Initiative for Climate Action Transparency (ICAT):

Improving Thailand's MRV System for Climate Change Mitigation

Final Report on MRV for the Building Sector

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Initiative for Climate Action Transparency - ICAT -

Improving Thailand's MRV System for Climate Change Mitigation

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ABBREVIATIONS

ACMV	Air-Conditioning and Mechanical Ventilation
AEDP	Alternative Energy Development Plan
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers
BAU	Business-as-Usual
BEBR	Building Energy Benchmarking Report
BEC	Building Energy Code
BESS	Building Energy Submission System
BMA	Bangkok Metropolitan Administration
BREEF	Building Retrofit Energy Efficiency Financing
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CBECS	Commercial Building Energy Consumption Survey
CEPA	Committee on Energy Policy Administration
CHP	Combined Heat and Power
ChP	Chiller Performance
CH4	Methane
COE	Crude Oil Equivalent
COP	Coefficient of Performance
DEDE	Department of Alternate Energy Development and Efficiency
DOE	Department of Energy
DOEB	Department of Energy Business
DPT	Department of Public Works and Town & Country Planning
EEM	Energy Efficiency Measure
EEP	Energy Efficiency Plan
EER	Energy Efficiency Ratio
EERS	Energy Efficiency Resource Standards
EGAT	Electricity Generating Authority of Thailand
EIA	Energy Information Administration
ENCON	Energy Conservation
EPA	Environmental Protection Agency
EPPO	Energy Policy and Planning Office
ERCETS	Emission Trading Scheme
EU	European Union
EUI	Energy Use Intensity
ft	Foot
FTI	The Federation of Thai Industries
GDP	Gross Domestic Product
GFA	Gross Floor Area
GGGI	Global Green Growth Institute
GHG	Greenhouse Gases
GJ	Gigajoule

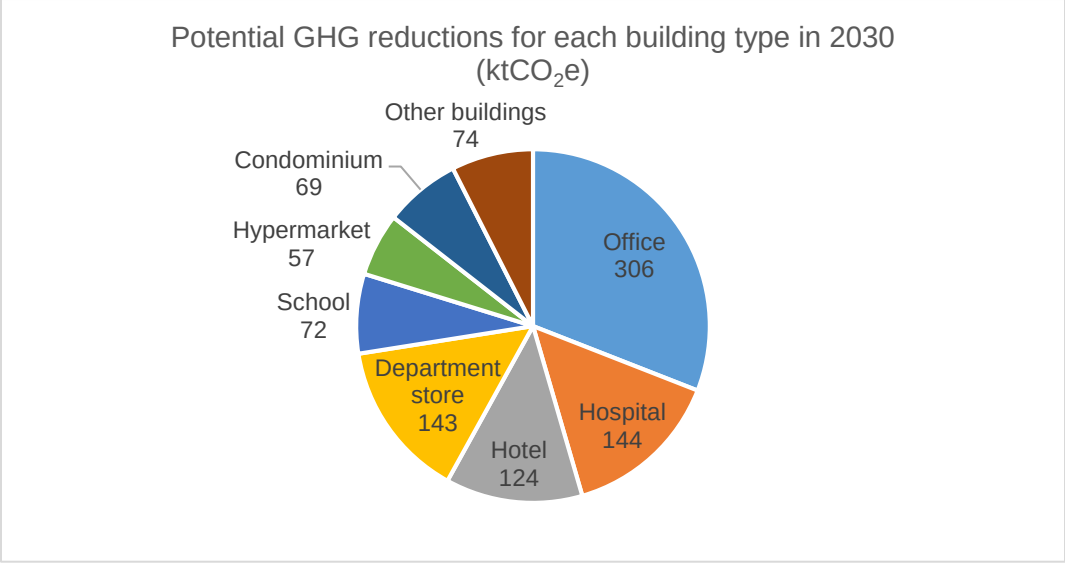
GMFM	Green Mark Facility Managers
GM-GFA	Green Mark Incentives Scheme for Gross Floor Area
GMIS-EB	Green Mark Incentives Scheme for Existing Buildings
GMIS-NB	Green Mark Incentives Scheme for New Buildings
GMIS-DP	Green Mark Incentives Scheme for Design Prototype
GMIS-EBP	Green Mark Incentives Scheme for Existing Building and Premises
GMM	Green Mark Managers
GMP	Green Mark Professionals
GPR	Gross Plot Ratio
GWh	Gigawatt hour
HFC	Hydrofluorocarbon
ICAT	Initiative for Climate Action Transparency
IEAT	Industrial Estate Authority of Thailand
INDC	Intended Nationally Determined Contribution
JPY	Japanese Yen
kBTU	kilo - British Thermal Units
kVA	kilovolt Ampere
kWh	kilowatt hour
LAO	Local Administration Organization
LDCs	Least Developed Countries
LP	Licensed Professional
LPD	Lighting Power Density
LULUCF	Land Use, Land-Use Change and Forestry
MEA	Metropolitan Electricity Authority
MER	Monthly Energy Review
MJ	Megajoule
MOT	Ministry of Transport
MRV	Measurement, Reporting and Verification
NAMA	Nationally Appropriate Mitigation Actions
NC	National Communication
NCCC	National Committee on Climate Change Policy
NEA	National Environment Agency
NEPC	National Energy Policy Council
NESDP	National Economic and Social Development Plan
NDC	Nationally Determined Contribution
OAE	Office of Agricultural Economics
OERC	Office of Energy Regulatory Commission
ONEP	Office of Natural Resources and Environmental Policy and Planning
OTP	Office of Transport and Traffic Policy and Planning
OTTV	Overall Thermal Transfer Value
PCD	Pollution Control Department
PDP	Power Development Plan
PE	Professional Mechanical Engineer
PEA	Provincial Electricity Authority

PFC	Perfluorocarbon
REC	Renewable Energy Certificate
RTS	Rapid Transit System
RTTV	Roof Thermal Transfer Value
SDG	Singaporean Dollar
SEC	Specific Energy Consumption
SF_6	Sulphur hexafluoride
SMF	Small and Medium Facility
tCO_2	Tons of Carbon dioxide
TGBI	Thai Green Building Institute
TGO	Thailand Greenhouse Gas Management Organization (Public Organization)
TREES	Thai's Rating of Energy and Environmental Sustainability
TMG	Tokyo Metropolitan Government
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

EXECUTIVE SUMMARY

Regarding the GHG emission mitigation measures, Thailand has made significant efforts as a signatory Party under the United Nations Framework Convention on Climate Change (UNFCCC) according to its capabilities. It pledged its first Nationally Appropriate Mitigation Actions (NAMAs) to the UNFCCC on 29 December 2014. The NAMA proposed that Thailand has put the efforts, along with given international supports, to reduce GHG emission in the range of 7-20% below the business-as-usual (BAU) level particularly in the energy and transportation sector by 2020. In addition, Intended Nationally Determined Contributions (INDCs) and relevant information was submitted to UNFCCC on 1 October 2015 to restate that GHG emissions would be reduced by 20% (111 $MtCO_2e$) from BAU level by 2030, and up to 25% with international support. As of now, there is no common methodological framework to measure, report and verify the progress made through the GHG mitigation measures that suitable for all sectors and countries. Thus, this report is prepared to study the current situation/baseline of current measurement, reporting and verification (MRV) practice/gaps/barriers and opportunities for an effective MRV. Further the report provides recommendations to strengthen MRV in the building sector especially for office building, department store and hospital as they are the top three highest potential GHG reductions in NDC period.

As per the Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030 (NDC Roadmap), building sector is classified as a sub-sector under the energy and transportation sector and it targets commercial and public buildings. It is expected that the GHG emission reductions through energy efficiency measures (EEMs) from these commercial and public buildings would contribute to around one million tCO_2. Its target of GHG reductions are divided into eight building types 1) Office 2) Hospital 3) Hotel 4) Department store 5) School 6) Hypermarket 7) Condominium and 8) Other buildings, with four measures for energy efficiency improvement 1) Lighting system 2) Air conditioning system 3) Office equipment and 4) Other systems.



Potential GHG reductions for each building type in 2030

Referring to the above potential GHG reductions, the highest potential GHG reductions is in office buildings (306 $ktCO_2e$), followed by hospital (144 $ktCO_2e$) and department store (143 $ktCO_2e$) respectively. Total potential GHG reductions of these three building types are 593 $ktCO_2e$ or 59.3% of total potential GHG reductions in building sector.

The report observes that the NAMA does not indicate specific GHG mitigation measures for the building sector and there is no existing MRV in this sector. Based on the study, analysis and discussion with the stakeholders, the report proposes a MRV practice developed based on the current institutional arrangement and the existing reporting practice followed by the designated buildings in Thailand.

The recommendations are provided as below;

(1) At present, the designated buildings are mandated to submit an energy management report on an annual basis. This report contains almost data required for the GHG calculation, but it is not generally reported in term of GHG inventory or emission reduction data. It needs to be further calculated as the GHG inventory or emission reduction data. Thus, the GHG report is required to be developed on annual basis (calendar year) for the best MRV practice.
(2) Unlike the designated building, BEC and non-designated buildings have no process or reporting system for the report submission on an annual basis. Therefore, it is required to create a reporting system for the BEC building and non-designated buildings participating in the DEDE's promotion/mitigation measures to submit the report on annual basis until 2030 (end of NDC period).
(3) Quantification and monetization of (positive and negative) externalities over the building life cycle should be well-integrated into decision-making processes.
(4) Continuous monitoring and constant modification of performance and dynamics of building codes would allow implementation to catch up with the potential for efficiency improvements and co-benefits. This would also provide better feedback to the policymaking process, creating awareness, capacity building and training. For the designated building, there is a well-designed data collection and reporting system. In order to improve this existing practice to be an appropriate MRV for GHG emissions, the determination of quality indicator for the responsible organizations should be measurable as per institutional arrangement policy and design of domestic MRV system should be conformed to an existing practice.
(5) As per the BEC building measure in the Energy Efficiency Plan (EEP2015) that aims to reduce energy demand by 36% (1,166 ktoe) of the total energy demand in new buildings to achieve international green building standard such as Leadership in Energy and Environment Design (LEED) or Thai's Rating of Energy and Environmental Sustainability (TREEs) standards by Thai Green Building Institute (TGBI). If these plans could combine or link to GHG emission term, then it would be a clear understanding.
(6) The data of Label no.5[1] should be separately identified in the energy management report for avoiding on double counting issue.
(7) The recommendation on the GHG emission methodology is provided in Chapter 7.

[1] An energy efficiency labelling scheme

(8) Generally, the GHG emission inventory and the GHG emission mitigation measure are reported on annual basis. Since the GHG reporting format has not been created so far, therefore it should be created by all relevant agencies e.g. TGO, DEDE, ONEP and Energy Working Group. The GHG report could be reported via online submission for ease of convenience to the related agencies.

(9) Verification is the periodic independent review of reported data. It is the process of confirming the GHG inventory as well as the GHG emission mitigation actions achieved by the implemented measures. Thus, based on the domestic MRV system and institutional arrangement proposed in the second BUR, the GHG data should be verified by the Energy Working Group and the Climate Change Knowledge and Database Sub-Committee respectively. The verification guideline should be determined by all relevant agencies e.g. TGO, DEDE, ONEP and Energy Working Group as appropriate for the building sector.

1. INTRODUCTION

Thailand is located in Southeast Asia and covers an area of 513,115 km^2. The country is bordered on the north by Myanmar and Laos; on the east by Laos, Cambodia, and the Gulf of Thailand; on the south by Malaysia; and on the west by Myanmar and the Andaman Sea. The topographic relief of Thailand includes hills in the north and flatland in the central part of the country. The southern part of Thailand features a long peninsula between the western Andaman Sea and the eastern South China Sea. The country is divided into five parts: Northern, Northeastern, Central, Eastern, and Southern region. The population of Thailand was around 66.4 million based on the registration records in December 2018[2].

For the past decade, Thailand's total final energy consumption[3] has been steadily increasing at an average rate of 2.3% per year as illustrated in Figure 1-1. The transportation and industrial sectors consumed around three-quarters of the total final energy consumption. The average energy consumption transportation and industrial sector is 35.5% and 35.3% of the total final energy consumption respectively.

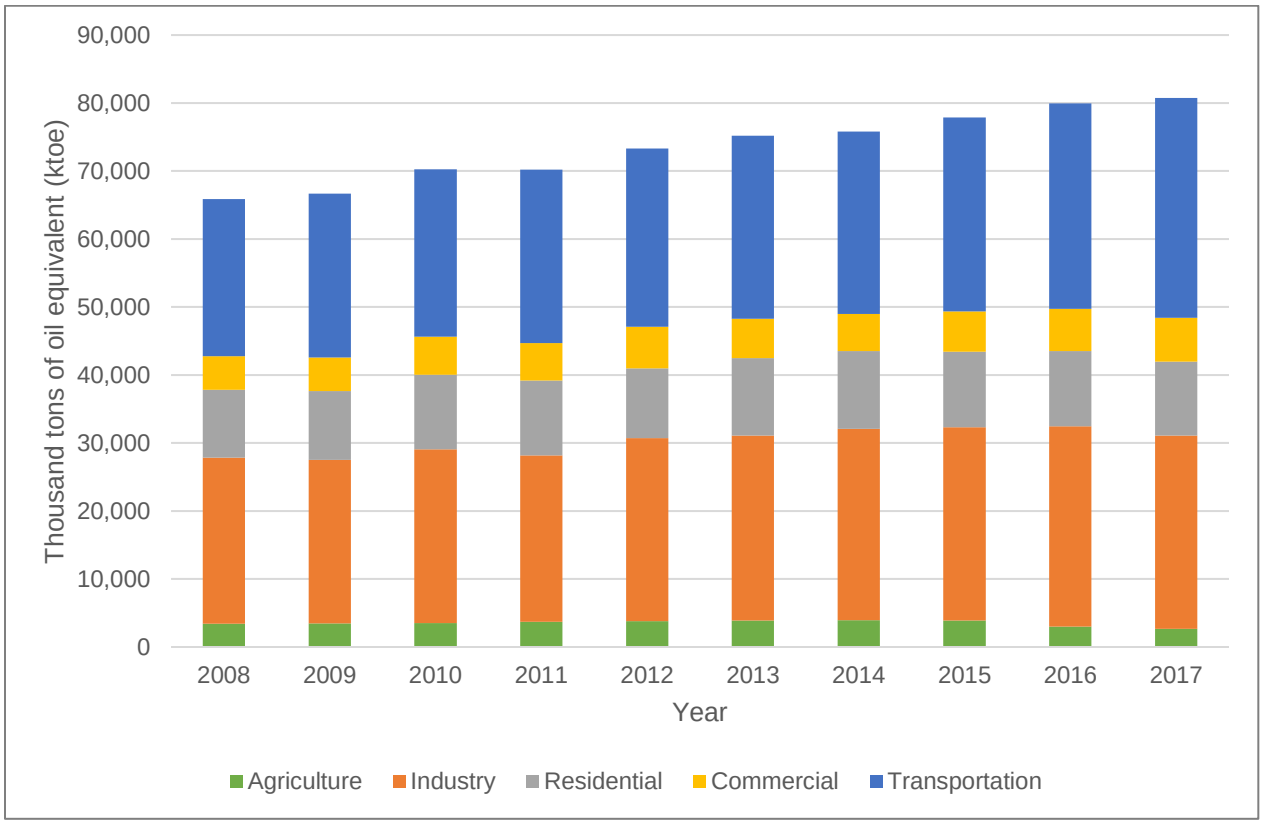


Figure 1- 1. Historic energy consumption trend in Thailand

As per the national greenhouse gases (GHG) inventory, during 2000–2013, the total emissions (excluding those from the Land use, land-use change, and forestry (LULUCF) sector) increased

[2] Department of Provincial Administration
[3] Department of Alternative Energy Development and Efficiency

from 226,086 $GgCO_2e$ in 2000 to 318,662 $GgCO_2e$ in 2013. The net removal of CO_2 increased from 11,995 $GgCO_2e$ in 2000 to 86,102 $GgCO_2e$ in 2013. Therefore, the net GHG emission increased from 214,091 $GgCO_2e$ in 2000 to 232,560 $GgCO_2e$ in 2013, with annual increase of 0.6%. With the inclusion of the LULUCF sector, the net emission in 2013 increased by 8.6% when compared with the net emission in 2000 (refer Figure 1-2). The major source of GHG emissions was the energy sector, which increased from 161,005 $GgCO_2e$ in 2000 to 236,936 $GgCO_2e$ in 2013, an increase of 47.2%.

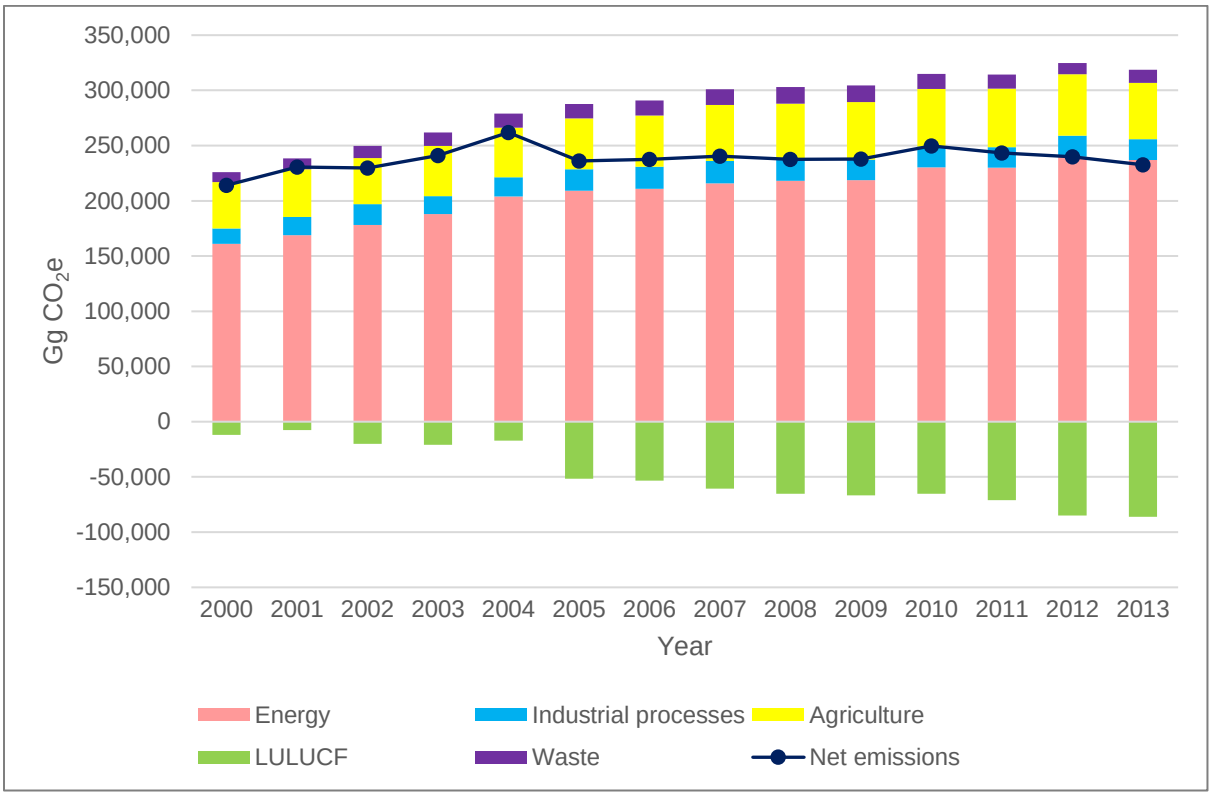


Figure 1- 2 Historic GHG emissions/removal[4]

Regarding the GHG emission reduction target, Thailand has made significant efforts as a signatory Party under the United Nations Framework Convention on Climate Change (UNFCCC) according to its capabilities. Thailand pledged its first Nationally Appropriate Mitigation Actions (NAMAs) to the UNFCCC on 29 December 2014. The NAMA proposed that Thailand has put the efforts, along with given international supports, to reduce GHG emission in the range of 7-20% below the business-as-usual (BAU) level particularly in the energy and transportation sector by 2020. In addition, Intended Nationally Determined Contributions (INDCs) and relevant information was submitted to UNFCCC on 1 October 2015 to restate that GHG emissions would be reduced by 20% (111 $MtCO_2e$) from BAU level by 2030 (refer Figure 1-3), and up to 25% with international support.

[4] Second Biennial Update Report of Thailand

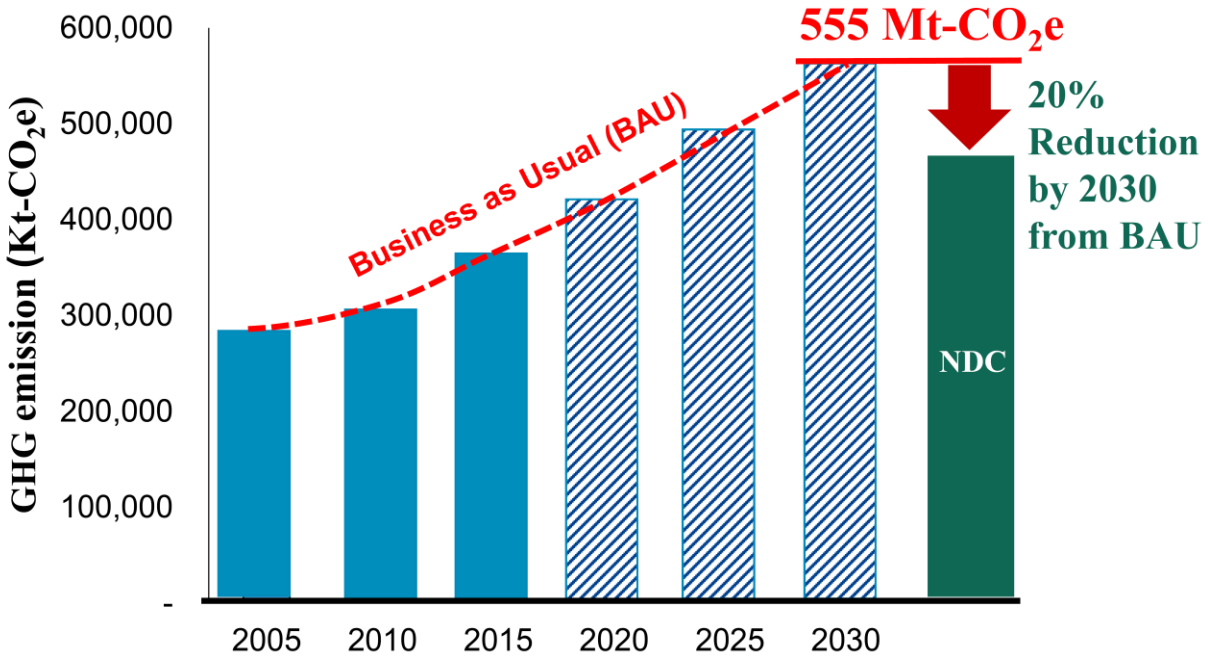


Figure 1- 3 Thailand's NDC Targets[5]

Since the submission of its NAMAs, several climate-change mitigation policies and measures have been put in place at the national level to fulfill Thailand's drive toward a resilient, low-carbon society, as stated in the 12th National Economic and Social Development Plan (NESDP), 2017-2021. The 12th NESDP supports Thailand's NAMAs and sustains efforts towards reduction of GHGs by 7–20 % in 2020. According to the Second Biennial Update Report of Thailand, the country had achieved GHG reductions of 40.14 $MtCO_2e$ thus meeting its NAMA target of 7% (24.9 $MtCO_2e$) reduction in GHG emissions over the BAU level by 2020.

For NDC[6], in order to meet its target (111 $MtCO_2e$ or 20% from BAU level by 2030), the Cabinet approved Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030 on 23 May 2017. The roadmap is based on the relevant national plans already approved or in the pipeline for approval by the Cabinet. The total potential GHG reductions in this roadmap is 115.6 $MtCO_2e$ or 20.8% from the BAU level by 2030 which is conformed to the NDC's target. The roadmap considers five sectors according to Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories; 1) energy and transport, 2) industrial processes, 3) agriculture, 4) LULUCF, and 5) waste. The major mitigation measures in this roadmap are focused on the energy and transport, industrial processes and waste sectors, while agriculture and LULUCF sectors are in study process of potential GHG reductions. The potential GHG reductions in each sector and the summary information on Thailand's NDC mitigation measures are shown in Figure 1-4 and Table 1-1 respectively.

[5] Office of Natural Resources and Environmental Policy and Planning
[6] Nationally Determined Contribution (NDC) was used instead of Intended Nationally Determined Contributions (INDCs) after the Paris Agreement entered into force on 4 November 2016

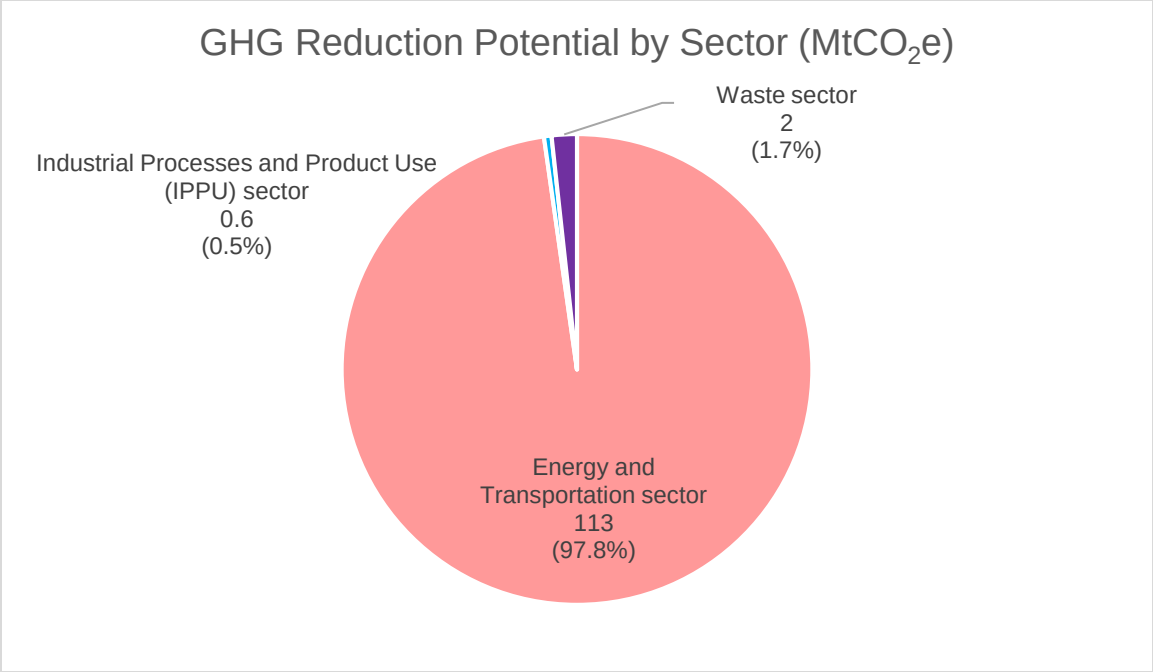


Figure 1- 4 GHG Reduction by Sector

Table 1- 1 Summary information on Thailand's NDC mitigation measures[7]

No.	Measure	Potential GHG reductions ($MtCO_2e$)	Target group
1	**Energy and Transportation (Total potential GHG reductions 113.0 $MtCO_2e$ or 20.4% from BAU level by 2030)**		
1.1	**Power generation**	**24**	
	1) Energy efficiency improvement	6	Power producers
	2) Substitution of renewable energy	18	
1.2	**Residential**	**4**	
	1) Energy efficiency improvement	4	Residential
	2) Substitution of renewable energy		
1.3	**Building**	**1**	
	1) Energy efficiency improvement	1	Building
1.4	**Industry**	**43**	
	1) Energy efficiency improvement	11	Private entrepreneur
	2) Substitution of renewable energy	32	
1.5	**Transportation**	**41**	
	1) Energy efficiency improvement	31	Producers/ travelers/ land, water, air transport system/ people

[7] Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030

No.	Measure	Potential GHG reductions ($MtCO_2e$)	Target group
	2) Substitution of renewable energy	10	Car producers / users
2	**Industrial Processes and Product Use (IPPU) (Total potential GHG reductions 0.6 $MtCO_2e$ or 0.1% from BAU level by 2030)**		
2.1	**Process change**	**0.6**	
	1) Substitution of clinker substance	0.3	Cement factories/ construction materials
	2) Substitution of refrigerant substance	0.3	Refrigerant producers/ users
3	**Waste (Total potential GHG reductions 2.0 $MtCO_2e$ or 0.3% from BAU level by 2030)**		
3.1	**Waste**	**1.3**	
	1) Waste management	1.3	Households /communities
3.2	**Wastewater**	**0.7**	
	1) Methane recovery from industrial wastewater	0.7	Industrial factories
	2) Clean technology		Industrial factories
	3) Municipal wastewater management		Households /communities
	Total	**115.6**	

For the Measurement, Reporting and Verification (MRV) on GHG inventories and emission reductions according to the NAMAs Roadmap, Thailand has developed MRV system as follows:

- Measurement is carried out according to specific GHG emission reduction measures by responsible installations/sources (e.g., power plants and liquid fuel production plants);

- Reporting is carried out by responsible installations to corresponding authorities (e.g., Energy Regulatory Commission, Department of Energy Business, and Electricity Generating Authority of Thailand (EGAT); and

- Verification is undertaken by authorized agencies such as the Department of Alternative Energy Development and Efficiency (DEDE)

1.1. Project background

To pursue sustainable development and reduce national GHG emissions, Thailand is still lack effective tools and well-designed institutional arrangements to comprehensively assess the impacts of national climate policies and actions. There is no common methodological framework to measure, report and verify the progress made by a country through its GHG mitigation measures.

To respond to the above challenge, Initiative for Climate Action Transparency (ICAT), a global initiative assisting policy makers around the world with tools and support to measure and assess the impacts of their climate actions, in partnership with the Natural Resources and Environmental

Policy and Planning (ONEP), join force in executing the *Improving Thailand's MRV System for Climate Change Mitigation project* ('the project'). The project aims to strengthen MRV system for Thailand's climate change mitigation; especially in the areas of industry and buildings.

Based on rigorous consultations with ONEP, Ministry of Natural Resources and Environment, who is the project counterpart, it was agreed that the initiative in Thailand will focus on strengthening MRV systems in buildings, that is this report (in addition to the industrial sector). Also, these two activities should be aligned with, and contribute to, the implementation of Thailand's NDC Roadmap.

With this, the project has three major components:

1. MRV in the industrial sector;
2. MRV in the building sector (*this component is covered in this report*); and
3. Contribution to Thailand's NDC Roadmap - Presenting sector findings to the relevant stakeholders.

1.2. Objective and scope

In line with the project background discussed above, the objectives and scopes for the building sector are listed as follows:

1. Review of international best practice/case studies on MRV in the building sector;
2. Identification of current situation/baseline of current MRV practice for the building sector in Thailand for three building types (office, department store and hospital);
3. Identification of gaps, barriers and opportunities for effective MRV in the building sector; and
4. Formulation of recommendations to strengthen MRV in the building sector.

2. OVERVIEW OF THAILAND's BUILDING SECTOR

The building sector is considered as one of the critical GHG emitters and GHG reduction contributor. Under the NDC Roadmap, it is expected that GHG from the sector could be reduced by 1 MtCO2e. It is, however, found that there is currently no MRV system for Thailand's building sector. The closest system that could effectively apply for is the energy reporting system under the Energy Conservation Promotion Act B.E.2535 (1992).

The act has been effective since 3 April 1992. Since then, the energy conservation in Thailand has been substantialized. This Act aims to:

- Identify the measure to supervise, promote, and assist the energy usage through energy conservation policies, energy conservation goals and plans, audit and analysis of energy conservation, procedures in energy conservation;
- Identify the level of energy usage in machinery and equipment;
- Establish energy conservation promotion fund to support and assist the energy conservation;
- Protecting and solve the environmental problems from energy usage and the research on energy; and
- Identifying the measures to support the energy conservation or to produce highly efficient machinery and equipment or materials for energy conservation.

The amended Energy Conservation Promotion Act (No.2) B.E.2550 (2007) has been effective since 1 June 2008.

The Energy Conservation Promotion Act B.E.2535 (1992) and its amendment in B.E.2550 (2007) has the following three main objectives:

1. To supervise, promote, and support the persons who need energy conservation according to the law to conserve energy from the efficient and economical energy production and usage.
2. To promote and support the production and the usage of highly efficient machinery and equipment, and the materials used in the energy conservation within the country.
3. To promote and support the energy conservation by establishing "Energy Conservation Promotion Fund" to provide financial assistance to persons who must implement energy conservation according to the law.

According to this Act, many regulations have been launched for prescribing details on energy conservation as shown in Table 2-1 and Figure 2-1.

Table 2- 1 Main regulations related to energy conservation in building sector

Type of Regulation	Name of Regulation
Act	Energy Conservation Promotion Act B.E.2535 (1992)
	Energy Conservation Promotion Act (No.2) B.E.2550 (2007)
Royal Decree	Royal Decree on Designated Building B.E.2538 (1995)
Ministerial Regulation	Ministerial Regulation Prescribing Standards, Criteria and Energy Management Procedures in the Designated Factory and Building B.E.2552 (2009).
	Ministerial Regulation Prescribing Qualifications, Duties and Number of Person Responsible for Energy B.E.2552 (2009)
	Ministerial Regulation Prescribing Type or Size of Building and Standard, Criteria and Procedure in Designing Building for Energy Conservation B.E.2552 (2009)
	Ministerial Regulation Prescribing Qualifications, Criteria, Procedures and Conditions for Auditing and Certification of Energy Management for Energy Auditor B.E.2555 (2012)
	Ministerial Regulations related to energy efficiency standards for machines and equipment (e.g. chiller, refrigerator, air-conditioner)

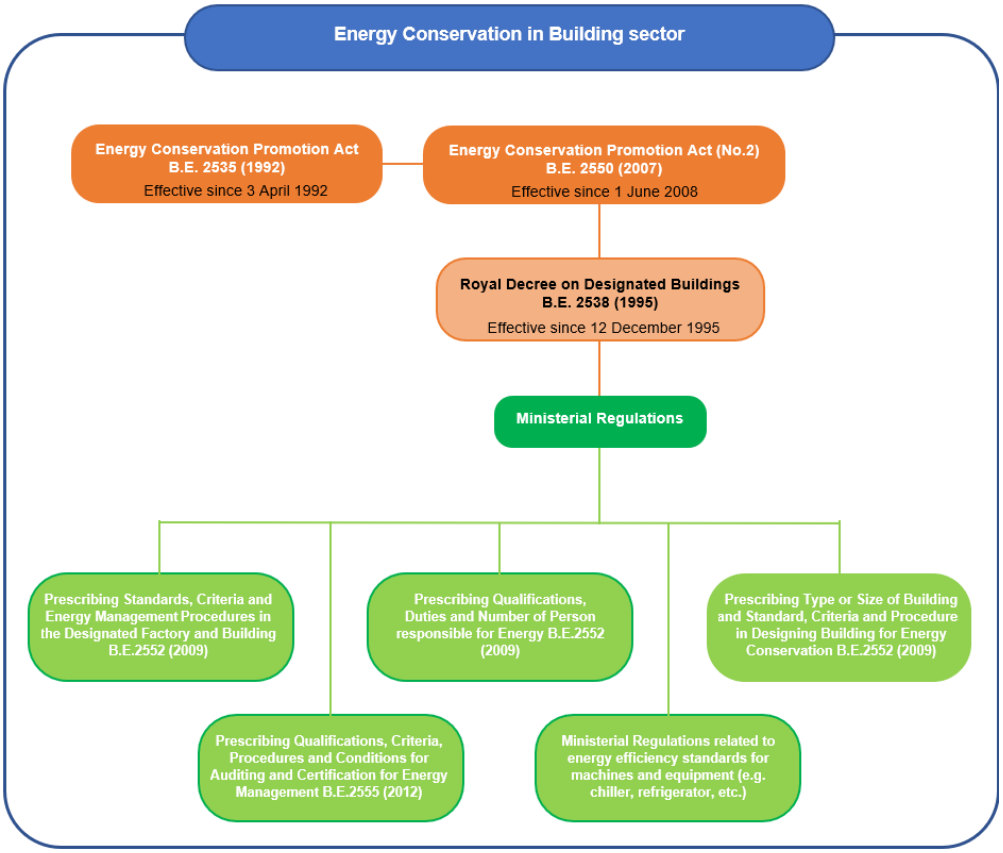


Figure 2- 1 Regulations for energy conservation in building sector[8]

[8] The original diagram is from www.dede.go.th and modified by the author

As per the above regulations, energy conservation in building sector can be divided into two groups;

1. Energy conservation for new / modified building
2. Energy conservation for existing building

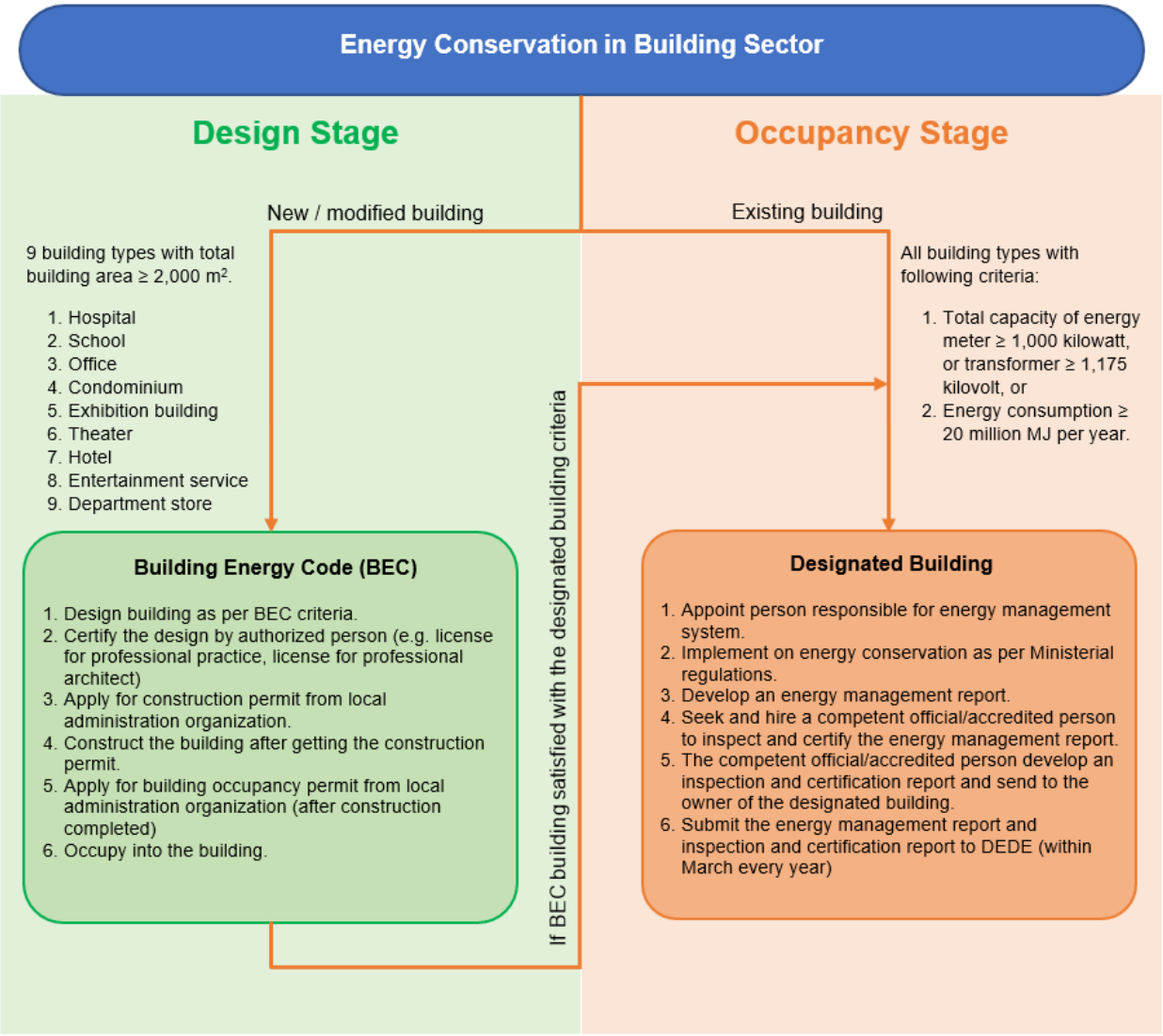


Figure 2- 2 Energy conservation in building sector[9]

1. Energy conservation for new / modified building

The new building or modified building - with a total area of 2,000 square meters or above must be designed to comply with Building Energy Code (BEC) standard. The building design must be approved by authorized person holding relevant license (e.g. license for professional practice, license for professional architect) before submitting to local administration organization for building construction / modification permit. There are nine types of targeted building for BEC as listed below.

[9] The diagram is developed by the author

1) Hospital
2) School
3) Office
4) Condominium
5) Exhibition building
6) Theater
7) Hotel
8) Entertainment service
9) Department store

BEC standard comprises of six components and, the design for each component must be complied to its standard as follows;

1) Building envelope (wall and roof)
The Overall Thermal Transfer Value (OTTV) and Roof Thermal Transfer Value (RTTV) of the building envelope shall comply to the following standard value.

Table 2- 2 Standards of OTTV and RTTV for building envelope[10]

Type of targeted building	OTTV (watt/m^2)	RTTV (watt/m^2)
a) School, Office	≤ 50	≤ 15
b) Exhibition building, Theater, Entertainment service, Department store	≤ 40	≤ 12
c) Hotel, Hospital, Condominium	≤ 30	≤ 10

2) Lighting system
Power consumption rate for lighting system shall comply to the following standard value.

Table 2- 3 Standard of power consumption rate for lighting system[11]

Type of targeted building	Power consumption rate (watt/m^2)
a) School, Office	≤ 14
b) Exhibition building, Theater, Entertainment service, Department store	≤ 18
c) Hotel, Hospital, Condominium	≤ 12

3) Air-conditioning system
Coefficient of Performance (CoP) and Energy Efficient Ratio (EER) standards for small air-conditioning system (split type), and Chiller Performance (ChP) standard for large air-conditioning system (chiller) are shown in Table 2-4 and 2-5 respectively.

[10] The standard values are based on the Ministerial Regulation Prescribing Type or Size of Building and Standard, Criteria and Procedure in Designing Building for Energy Conservation B.E.2552 (2009)

[11] The standard values are based on the Ministerial Regulation Prescribing Type or Size of Building and Standard, Criteria and Procedure in Designing Building for Energy Conservation B.E.2552 (2009)

Table 2- 4 COP and EER standards for small air-conditioning system (split type) [12]

Size of split type (watt)	COP (watt/watt)	EER (Btu/hr/watt)
≤ 12,000	≥ 3.22	≥ 11

Table 2- 5 ChP standard for large air-conditioning system (chiller) [13]

Type of chiller		Refrigeration capacity (full load) (ton of refrigeration)	ChP (kilowatt/ton of refrigeration)
Type of condenser	Type of compressor		
Air-cooled	All types	≤ 300 > 300	≤ 1.33 ≤ 1.31
Water-cooled	Reciprocating	All capacities	≤ 1.24
	Rotary, Screw and Scroll	≤ 150 > 150	≤ 0.89 ≤ 0.78
	Centrifugal	≤ 500 > 500	≤ 0.76 ≤ 0.62

4) Hot water generating system

Hot water generating system is divided into two systems: (1) boiler and (2) air-source heat pump water heater. Standards for these two systems are shown in Table 2-6 and 2-7.

(1) Boiler

Table 2- 6 Standard of boiler efficiency[14]

Type of boiler	Boiler efficiency (%)
a) Oil fired steam boiler	≥ 85
b) Oil fired hot water boiler	≥ 80
c) Gas fired steam boiler	≥ 80
d) Gas fire hot water boiler	≥ 80

(2) Air-source heat pump water heater

[12] The standard values are based on the Ministry of Energy Notification Prescribing Minimum standard of COP, EER and ChP for air-conditioning system installed in Building B.E.2552 (2009)

[13] The standard values are based on the Ministry of Energy Notification Prescribing Minimum standard of COP, EER and ChP for air-conditioning system installed in Building B.E.2552 (2009)

[14] The standard values are based on the Ministerial Regulation Prescribing Type or Size of Building and Standard, Criteria and Procedure in Designing Building for Energy Conservation B.E.2552 (2009)

Table 2- 7 COP standard of air-source heat pump water heater[15]

Type of design	Temperature of water inflow (ºC)	Temperature of water outflow (ºC)	Temperature of ambient (ºC)	COP
a) Type 1 b) Type 2	30.0 30.0	50.0 60.0	30.0 30.0	≥ 3.5 ≥ 3.0

5) Whole building energy performance

If the design for new / modified building does not satisfy on the standard in building envelope, lighting system or air-conditioning system, then the whole building energy performance must be lower than that of its reference building

6) Renewable energy utilization

In case the building consumes energy from the renewable source, then it will not be taken into account in the total energy consumption.

There are two options for designing building to be qualified in BEC standard

1) Qualified by passing in four components (building envelope, lighting system, air-conditioning system and, hot water generating system)
2) Qualified by passing in whole building energy performance and hot water generating system.

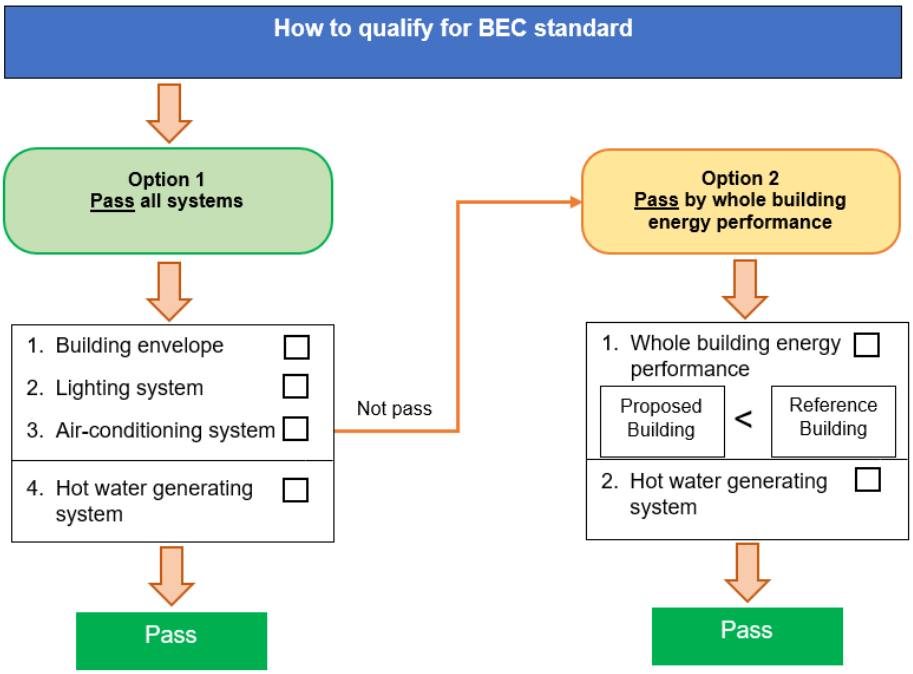


Figure 2- 3 Options for designing building to be qualified BEC standard[16]

[15] The standard values are based on the Ministerial Regulation Prescribing Type or Size of Building and Standard, Criteria and Procedure in Designing Building for Energy Conservation B.E.2552 (2009)

[16] Source: A guidebook on evaluation of BEC standard

As of June 2019, there are total 1,895 buildings qualified as per BEC standard. The building types such as condominium, office and hotel are largely certified. Figure 2-4 provides the total number of BEC certified buildings in Thailand.

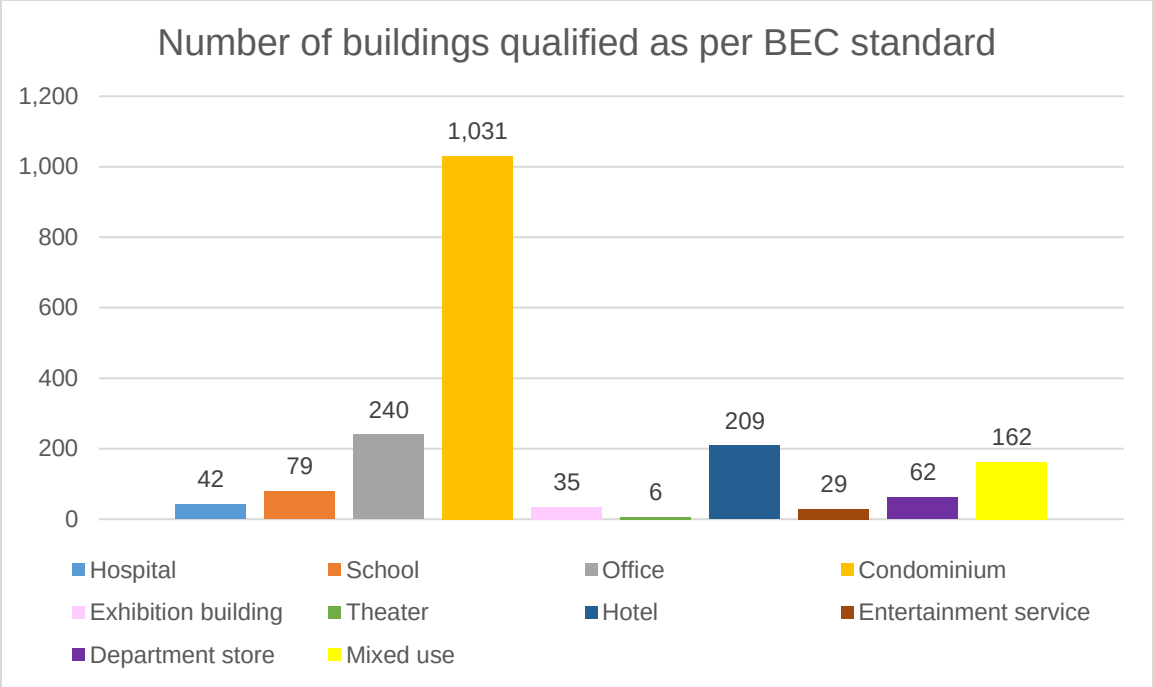


Figure 2- 4 Number of building qualified as per BEC standard[17]

Currently, BEC standard is based on voluntary basis for new building or modified building - with a total area of 2,000 square meters or above. However, it is on the legal process for mandatory basis which is expected to be finalized within 2019.

2. Energy conservation for existing building

According to the Royal Decree on Designated Building B.E. 2538 (1995), the building that satisfies the following criteria is defined as the “designated building”:

1) A single building or more registered in the same address which has one energy meter or more with total capacity 1,000 kilowatt or above, or has one transformer or more with total capacity 1,175 kilovolt ampere (kVA) or above.

2) A single building or more registered in the same address, using grid electricity or heat from the district steam or non-renewable sources, with total annual energy consumption of 20 million Megajoule (MJ) or above (during calendar year).

The duties of owner of the designated building are listed as follows;

[17] Source: Coordinating Center for Energy Conservation Building Design

1) Assigning the responsible persons for energy management in each designated building is based on the criteria given in Table 2-8.

Table 2- 8 Number of responsible persons for energy management[18]

Item	Designated building	
Capacity of energy meter (kilowatt)	< 3,000	≥ 3,000
Capacity of transformer (kVA)	< 3,530	≥ 3,530
Total energy consumption (million MJ/year)	< 60	≥ 60
Number of person responsible for energy	1	2

2) Developing and implementing the energy management and energy conservation activities There are eight steps in energy management guideline as given in Figure 2-5:

(1) Establishing a structure, committee/working group for energy management
(2) Evaluating the existing energy management situation
(3) Determining policy for energy conservation and public relation
(4) Evaluating on energy conservation potential
(5) Determining targeted energy conservation measure
(6) Developing energy conservation plan
(7) Implementing activities according to the energy conservation plan
(8) Reviewing, analyzing, revising on weak points of the energy management system

[18] The standard values are based on the Ministerial Regulation Prescribing Qualifications, Duties and Number of Person Responsible for Energy B.E.2552 (2009)

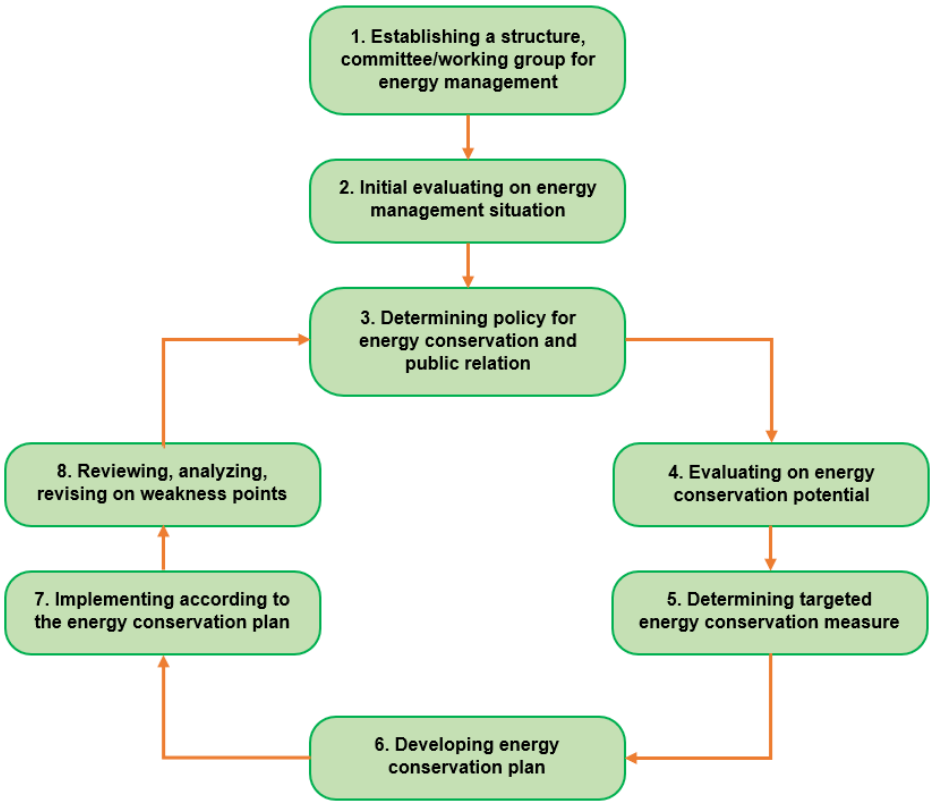


Figure 2- 5 Energy management guideline[19]

3) Submitting the energy management report and the auditing & certification energy report to Department of Alternative Energy Development and Efficiency (DEDE) within March every year.

   Owner of the designated building must develop an energy management report and then send to the competent official / accredited person for approval. After getting approval and receiving the auditing and certification energy report from the competent official/accredited person, the owner of designated building must submit the energy management report and auditing and certification energy report to DEDE within March every year. Figure 2-6 shows the flow chart of steps involved in submission of the energy management report to the DEDE.

[19] Source: Manual for explanation on the Energy Conservation Promotion Act B.E.2535 (1992) for designated factory and designated building

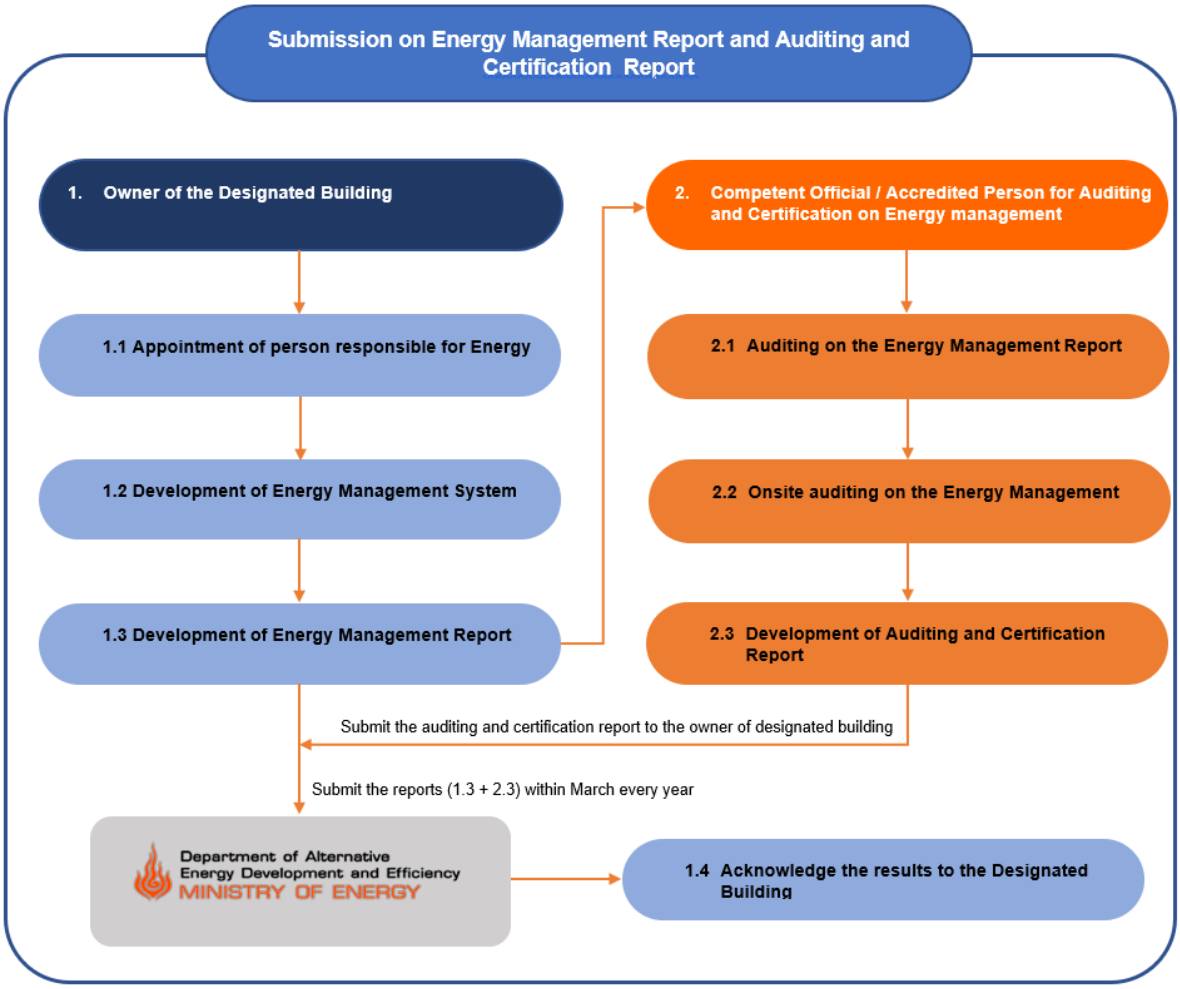


Figure 2- 6 Submission on energy management report[20]

According to DEDE's database, there are 3,104 designated buildings in 2018. The number of designated buildings has increased since 2015. The department store has highest number of designated buildings (762), followed by office buildings (734) and hotel buildings (551) respectively as shown in Table 2-9.

Table 2- 9 Number of designated buildings in Thailand[21]

Type of building \ Year	2015	2016	2017	2018
Water supply	3	3	3	3
Electricity	7	7	7	8
Livestock farm	97	95	99	95

[20] Source: The energy conservation center of Thailand
[21] Source: Department of Alternate Energy Development and Efficiency, May 2019

Hospital	268	271	271	279
Hotel	522	535	544	551
Department store	669	712	735	762
School	282	283	286	286
Office	701	710	729	734
Other buildings	356	366	374	386
Total	**2,905**	**2,982**	**3,048**	**3,104**
Increase/decrease	**-**	**2.65%**	**2.21%**	**1.84%**

As per the energy consumption data for each type of building from DEDE's database, the major energy intensive building types are department stores, office and hotels. Figure 2-7 and Table 2-10 provided the energy consumption data for each building types.

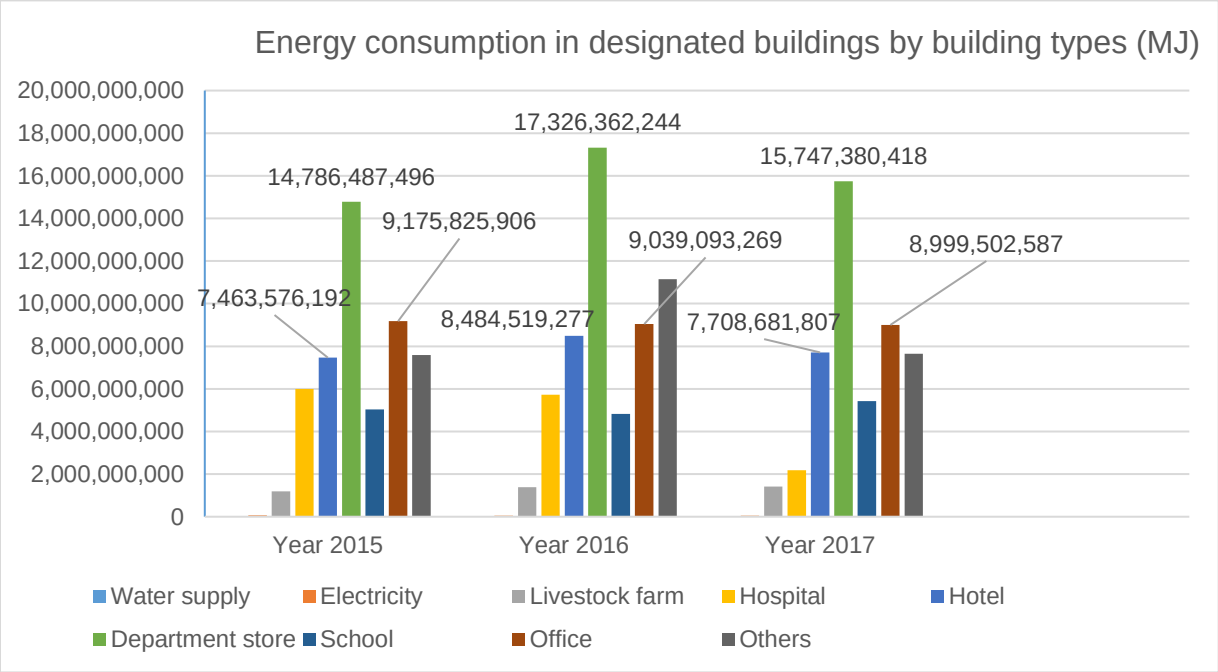


Figure 2- 7 Energy consumption in designated building by building types

Table 2- 10 Energy consumption in designated building

Type of building	2015			2016			2017		
	Electricity (kWh)	Thermal (MJ)	Total (MJ)	Electricity (kWh)	Thermal (MJ)	Total (MJ)	Electricity (kWh)	Thermal (MJ)	Total (MJ)
Water supply	7,859,538	0	28,294,338	6,040,519	0	21,745,868	7,549,205	0	27,177,137
Electricity	15,927,316	0	57,338,338	12,603,400	0	45,372,240	12,691,842	0	45,690,631
Livestock farm	296,130,468	124,835,840	1,190,905,523	343,729,001	151,791,800	1,389,216,204	326,606,582	238,583,089	1,414,366,783
Hospital	1,495,789,927	614,385,712	5,999,229,449	1,430,215,108	580,853,869	5,729,628,258	576,939,739	107,053,427	2,184,036,487
Hotel	1,645,051,616	1,541,390,376	7,463,576,192	1,871,118,561	1,748,492,456	8,484,519,277	1,673,808,137	1,682,972,513	7,708,681,807
Department store	4,066,392,279	147,475,290	14,786,487,496	4,792,256,778	74,237,843	17,326,362,244	4,368,603,693	20,407,124	15,747,380,418
School	1,371,237,155	104,857,451	5,041,311,208	1,327,194,035	46,588,643	4,824,487,170	1,489,871,452	63,831,281	5,427,368,509
Office	2,535,906,703	46,561,777	9,175,825,906	2,497,625,222	47,642,469	9,039,093,269	2,491,613,379	29,694,422	8,999,502,587
Other buildings	1,941,270,703	606,103,739	7,594,678,271	2,093,744,092	3,605,388,102	11,142,866,831	2,020,918,023	373,242,898	7,648,547,780
Total	**13,375,565,704**	**3,185,610,184**	**51,337,646,720**	**14,374,526,717**	**6,254,995,182**	**58,003,291,362**	**12,968,602,051**	**2,515,784,754**	**49,202,752,139**
Increase/decrease	**-**	**-**	**-**	**7.47%**	**96.35%**	**12.98%**	**-9.78%**	**-59.78%**	**-15.17%**

3. KEY STAKEHOLDERS

Some of the key bodies identified from the building sector energy efficiency in relation to MRV practices in Thailand are provided below and Figure 3-1:

1) National Committee on Climate Change Policy (NCCC)

The Government has established the National Committee on Climate Change Policy (NCCC), chaired by the Prime Minister. The NCCC is responsible for

(1) national climate change policy and strategy;
(2) determination of national positions the international negotiations under UNFCCC and any relevant international agreements; and
(3) monitoring and evaluating implementation results of government agencies as stated in national policy and strategy.

2) Subcommittee on Climate Change Knowledge and Database

The Subcommittee on Climate Change Knowledge and Database, chaired by the Permanent Secretary of Ministry of Natural Resources and Environment, is to verify GHG estimation methodology and amount of GHG emission reduction.

3) Working Group on GHG Inventory and Mitigation Measure

The Working Group on GHG Inventory and Mitigation Measure is to verify GHG estimation methodology and amount of GHG emission reduction. There are five sectoral working groups under the Working Group on GHG Inventory and Mitigation Measure; namely energy, industrial processes, agriculture, LULUCF, and waste, are to determine evaluation criteria for GHG emission reductions including:

1. Selection GHG emission reduction policies and measure to be monitored
2. MRV process and structure
3. Appropriate GHG emission reduction methodologies
4. Emission factors

4) Office of Natural Resources and Environmental Policy and Planning (ONEP)

The ONEP is a government agency under the Ministry of Natural Resources and Environment. According to the Ministerial Notification on the Organization Chart of the Office of Natural Resources and Environmental Policy and Planning, the Ministry of Natural Resources and Environment, B.E. 2560 (2017), the ONEP performs the following roles and responsibilities:

- Establishing policies and plans for the natural resources and environment conservation and managing the natural resources and environment.
- Coordinating and establishing management plans for the natural resources and environment and performing other functions according to the laws of Promotion and Conservation of National Environmental Quality and other related laws, including coordinating management to lead concrete practice.
- Studying, analyzing, coordinating and processing to announce the areas and measures for natural resources and environment.
- Following-up, monitoring, evaluating the results of operations according to policies, plans and measures and preparing environmental quality reports.

- Proceeding on the environmental impact assessment that may occur from projects or activities proposed by the government or private and tend to cause damage to the environment quality.
- Efficiently managing the environmental fund for supporting the policies, plans and measures, and management of the natural resources and environment in all dimensions,
- Proposing opinions for the consideration on establishment of policies and guidelines for land management and soil resources, land owning plans, land conservation and development for the public and conservation or prohibition of state land.
- Cooperating with the international and national organizations on development of draft policies and plans for the natural resources and environment conservation and management.
- Proposing opinions for consideration on establishment of policies and strategies for prevention and problem solving on climate change, GHG inventories and emissions, including studying, researching and developing related to climate change.
- Proposing opinions for consideration on establishment of policies and plans for sustainable conservation and utilization biodiversity, including implementing on obligations of international agreements related to biodiversity and wetlands.
- Performing other functions as required by law, the Ministry of Natural Resources and Environment or the Cabinet.

Regarding the MRV practices, ONEP is the secretariat of the NCCC. In addition, the ONEP takes a leading role in the development and oversight of national climate policies and strategies, while providing the needed support to implementation of the strategies and policies at the sectoral and subnational levels. The ONEP also acts as a focal point in coordinating potential and received international support related to climate change.

5) Energy Policy and Planning Office (EPPO):

The EPPO is a government agency under the Ministry of Energy whose mandate is to devise related national policies, strategies and measures on energy. The EPPO plays a key role in the administration of national energy affairs and is responsible for the energy administration plans, promotion of energy conservation and alternative energy as well as prevention of fuel shortages over short and long terms. It also monitors and assesses the efficiency and success of national energy policies and plans, as well as strategies and measures. In order to efficiently and successfully drive energy policies, strategies and measures, the EPPO has been working through various committees' mechanism as follows:

1. National Energy Policy Council (NEPC)

The NEPC is chaired by the Prime Minister, with the EPPO serving as its secretariat. With senior ministers and heads of various government agencies being its members, the NEPC is the central supreme body for energy policy formulation, which enables itself to efficiently make recommendations on the national energy policies and plans for the Cabinet. The NEPC is tasked with

- Making recommendations for the Cabinet on the national policies and plans concerning energy administration and development.
- Developing rules and terms for energy pricing in harmony with such national policies and plans.
- Monitoring, overseeing, coordinating, supporting and accelerating tasks performed by all empowered committees.
- Assessing the compliance of these tasks with the national policies and plans.

2. Committee on Energy Policy Administration (CEPA)

To ensure efficient operation, resolve dispute of problem-solving and make recommendations on the formulation of national energy administration and energy development policies, the NEPC established the Committee on Energy Policy Administration (CEPA), chaired by the Minister of Energy, with the EPPO serving as its secretariat. The CEPA is tasked with

- Advocating energy policies, plans and measures involving energy administration and energy development.
- Making recommendations on and ranking plans/projects involving energy affairs.
- Setting energy prices and rates of contribution to the Oil Fund as instructed by the NEPC.
- Recommending energy pricing policies and measures.
- Giving recommendations to the NEPC on decrees, ministerial regulations and other measures to be in line with the regulations of the promoting energy conservation.
- Requesting ministries, departments and other local government agencies, state enterprises, and individuals to submit academic data, financial information, statistics, and other essential facts and figures for the national energy policies and plans on energy administration and development.
- Appointing subcommittees to support its work as necessary.

3. Energy Conservation Promotion Fund (ENCON Fund) Committee

To support the promotion of energy conservation and the administration of the Energy Conservation Promotion Fund (ENCON Fund), the NEPC is also bound by the Energy Conservation Promotion Act B.E. 2535 (1992) and its second amendment B.E. 2550 (2007) to make recommendations to the Cabinet on policies, goals and measures for energy conservation, and set monetary contribution to the above-mentioned fund by different fuel type. To this end, the ENCON Fund committee was set up, chaired by a deputy Prime Minister assigned by the Prime Minister, with the EPPO serving as its secretariat. The committee is tasked with

- Recommending criteria, terms and priorities for fund-spending to ensure conformity to Article 25 to the NEPC.
- Allocating the fund as intended by Article 25 in line with the criteria, terms and priorities set by the NEPC under Article 4(4).
- Setting rules and procedures to file requests for assistance or support by the fund.
- Proposing on the rate of contribution to the fund from fuel sales.
- Proposing to the types of fuel exempted from contribution to the fund.
- Setting the NEPC-endorsed special tariffs
- Granting special tariffs exemption.
- Approving requests for support and assistance under Article 40 (2) in line with the NEPC's criteria and terms under Article 4 (8).
- Devising criteria and procedures for filing requests for support and assistance under Article 41.

Regarding the MRV practices, EPPO is responsible for developing the Thailand's NDC Action Plan for the Energy Sector 2021-2030 (NDC Action Plan), compiling all required activity data for GHG emission calculation from the Department of Alternative Energy Development and Efficiency (DEDE) and other government agencies under the energy sector.

6) Department of Alternate Energy Development and Efficiency (DEDE)

The DEDE is a government agency under the Ministry of Energy. The roles and responsibilities of the DEDE are as below.

a) As announced by the Ministerial Notification on the Organization Chart of the DEDE under the Ministry of Energy, B.E. 2551 (2008).

The DEDE performs the functions to promote and regulate energy efficiency and conservation, including the identification of the energy resources, development of different options for alternative energy mix as well as systematically disseminate the energy technology to respond sufficiently to all sectors requirement with reasonable cost effectiveness for the country's development and better quality of life of the people. Accordingly, the DEDE is tasked with;

- Promoting, supporting and regulating the energy conservation.
- Conducting research, development and promotion of the alternative energy.
- Establishing regulations and standards, provide technology transfer and dissemination on the energy production, transformation, transmission, consumption and conservation development.
- Following-up and evaluating the result of alternative energy and energy conservation development initiatives.
- Managing all data and information about alternative energy and energy conservation.
- Performing other functions as required by law, the Ministry of Energy or the Cabinet.

b) As prescribed by the Energy Conservation and Promotion Act B.E. 2535 (1992) and its Additional Amendment B.E. 2550 (2007).

The DEDE is authorized to regulate, oversee and facilitate large designed factories/building to ensure that they can appropriately and efficiently implement their roles as prescribed in the Royal Decree, the Energy Conservation Promotion Act, Ministerial Regulations and Orders.

c) As prescribed by the Energy Development and Promotion Act B.E. 2535 (1992).

The DEDE has responsibilities to look for the energy resources, production and construction and to consider energy production license and expansion of controlled energy set in the Royal Decree, taking into account the impact on the environment, economy, security of the country, any harm that may arise from energy production/expansion and the technical use of the raw materials and the natural resources.

Regarding the MRV practices, DEDE is responsible for collecting and verifying all required activity data for GHG emission calculation for building sector before submitting to the EPPO.

7) Thailand Greenhouse Gas Management Organization (TGO)

The Thai Cabinet's resolution approved the establishment of the Greenhouse Gas Management Organization as a public organization in accordance with the law on public organization on May 15 B.E. 2550 (2007). While the autonomous public organization has an administrative independence, it also acts as the center for collaboration among government, private sector and international organizations. As published in Government Gazette in July 6 B.E. 2550 (2007), the TGO is established with the following objectives;

- Analyzing, scrutinizing and collecting views and opinions on approval and appraisal of authorized projects to further project advancements and the market of greenhouse gas quantity trading as approved.

- Being an information center for circumstances on GHG operations.
- Making a database about the authorized projects and the approved trading of GHG reduction quantity
- Enhancing the efficiency and provide instructions to public agency and private body in the management of GHG emissions
- Disseminating and conducting public relations campaign on the GHG management.
- Promoting and supporting relevant climate change operations.

Regarding the MRV practices, TGO is responsible for developing GHG methodologies, designing on the MRV system, supporting in capacity building in collecting data and quality control, supporting as GHG data center, and technical support related to GHG.

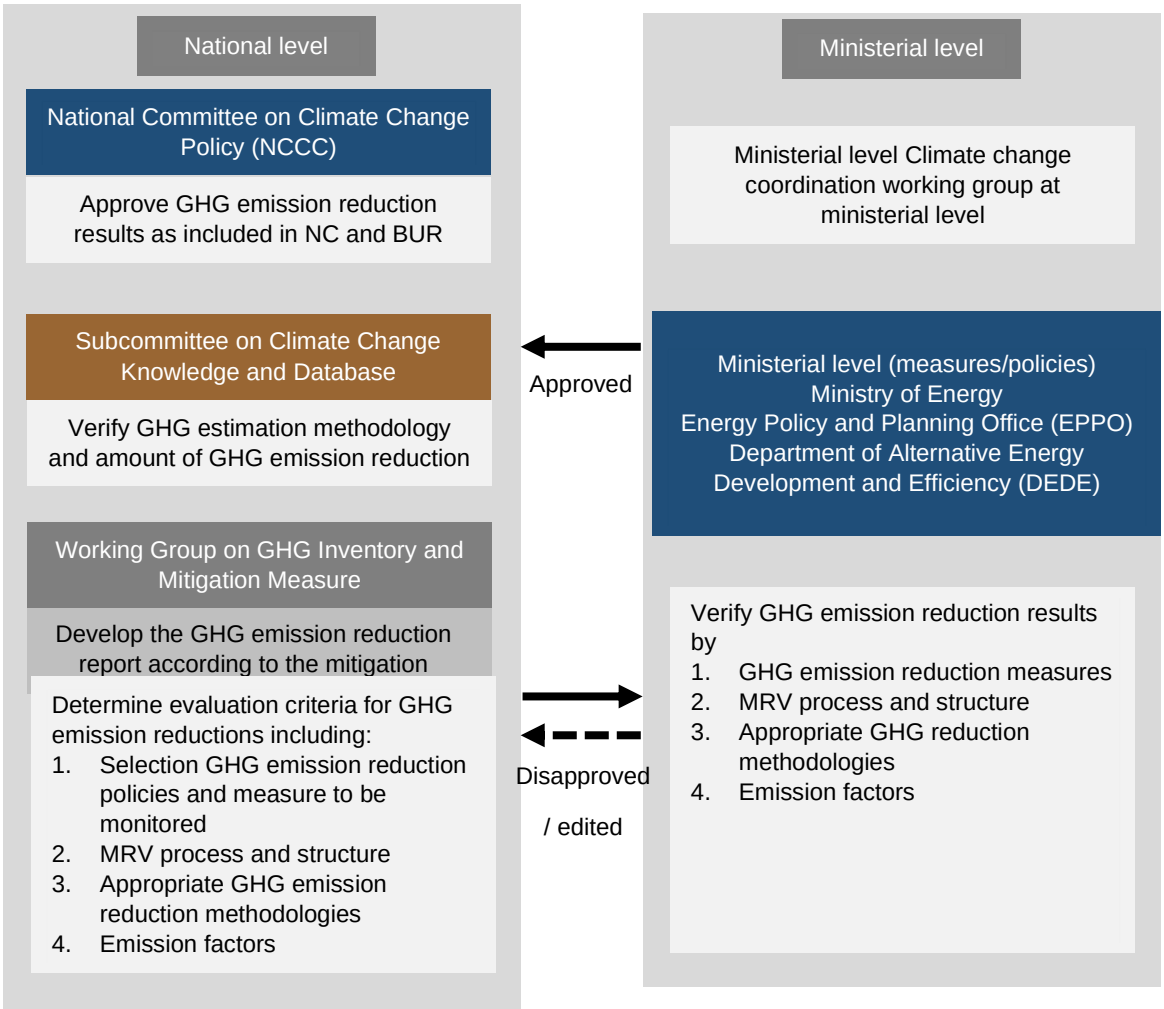


Figure 3- 1 Institutional structure in relation to MRV practices

4. CURRENT MRV PRACTICES IN THE BUILDING SECTOR

4.1. Review of NDC and related policies

As per the Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030, building sector is classified as a sub-sector under the energy and transportation sector and it mainly targets commercial and public buildings. It is expected that the GHG emission reductions through energy efficiency measures (EEMs) from these commercial and public buildings would contribute to around 1 million tCO_2. The buildings are classified into eight types with four important EEMs.

The eight targeted building types for GHG reductions in building sector are as follows:

1) Office
2) Hospital
3) Hotel
4) Department store
5) School
6) Hypermarket
7) Condominium
8) Other buildings

There are four measures for energy efficiency improvement in building sector;

1) Lighting system (e.g. T5 and LED)
2) Air conditioning system (e.g. efficient air conditioning (COP5 and COP8))
3) Office equipment (e.g. efficient office equipment)
4) Other systems (e.g. efficient heater)

Potential GHG reductions for each measure and in each building type is shown in Table 4-1 and Table 4-2 respectively.

Table 4- 1 Potential GHG reductions for each measure in building sector[22]

Measure	Potential GHG reductions ($ktCO_2e$)			
	Year 2015	Year 2020	Year 2025	Year 2030
Lighting system	16	34	100	180
Air conditioning system	44	93	275	490
Office equipment	20	42	124	225
Other systems	10	20	58	105
Total	**90**	**189**	**557**	**1,000**

Figure 4-1 provides the potential GHG emission reductions in each building type in 2030.

[22] Source: Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030

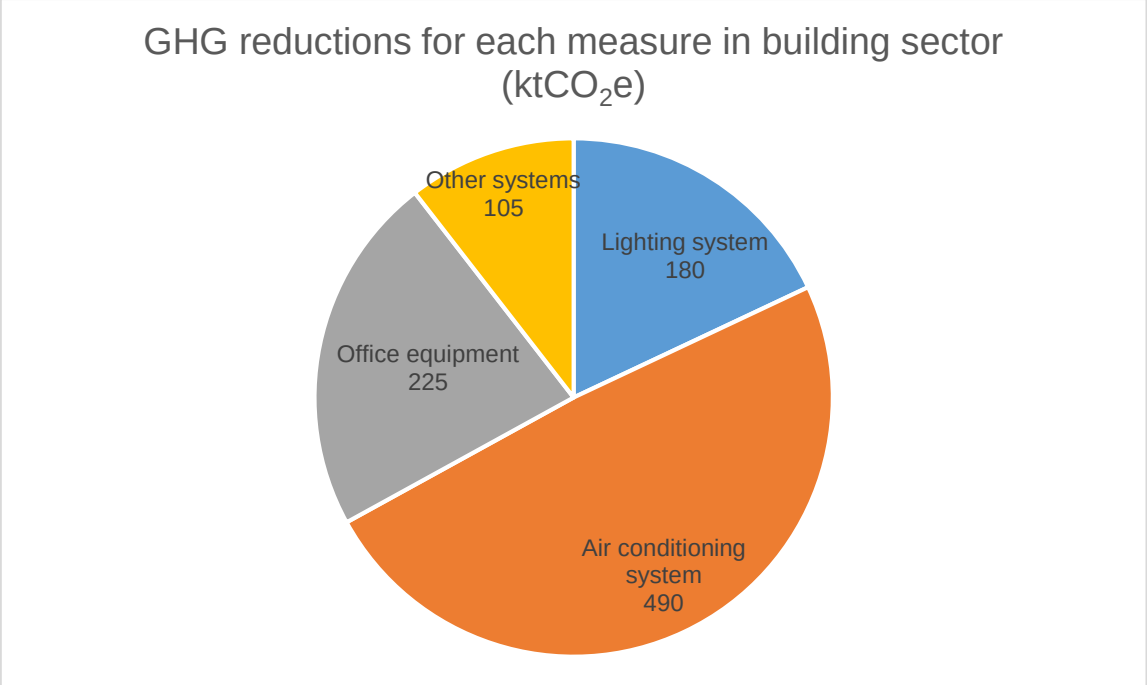


Figure 4- 1 Potential GHG reductions for each measure in building sector in year 2030

Table 4- 2 Potential GHG reductions for each building type[23]

Type of building	Potential GHG reductions ($ktCO_2e$)		
	2010	2020	2030
Office	**0**	**64**	**306**
- Lighting system	0	12	62
- Air conditioning system	0	35	155
- Office equipment	0	14	76
- Other systems	0	2	13
Hospital	**0**	**28**	**144**
- Lighting system	0	4	22
- Air conditioning system	0	12	58
- Office equipment	0	4	26
- Other systems	0	7	38
Hotel	**0**	**24**	**124**
- Lighting system	0	2	10
- Air conditioning system	0	14	68
- Office equipment	0	2	16
- Other systems	0	6	30
Department store	**0**	**24**	**143**
- Lighting system	0	5	25
- Air conditioning system	0	12	80
- Office equipment	0	4	23
- Other systems	0	3	14
School	**0**	**12**	**72**
- Lighting system	0	2	13
- Air conditioning system	0	4	28
- Office equipment	0	5	27
- Other systems	0	1	4

[23] Source: Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030

Type of building	Potential GHG reductions ($ktCO_2e$)		
	2010	2020	2030
Hypermarket	**0**	**12**	**57**
- Lighting system	0	2	11
- Air conditioning system	0	4	19
- Office equipment	0	5	24
- Other systems	0	1	3
Condominium	**0**	**12**	**69**
- Lighting system	0	2	9
- Air conditioning system	0	7	50
- Office equipment	0	3	8
- Other systems	0	0	2
Other buildings	**0**	**13**	**74**
- Lighting system	0	3	16
- Air conditioning system	0	5	32
- Office equipment	0	5	25
- Other systems	0	0	1
Total	**0**	**189**	**1,000**

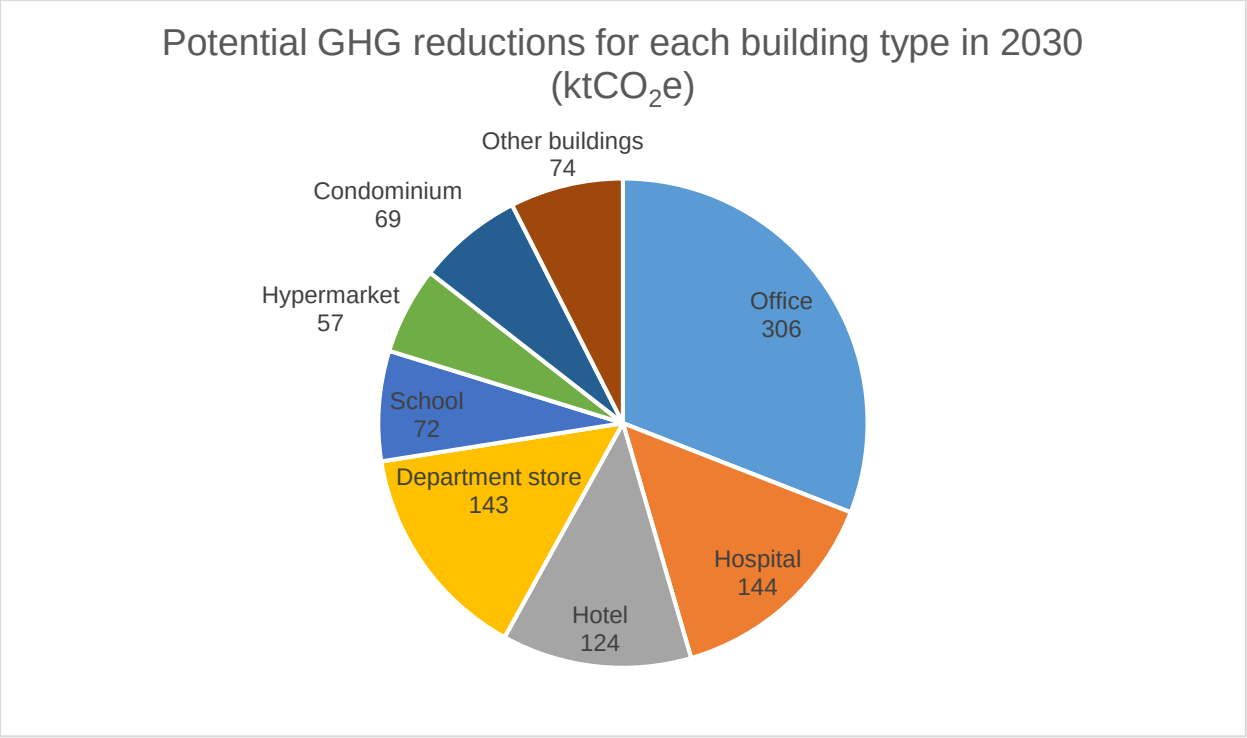


Figure 4- 2 Potential GHG reductions for each building type in 2030

As per the potential GHG reductions for each building type, the office buildings have highest potential GHG reductions (306 $ktCO_2e$), followed by hospital (144 $ktCO_2e$) and department store (143 $ktCO_2e$) respectively. The total potential GHG reductions of these three building types are 593 $ktCO_2e$ or 59.3% of total potential GHG reductions in the building sector.

As the Energy Efficiency Plan (year 2015-2036) (EEP2015) is the master plan for energy efficiency development and GHG reductions on energy efficiency improvement (including building sector), therefore DEDE as the main responsible government agency for energy efficiency development has developed the 5-year energy efficiency action plan (year 2017-

2021) in synergy with the EEP2015. In this action plan, there are three strategies to be applied for energy efficiency development in building sector as follows:

1) Compulsory Program
   1.1) Enforcement measures on energy conservation standards according to the Energy Conservation Promotion Act B.E. 2535 and its amended B.E. 2550 on the energy conservation management system in designated building.
   1.2) Enforcement measures on BEC standard for new building.
   1.3) Measures to determine standards and labeling equipment, machinery and materials for energy conservation.
   1.4) Enforcement measures on Energy Efficiency Resource Standards (EERS) for energy producer and distributor.
2) Voluntary Program
   2.1) Support/subsidy measures on energy conservation implementation.
   2.2) Promotion measures on the use of lighting for energy conservation.
3) Complementary Program
   3.1) Capacity building measures to energy conservation personnel.
   3.2) Public relation measures to raise energy conservation consciousness

4.2. Review of the existing MRV practices for the sector

Currently, there is no existing MRV practice in the building sector. However, the designated buildings have to report their energy consumption through an energy management report on annual basis. The owner of designated building is required by law to assign energy manager to be responsible for energy management as indicated in the Table 2-8. The steps in the existing reporting practice are listed below:

1. The designated building implements the energy conservation measure;
2. The designated building measure and record data as required by the energy management report;
3. Owner of the designated building develop the energy management report;
4. Owner of the designated building seek and send the energy management report to a competent official / accredited person for approval;
5. The competent official / accredited person verifies the energy management report and develop an auditing and certification energy report and send to the designated building; and
6. The designated building submits the energy management report and auditing and certification energy report to DEDE within March every year.

4.3. Review of current institutional arrangement

To effectively capture GHG reduction and transparently report the results, Thailand has developed the domestic MRV system by which duties and responsibilities are based on institutional arrangement which is shown in Figure 4-3 below. This institutional arrangement is set primarily for consolidating energy and GHG data, evaluating the emissions and summarizing the findings for inclusion in the National Communication (NC) and Biennial Update Report (BUR)/ Biennial Transparency Report (BTR).

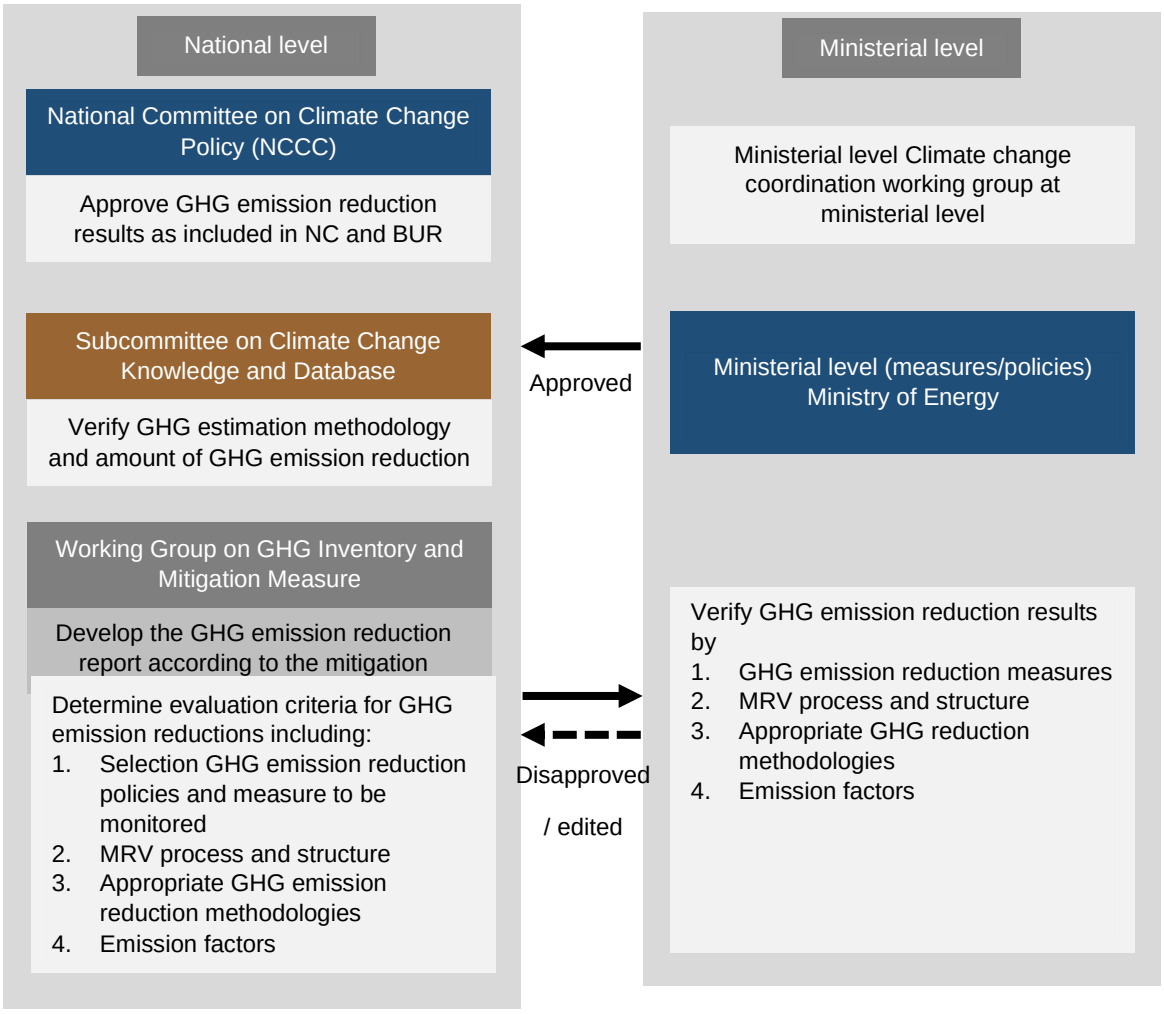


Figure 4- 3 Current institutional arrangement

The descriptions of current institutional arrangement for GHG emission is provided as below;

1) Working Group on GHG Inventory and Mitigation Measure

The Working Group on GHG Inventory and Mitigation Measure has main responsibilities as follows:

1.1) Estimate GHG emissions and develop the GHG emission report

1.2) Determine evaluation criteria for GHG emission reduction including;

- Selection of the GHG emission reduction policy and measure to be monitored
- MRV process and structure
- Appropriate GHG emission reduction methodologies
- Emission factors

2) Ministry of Energy

Once the Working Group on GHG Inventory and Mitigation Measure develops the mitigation plan as described above, then all information will be sent to the Ministry of Energy for approval in following topics:

2.1) Appropriate measures/policies for MRV process

2.2) GHG emission reduction methodologies

2.3) MRV structure for activity data

2.4) Mitigation result according to the measures/policies

The Ministry of Energy has established a working group of energy sector to review and assess above aspects. After the detailed review and analysis, the Ministry of Energy approves them and then informs the Working Group on GHG Inventory and Mitigation Measure (via ONEP as the secretariat of the working group).

3) Subcommittee on Climate Change Knowledge and Database

After the Ministry of Energy approves on all aspects of GHG mitigation plan as above, all information will be sent to the Subcommittee on Climate Change Knowledge and Database (via ONEP as the secretariat of the Subcommittee on Climate Change Knowledge and Database) for approval.

4) National Committee on Climate Change Policy

After the Subcommittee on Climate Change Knowledge and Database approves it, then it will be sent to the National Committee on Climate Change Policy for approval as inclusion in the National Communication (NC) and Biennial Update Report (BUR)/ Biennial Transparency Report (BTR).

From the review, the project found that Thailand successfully established key foundations for effective MRV systems. All institutional mandates are clarified and roles for each relevant agency is identified. Reporting and approval workflow is well developed. This provides a vital steppingstone for the country to develop effective MRV system.

With these all necessary components in place, it would help the country save a lot of time and effort in moving forward with clear and transparent MRV systems for key mitigation sectors; i.e. building and industry. It is highly recommended that MRV systems for mitigation sectors should be developed under this framework.

5. INTERNATIONAL MRV BEST PRACTICES IN THE BUILDING SECTOR

With raising global consensus on the need for strong measures against the climate change, the greenhouse gas (GHG) measurement, reporting and verification (MRV) plays a significant role in mitigating the emissions from the economic and development activities of any country. The key function of MRV is to enhance transparency through the tracking of national GHG emission levels, the impact of mitigation actions, climate funds, etc. The MRV facilitates sharing information and creates transparency and shows the continuity of a country's actions against climate change. The transparent MRV approaches can improve comparability at national and international levels thus supporting coherence between domestic and international MRV systems. The MRV system will be also helpful for the countries in reporting the GHG emission compliances under the Paris Agreement during the NDC period.

5.1 Development of international MRV guidelines

The guidance and tools for implementing the MRV system were developed by several international organizations such as the Greenhouse gas (GHG) Protocol, International Organization for Standardization (ISO), Intergovernmental Panel on Climate Change (IPCC), , Initiative for Climate Action Transparency (ICAT), and etc. These international standards and tools are helpful for the countries to report their direct and indirect GHG emissions at the national level and at sector level.

a) The GHG Protocol[24]

The GHG Protocol was formed in 1988 through coordination of businesses, non-governmental organizations (NGOs), governments, academic institutions and others convened by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD). This international standard is widely followed by business entities in developed and developing countries to report their emissions. In 2016, 92% of Fortune 500 companies reported their carbon emissions using GHG Protocol directly or indirectly.

b) ISO standards

Similarly, the ISO published in 2006 the ISO 14064 (Greenhouse Gas Emissions and Removals Quantification and Reporting) standard[25] in addition to the ISO 14000 environmental management series to address the climate change effects. This standard gives the guidance for quantifying, reporting and verification of GHG emissions at the organizational level.

c) IPCC[26]

The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess the climate change. It provides scientific information at all levels to the governments so that they can use them develop climate policies. It also conducts a comprehensive assessment on climate change and reports the findings to the United Nations Climate Change Conference (UNFCCC). In 2006, the IPCC has published its guidelines for the national GHG inventories which is currently followed by most of the countries to report their emission levels. The Clean Development Mechanism framework under UNFCCC uses the IPCC standards for its projects. The IPCC suggests three

[24] http://ghgprotocol.org/
[25] https://www.iso.org/standard/66453.html
[26] https://www.ipcc.ch/

different tier levels (Tier 1, 2 and 3) for the GHG emission reporting based on the quantity of data required and the degree of analytical complexity of data.

- Tier 1 - Uses the default emission factors and other assumptions provided by the IPCC
- Tier 2 - Uses emission factors and other parameters which are specific to the country
- Tier 3 - Uses most complex and equipment & activity specific data and emission factors

Progressing from Tier 1 to Tier 3 generally represents a reduction in the uncertainty of GHG estimates, though at a cost of an increase in the complexity of measurement processes and analyses. Most of the countries report their emission levels to UNFCCC using Tier 1 approach as defined by the IPCC. However, the countries should consider Tier 2 approach as defined by the IPCC for orientation, when developing their initial MRV systems. The Tier 2 approach requires a proper coordination of relevant institutions and implementation of robust MRV system at domestic and national level for GHG emissions, which will result in estimation of accurate emission levels of the country.

d) Initiative for Climate Action Transparency (ICAT)

ICAT developed series of guidance for assessing the impacts of policies and actions addressing GHG emissions. It is intended to be used in combination with any other. The series of guidance is intended to enable users that choose to assess GHG impacts, sustainable development impacts and transformational impacts of a policy to do so in an integrated and consistent way within a single impact assessment process.

One of the series is the Building Efficiency Guidance. The guidance provides methods for assessing the GHG impacts of energy efficiency policies in the buildings sector. The guidance targets residential, commercial and public buildings. Also, it is applicable to three building stock types: new buildings, existing buildings with retrofit, and existing buildings without retrofit.

5.2 General approaches in national/sector level MRV

In general, the data collection for the MRV of primary energy consumption or GHG emissions at the national level follow two significant approaches:

Top-down approach: Figure 5-1 represents the tentative top-down approach in implementing a nation-wide energy efficiency labeling program.

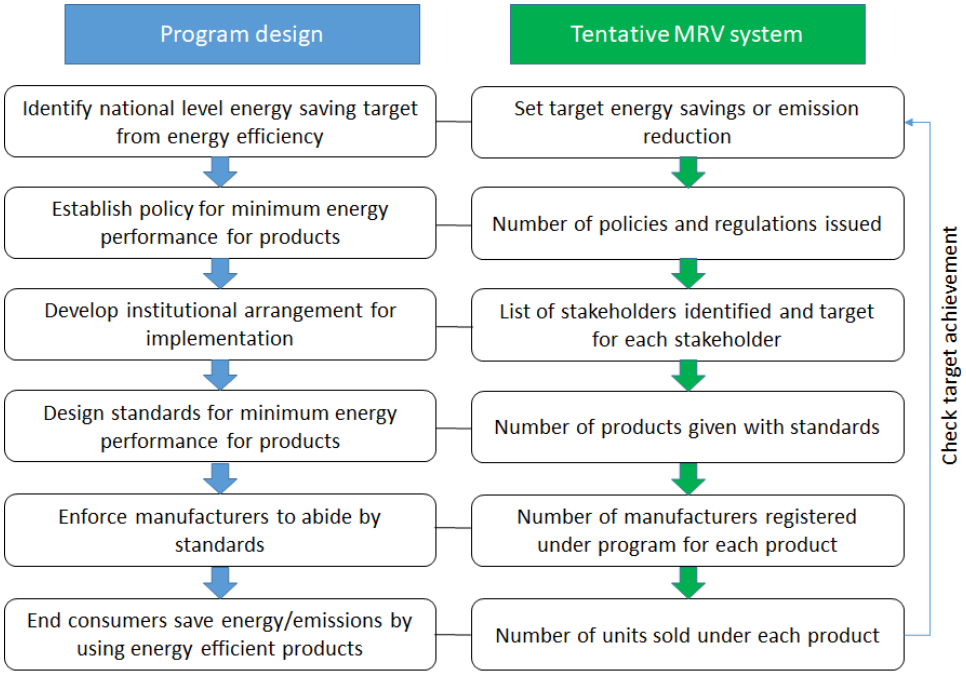


Figure 5. 1 Program with top-down MRV system

The data are aggregated from the sector level or regional or ministerial records and/or registries and then the contribution of different sectors or buildings are proportioned based on the available economic or development statistics. A top-down approach to an MRV system design has the advantage of direct linkage to the goals defined in an NDC and other national level planning. This approach allows for a broader overview of MRV governance. However, this approach requires a well-established institutional set-up and coordination of stakeholder groups involved at the various levels for MRV. Since the data are taken from the market registries or records, the accuracy of results achieved could be low. However, this approach is cost-effective as it requires relatively low administrative effort. This is the approach followed by most of the developing countries and least developed countries (LDCs) in reporting their energy consumption and GHG emissions.

Bottom-up approach: Figure 5-2 represents the tentative bottom-up approach in implementing the GHG emission reduction program in different sectors.

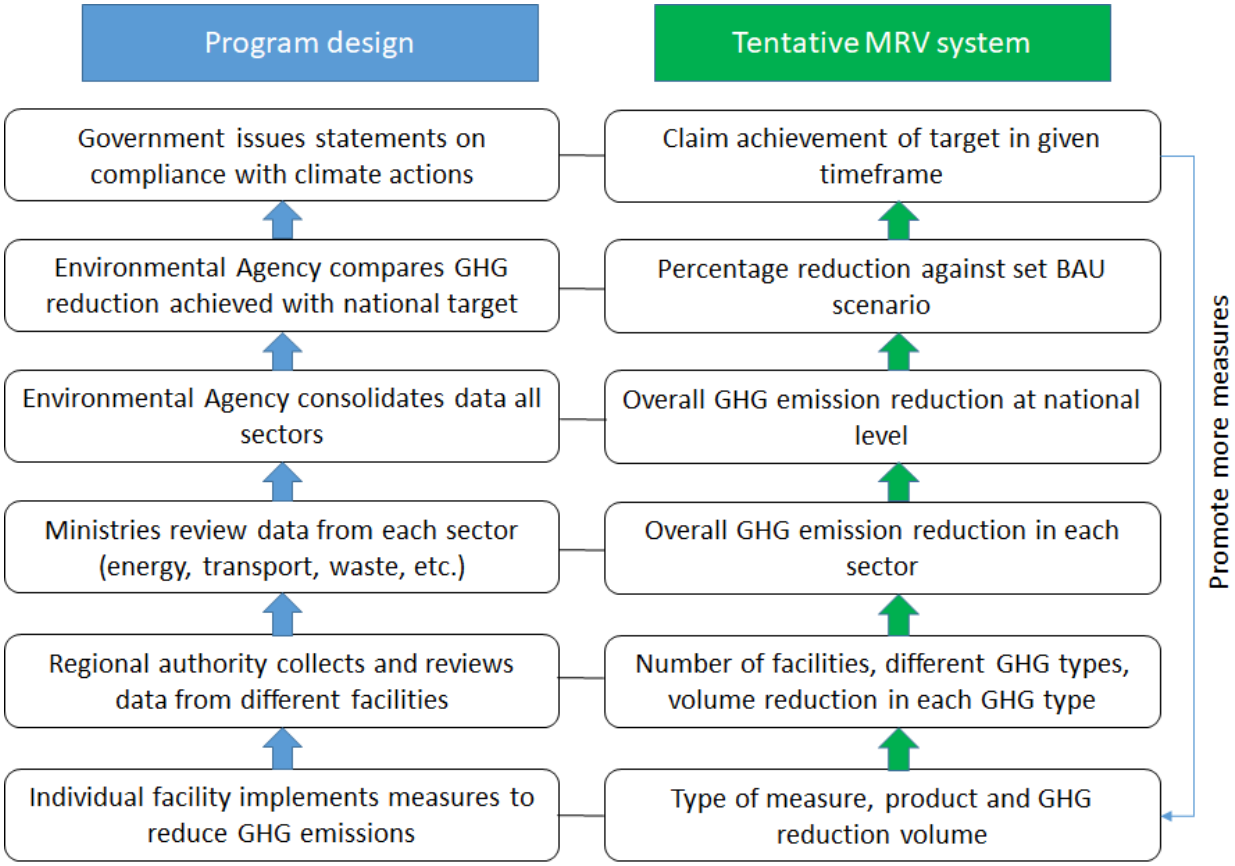


Figure 5. 2 Program with bottom-up MRV approach

The data are collected at the point of energy consumption or GHG emission at the consumer end (for example at individual buildings). The data are then consolidated at sector level or regional level and then up to the national level. Since the data are monitored and reported at the energy consumption or emission point itself, the accuracy of the results achieved tend to be high. However, this approach requires (i) an extensive effort from a number of stakeholders and ministries, (ii) very high investments and (iii) sufficient capacity at all stakeholder levels. It also consumes more time. This bottom-up approach can lead to completely different MRV designs for different mitigation actions, even within the same sector and especially between different sectors. However, the bottom-up approach offers the advantage of direct linking the MRV system to specific actions at the consumer or facility level. This approach is followed by the developed countries those who have a well-established national level monitoring and reporting systems connected to every individual energy consumer or GHG emitter.

Both the top-down and bottom-up approaches to MRV system design have a risk of information being misaligned with national targets. Risks exists in a top-down approach, when a stakeholder cannot deliver a defined parameter. Similarly, risks exist under a bottom-up approach when the information delivered by the stakeholder cannot be used within the national level MRV system. The most appropriate MRV system (even with synergies between the two approaches) can be selected based on the existing conditions at national level and sector level.

5.3 Best practice case studies in building sector MRV

Several countries such as EU, India, Indonesia, Japan, Singapore, US, etc., have launched the building sector MRV under varied context of energy efficiency initiatives and GHG mitigation programs with varied level of enforcements. The Paris Agreement requires all

Parties to put forward their best efforts through “nationally determined contributions” (NDCs) and to strengthen these efforts in the years ahead. This includes requirements that all Parties must report regularly on their emissions and on their implementation efforts[27]. Therefore, other countries are now working on developing appropriate national level or sector level MRV mechanism to fulfil their emission reporting compliance under the Paris Agreement.

The general practices of MRV design in terms of legal framework, institutional arrangement, boundary setting, robust database management, etc., that are applicable for any national level industrial or power sector program are applicable to the building sector MRV as well. The assessment metrics (mainly energy consumption) for different building types in the building sector do not vary significantly when compared to the wide range of assessment metrics needed for different type of processes (product types, process emissions, waste treatment, etc.) as in the industrial sectors. However, the building sector is diverse, disaggregated and dispersed in nature which makes the collection of data and database management complicated for different building types. Therefore, for review of best practices in this report, few other aspects that are specific to the building sector are considered in this section with references from the international best practices. There are three reference case studies related to building sector; 1) Green Mark Program, Singapore 2) Energy Star Program, United State and 3) Tokyo Emission Trading System, Japan. The overview of reference case studies considered in this report are provided below.

a) Green Mark Program, Singapore:

The Green Mark program is the main initiative under its Clean Energy Strategy, which features a national target of greening at least 80 percent of its buildings by 2030. The scheme involves a rating system to evaluate the environmental impact and the buildings performance based on the internationally-recognized best practices. As of July 2018, more than 3,300 buildings or 36% of the building stocks by ground floor area, Singapore have achieved Green Mark standards. This scheme has been adopted outside of Singapore with certified projects in Indonesia, Malaysia, Thailand and China. To date, close to 50 Singapore-based firms are involved in over 300 overseas Green Mark projects in 14 countries.

The MRV of the building performance are set within the certification process of the program. The three key elements in the Green Mark certification;

(1) Minimum Green Mark standard for building with GFA of at least 15,000 m^2
(2) Three-yearly energy audit (by accredited auditor) on the building with GFA of at least 15,000 m^2
(3) Annual mandatory submission of the building information and energy consumption data via online portal. The government agency can directly draw electricity data from utility companies.

Measurement: The building measures and records all relevant data (building information, energy consumption data, etc.)

Reporting: Annual mandatory submission of the building information and energy consumption data via online portal. The government agency (Building and Construction Authority: BCA) can directly draw electricity data from utility companies.

Verification: All data is verified by third party (professional mechanical engineer registered with the BCA)

b) Energy Star Program, United States:

The Energy Star is a voluntary program which was initiated by the United States Environmental Protection Agency (EPA) in 1992 to drive the economy towards an energy

[27] https://unfccc.int/process-and-meetings/the-paris-agreement/what-is-the-paris-agreement

efficient and cost -effective path. Initially, the program started with star labelling of energy efficient products and over the years was expanded to include all major appliances, office equipment, lighting, home electronics and the energy performance assessment of the residential buildings and commercial & industrial buildings and manufacturing plants. More than 9,500 buildings in US and Canada had earned the Energy Star certification in 2017, bringing the total to more than 32,000 buildings certified so far. On an average, the Energy Star certified buildings are found to use 35% less energy than the typical buildings nationwide. The energy star program is helpful in reporting the GHG emissions in the National Communications and Biennial Update Report (BUR) to the UNFCCC from the US building sector[28].

The MRV of this program are set within the certification process of the program. The Energy Star certification is valid for 12 months. To qualify for the Energy Star certification, a building should be benchmarked in the Portfolio Manager tool. The verification process will be done by the accredited verifier. Once the verification process is complete, the owner has to upload the signed application form in the Portfolio Manager tool and submit it to the EPA. The EPA reviews the application and provides the Energy Star certification to the building.

Measurement: The building measure and record all relevant data
Reporting: The owner of the building upload the application form signed by the licensed professional and submit to the United States Environmental Protection Agency (EPA)
Verification: All data is verified by third party (licensed professional accredited by EPA)

c) Tokyo Emission Trading System (ETS), Japan:

The Tokyo Emission Trading Scheme (ETS) was launched in 2010 by the Tokyo Metropolitan Government (TMG) as an initiative enforcing the mandatory GHG emission reduction by the large facilities located within the limits of Tokyo city. This program is not only the first cap-and-trade scheme in Japan, but also the world's first urban cap-and-trade scheme which specifically targets large facilities of the commercial sector. The first compliance period of the Tokyo ETS came to an end in December 2014 and achieved an emissions reduction of 23% compared to the base year emissions during the four years. In 2017, the emissions from covered facilities amounted to 12.04 million tCO_2, achieving a 27% reduction from base emission as a result of continuous energy efficiency efforts.

The MRV of this program, the covered facilities are required to submit an annual report on the previous year's emissions and their emission reduction plans by the end of November of the following year. The report must cover GHG emission of all types (CO_2, CH_4, N_2O, PFC, HFC and SF_6). The verification process will be done by a registered independent verification agency. Once the verification process is complete, a verification report issued by a registered independent verification agency must be attached to the emission data report. The verification is mandatory at the following stages:

- Reporting of compliance for the period
- Applying for a top-level facility certification
- Applying for offset credits

Then, the owner has to submit the verified application to TMG for certification and for credit issuance respectively.

Measurement: The covered facilities (buildings) measures and records all relevant data as per their monitoring plans

[28] United States Climate Action Report, 2014

Reporting: The covered facilities (buildings) are required to submit an annual report on the previous year's emissions and their emission reductions plans. The report must cover GHG emission of all types (CO_2. CH_4, N_2O, PFC, HFC and SF_6)
Verification: All data is verified by third party (verifier registered with the TMG)

More details on each of the referred case study are provided as separate annexes (Annex 1, 2 and 3) to this report.

5.3.1. Extracting energy use data directly from the energy supply utilities

The electricity is the major source of energy in any type of buildings. The energy used for the heating and cooling, backup electricity generation, etc., are subject to the country and regional conditions. Since the buildings (commercial, residential, institutional, etc.) consume electricity from the grid supply utilities and payment is made for the metered consumer account, it is possible to collect the energy consumption of any consumer directly from the database of the grid utilities. The same concept is also applicable for natural gas supply or steam use from the district heating systems, if it is done through the registered utilities with established pipeline networks. This approach is more reliable and at the same time less resource consuming.

The consideration of the same in selected case study programs is presented below.

a) Green Mark Program, Singapore: The Building Energy Submission System (BESS), an online database under the program, facilitates seamless data collection by drawing electricity data directly from the power supply utilities. The building owners are only required to update any changes to the building information as they arise and review the energy consumption data prior to the submission. Other fuel consumption such as diesel or natural gas is very minor in Singapore and they can be reported by building owners separately through the BESS.

b) Energy Star Program, United States: The Portfolio Manager, an online tool facilitates the electricity data collection directly from the power supply utilities. Apart from electricity, the natural gas consumption and steam consumption from the district heating systems are also significant in the United States. Thus, the Portfolio Manager tool also includes data collection from these energy supply utilities.

Since the data is extracted from the utilities database, it would be easier to track and compare the reduction in energy consumption achieved through top-down approach as well.

5.3.2. Identification of source of energy use and related emissions

The buildings can source their electricity from different available power distribution companies in the region or diesel or natural gas-powered generators or through renewable sources. Further, there will be transmission and distribution losses in electricity supply. Thus, it is important to capture the sources of electricity when there are several grid utilities supplying electricity from different sources and also when electricity is transmitted over very long distances. The same approach can be considered for other energy sources such as natural gas, diesel, steam, etc., as applicable. Depending on these sources, the GHG emissions for the energy use will also vary.

a) Green Mark Program, Singapore: Given that Singapore is a small country with single grid network, only the site energy consumption is taken into consideration.

b) Energy Star Program, United States: The program objective is to evaluate individual building performance, it considers source energy intensity (i.e., site energy consumption + losses occurred in supply network for that energy consumption amount) and uses source-site

ratio parameter to convert site energy consumptions. Because the Portfolio Manager tool is available in both the United States and Canada the country-specific source-site ratios are used. The energy sources include grid electricity, petroleum products, district heating system, etc. For each country, there is only one national source-site ratio for each of the primary and secondary fuels in the Portfolio Manager. The source-site ratios computed and applied in the Portfolio Manager tool depend on several characteristics including the quality of the fuels, the average efficiency of conversion from primary to secondary energy and the distribution efficiency. The ratios are expected to change in due course of time as the national infrastructure and fuel mix evolve. Therefore, the ratios for all fuels are reviewed every three to five years and updated accordingly. Additionally, the specific ratios may be updated as needed to reflect new information, methodologies or policies.

c) Tokyo Emission Trading System (ETS), Japan: Since the program boundary is limited to the authority of Tokyo city, the energy consumption is considered only at the site level (no consideration of transmission and distribution losses of energy from the source).

Thus, identification of energy sources can be helpful in the analysis losses associated with different sources and also in understanding their emission intensity.

5.3.3. Compliance reporting based on building's energy use intensity (EUI)[29]

Different type of buildings such as commercial offices, hotels & restaurants, hospitals, educational institutions, residential buildings, malls & supermarkets, public infrastructure such as parks, etc., have different energy consumption patterns. Therefore, it is necessary to define the EUI for each of these building types separately for more accurate planning, benchmarking, reporting of energy use and evaluation of performance. The level of energy conservation and MRV procedures to be followed may vary based on the baseline EUI level of any building. The building owners must ensure that the energy consumption within the buildings are in compliance with any set limits of EUI and the parameters for such evaluation are monitored, documented and reported during the compliance period.

The consideration of the same in selected case study programs is presented below.

a) Green Mark Program, Singapore: Since its launch in 2005, the scheme has evolved to 17 different categories covering all building infrastructure like parks, data centers, retail outlets, supermarkets, homes and offices. The scheme also distinguishes new buildings from the existing buildings in its compliance requirements.

b) Energy Star Program, United States: The performance of a building is compared to performance of similar other buildings nationwide that have the same primary use. Every four years, the U.S. Department of Energy's Energy Information Administration conducts a national survey to gather data on the building characteristics and energy use from thousands of buildings across the country. As of now, the energy performance scores are available for 15 different types of buildings which represents over 50% of the commercial building space in US.

c) Tokyo ETS, Japan: The legal obligations of the scheme applie to the large-scale facilities, which are defined as the individual buildings or facilities that annually consumes above 1,500 kl of crude oil equivalent (COE). The medium/small-scale energy intensive facilities must submit an annual energy efficiency report if they belong to a corporation that annually consumes above 3,000 kl of COE. However, reductions are not mandatory for such facilities.

[29] Energy use intensity is the amount of energy consumed per unit area of the building. It may vary based type of building such as hotels, schools, hospitals, etc.

Given that there are several options in grouping the building types and their energy performance as discussed above, initially the program MRV can cover only the major energy intensive building types and it can be gradually expanded over time to include other building types as well.

5.3.4. Clubbing with concepts of the green buildings and/or sustainable buildings

More often the energy efficiency improvement initiatives for the buildings are related with the concepts of the green buildings and/or sustainable buildings. Therefore, along with energy consumption, other aspects such as water use, indoor air quality, environmental protection, innovative green building design, use of energy efficient equipment and air-conditioning systems, etc., can also be included in the assessment of building performance. This approach ensures that the overall living environment of the building is improved. For the reporting of energy savings or emission reduction from the building sector, only that relevant information can be extracted from the MRV reporting for calculation of the GHG reduction benefits.

The consideration of the same in selected case study programs is discussed below.

a) Green Mark Program, Singapore: The scheme rates the buildings according to five key criteria which are (i) energy efficiency, (ii) water efficiency, (iii) environmental protection, (iv) indoor environmental quality and (v) other green and innovative features that contribute to the better building performance. Based on the overall assessment, a building will be awarded the Green Mark ratings (ranging from 75 to 190). The certified buildings are required to be re-assessed every three years to maintain the Green Mark status.

b) Energy Star Program, United States: This program does not evaluate performance of environmental or sustainability aspects, except for the energy performance and water consumption of a building. Though the Energy Star program is voluntary, many building owners actively participated in the program since studies found that the Energy Star certified buildings command a higher premium of up to 16 percent for the sales prices and rental rates. Also, the federal agencies may not lease space in any building that has not earned the Energy Star label in the most recent year.

c) Tokyo ETS, Japan: The program regulates only the GHG emissions at the building level. However, the facilities are allowed to sell their emission allowances that are left over once a facility's annual emissions are accounted for, thus providing opportunity to generate additional revenue.

In summary, clubbing of other sustainability concepts can encourage the building developer and/or building owners to effectively implement the MRV in order to achieve potential additional benefits from the increased rentals rates or revenue. This would lead to increased participation under the MRV program.

5.3.5. Digitalization of MRV

The digitalization of MRV would facilitate the program management, handles large volumes of information, allow access to multiple users and as well as integrate with other data management systems. A diligent design and standard format is essential for an efficient and effective MRV system. The data collection template can take up considerable part of the overall MRV efforts. The MRV system also needs to be able to accommodate changes in data sources and data structure. A traceable of data/ data sources and systematic of data flow helps ensure that the quality of the MRV system is maintained.

The consideration of the same in selected case study programs is discussed below.

a) Green Mark Program, Singapore: The program uses central electronic systems called as BCA Green Mark Online. It is a one stop platform for documentary evidence submission and Green Mark assessment. The platform offers multiple support tools such as e-score calculator, e-filing portal, building energy assessment system and technical support courses to stakeholders. The system directly collects the electricity consumption details of the building directly from the power utilities database.

b) Energy Star Program, United States: The electronic tool of the program is called as Portfolio Manager. It is an online tool that the industries can use to measure and track their energy and water consumption, as well as the GHG emissions. It can be used to benchmark the performance of one building or a whole portfolio of buildings and share reports with others, all in a secure online environment. Forty percent of commercial building space in the U.S., including 35% of the Fortune 500 are already assessing their performance using the Portfolio Manager[30].

c) Tokyo ETS, Japan: The program uses the Tokyo Registry System to manage the compliance reporting, assessment and crediting of allowances and trading of credits. The details of covered facilities are made publicly available on-line through the database.

Thus, a reliable database management is important for the accurate estimation of energy savings or emission reductions benefits from a program and assure that the emission reductions achieved are real and tradable under international climate/carbon markets standards.

As of July 2018, more than 3,300 buildings or 36% of the building stocks by ground floor area I Singapore have achieved Green Mark standards. This scheme has been adopted outside of Singapore with certified projects in Indonesia, Malaysia, Thailand and China. To date, close to 50 Singapore-based firms are involved in over 300 overseas Green Mark projects in 14 countries.

More than 9,500 buildings in US and Canada had earned the Energy Star certification in 2017, bringing the total to more than 32,000 buildings certified so far. On an average, the Energy Star certified buildings are found to use 35% less energy than the typical buildings nationwide.

The first compliance period of the Tokyo ETS came to an end in December 2014 and achieved an emissions reduction of 23% compared to the base year emissions during the four years. In 2017, the emissions from covered facilities amounted to 12.04 million tCO_2, achieving a 27% reduction from base emission as a result of continuous energy efficiency efforts.

The review of international best practices above provides valuable key lessons learned for Thailand as well as other countries to leapfrog their MRV system development. As part of this project, the key lessons learned have been integrated into the recommendations provided in the chapter below.

[30] Overview of EPA's ENERGY STAR Portfolio Manager®: A tool to measure and track energy consumption and greenhouse gas emissions

6. BARRIERS, GAPS AND OPPORTUNITIES

Ideally, effective MRV systems will allow policymakers to determine which policies are contributing most effectively to the climate mitigation goals, and to measure whether policies are achieving their goals cost-effectively. As demonstrated by some systems described in this project, tracking systems are well-equipped to serve this role when they involve an impartial review process, present information in a timely manner, and have a strong institutional connection to the policy development process. A strong, dynamic MRV system can allow policymakers to continually readjust to find the most efficient and effective policies and make the best use of available resources.

The barriers, gaps and opportunities are provided as follows:

(i) Barriers and gaps

(1) Lack of action, information linkage and guidelines between the energy and GHG emission reduction policies. e.g. the Alternative Energy Development Plan (AEDP2015) and the Energy Efficiency Plan (EEP2015) are presented in energy term (megawatt / ton of oil equivalent). However, there are not linkage to the GHG emission reductions (tCO_2); especially the GHG reduction targets under the Paris Agreement.
(2) MRV at the sector level and policy level need to use data from many government agencies in various ministries, and this data is not always easily accessible. Thus, there is a barrier in data access.
(3) For the BEC building/designated building measures, GHG emission reductions in building sector can be calculated from the energy efficiency improvement data in the energy management report. However, this energy efficiency improvement data might also include the energy efficiency data from the Label No.5 measure which could lead to double counting issue.
(4) There is limitation of data to determine the baseline, building energy use and building stock types. Without this data, it is challenging to develop reliable and practical baselines.
(5) Regarding the NDC Roadmap and NDC Action Plan (Energy sector), there are some mitigation measures that will promote/apply to non-designated building. They are not clear on how to engage the non-designated building to submit the required data on annual basis until 2030 (end of NDC period).
(6) Regarding the BEC building measure in the NDC Roadmap and NDC Action Plan (Energy sector), it is not clear on how to engage condominium and non-designated building to submit a report/energy management report on annual basis until 2030 (end of NDC period). Note that these types of building consume rather significant amount of energy and emit GHG emissions. However, in the current energy management system, these types are not covered.
(7) Comparing to the Green Mark Program (Singapore) reviewed in the previous chapter, the project found that there is a strong similarity with Thailand's BEC. From the analysis, it is found that there are gaps for Thailand's program. The Green Mark Certificate has 3-year validity with annual mandatory submission of the building information and energy consumption data, while the BEC standard is not clear on the validity period of the certificate as well as it has no annual mandatory submission of the building information and energy consumption data yet.

(8) Based on the comparison with the Energy Star program for building (USA) reviewed in the previous chapter, it is found that it is fairly resemble to BEC building in Thailand, but there are gaps. The Energy Star Certificate has 12-month validity, while the BEC standard is not clear on the validity period of the certificate.
(9) Based on the comparison with the Tokyo Emission Trading Scheme (Japan reviewed in the previous chapter). The scheme is a cap and trade the emission allowance. Thailand has not set the target group or cap of emission allowance for each building yet.

(ii) Opportunities

(1) As the building sector will be implemented in NDC period (year 2021-2030), so there is a period of time and opportunity to collect data from related government agencies and then establish a data center for relevant government agencies to access the data required for GHG emission.
(2) Since the existing energy management reporting system only covers designated buildings, there is an opportunity to expand the reporting requirement to capture energy consumption and GHG reductions from other types of buildings; especially buildings in the BEC scheme, condominiums, and other non-designated buildings.
(3) Currently, BEC standard is based on voluntary basis for new building or modified building. It is on the legal process for mandatory basis which is expected to be finalized within 2019. So, it is an opportunity to add a mandatory report submission on annual basis into this legal notification or following regulations.
(4) Given the fact that awareness on environmental conservation and sustainable development has increased significantly over the past few years, there are currently several private companies, real estate developers, building owners, and other relevant stakeholders developing their own GHG reporting systems and green building initiatives. Some of the leading companies are even listed on Dow Jones Sustainability Indices (DJSI). This provides a great opportunity for the government to engage these building owners to take parts in newly developed MRV system for building.
(5) With the experiences from international best practices reviewed in the previous chapter, it is found that there is a large opportunity to digitize the MRV system for buildings. This will enable building owners to easily input necessary data, process data efficiently, and extract and utilize the data effectively. This is also in line with the Thai Government's vision on Thailand 4.0 and Smart Cities.
(6) Although baseline is strongly needed for effective MRV system for buildings, there is currently a limitation of necessary data for baseline establishment. This is in fact another opportunity for Thailand MRV system development. Effective data collection, including energy use intensity (EUI), should be set up.

7. RECOMMENDATIONS TO STRENGTHEN MRV SYSTEM

7.1 Recommendation for the MRV practice

The proposed MRV practice for the building sector for both GHG inventory and mitigation measures is based on the current institutional arrangement and the existing reporting practice of designated building. The steps in the proposed MRV practice is as follows:

1. Owner of BEC building/designated building implements the BEC standard/energy conservation measure
2. The activity data of BEC building and the designated building is verified and compiled by the Department of Alternate Energy Development and Efficiency (DEDE)
3. The DEDE submits the activity data to the Energy Policy and Planning Office (EPPO)
4. The EPPO compiles the activity data from the DEDE and other government agencies (other subsectors in energy sector)
5. Relevant government agencies estimate GHG emissions
6. Working Groups (with support from TGO) review the estimation
7. The GHG emission estimation is submitted to the Climate Change Knowledge and Database Sub-Committee
8. The Climate Change Knowledge and Database Sub-Committee verifies the reported GHG emissions
9. The National Committee on Climate Change Policy (NCCC) approve the GHG emissions as included in the National Communication (NC) and Biennial Update Report (BUR)/ Biennial Transparency Report (BTR)

The proposed MRV practice in building sector is shown in Figure 7.1

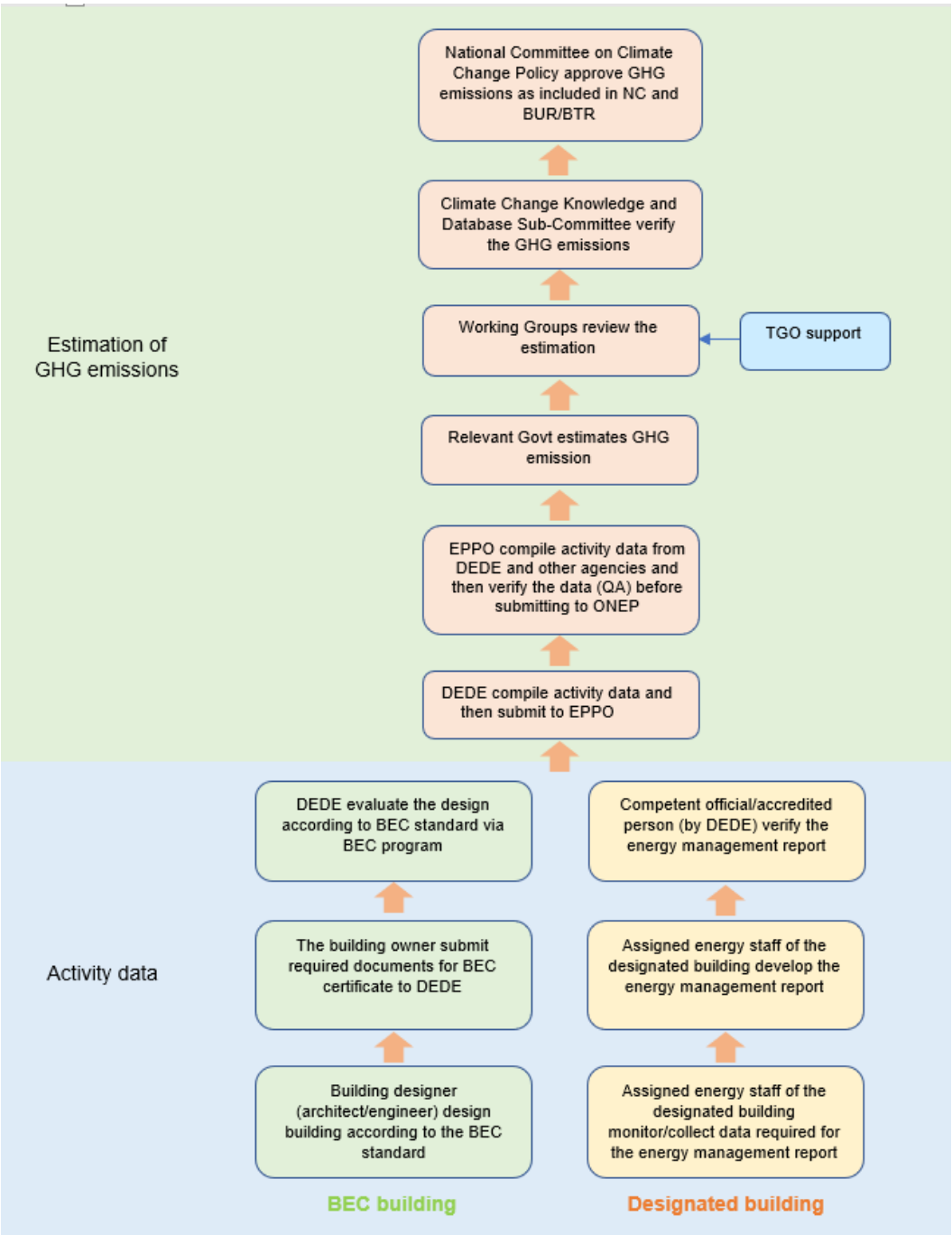


Figure 7- 1 Proposed MRV practice in building sector[31]

The relevant agencies involved in the GHG emissions in the building sector and their roles and responsibilities are shown in the Table 7-1.

[31] The proposed MRV diagram is developed by the author

Table 7- 1 List of relevant agencies and their roles and responsibilities

Agency name	Roles and responsibilities
Owner of BEC/designated building	- Support the national policy on energy efficiency/GHG emission reductions - Collect energy consumption data and prepare the energy management report in the required template - Submit to the competent authority/accredited person to review and approve the data by providing the energy audit and certification report - In case of BEC buildings, the owner submits the design of BEC building and other documents to the DEDE
Department of Alternative Energy Development and Efficiency (DEDE)	- Collect activity data from BEC building and designated building - Verify the required activity data for GHG emission estimation
Thailand Greenhouse Gas Management Organization (Public Organization) (TGO)	- Develop GHG methodologies - Design on the MRV system - Support in capacity building in collecting data and quality control - Support as GHG data center - Technical support related to GHG
Energy Policy and Planning Office (EPPO)	- Develop the NDC Action Plan in Energy Sector - Compile all activity data in energy sector
Office of Natural Resources and Environmental Policy and Planning (ONEP)	- Submit the GHG emission estimation to the Climate Change Knowledge and Database Sub-Committee
Working Group (Energy sector)	- Review the methodology of the GHG emission estimation as part of quality control to ensure that the GHG emission estimation is valid, accurate and compete
Climate Change Knowledge and Database Sub-Committee	- Verify the GHG emissions
National Committee on Climate Change Policy	- Approve the GHG emissions as included in the National Communication (NC) and Biennial Update Report (BUR)/ Biennial Transparency Report (BTR)

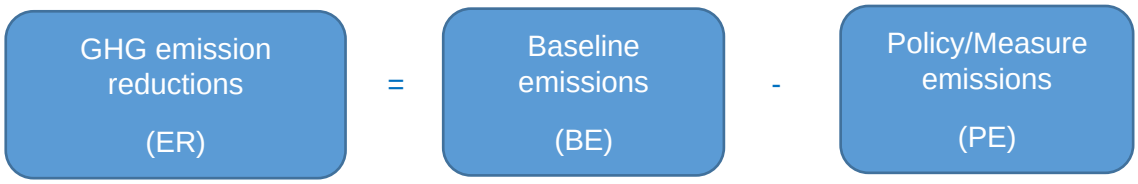
7.2 General recommendations for the building sector

(1) At present, the designated buildings are mandated to submit an energy management report on an annual basis. This report contains almost data required for the GHG calculation, but it is not generally reported in term of GHG inventory or emission reduction data. It needs to be further calculated as the GHG inventory or emission reduction data. Thus, the GHG report is required to be developed on annual basis (calendar year) for the best MRV practice.

(2) Unlike the designated building, BEC and non-designated buildings have no process or reporting system for the report submission on an annual basis. Therefore, it is required to create a reporting system for the BEC building and non-designated buildings participating in the DEDE's promotion/mitigation measures to submit the report on annual basis until 2030 (end of NDC period).

(3) Quantification and monetization of (positive and negative) externalities over the building life cycle should be well-integrated into decision-making processes.
(4) Continuous monitoring and constant modification of performance and dynamics of building codes would allow implementation to catch up with the potential for efficiency improvements and co-benefits. This would also provide better feedback to the policymaking process, creating awareness, capacity building and training. For the designated building, there is a well-designed data collection and reporting system. In order to improve this existing practice to be an appropriate MRV for GHG emissions, the determination of quality indicator for the responsible organizations should be measurable as per institutional arrangement policy and design of domestic MRV system should be conformed to an existing practice.
(5) As per the BEC building measure in the Energy Efficiency Plan (EEP2015) that aims to reduce energy demand by 36% (1,166 ktoe) of the total energy demand in new buildings to achieve international green building standard such as Leadership in Energy and Environment Design (LEED) or Thai's Rating of Energy and Environmental Sustainability (TREEs) standards by Thai Green Building Institute (TGBI). If these plans could combine or link to GHG emission term, then it would be a clear understanding.
(6) The data of Label no.5 should be separately identified in the energy management report for avoiding on double counting issue.
(7) The recommendation on the GHG emission methodology is provided below;

The general equations to calculate the GHG emissions are given below.



GHG emission = Activity Data (AD) x Emission Factor (EF)

Where:

BE_y = Baseline emission in year y (tCO_2/year)
PE_y = Policy/Measure/Project/Activity emission in year y (tCO_2/year)
ER_y = Emission reduction in year y (tCO_2/year)
AD = Activity data (unit/year)
EF = CO_2 emission factor (tCO_2/MWh)

The activity data is the measure of energy consumption in a facility/unit. In buildings, electricity is the major source and hence any savings in the electricity would result in reduction of GHG emissions.

1) Fixed baseline year (energy saving multiply by grid emission factor)

$$ER_y = \Delta EC_y \times EF_{EC,y} \times 10^{-3}$$

Where:

$$\Delta EC_y = BE_{EC,y} - PE_{EC,y}$$

Where:

ER_y = Emission reductions in year y (tCO_2/year)
ΔEC_y = Electricity saving in year y (kWh/year)
$EF_{EC,y}$ = Grid emission factor in year y (tCO_2/MWh)
$BE_{EC,y}$ = Baseline electricity consumption in year y (kWh/year)
$PE_{EC,y}$ = Policy/Measure/Project/Activity electricity consumption in year y (kWh/year)

2) Specific Energy Consumption

The emission reduction calculation based on the specific energy consumption formulae is

$$BE_y = SEC_{BL,y} \times Area_{PJ,y} \times EF_{EC,y} \times 10^{-3}$$
$$PE_y = SEC_{PJ,y} \times Area_{PJ,y} \times EF_{EC,y} \times 10^{-3}$$
$$ER_y = (SEC_{BL,y} - SEC_{PJ,y}) \times Area_{PJ,y} \times EF_{EC,y} \times 10^{-3}$$

Where:

$$SEC_{PJ,y} = EC_{PJ,y} / Area_{PJ,y}$$

Where:

BE_y = Baseline emission in year y (tCO_2e/year)
PE_y = Policy/Measure/Project/Activity emission in year y (tCO_2e/year)
ER_y = Emission reductions in year y (tCO_2e/year)
$SEC_{BL,y}$ = Baseline specific energy consumption saving in year y (kWh/m^2)
$SEC_{PJ,y}$ = Policy/Measure/Project/Activity specific energy consumption saving in year y (kWh/m^2)
$EF_{EC,y}$ = CO_2 emission factor of the grid electricity in year y (tCO_2e/kWh)
$EC_{PJ,y}$ = Policy/Measure/Project/Activity electricity consumption in year y (kWh/year)
$Area_{PJ,y}$ = Policy/Measure/Project/Activity covered area in year y (m^2)

(8) Generally, the GHG emission inventory and the GHG emission mitigation measure are reported on annual basis. Since the GHG reporting format has not been created so far, therefore it should be created by all relevant agencies e.g. TGO, DEDE, ONEP and Energy Working Group. The GHG report could be reported via online submission for ease of convenience to the related agencies.

(9) Verification is the periodic independent review of reported data. It is the process of confirming the GHG inventory as well as the GHG emission mitigation actions achieved by the implemented measures. Thus, based on the domestic MRV system and institutional arrangement proposed in the second BUR, the GHG data should be verified by the Energy Working Group and the Climate Change Knowledge and Database Sub-Committee respectively. The verification guideline should be determined by all relevant agencies e.g. TGO, DEDE, ONEP and Energy Working Group as appropriate for the building sector.