHG inventory. MRV under CORSIA is still to be defined. Whereas MRV for national aviation follows IPCC methods based on fuel consumption by fuel type. CAAT has activity data / fuel consumption from 12 airlines in 2017 on a voluntary basis, domestically it is predominantly 5 airlines. CAAT is working to focus all MRV based on the CORSIA methodology for GHG emissions, where current gaps are gathering full activity data in a mandatory process, accurately converting fuels from tonnes to litres, and knowing actual fuel densities by type.
Domestic Measurement, Reporting and Verification System ("MRV") - TGCP consultants

The TGCP consultants highlighted that a national MRV system is built upon existing efforts for monitoring and reporting in a sector. Under the Paris Agreement (Enhanced Transparency Framework) the MRV system should not only track GHG emissions, but also progress made towards the targets defined in the NDC in the form of actions, and the use and results of support in the form of Means of Implementation (e.g. capacity building, technology transfer, and finance). The presentation gave a short example of data needs and methodology for GHG tracking in intercity rail, and highlighted MRV of a policy-based mitigation action in Fiji for hybrid vehicles. TGCP consultants and GIZ introduced the breakouts of the FGD which where to focused on specific gaps in MRV.

The breakout sessions of the FGD were based on the available participants, and focused on road, rail, and aviation transport, and sea port operations. The breakout sessions indicated that MRV with these subsectors was currently done at the macro level, but that bottom up approaches were in the process of development / planning and later implementation. Some specific gaps in more accurate GHG emission reporting were identified for each sub-sector, and a summary of the gaps and potential solutions identified during the breakout sessions is provided in the table below. It is noted that there is no systematic MRV for tracking means of implementation, and the tracking of progress can currently be done indirectly by using data from GHG emission reporting, though the relative accuracy of indirect tracking of progress needs to be determined.

Sub-sector	Identified Gap	Potential Solutions	Responsible Party
Road transport	<p>Need for data on separation of vehicle type and fuels types (incl. dual fuel use)</p> <p>Lack of data on specific fuel use of vehicle by type</p>	<p>Undertake statistically relevant surveys.</p> <p>Record data on the consumption volume of fuels are petrol stations.</p> <p>Determining the frequency of refuelling of vehicles by vehicle type and fuels type (can be based on station revenue from fuel sales).</p> <p>Dual fuel vehicle can present identification card when tanking up.</p> <p>Gas stations record fuel consumption by vehicle type and fuels type</p>	<p>No agency currently responsible</p> <p>People in general</p>
Rail transport	<p>Cannot current separate the emissions / fuel used between freight and passenger locomotives.</p>	<p>Determine through operational data the fuel use per km of the different types of locomotives.</p> <p>Sperate the journeys (km travel) freight or passenger, and route travelled.</p> <p>The above can be addressed by data gained for fuels use, passenger / fright numbers, and locomotive tracking under a future Information and Safety system to be implemented.</p>	SRT
Aviation transport	<p>Need for a common MRV system for both national and international GHG emission reporting.</p> <p>Need for a formal verification process for GHG data.</p>	<p>Use the MRV system to be defined by CORSIA (in 2019), where both national and international data and methodology are similar and allowing for inputs to the GHG inventory.</p> <p>Start with a bottom-up verification process, with new regulation requiring airlines to (3rd party) audit the GHG emissions data provided to CAAT.</p>	CAAT
Sea port operations	<p>PAT does not currently have a mandated system to fully measure, report, and verify energy use and GHG emissions from sea port operations.</p>	<p>Make the MRV of energy use and GHG emissions from sea port operations, mandatory under regulations.</p>	PAT

		<p>Appoint an entity responsible for collecting GHG emissions data from all sea ports, who can also verify the GHG emissions data and results.</p>	
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Based on the content of the FGD, and the sub-sector breakout sessions, these are the following gaps or capacity development needs:

1. *Road Transport*: To prepare the statistically relevant survey requirements and methodology, and survey templates, for determining the separation of vehicle type and fuels types for passenger road transport and provide training or national counterparts /consultants who will conduct and compile the results of the survey.
2. *Rail Transport*: To prepare data requirements, description of information pathways, and determination methodology to separate the emissions / fuel used between freight and passenger locomotives.
3. *Aviation transport*: To prepare data requirements, description of information pathways, and determination methodology for an integrated (national & international) MRV system based on CORSIA guidelines and methodology.
4. *Aviation transport*: To prepare draft policy documentation, including regulatory act, requiring airlines to have 3rd party audits for data used for the reporting of fuel use and GHG emissions.
5. *Sea port operations*: To prepare draft policy documentation, including regulatory act, requiring all sea ports to report on their energy use and MRV requirements.
6. *General*: Prepare guidance documentation for the tracking of the use of means of implementation within the individual sub-sectors of the transport sector.

Annex F: Summary of Baseline Training Workshop

The purpose of the Baseline Training Workshop was to support Thailand in gaining a greater understanding of the requirements for information and the various approaches and principles to develop baselines for GHG emissions within the broader context of the Paris Agreement (PA), and the specific context of Thailand's Nationally Determined Contribution (NDC). Taking this into account this scope, the Baseline Training Workshop addressed the following:

1. To highlight the purpose a baseline within the NDC, focusing on the Business-as-Usual (BAU) scenario and how to compare the same against a mitigation scenario to determine the emission reduction potential (ex-ante) and achieved (ex-post);
2. To emphasis the differences between the national inventory and other reporting under the UNFCCC's requirements for National Communications (NCs) / Biennial Update Reports (BURs) and the baselines for NDCs;
3. To introduce the different approaches and methods for determining NDC baselines, and the different tools which countries are using in determining NDC baselines and challenges faced;
4. To review the approach and examples of how NDC baselines are determined for the energy sector;
5. To review the approach and examples of how NDC baselines are determined for the waste sector;
6. To assess the parameters for baseline development in the agriculture sector

It should be noted, that the Baseline Training Workshop included several breakout exercises for participants.

The Baseline Training Workshop was held on 14th November 2018 at The Quarter Ari at Ari Hills in Bangkok, and attended by the following groups:

IPPU Sector	Energy Sector
<ul style="list-style-type: none"> ▪ Iron and Steel Institute of Thailand ▪ Electrical and Electronics Institute ▪ Petroleum Institute of Thailand ▪ Center of Excellence and Sustainability SCG ▪ Environmental Department, SCG ▪ Office of Industrial Economics ▪ Department of Industrial Works (DIW) 	<ul style="list-style-type: none"> ▪ Department of Alternative Energy Development and Efficiency (DEDE) ▪ Energy Policy and Planning Office (EPPO) ▪ Department of Mineral Fuels (DMF) ▪ Electricity Generating Authority of Thailand (EGAT) ▪ Ministry for Energy – Permanent Strategy Office (PSO)
Transport Sector	Waste Sector
<ul style="list-style-type: none"> ▪ Department of Energy Business ▪ Marine Department ▪ Department of Land Transport ▪ State Railway Thailand 	<ul style="list-style-type: none"> ▪ Pollution Control Department (PCD) ▪ Environmental Office, Bangkok Metropolitan Administration (BMA) ▪ Department of Health (DoH) ▪ Water Management Authority (WMA) ▪ Department for Local Authority (DLA)
LULUCF Sector	Agriculture Sector

<ul style="list-style-type: none"> ▪ Department of National Parks, Wildlife and Plant Conservation (DNP) ▪ The Forest Industry Organization 	<ul style="list-style-type: none"> ▪ Rice Department (RD) ▪ Department of Livestock Development (DLD) ▪ Department of Agriculture (DOA) ▪ Office of Agricultural Economics (OAE) ▪ Department of Agricultural Extension (DOAE) ▪ Land Development Department (LDD)
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The Baseline Training Workshop included a mixture of presentations (incl. examples) and exercises for participants. The agenda for the Baseline Training Workshop included a short introduction by ONEP and GIZ, followed by five presentations from the TGCP consultants, and closing remarks. There was good participation in the questions and answers sessions after each presentation, as well as during the exercises for participants. The subject and a general short summary of the presentations is provided in the table below.

Introduction of the workshop and participants, Dr. Natthanich Asvapoositkul from ONEP and Dr. Angkana Chalermpong and Ms. Kirsten Orschulok from GIZ

ONEP opened the workshop by highlighting the importance of a baseline as the means to measure progress and success in meeting Thailand's NDC targets, and indicating that each country has its own way of address baselines under their NDCs. GIZ highlighted that the aim of the Thai-German Climate Programme TGCP was to support Thailand in achieving its climate change goals and ensuring institutional memory. The support will focus on tailored made and national appropriate solutions within the agriculture, energy, waste, and water management sectors. The participants were asked to introduce themselves and to indicate their expectations for the workshop, which were mainly:

- Present Case Study examples
- How to develop a baseline for sectors & close gaps
- How to apply knowledge again about baselines and QA&QC in current work
- What methodologies to collect data

Both ONEP and GIZ encouraged active participation of the participants.

Introduction to NDC baselines, Mr. Sven Feige, TGCP Consultant from Perspectives Climate Change

In the first session of the workshop, the context NDCs baselines within the PA was introduced as an important aspect to define emission reductions provided by each country. Likewise, Thailand's NDC is based on an emission reduction target compared to the BAU (Business-as-usual) baseline scenarios by – 20%, which can be add up to -25% with international support. Accordingly, the introduction provided an overview of general approaches to define a baseline or more specific a BAU scenario and how to compare the same against a mitigation scenario to determine the emission reduction potential or target. Related to this, the top-down and bottom-up approach was introduced and along with a simple clarification of the difference between ex-ante and ex-post approaches. The presentation provided in addition an overview on how NDCs deal with the topic of baselines (i.e. a quantitative analysis of the number of NDCs applying which approaches for the definition of their emission reduction targets: Business-as-Usual, absolute targets, intensity targets, peaking targets, policies and actions, and adaptation with mitigation co-benefits).

GHG Emissions and NDC Baselines in the context of UNFCCC and beyond, Ms. Madhura Mitra, TGCP Consultant from PwC India

The session was prepared with the objective of familiarising the audience about the significance of NDC baselines in the context & differences of current GHG emissions reporting to the UNFCCC and expected baseline reporting under NDCs (and NAMAs prior to 2020). This session was a continuation of the first session and explained requirements on reporting of GHG emissions & emissions scenarios from NC and BUR, and perspective in reporting of GHG emissions baselines and mitigation under the Paris Agreement. The presentation elaborated on the basics process and key considerations while preparing baselines in general and the steps to be followed for developing baseline scenario in the context of NDC.

Overview of (Baseline) modelling tools, Mr. Douglas Marett, TGCP Consultant from GH Sustainability

This third session of the workshop centred around the approach and tools for modelling of GHG emissions baselines. The session highlighted in more detail the types of baselines (ex-ante, ex-post, static, dynamic) and the influence of choices in data and types of baseline models, as well as a comparison in approaches of top-down and bottom-up modelling. Different baseline types of models were explained, including the use of such models by different countries (model-type and software). Finally, the challenges and limitations of the different approaches to modelling were explained. The session concluded with a breakout session which asked participants to evaluate the strengths of modelling methods, and to indicate which method would fit best for baseline modelling in their work.

Review of Sectoral NDC baseline-Energy Sector, Mr. Bhaskar Nath, TGCP Consultant from PwC India

The aim of this session was to provide a greater understanding of the actual development of sector-based NDC baselines, with a focus on the energy sector. The session started with a brief explanation of key guiding documents for the development of GHG emission baselines and emission reduction calculation for the energy sector (e.g. IPCC guidelines, GHG protocol, ISO 14064, UNFCCC-CDM methodologies, and Gold Standard and Verified Carbon Standard methodologies). The presentation then highlighted the IPCC three-tiered approach to emission estimation for energy sector: 1) Tier 1 (International Default Factors), 2) Tier 2 (National Default Factor), and 3) Tier 3 (Country Specific Methods). Common data types for energy sector baseline modelling were explained, including macroeconomic data, energy demand and supply data, data related to technology options, and emissions factors. This was followed by a detailed explanation on the objective and approach to a sectoral NDC baseline review, which addresses correctness, appropriateness, comprehensiveness, suitability/robustness, and effectiveness of a developed baseline. Finally, a case study of a review of an energy sector NDC baseline for Indonesia was presented. The session was concluded with a breakout session which briefly discussed at a high level the Thailand NDC and sector baseline via in groups (looking at energy and agriculture baselines).

Review of Sectoral NDC baseline - Waste sector, Mr. Sven Feige, TGCP Consultant from Perspectives Climate Change

This session focused on answering the guiding questions regarding the baseline for the waste sector under Thailand's NDC and mitigation roadmap. These guiding questions were:

- How has the waste sector NDC baseline been established?
- How can the emission reduction potential be evaluated?
- How robust is the current waste sector baseline of Thailand's NDC?
- How can it be further strengthened?

The session started with an overview of the total NDC baseline in terms of GHG emissions and the contribution from the waste sector, which is comparatively low (i.e. about 3 to 4%). However, it was highlighted, that the waste sector is of high importance due to a strong linkage to other sectors such as energy (e.g. affected by waste to energy activities) and industry (e.g. affected by recycling activities). Based on the IPCC calculation methodology for the waste sector, the participants were

guided through breakout discussions of which parameters, data, and the related assumptions for future development of the same may impact the development of the NDC BAU baseline emission scenario (looking at municipal solid waste, industrial waste, and waste water).

Q&A and closing remarks

In the final session, questions and answers (Q&A) were addressed for remaining open questions of the participants regarding baselines and related elements. This Q&A was followed by a general summary of the day's activities and outputs, where the high-level outputs from the breakout sessions regarding baselines are presented below.

○ Wrap-up From Day-1!

Agriculture:

- Ideally, the NDC baseline should cover 1) rice 2) non-rice crops) and 3) livestock
- The baseline may be ex-post to accommodate revision of Tier 1 values with Tier 2
- FAO's modelling tool may be used for baseline projection

Energy baseline:

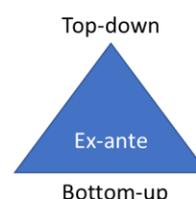
- Good sub-sector coverage of in data / modeling, but may need to update the baseline with revised planning and a few cross-boundary activities (WTE, biogas...)
- May need to review assumptions made in future
- Regular data and updates are needed to track progress
- ENERGY DEMAND WILL INCREASE

Modelling approaches what will benefit people in their job:

(1) Ex-Ante / Bottom-up:
Agriculture & Forestry, Industry, Transport, Oil & Gas

(2) Ex-Ante / Top-down:
Waste, Energy, Inventory,

(3) Ex-Post / Bottom-up:
Agriculture, Industry, Waste

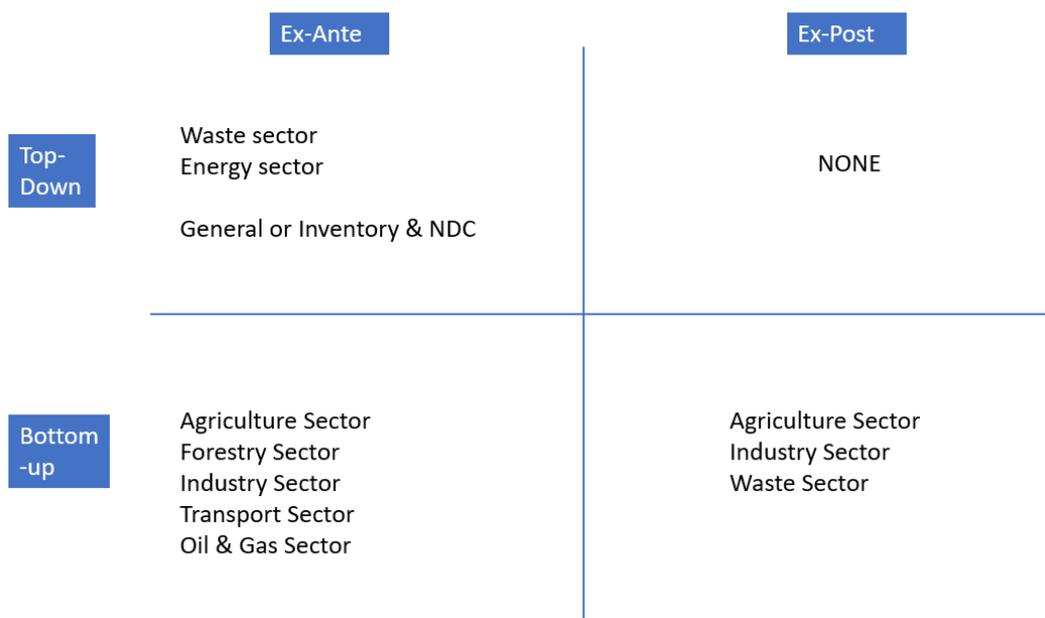


Waste baseline:

- Still gaps to be closed (migrant & tourist population)
- Waste composition and quantities will change in the future
- A lot of "green" activities are already ongoing (municipal, industry...), awareness raising.

Key outcomes of breakout session (Modelling):

After the session on modelling and tools the participants were asked to identify which type(s) of GHG baseline model would best suit them in their daily activities in their sector / sub-sector. The participants were instructed to take into account that the preference of the model should address the annual GHG emissions, tracking of progress (and planning and policy/regulation), information availability, and ease of use. The outcome preferred model is as follows.



Key outcomes of breakout session (Energy):

Post presentation on *Sectoral NDC baseline-Energy Sector*, a group / breakout exercise was conducted to gather inputs on the energy sector NDC baseline of Thailand. Key issues raised by the participants were:

1. The sub-sectors covered under the energy sector baseline are electricity generation (including generation from renewable energy sources), heat energy and energy efficiency measures (both supply side and demand side energy efficiency). Though sub-sectoral coverage is appropriate, it was highlighted by the participants that some cross-boundary activities such as Waste to Energy (since waste is a key issue in Thailand), Biogas generation are not included in the baseline development.
2. The Thailand's energy sector baseline is formulated based on the projections made in the key sectoral policy plans Power Development Plan (PDP 2015), Thailand Energy Efficiency Development Plan (EEDP 2015-2036) and Thailand Alternative Energy Development Plan (AEDP 2015). These policy plans will be updated in coming years to revise the sectoral objectives considering new facts on the ground. The impact of these revisions may be considered while reviewing/ revising the energy sector baseline.

Thailand may review critical assumptions considered for energy sector NDC baseline development such as GDP and population growth rate, and identify possible inherent uncertainties and their impact on baseline scenario. The assumptions communicated in the NDC may be strengthened by addressing how changes in the drivers are likely to be reflected in changes to the baseline scenario in the given timeframe. It is important to regularly update the assumptions in order to track the NDC progress along with better coordination in terms of data collection and reporting, and QA/QC between the agencies.

Key outcomes of breakout session (Agriculture):

After presentation on *Sectoral NDC baseline-Energy Sector*, a special group / breakout exercise was conducted for the agriculture sector addressing baseline issues. The key issues raised by the participants were:

1. There is some uncertainty as to the inclusion of agriculture sector energy use in the NDC baseline boundary. The agriculture sector has already, and it is expected an increase, the use of in renewable energy in the form of biogas, biomass, solar, etc.
2. Given the agenda for more afforestation, it was questioned if the NDC baseline boundary should in the future include land use and forestry.
3. Ideally the NDC baseline boundary should include cash crops (such as rice) and livestock, and possible ex-post to accommodate a revision from tier-1 to tier-2 approach using an FAO model.

Key outcomes of breakout session (Waste):

After the presentation on the *sectoral NDC baseline for the waste sector*, a group / breakout exercise was conducted to facilitate better understanding of which parameters and assumptions have an impact on the NDC baseline and to enable participants in further engaging in any future update or review of the NDC baseline for the waste sector NDC baseline of Thailand. The issues raised by the participants were:

1. The participants have identified the key parameters impacting the NDC baseline such as the size of the population, the GDP, the income situation and the size of households and the related projection for the period up to 2030. At the same time, the existing data gaps identified for the development of the GHG inventory have been mentioned rightly to be problematic for the NDC baseline development as well (migrant and tourist population, waste composition, etc.). In addition, it was highlighted that there are a lot of "green" activities ongoing in the waste sector at different levels (municipalities, industry) including steadily awareness raising related to better waste management and technology changes.

Generally, it became obvious that there is a strong interest in the topic and that the currently available information on how the NDC baseline was developed is not enough or not sufficiently made available among all stakeholder. Considering the aim of enhanced transparency, it was recommended to elaborate options to provide such information to understand the NDC baseline development and contribute to any future update or review.

Annex G: Summary of QA/QC Training Workshop

The purpose of the QA/QC Training Workshop was to Thailand in gaining a greater understanding of the requirements for Quality Assurance and Quality Control (QA/QC) and the various approaches and principles of QA/QC as applied to inventories and baselines for GHG emissions within the broader context of the Paris Agreement (PA), and the specific context of Thailand's Nationally Determined Contribution (NDC). Taking this into account this scope, the QA/QC Training Workshop addressed the following:

1. To highlight the main concepts of QA/QC, available guidance and tools from the UNFCCC and US-EPA;
2. To provide an overview of the types of data gaps and uncertainty found in GHG inventories, NDC baselines, and mitigation actions. Along with some examples;
3. To carry out group breakout sessions to review and define gaps & possibilities with the existing QA/QC process in the GHG inventory development, in the agriculture, energy, waste, and transport sectors;
4. To provide some examples of QA/QC in the energy sector;
5. To highlight the requirement for transparency in the form of the Enhanced Transparency Framework (ETF) under the PA.

It should be noted, that the QA/QC Training Workshop included a breakout session for participants.

The QA/QC Training Workshop was held on 15th November 2018 at The Quarter Ari at Ari Hills in Bangkok, and attended by the following groups:

IPPU Sector	Energy Sector
<ul style="list-style-type: none"> ▪ Iron and Steel Institute of Thailand ▪ Electrical and Electronics Institute ▪ Iron and Steel Industry 	<ul style="list-style-type: none"> ▪ Department of Mineral Fuels (DMF) ▪ Electricity Generating Authority of Thailand (EGAT)
Transport Sector	Waste Sector
<ul style="list-style-type: none"> ▪ Department of Energy Business ▪ Marine Department ▪ Department of Land Transport ▪ Office of Transport and Traffic Policy and Planning (OTP) 	<ul style="list-style-type: none"> ▪ Pollution Control Department (PCD) ▪ Environmental Office, Bangkok Metropolitan Administration (BMA) ▪ Department of Health (DoH) ▪ Department of Environmental Quality Promotion (DEQP)
LULUCF Sector	Agriculture Sector
<ul style="list-style-type: none"> ▪ Department of National Parks, Wildlife and Plant Conservation (DNP) 	<ul style="list-style-type: none"> ▪ Rice Department (RD) ▪ Department of Livestock Development (DLD) ▪ Department of Agriculture (DOA) ▪ Office of Agricultural Economics (OAE)

The QA/QC Training Workshop included a mixture of presentations (incl. examples) and exercises for participants. The agenda for the QA/QC Training Workshop included a short introduction by ONEP and GIZ, followed by five presentations from the TGCP consultants, and closing remarks. There was good participation in the questions and answers sessions and the breakout sessions. The subject and a general short summary of the presentations is provided in the table below.

Introduction of the workshop and participants, Mr. Sivach Kaewcharoen from ONEP, and Mr. Douglas Marett, TGCP Consultant from GH Sustainability

ONEP opened the workshop by highlighting the importance QA/QC in the GHG inventory and NDC baseline development processes. The TGCP Consultant introduced the agenda for the day, along with the general participants expectations and key-words to remember from previous day (Baseline Training Workshop).

Guidance on QA / QC in Climate Change, Mr. Douglas Marett TGCP Consultant from GH Sustainability

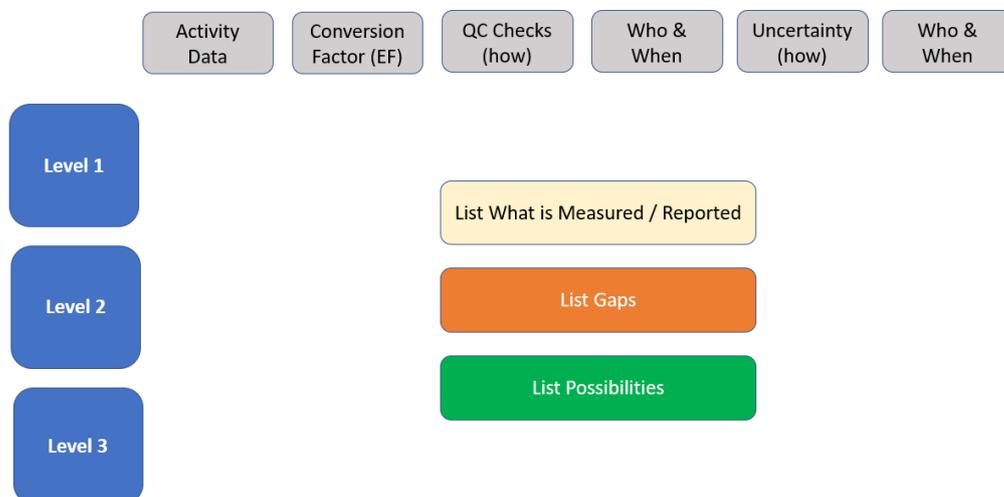
In the first session of the workshop, highlighted that the process for QA/QC for GHG Inventory and NDC baselines & mitigation should be similar. The content of the session started with the difference between Quality Assurance and Quality Control, and the key aspects which make up each. This was followed by an explanation of the QC process of UNFCCC / IPCC guidelines for GHG inventories, which focused on emission factors, direct- and activity-level emissions. Then the minimum QA activities required under the UNFCCC / IPCC guidelines were presented. Then the US-EPA QA/QC system for GHG inventories was presented. The participants were introduced to tools for QA/QC and an example of QA/QC in the municipal wastewater sector in Thailand. Finally, what was emphasised was the need to ensure documentation of the QA/QC process and information sources throughout the GHG inventory development process (guided by what, where, how, who, and when).

How to deal with data gaps and uncertainty, Mr. Douglas Marett, TGCP Consultant from GH Sustainability

The second session defined different types of data gaps commonly found in GHG Inventory and NDC baselines & mitigation calculations, along with a few examples how to address the data gaps. Then the concept of bias and uncertainty (scientific and estimation) was presented to the participants, along with a theoretical example of how to address uncertainty. Finally, participants were asked to review their own work in terms of data and calculations which are directly or indirectly used to determine GHG emissions or mitigation, and write down for themselves how QA/QC is followed with regards to that data and calculations (this information was not collected).

Status quo observed in Thailand and potential for improvements (breakout groups)

The third session focused specifically on breakout groups who had the task to map out the QA/QC processes (and gaps / possibilities) within the agriculture, waste, energy, and transport sectors. Noting that due to the availability of personal from government entities only certain subsectors were addressed. The participants were to define (where possible) the QA/QC processes based on the following matrix:



Case Study: Mitigation actions on Access to Clean Energy (Ghana), Mr. Bhaskar Nath, TGCP Consultant from PwC India

An example of the use of Linear Regression to address a data gap (e.g. a mission month of data using several years of data) was shown to the participants. Followed by a case study highlighting the QA/QC process under the MRV system of an Off-grid energy generation programme "Mitigation actions on access to clean energy" from Ghana. The two interventions on off-grid Renewable Energy generation and distribution of Clean cooking technologies were discussed along with their MRV system. The presentation highlighted on how QA/QC is being carried out at different data points and responsible entities to carry out the QA/QC for various parameters related to GHG emission reductions, sustainable development impacts, and means of implementation (capacity building, technology transfer, finance support) received by the programme.

The Enhanced Transparency Framework (ETF), Mr. Sven Feige, TGCP Consultant from Perspectives Climate Change

The presentation provided an overview of the Enhanced Transparency Framework (ETF) as formulated in Article 13 of the Paris Agreement. The currently known requirements have been presented. Given that the detailed definition of rules (i.e. the "Paris Agreement Working Programme (PAWP)") were still to be defined and therefore on the agenda of negotiation of the COP 24, the current status of negotiation and outcome of meetings in the run-up of the COP were presented based on examples (e.g. the requirements related to application of IPCC guidelines).

Q&A and closing remarks

In the final session, questions and answers (Q&A) were addressed for remaining open questions of the participants regarding baselines and related elements. This Q&A was followed by a general summary of the activities and outputs for Day 1 (baselines) and Day 2 (QA/QC), as well as key words for participants to remember going forward,

Waste QA/QC :

- For BMA there is QC check in place with authorities double checking data reported
- Need for a committee at the PCD to do QC before data is given to ONEP

Energy QA/QC:

- Fuels and electricity are measured at power generation plants, and other fuel sources
- QC of calorific values need to be investigated
- Not certain of QC at the levels up to ONEP

QA/QC, Data Gaps, Uncertainty:

- QC is the procedures for reviewing data and conversion factors, and models
- QA is the process of reviewing the process
- Where data gaps come from and solutions
- Scientific uncertainty, estimation uncertainty
- Error and uncertainty are circular in process one point creates, error at another point)

Agriculture QA/QC:

- A lot of crop and livestock data is collected in different formats and delivered to several different entities
- Calibration of gas chromatography should follow internal standards
- No or limited QC on livestock data

○ Key words to remember today!

Quality Assurance

BAU – Business-as-Usual

Ex-Post

Quality Control

Top-Down

NDC Baseline

GHG Inventory

Uncertainty

Activity Data

Mitigation

Ex-Ante

Bottom-Up

Data Gaps

QA/QC Plan

Models

Emissions Factors

Key outcomes of break out session (Agriculture Sector):

There is a QC process for the review of several forms of data by various government entities (DOAE for crops, Dpt. of Livestock for livestock), as well as a QA/QC process for an annual review by a Joint Committee at OAE at the sector level. Whereas QC at ONEP mainly consists of comparison of data from year to the other, and between import and exports in some cases. There are also a series of surveys and fields checks on certain types of data at the activity level. In general, the process is unmapped, so it is difficult to show where QC is being done and how uncertainty is being determined. As well there appears to be many formats for data collection with possible duplication and error. A first observation is that data gathered and a level of QA/QC is in place, but it is difficult to follow and determine uncertainty.

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	When is it reported to ONEP?
3 National ONEP	-	-	Working group of experts of DOA calibrates with research value	Verification by DOAE for all crops as per crop calendar Verification for livestock by Dept. of Livestock round the year,	Crops as per crop calendar Livestock around the year Annual review and compilation by ONEP
2 Sector Agency	-	CH4/Ha/year Nitrogen percentage per volume of fertilizers (both Tier 1 and 2)	Activity for crops verified as per IRRI standards Cross checking of nitrogen use with import-export values and percentage of deviation is calculated. CH4, N2 analysis and calibration by in-house laboratory of the rice department	Annual review by Joint Committee at OAE Annual review and compilation through TGEIS by ONEP for the nation	
1 Installation / Activity	Type & production of crops Flooding & cropping days Type & number of animals	-	Sample field checks by experts from DOAE		

Type and volume of fertilizer use	Area under cultivation				
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Key outcomes of break out session (Energy/Electricity Sector):

The QA/QC process for the data parameters under the electricity generation (on-grid electricity generation) sub-sector includes various organisations such as power plants, EGAT, ERC, Energy Working Group (under the Ministry of Energy), EPPO and ONEP as shown in the figure to the side. The Quality Control (QC) of the electricity generation data is being carried out at three levels-EGAT, EPPO and ONEP while Energy Working Group is responsible for overall quality assurance (QA) of the data. Though it was mentioned that a specific set of questionnaires is being followed for the QA/QC process at different levels, the detail of this questionnaire (i.e. templates) is unknown to the consultants and the participants.

Although QC process followed at ONEP is considered adequate, the process followed at bottom level (i.e. at plant, ERC and EPPO) is unknown. In addition, the process for quantification of uncertainty needs to be developed and implemented at ONEP level. There is a need for further review the QC process at bottom level in order to estimate uncertainty arises from the meters (used to monitor/measure the electricity generation) and calorific value of the fuel used in the power plant.

For the energy efficiency subsector, nearly all the overall QA/QC process is unknown and there is a need to improve the overall QA/QC process through development of guidelines and standardised templates.

Electricity Generation

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	When is it reported?
3 National ONEP	Electricity generation from on-grid power plant (by Fuel type including electricity generation from Renewable Energy)	Fuel calorific energy values come from DEDE Emission factors default IPCC values are used	QC based on comparing new data with old data. QC is not done for calculations (TGEIS may do this)	ONEP	Annually by ONEP

	Fuel consumption by the on-grid power plants (by fuel type)		No uncertain analysis (new process to be developed TGEIS may do part of this)		
2 Sector Agency	Electricity generation from on-grid power plant (by Fuel type including electricity generation from Renewable Energy) Fuel consumption by the on-grid power plants (by fuel type)	Not known	Not known	ERC for fuels EPPO for generation	Annually to ONEP
1 Installation / Activity	Electricity generation from on-grid power plant (by Fuel type including electricity generation from Renewable Energy) Fuel consumption by the on-grid power plants (by fuel type)	Fuel calorific energy values Emission factors default IPCC values are used	Generation data at plants is expected to come from calibrated meters Fuel consumption data at plants is expected to come from calibrated meters QC of DEDE data is unknown.	Power plant (EGAT) should be doing QC annually Coal calorific energy values comes from ICAT Oil & petroleum from PTT (missing the uncertainty levels)	The power plants report data to EGAT on monthly basis.

Energy Efficiency in Large Buildings

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	When is it reported?
3 National ONEP	Not known	Not known	Not known	Not known	Not known
2 Sector Agency	Not known	Not known	Not known	Not known	Not known
1 Installation / Activity	Electricity and fuel consumption in large buildings (exceeding 10,000 m ²)	Not known	Not known Possibly through building design (calculations)	Not known	The building owner reported the data to DEDE through the ePortal. Finally, DEDE reports the data to ONEP annually.

Energy Efficiency in Large Factories

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	
3 National ONEP	Not known	Not known	Not known	Not known	Not known
2 Sector Agency	Not known	Not known	Not known	Not known	Not known
1 Installation / Activity	Electricity and fuel consumption in large factories	Not known	Not known Possibly through audits based on the energy management system	Not known	The factory owner reported the data to DEDE through the ePortal. Finally, DEDE reports the data to ONEP annually.

Key outcomes of breakout session (Waste Sector):

At the level of primary / activity data collection (i.e. measurement) it was discussed that there are quite some differences dependent on the actual agency involved. While for example for weighing equipment regular calibration checks are foreseen at the Bangkok Metropolitan Administration, especially, if data related to waste quantities is estimated based on population figure, implementation of QA/QC procedures can be assumed not existing at the required level.

Not only at local level, also at central level it was mentioned that for example at PCD a QC committee with the relevant agencies should be established to conduct a more comprehensive check of the data before the submission to ONEP.

As a general observation, it appears that QC procedures are already implemented to a higher extend compared to QA procedures. Furthermore, it was mentioned that the introduction of TGEIS is expected to provide also some functionality in terms of QA/QC procedures as the system is expected to provide indications related to inconsistency of data. Accordingly, it must be assessed in more detail, which functions TGEIS finally offers and how this can be efficiently used by the staff running TGEIS.

Solid Waste

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	When is it reported?
3 National ONEP	Solid waste as per IPCC Tier 1	Using Tier 1 IPCC Future to use Tier 2 IPCC	Not Known	ONEP (also expected to be part of TGEIS)	Annually
2 Sector Agency	Solid waste as per IPCC Tier 1. Amount collected Composition Population	Not Known	Not Known	PCD, REO, DLA	Annually to ONEP
1 Installation / Activity	Solid waste as per IPCC Tier 1. Amount collected Composition Population	Generation per person (past study) Composition (monthly at 3 landfills)	Not Known	Not Known	Not Known

Wastewater

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	When is it reported?
3 National ONEP	Wastewater (only a portion from WWTPs) BOD and Flow (Influent & Effluent),	-	Not Known	Not Known	Annually
2 Sector Agency	Wastewater (only a portion from WWTPs) BOD and Flow (Influent & Effluent),	-	Not Known	Not Known	Annually to ONEP
1 Installation / Activity	Wastewater (only a portion from WWTPs) BOD and Flow (Influent & Effluent),	-	REOs do standardised testing of samples for BOD based on national standards, and site visits check for flow.	Not Known	Every six months or monthly

Transport Sector

Only fuel data was addressed regarding the transport sector, which consisted of fuel amounts and fuel calorific energy values. There was no clear indication of how fuel calorific energy values are determined and QC. It was also not known how QC is done on the full amounts before it reaches ONEP.

Level	Data Parameters	Conversion Factors	How is QC being done?	Who is doing QC?	When is it reported?
3 National ONEP	All Fuels amounts	Fuel calorific energy values come from DEDE Emission factors default IPCC values are used	All Fuels amounts are done by comparison of values	ONEP	Annually
2 Sector Agency	All Fuels amounts	-	-	Not Known	OTP to ONEP annually

1 Installation / Activity	Fuels amounts (ethanol/gasoline, diesel, gasoline, jet fuel, LPG, CNG, fuel oil)	Fuel calorific energy values come from DEDE Emission factors default IPCC values are used	Not known how DEDE does Fuel calorific energy values QC	DEDE	DEDE
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QA/QC gaps and capacity development needs

With the focus on the above results of the breakout sessions, the following QA/QC gaps and capacity development needs are identified, and recommendations are made to improve QA/QC.

No.	Gaps and Capacity Development Needs	Recommended Actions
1	<i>Agriculture:</i> Diverse data sets lead to greater uncertainty, and there is duplication of efforts reflect the lack of clarity in terms of roles of each of the stakeholder in the MRV process and lack of coordinated efforts.	QA/QC guidelines and templates as per the requirements of UNFCCC/ US EPA (other better) may be developed as a part of TGCP for each sub-sector. The parties doing the QC and QA need to be defined as a part of the above.
2	<i>Agriculture:</i> Laboratory analysis and international standards for calibration for CH ₄ emissions data from rice cultivation is limited and can lead to higher uncertainty.	Appropriate and representative sample sizes need to be addressed to ensure higher certainty in countrywide emission factors. This starts with calibrated / certified laboratory instruments (e.g. glass chromatograph) which carried out annually by a third party (other than the Rice Department) who is internationally accredited (e.g. as per standards defined by IRRI) to increase reliability of the data.
3	<i>Energy:</i> Processed to better define the level of uncertainty for energy sector data needs to be implemented at both ONEP and the bottom level of data collection.	There is a need to improve the overall QA/QC process through development of guidelines and standardised templates for QA/QC. Capacity building sessions on the QA/QC guidelines and templates should be conducted. There is a need for further include the QA/QC at the bottom level (i.e. Power plants / EGAT) to determine the general uncertainty from meters and calorific values of the fuels. This could be done by a representative sample.
4	<i>Energy:</i> For the energy efficiency subsector, the overall QA/QC process is unknown.	To improve the overall QA/QC process relating to energy efficiency a mapping is needed to determine the existing practice of QA/QC within the energy management system requirements. The existing system may or

		may not include third-party auditing, which typically includes QA/QC and a determination of uncertainty. may or may not include through development of guidelines and standardised templates
5	<i>Municipal Solid Waste:</i> The uncertainly level of several key factors used is not known (such as waste composition and waste generation per-person).	Appropriate, recent, and more representative sample sizes need to be addressed to ensure higher certainty in national generation factors, or sub-national generation factors.
6	<i>Wastewater:</i> QC at the Sector Agency Level is not clear.	A mapping of the QC processes at the Sector Agency Level can be done, and improvement recommendations provided.
7	<i>Transport:</i> It is not known how DEDE does the QC on fuel calorific energy values. And the level of uncertainly fuel calorific energy values.	This could be done by a representative sample from fuel calorific energy values test from certified laboratories.
8	<i>General:</i> The QA/QC process needs to be mapped out in the sector at all three levels.	<p>Starting with ONEP (National Level) a QA/QC process and management system can be developed for ONEP's own activities.</p> <p>At the Sector Agency Level two approaches can be taken to (1) map out data flows and QA/QC points in the sectors / subsectors, or (2) to define the GHG data needed top-down based on Tier 2 data needs, and then to prepare QA/QC criteria templates for this data which the sector agencies need to complete before send final data to ONEP (e.g. do the QA/QC and determine uncertainties.</p> <p>A general training of ONEP and for each sector in QA/QC and uncertainties could also be given after the two points above.</p>

Annex H: Details of Measures in the Climate Change Master Plan 2015 – 2050 of Thailand

1) Integrated water resources management

- a. Promote information exchange and integration concerning water resources among relevant agencies and develop/improve water footprints and data collection on water consumption to support planning for equitable water resource management.
- b. Encourage active participation in river basin policy, planning and management by all stakeholders, including general consumers, farmers (energy and food crops) and industry.
- c. Develop a master plan on water utility development to facilitate systematic and efficient utilization of water resources by promoting integrated use of surface and ground water according to basin-based capability in order to provide equal access to clean water for all.
- d. Promote water conservation and increase the efficiency of water consumption in the service, industrial, agricultural and household sectors.
- e. Strengthen the capability of local administrative bodies in efficient and sustainable water resource management.
- f. Develop basin-based land-use plans and appropriate land-use zoning for municipal development, agriculture and conservation that is in alignment with climate change and local water resources management plans.
- g. Accelerate the implementation of internationally recognized measures on sustainable water management.

2) Flood and drought mitigation and adaptation

- a. Regenerate upstream forests to regulate water flow and maintain biodiversity; promote soil and water conservation in areas utilizing slope agriculture to prevent and minimise soil erosion and degradation.
- b. Create water retention areas, flood diversion channels and river catchment boundary markers, etc., for flood preparedness that is in harmony with the local ecological conditions.
- c. Increase water supply and capability of water storage systems by restoring natural catchment areas, create a database of natural water resources, improve small water resources and groundwater sources in non-irrigation agricultural areas, expand irrigation coverage to areas with agricultural potential, and promote water storage systems for the dry season.
- d. Update water resource management criteria for existing and new water reservoirs to ensure optimization to each river basin, taking into account climate variation factors.
- e. Conduct studies on local water consumption patterns to improve water demand management and explore measures to enhance the efficiency of consumption as options in adapting to climate change.

3) Flood and drought risk management

- a. Assess the impact of climate change and evaluate predicted impact, especially in high-risk areas, on the hydrological cycles using climate model simulations.
- b. Create risk maps demonstrating flood and drought prone areas at national, regional, water basin, provincial, and community levels in order develop an effective risk management and preparedness plan.
- c. Develop an early warning system that offers accurate and long-range predictions (including meteorological forecasts) along with standard operation procedures and practical guidelines for the public according to the magnitude and severity of the incident.
- d. Develop networks for to facilitate early warning and relief for emergencies at national and local levels with defined roles and responsibilities, together with integrated action plans for relief.
- e. Develop and promote insurance systems for natural disasters in areas that are at risk.



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