Initiative for Climate Action Transparency (ICAT):

Improving Thailand's MRV System for Climate Change Mitigation

Final Report on MRV for the Industrial Sector

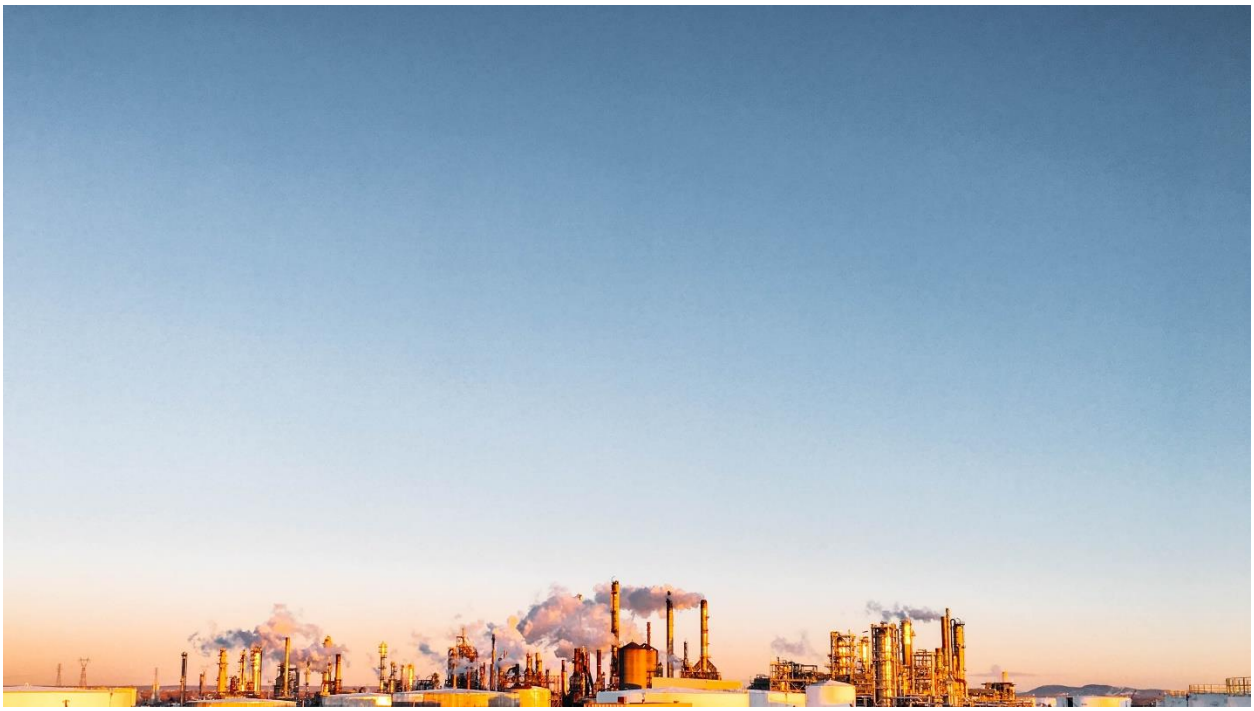


Photo by Chris Liverani on Unsplash

Initiative for Climate Action Transparency - ICAT -

Improving Thailand's MRV System for Climate Change Mitigation

Deliverable #1

AUTHORS

The Global Green Growth Institute

Date of the deliverable 27 September 2019

PUBLISHED BY

Office of Natural Resources and Environmental Policy and Planning (ONEP), Thailand's Ministry of Natural Resources and Environment

PREPARED UNDER

Initiative for Climate Action Transparency (ICAT) project supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the Children´s Investment Fund Foundation (CIFF), the Italian Ministry for Environment, Land and Sea Protection, and ClimateWorks

The ICAT project is hosted by the United Nations Office for Project Services (UNOPS)

ACKNOWLEDGEMENT

We would like to acknowledge and express gratitude to the Royal Thai Government, especially the Office of Natural Resources and Environmental Policy and Planning, Thailand Greenhouse Gas Management Organization, Department of Alternative Energy Development and Efficiency, and other relevant agencies, for their strong commitments to assist the global communities in addressing climate emergency and strong support to the project. Also, we would like to thank other relevant stakeholders for their constructive and useful contributions to the project.

The project was done under the technical guidance and coordination of Emmanuel K. Ackom, Susanne Konrad, and Denis Desgain from UNEP DTU Partnership, and made possible with supports from the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the Children´s Investment Fund Foundation (CIFF), the Italian Ministry for Environment, Land and Sea Protection, and ClimateWorks.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

AER	Annual Emission Report
AT&C	Aggregate Technical and Commercial loss
BAU	Business-as-Usual
BEE	Bureau of Energy Efficiency
BEIS	Department of Business, Energy and Strategy
BOI	Board of Investment
BTR	Biennial Transparency Report
BUR	Biennial Update Report
CCA	Climate Change Agreement
CCC	Committee on Climate Change
CCL	Climate Change Levy
CEMS	Continuous Emissions Monitoring System
CEPA	Committee on Energy Policy Administration
CHP	Combined Heat and Power
CO_2	Carbon-di-oxide
CH_4	Methane
CRC	Carbon Reduction Commitment
DAA	Directly Associated Activities
DC	Designated Consumer
DEDE	Department of Alternate Energy Development and Efficiency
DIW	Department of Industrial Works
DISCOMS	Distribution Companies
EA	Environment Agency
ECA	Energy Conservation Act
EEM	Energy Efficiency Measure
EEP	Energy Efficiency Plan
EESL	Energy Efficiency Services Limited
EmAEA	Empanelled Accredited Energy Auditor
ENCON Fund	Energy Conservation Promotion Fund
EPPO	Energy Policy and Planning Office
ESCerts	Energy Saving Certificate
ETS	Emissions Trading Scheme
EU	European Union
EUR	Euro
FDF	Food and Drink Federation
FTI	The Federation of Thai Industries
GBP	Pound Sterling
GDP	Gross Domestic Product
GGGI	Global Green Growth Institute
GHG	Greenhouse Gases
GIR	Greenhouse Gas Inventory & Research Centre
HFC	Hexafluorocarbon

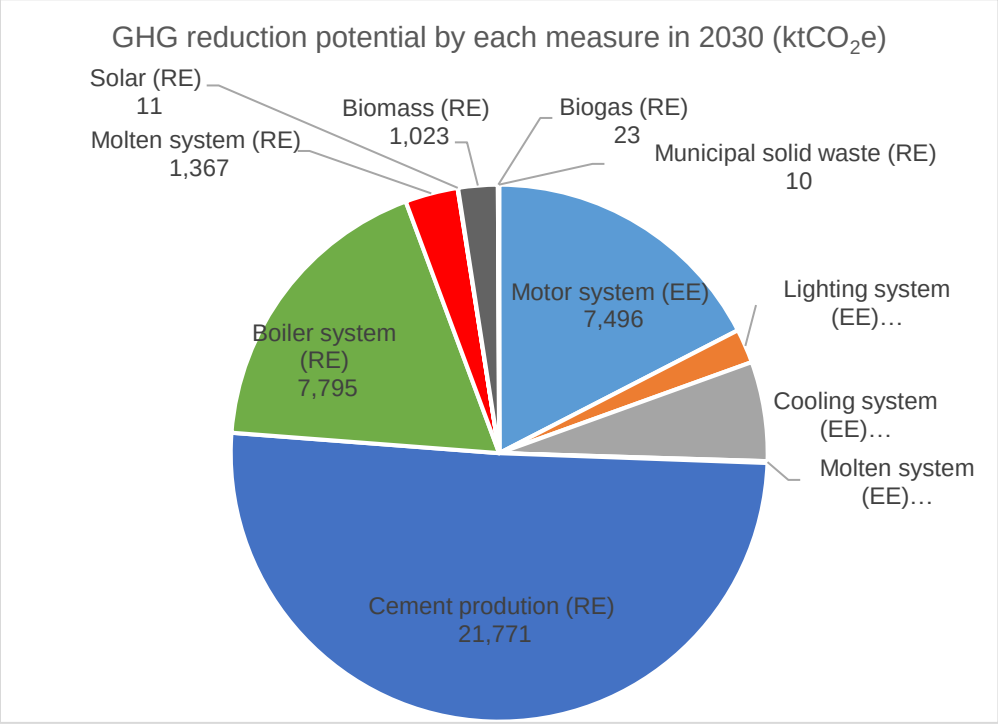
HMRC	Her Majesty Revenue and Customs
ICAT	Initiative for Climate Action Transparency
INDC	Intended Nationally Determined Contribution
IT	Information Technology
KETS	Korea Emissions Trading Scheme
kgC	kilogram of Carbon
KRX	Korea Stock Exchange
KRW	South Korea Won
ktoe	kilo-tons of Oil Equivalent
kVA	Kilovolt Ampere
kWh	kilo-watt hour
LDC	Least Developed Countries
LPG	Liquefied Petroleum Gas
LULUCF	Land use, land-use change, and forestry
MJ	Megajoule
MRV	Measurement, Reporting, and Verification
MOE	Ministry of Environment
MOP	Ministry of Power
MOSF	Ministry of Strategy and Finance
NAMA	Nationally Appropriate Mitigation Actions
NAPCC	National Action Plan on Climate Change
NC	National Communication
NCCC	National Committee on Climate Change Policy
NDC	Nationally Determined Contribution
NEPC	National Energy Policy Council
NESDP	National Economic and Social Development Plan
NFI	National Food Institute
NMEEE	National Mission on Enhanced Energy Efficiency
NSTDA	National Science and Technology Development Agency
OIE	Office of Industrial Economics
ONEP	Office of Natural Resources and Environmental Policy and Planning
OTC	Over-the-Counter exchange market
PAT	Perform, Achieve and Trade
PFC	Perfluorocarbon
QA	Quality Assurance
QC	Quality Control
RE	Renewable Energy
SDA	State Designated Agency
SEC	Specific Energy Consumption
SF_6	Sulphur hexafluoride
STU	Stationary Technical Unit
tCO_2	Tons of Carbon dioxide
TGO	Thailand Greenhouse Gas Management Organization
TMS	Target Management System

TOE	Tons of Oil Equivalent
TSIC	Thai Standard Industry Classification
USD	United States Dollar
UNFCCC	United Nations Framework Convention on Climate Change

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 industrial sector.

As per the Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030, the industrial sector is classified as a sub-sector under the energy and transportation sector and its main target measures are 1) energy efficiency improvement and 2) substitution of renewable energy - with total potential GHG reductions of 43 million tCO_2e.



GHG reduction potential by each measure in 2030

The report observes that the NAMA does not indicate specific GHG mitigation measures for the industrial 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 factories in Thailand. The recommendations are provided as below;

(1) At present, designated factories under the Energy Conservation Act, are required to submit an energy management report on annual basis. This report requirement contains most data needed for the GHG calculation. However, it is still not sufficient to use the data from the report to estimate GHG inventory and GHG reduction from those factories. It needs to be further calculated as the GHG inventory or emission reduction data. Thus, GHG report is required to be developed on annual basis for the best MRV practice.
(2) Unlike the designated factory, the non-designated factories have no process or reporting system for the report submission on annual basis. Therefore, it required to create a reporting system for the non-designated factories participating in the DEDE's promotion/mitigation measures on annual basis and submission until year 2030 (end of NDC period).
(3) The data of Label no.5[1] should be separately identified in the energy management report for avoiding on double counting issue.
(4) The recommendation on the GHG emission methodology is provided in Chapter 7.
(5) Generally, the GHG emission inventory and the GHG emission mitigation measure are reported on annual basis, thus the GHG emission inventory and GHG emission mitigation measure report should be reported in the same period basis. Since the GHG reporting format has not been created so far, then it should be created by all relevant agencies e.g. TGO, DIW, DEDE, ONEP and Energy Working Group. The GHG report could be reported via online submission for ease of convenience to the related agencies.
(6) 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, DIW, DEDE, ONEP and Energy Working Group as appropriate for the industrial sector.

[1] An energy efficiency labeling scheme

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 areas 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 in country 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 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 transportation sector consumed an average of 35.5% and the industrial sector consumed an average of 35.3% of the total final energy consumption. From the figure below, it could be observed that energy consumption in the industrial sector keeps increasing since 2008. This could be explained by the fact that the sector is expanding and has become a major economic driver for the country.

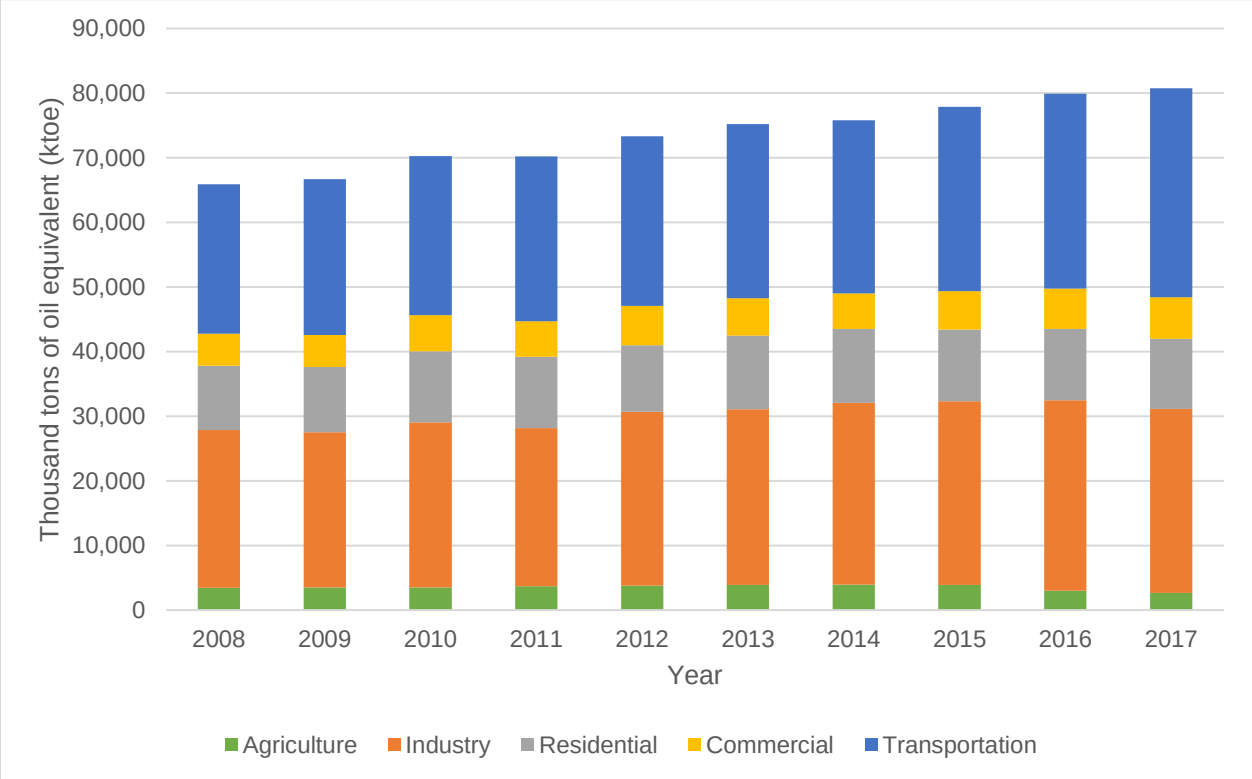


Figure 1- 1 Historic energy consumption trend in Thailand[4]

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] Source: Department of Provincial Administration
[3] Source: Department of Alternative Energy Development and Efficiency
[4] Source: Office of Natural Resources and Environmental Policy and Planning

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%. This is in line with energy consumption trend during the same period.

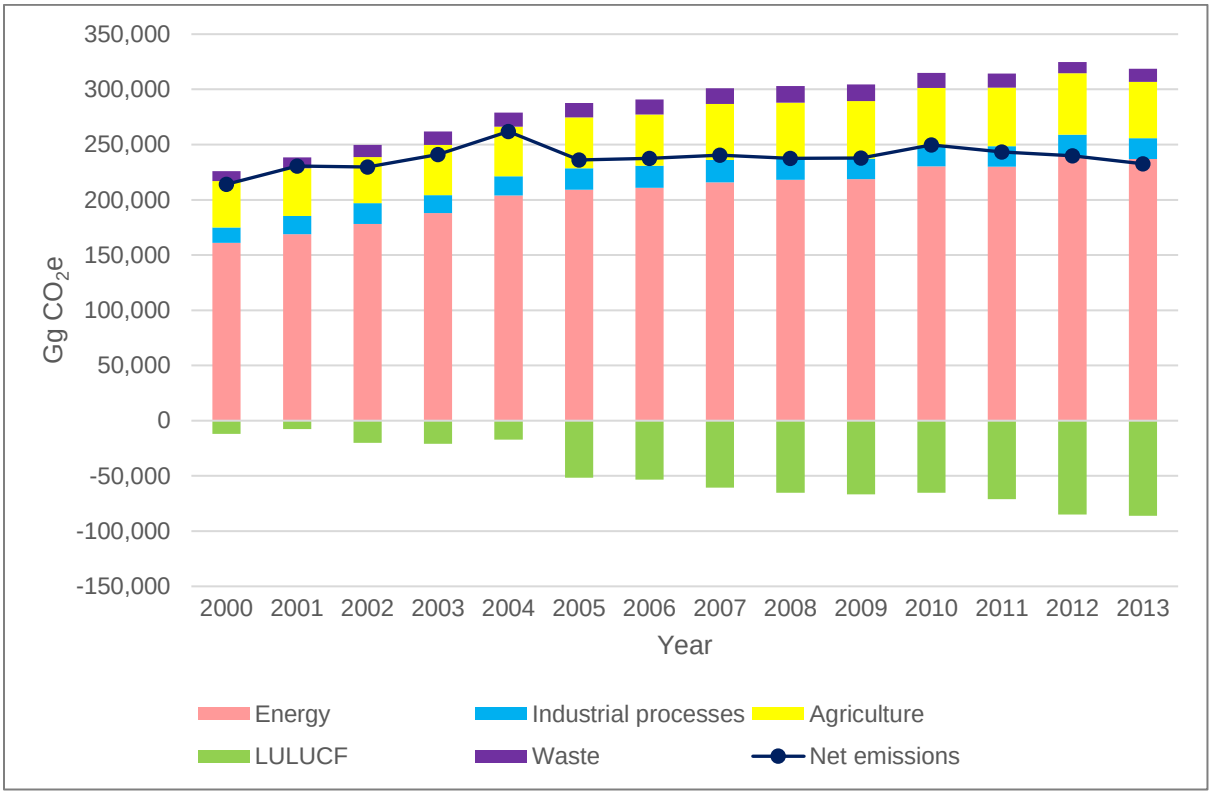


Figure 1- 2 Historic GHG emissions/removal[5]

According to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, there are four sectors/sources emitting GHGs. These are: 1) energy; 2) industrial process and product use (IPPU); 3) agriculture, forestry, and other land uses (AFOLU); and 4) waste. Since the focus of this report is on the industrial sector, the relevant GHG emitting sources are: 1) energy; 2) IPPU; and 3) waste.

Energy is the key emission source for the industrial sector as energy is one of the major inputs for all manufacturing process. This leads to GHG emissions both directly emitted at factory sites (e.g. fuel oil, LPG, diesel) and indirectly generated (e.g. GHG emission from grid electricity). However, GHG emissions from IPPU and waste from the sector are considered much more limited and less relevant. With this, Thailand's GHG reduction policies and measures described below give much less priority to these emission sources. Consequently, this report will focus mainly on GHG emissions from the energy rather than the other two emission sources.

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)

[5] Source: Second Biennial Update Report of Thailand

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.

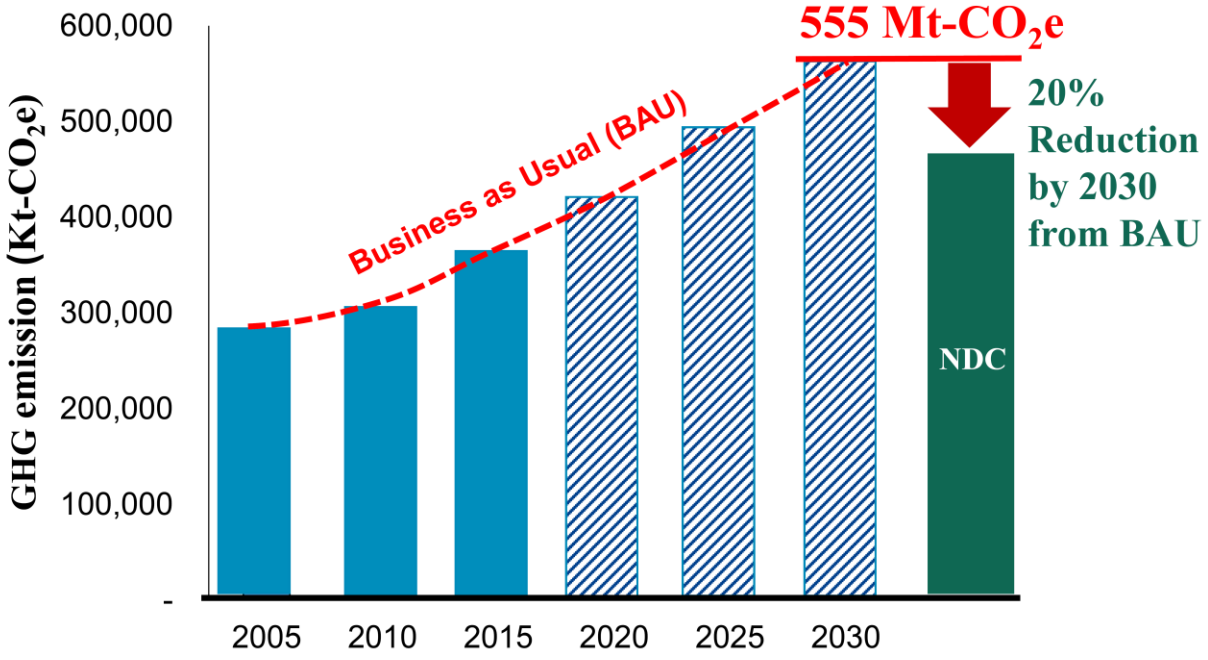


Figure 1- 3 Thailand's NDC Targets[6]

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[7], 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

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

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.

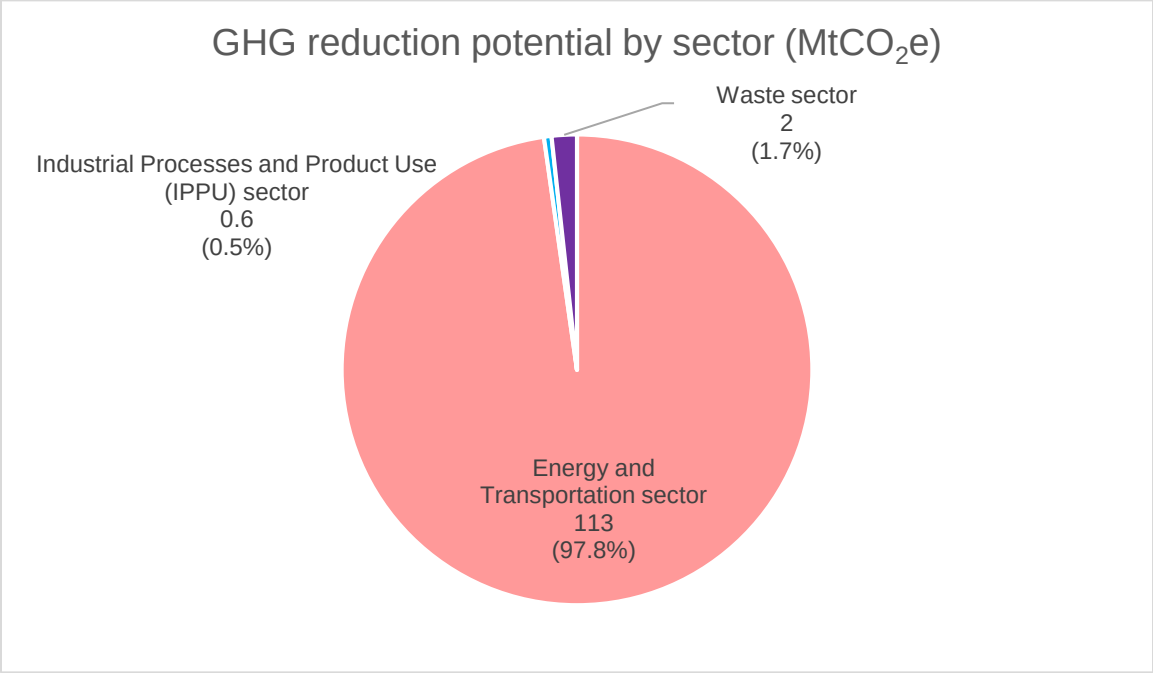


Figure 1- 4 Sectors wise GHG reduction potential

Table 1- 1 Summary information on Thailand's NDC mitigation measures[8]

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

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

No.	Measure	Potential GHG reductions ($MtCO_2e$)	Target group
	2) Substitution of renewable energy	32	
1.5	**Transportation**	**41**	
	1) Energy efficiency improvement	31	Producers/ travelers/ land, water, air transport system/ people
	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 (e.g., power plants and liquid fuel production plants);
- Reporting is carried out by responsible installations to corresponding authority (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 industry, that is this report (in addition to the building 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 *(This component is covered in this report);*
2. MRV in the building sector;
3. Contribution to Thailand's NDC Roadmap - Presenting sector findings to relevant stakeholders.

1.2. Objective and scope

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

1. Review of the international best practice/case studies on MRV in the industrial sector;
2. Identification of the current situation/baseline of current MRV practice for the industrial sector in Thailand;
3. Identification of the gaps, barriers and opportunities for effective MRV in the industrial sector; and
4. Formulation of recommendations to strengthen MRV in the industrial sector, with specific recommendation for the food industry.

2. OVERVIEW OF THAILAND's INDUSTRIAL SECTOR

Based on data from the DEDE, the final energy consumption in industrial sector has increased (average) by 1.7% per year between 2008 to 2017. Regarding the final energy consumption in 2017, the industrial sector consumed around 35.2% of total final energy consumption which is the second highest consumption after the transportation sector which consumed around 35.5%. Figure 2-1 shows the trend in the final energy consumption by different sectors.

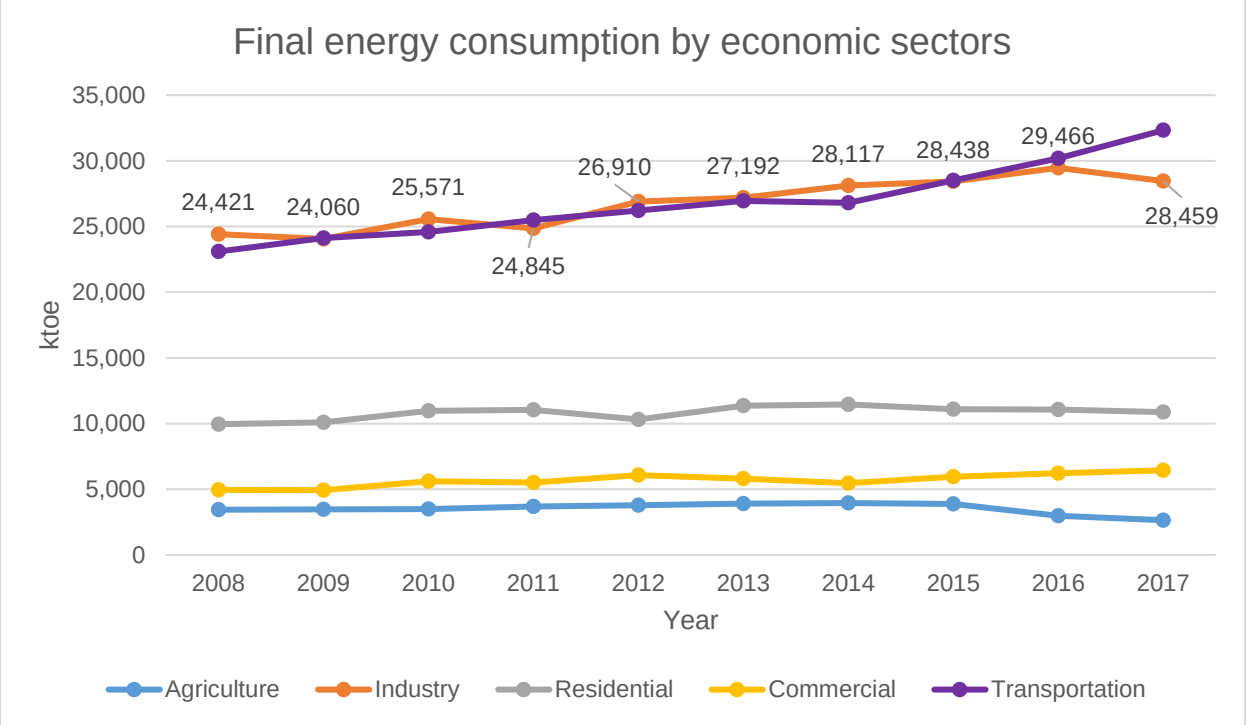


Figure 2- 1 Final energy consumption by sectors[9]

The industrial 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 43 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;

[9] Source: Department of Alternative Energy Development and Efficiency

- 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; and
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 2-2.

Table 2- 1 Main regulations related to energy conservation in industrial 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 Factory B.E.2540 (1997)
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 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)

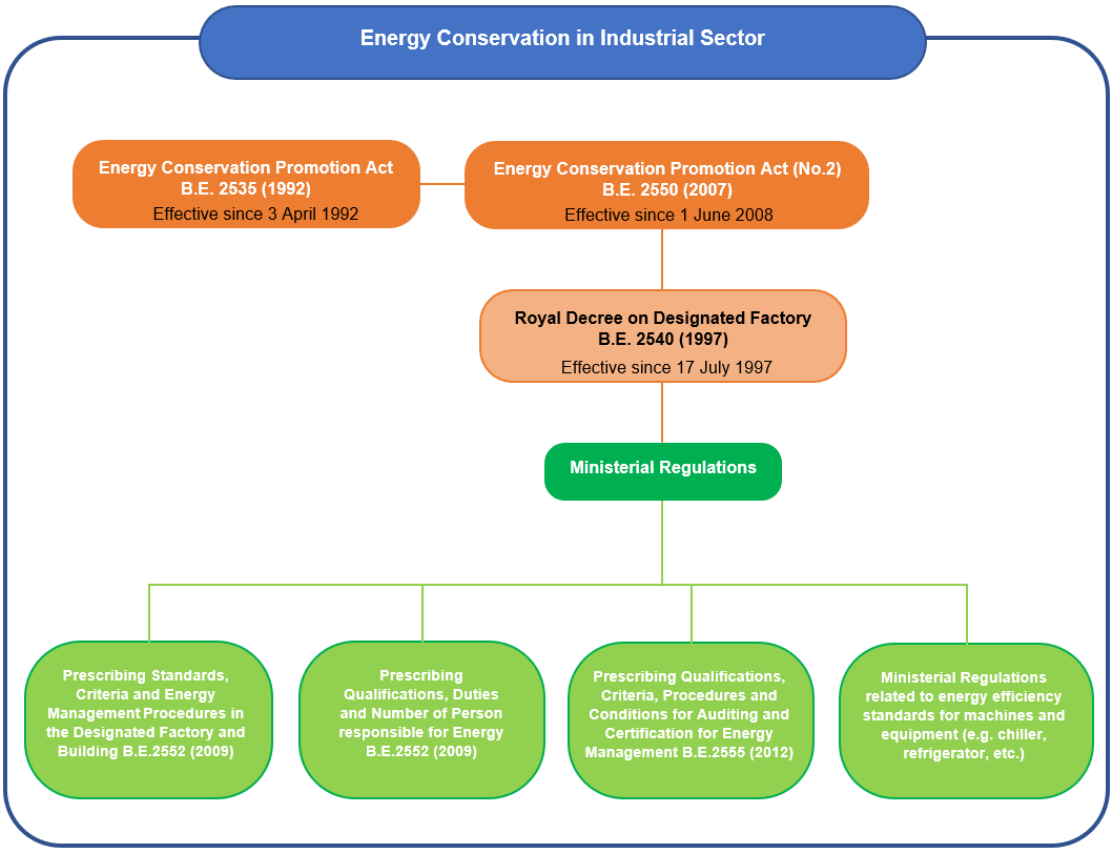


Figure 2- 2 Regulations for energy conservation in industrial sector[10]

According to the Royal Decree on Designated Factory B.E. 2540 (1997), a factory that satisfies the following criteria is defined as the "designated factory":

1) A single factory 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 factory 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).

A factory that is defined as "designated factory" must follow the relevant regulations on energy conservation. According to the Energy Conservation Promotion Act B.E.2535 (1992) and its amendment in B.E.2550 (2007), a designed factory must implement any one of following energy conservation measures:

1) Efficiency improvement of fuel combustion
2) Protection of energy loss
3) Energy reuse
4) Energy switching

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

5) Improvement of electricity usage via improvement of power factor, and reduction of electricity demand in the peak period of the electrical equipment system to be in line with the load and operation system
6) Use of highly efficient machinery or equipment including the control system and materials used for energy conservation
7) Other measures prescribed in the Ministerial Regulations

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

1) Assigning the responsible persons for energy management in each designated factory as following criteria;

Table 2- 2 Number of responsible persons for energy management[11]

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 on the energy management and energy conservation activities.

   There are eight steps in energy management guideline as follows:
   (1) Establishing a structure, committee/working group for energy management;
   (2) Evaluating on 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 as per the energy conservation plan;
   (8) Reviewing, analyzing, revising on weak points of the energy management system.

   The same is presented as flow chart in Figure 2-3.

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

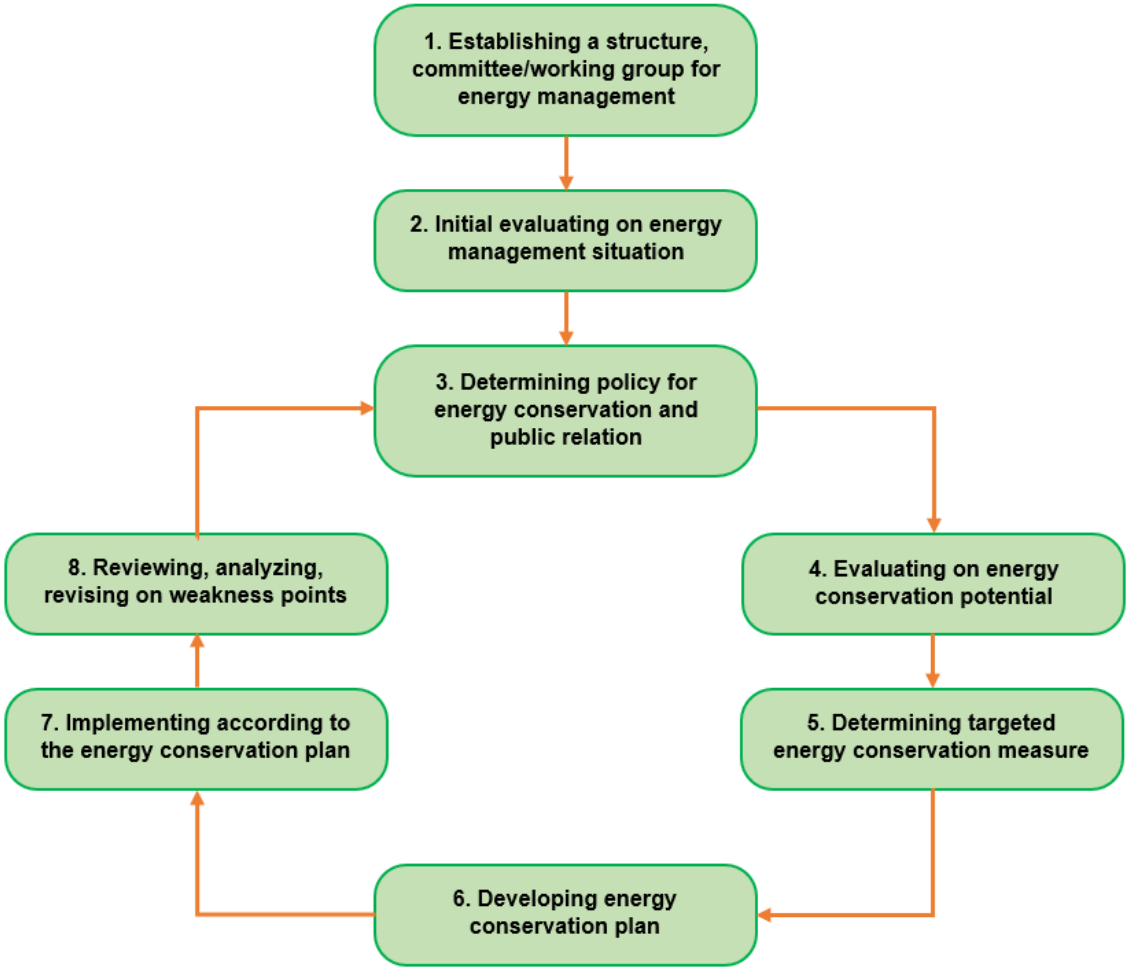


Figure 2- 3 Energy management guideline[12]

3) Submitting the energy management report and auditing & certification energy report to DEDE within March every year.

   Owner of the designated factory 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 factory must submit the energy management report and auditing and certification energy report to the DEDE within March every year. Figure 2-4 shows the flow chart of steps involved in submission of the energy management report to the DEDE.

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

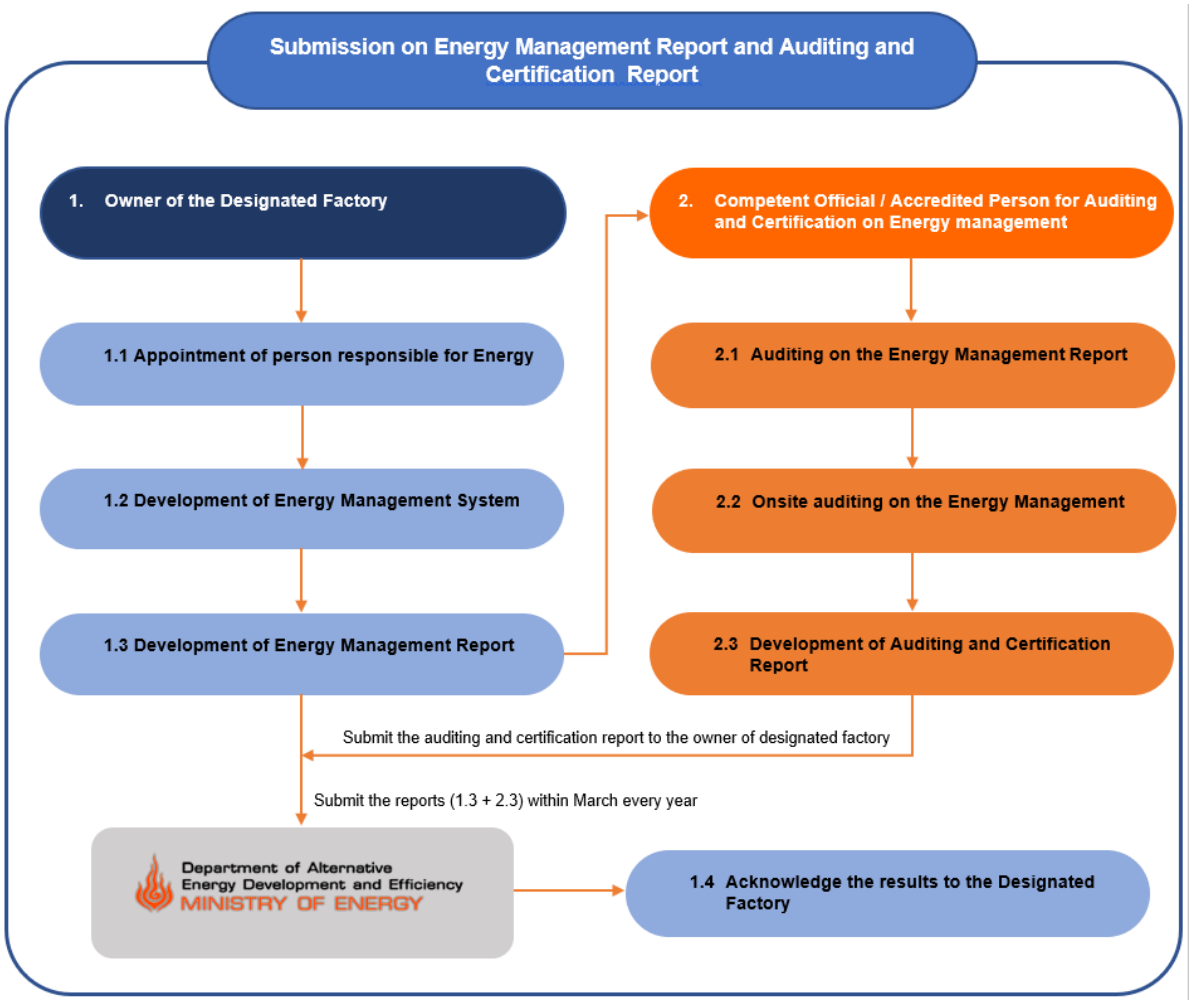


Figure 2- 4 Submission on energy management report[13]

According to the DEDE's database, there are 5,943 designated factories in 2018. The numbers have slightly increased every year since 2015. The food, beverage and tobacco industry has the highest designated factories (1,151 factories), followed by the non-metals industry (1,073 factories) and the metal product, machinery and equipment industry (1,031 factories) respectively as shown in Table 2-3.

[13] Source: The energy conservation center of Thailand

Table 2- 3 Number of designated factories in Thailand[14]

Type of factory \ Year	2015	2016	2017	2018
Paper	172	167	164	173
Gas	24	23	23	22
Water supply	27	27	28	33
Electricity supply	143	156	189	205
Chemicals	385	397	403	406
Metal product, machinery and equipment	963	989	1,007	1,031
Wood	87	89	93	99
Primary metals	362	363	372	373
Textiles	440	435	440	433
Stone, gravel and sand	79	79	78	79
Non-metals	1,024	1,035	1,051	1,073
Food, beverage and tobacco	1,089	1,108	1,124	1,151
Other products	800	825	848	865
Total	**5,595**	**5,693**	**5,820**	**5,943**
Increase/decrease	**-**	**1.8%**	**2.2%**	**2.1%**

Regarding the energy consumption data for each industry from the DEDE's database, the highest energy consumption in 2017 is chemicals industry at 370,427 TJ, followed by non-metals industry at 269,976 TJ and food, beverage and tobacco industry at 242,113 TJ respectively as shown in Figure 2-5.

[14] Department of Alternative Energy Development and Efficiency, May 2019

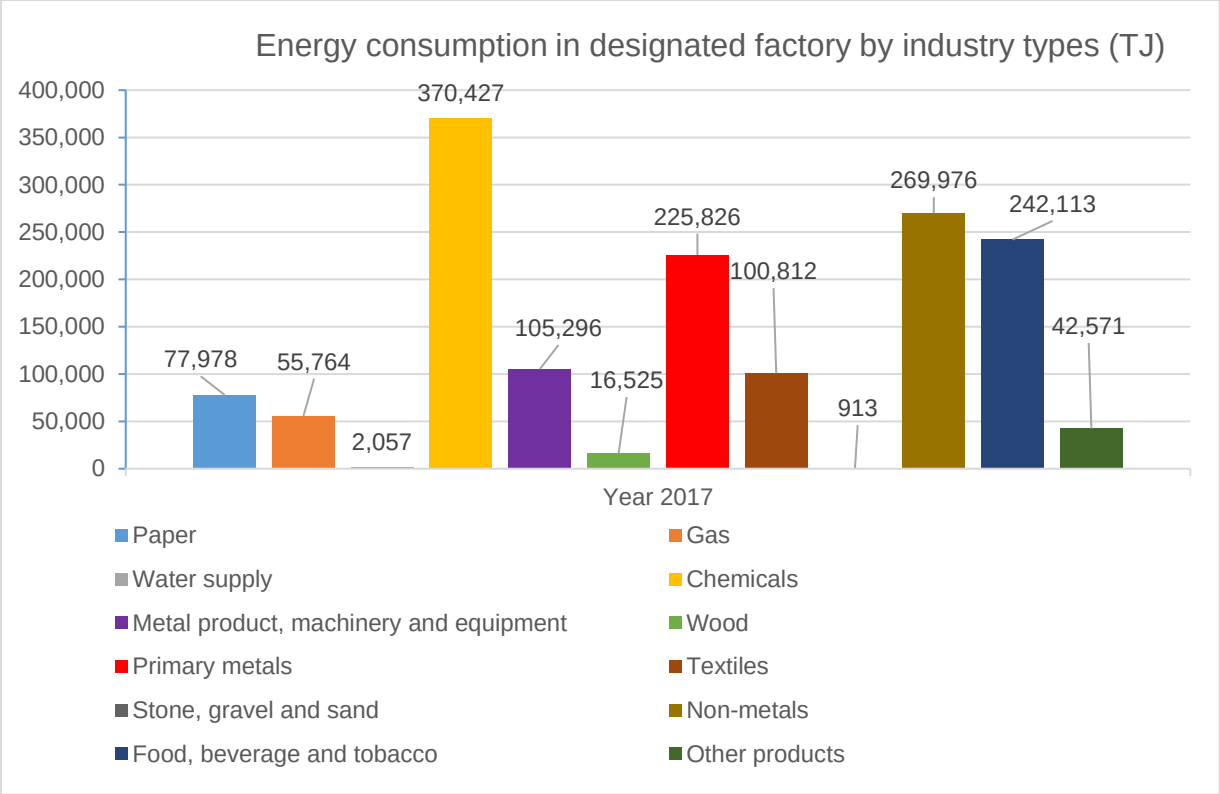


Figure 2- 5 Energy consumption in designated factory by industry types[15]

[15] Source: Department of Alternate Energy Development and Efficiency, May 2019

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 industrial 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.

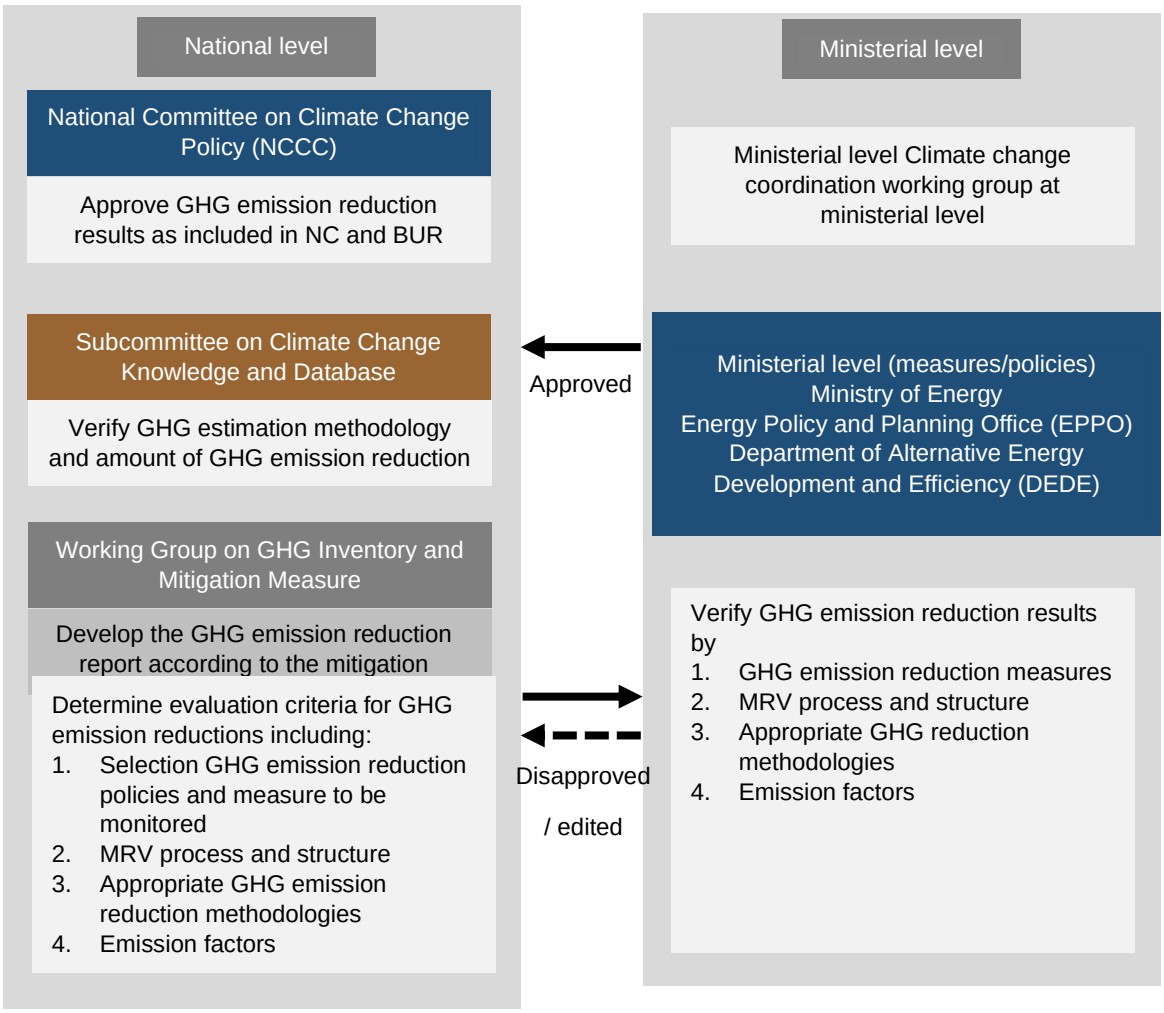


Figure 3- 1 Institutional structure in relation to MRV practices

4. CURRENT MRV PRACTICES IN THE INDUSTRIAL SECTOR

4.1. Review of NDC and related policies

As per the Thailand's Nationally Determined Contribution Roadmap on Mitigation 2021-2030, the industrial sector is classified as a sub-sector under the energy and transportation sector and its main target measures are 1) energy efficiency improvement and 2) substitution of renewable energy - with total potential GHG reductions of 43 million tCO_2e. The details of each measure are as follows.

1) Energy efficiency improvement

This measure is divided into four systems:

(1) Motor system;
(2) Lighting system;
(3) Cooling system;
(4) Molten system.

2) Substitution of renewable energy

This measure is divided into two components:

(1) Thermal energy consumption improvement:
There are three target systems in this component;
- Cement production;
  - Efficient kiln;
  - Efficient kiln with combined heat and power;
- Boiler system;
  - Efficient boiler;
  - Advanced boiler;
- Molten system;
  - Efficient furnace.

(2) Substitution of renewable energy:
- Solar;
- Biomass;
- Biogas;
- Municipal solid waste.

Table 4-1 provides the GHG reduction potential through each of above measures.

Table 4- 1 Potential GHG reductions for each measure in industrial sector[16]

Measure	Potential GHG reductions ($ktCO_2e$)			
	2015	2020	2025	2030
1) Energy efficiency improvement	**44**	**2,375**	**8,268**	**11,000**
(1) Motor system	43	1,618	5,634	7,496
(2) Lighting system	0	191	665	885
(3) Cooling system	1	556	1,935	2,574
(4) Molten system	0	9	34	46
2) Substitution of renewable energy	**1,735**	**11,446**	**19,653**	**32,000**
(1) Thermal energy consumption improvement				
- Cement production	1,072	7,853	13,414	21,771
- Boiler system	242	2,456	4,573	7,795
- Molten system	79	454	791	1,367
(2) Substitution of renewable energy				
- Solar	3	7	9	11
- Biomass	327	654	839	1,023
- Biogas	7	15	19	23
- Municipal solid waste	3	6	8	10
Total	**1,779**	**13,821**	**27,921**	**43,000**

Figure 4-1 shows the contribution of GHG reduction potential from different measures.

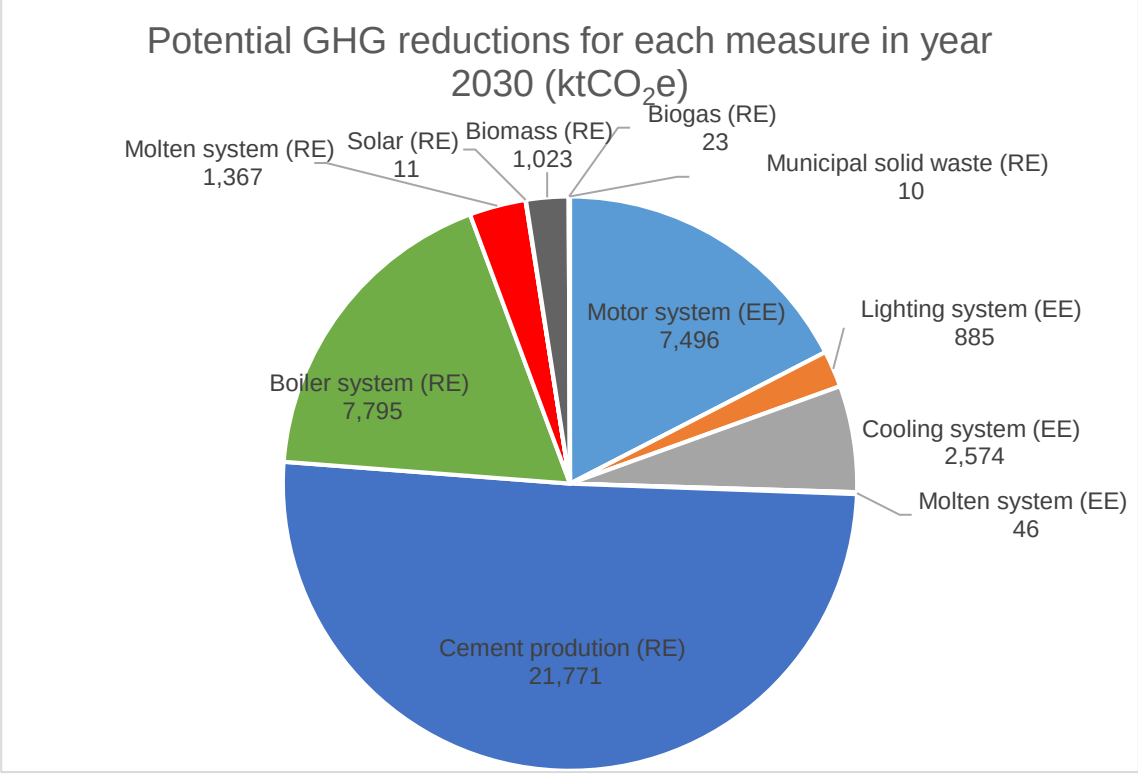


Figure 4- 1 Potential GHG reductions for each measure in year 2030

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

4.2. Review of the existing MRV practices

4.2.1. General overview for all industrial sectors

At present, there is no existing MRV practice for the industrial sector. There is only a reporting practice under which, the designated factory is responsible to submit an energy management report on annual basis. The owner of designated factory is required by law to assign energy manager to be responsible for energy management as indicated in the Table 2-2. The steps in the existing report practice are listed below:

1. The designated factory implements the energy conservation measure;
2. The designated factory measures and records data as required by the energy management report;
3. The designated factory develops the energy management report;
4. The designated factory seeks and sends the energy management report to a competent official / accredited person for approval;
5. The competent official / accredited person verifies the energy management report and develops an auditing and certification energy report and sends to the designated factory; and
6. The designated factory submits the energy management report and auditing and certification energy report to DEDE within March every year.

The data collected through this report from all the designated factories could be further used for GHG calculation. The proposed MRV practice based on this existing reporting practice is described in section 7.

4.2.2. Overview of the food sector as an example

As mentioned above, there is no existing MRV practice for the industrial sector as well as for food sector. There is only a reporting practice which is the same as those for all industrial sector as indicated in 4.2.1

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 show in Figure 4-2 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).

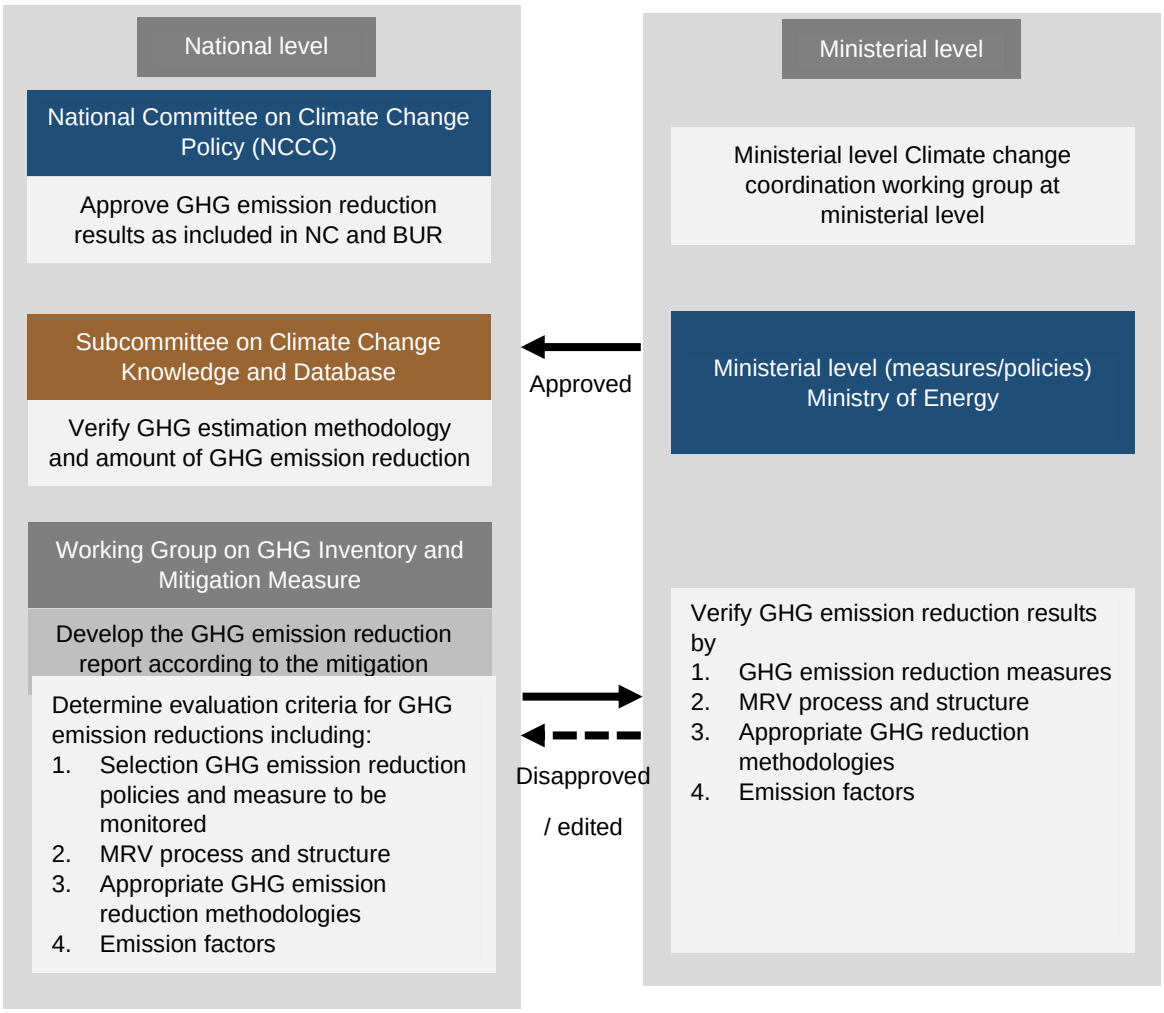


Figure 4- 2 Current institutional arrangement

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 above, 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 the current framework.

5. INTERNATIONAL MRV BEST PRACTICES IN THE INDUSTRIAL SECTOR

With raising global consensus on the need for strong measures against the climate change, the 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 towards the action against climate change. The transparent MRV approaches can improve comparability at national and international level 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), 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[17]

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[18] 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[19]

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

[17] http://ghgprotocol.org/
[18] https://www.iso.org/standard/66453.html
[19] https://www.ipcc.ch/

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 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.

5.2 Development of international MRV guidelines

In general, 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

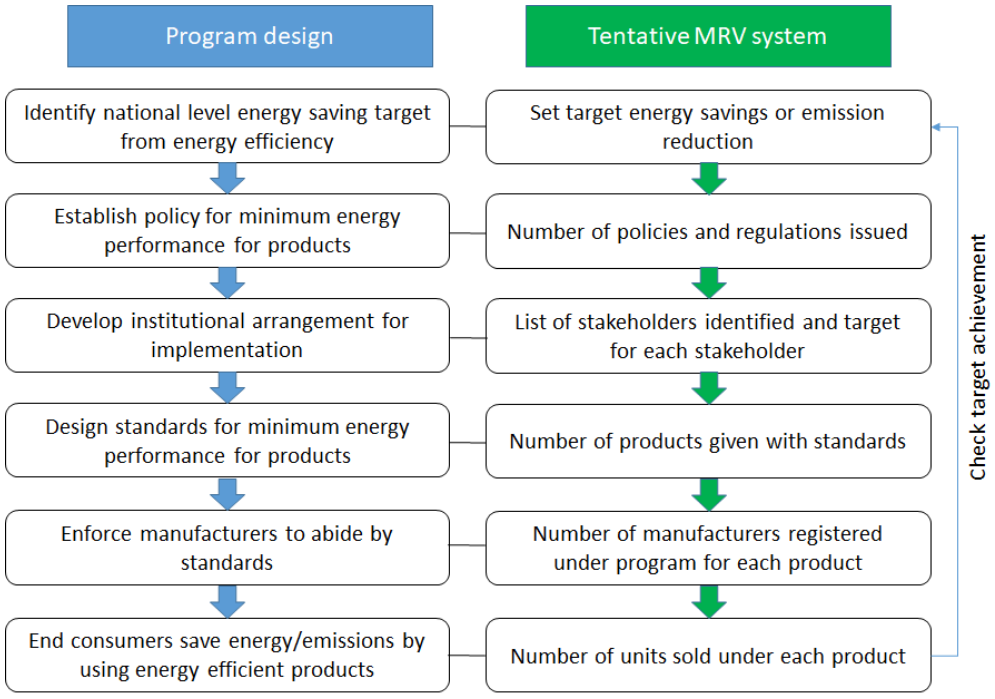


Figure 5-1 Program with top-down MRV system

The data are aggregated from the sector level or regional or ministerial records and/or registries and then the contribution of different sectors or industries 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.

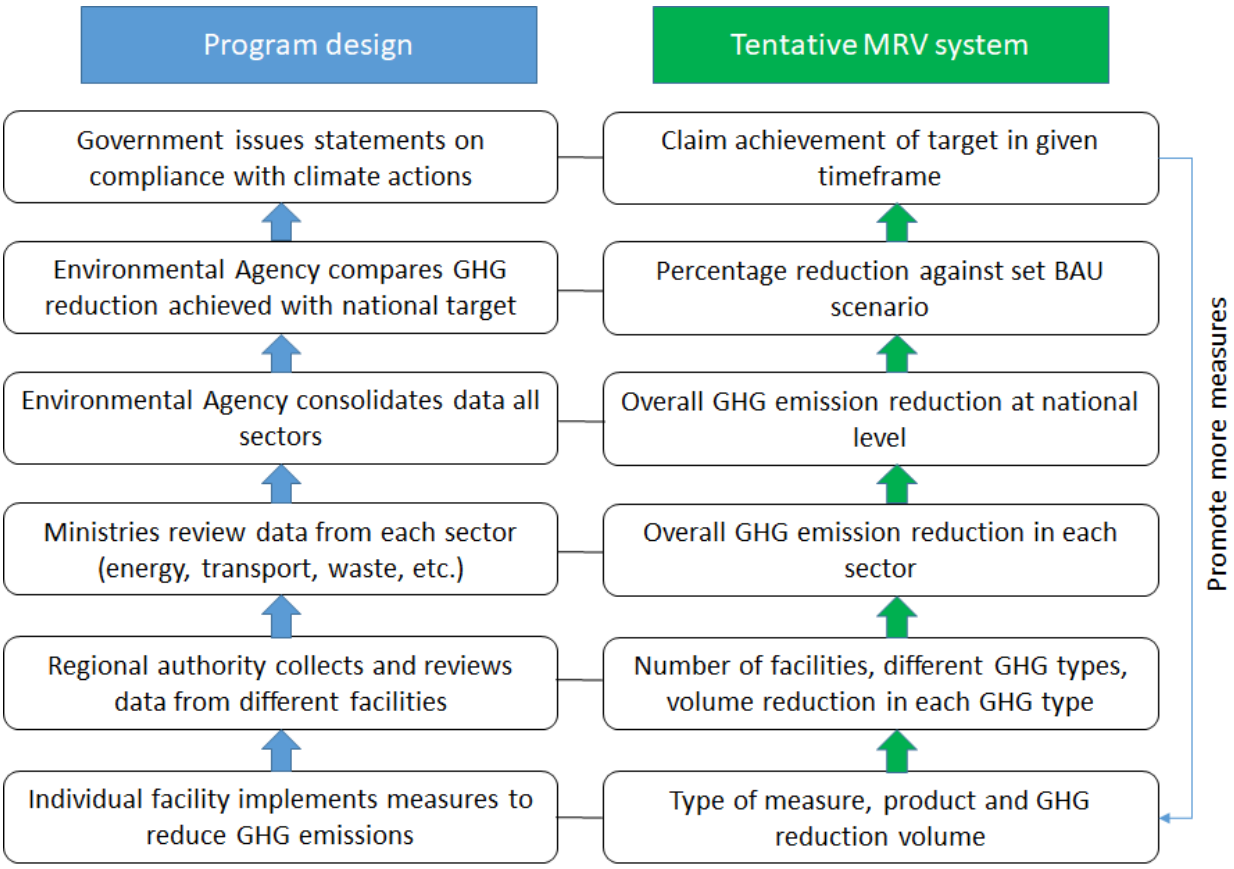


Figure 5-2 Program with bottom-up MRV approach

The data are collected at the point of energy consumption or GHG emission at the consumer end (for example at individual industrial facility). 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 stakeholders 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.

Several countries such as Australia, Chile, China, EU, India, Mexico, Morocco, South Korea, South Africa, Turkey, UK, etc., have launched the industrial sector MRV under varied context of energy efficiency initiatives and/or GHG mitigation programs. Other countries also are in the phase of developing similar programs with the bottom-up MRV approach. The key aspects in implementation of such MRV approach are discussed in this section with references from the international best practices. The overview of reference case studies considered in this report are provided below.

5.3 Best practice case studies in industrial sector MRV

Several countries such as Australia, Chile, China, EU, India, Mexico, Morocco, South Korea, South Africa, Turkey, UK, etc., have launched the industrial sector MRV under varied context of energy efficiency initiatives and/or GHG mitigation programs. Other countries also are in the phase of developing similar programs with the bottom-up MRV approach. 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[20]. 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 key aspects in implementation of such MRV approach are discussed in this section with references from the international best practices.

There are three reference case studies related to industrial sector:
1)Perform, Achieve and Trade Scheme, India;
2) Korean Emission Trading Scheme, Republic of South Korea and;
3) UK Climate Chang Agreement, United Kingdom.

The overview of reference case studies considered in this report are provided below:

a) Perform, Achieve and Trade (PAT) Scheme, India

The PAT scheme is an innovative, market-based trading program implemented by India. It aims to improve energy efficiency in the industrial sectors by capping energy consumption of the energy intensive industries. The energy savings obtained due to the reduction in SEC over and above a set target can be quantified and traded as the Energy Saving Certificate (ESCerts). The PAT scheme currently covers around 1,000 designated consumers from 13 different industrial sectors

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

and has announced its fourth target cycle for 2018-2021. At the end of PAT cycle I (2012-2015), it had achieved 8.67 million TOE energy savings which was 27% higher than expected.
For MRV of this program, The Designed Consumers (DCs) have to monitor the parameters and report their energy consumption in the prescribed format through online portal. The energy consumption data are submitted within 3 months at the end of every financial year. The DCs have to monitor the parameters such as raw material usage, final product output, fuel and electricity consumed, energy generation and consumption from captive power plant and waste heat recovery, etc. These parameters are monitored continuously or hourly or daily or weekly or monthly depending upon the monitoring plan. The DCs should also provide the reports, documents and information to the energy auditors during verification. The Engaging the Empanelled Accredited Energy Auditor (EmAEA) will assess and verify that the activities performed by the DCs. The EmAEA in-charge of check-verification will report the results of the assessment in a check-verification report to the Bureau of Energy Efficiency (BEE).

MRV of this scheme is identified as follows:

Measurement: The energy intensive industrial consumers or the designated consumers (DCs) measure and record all relevant data related to their specific energy consumption (production information, energy consumption data, etc.)

Reporting: The DCs have to report the parameters and energy consumption to the BEE on annual basis.

Verification: The report is verified by third party (EmAEA)

b) Korean Emissions Trading Scheme (KETS), Republic of South Korea

The KETS is the second largest carbon market after the European Union Emissions Trading Scheme (EU-ETS) and roughly covering two-third of the country's total emissions. It is the first nationwide emission trading scheme in Asia covering all the energy intensive industries and other facilities. The KETS is the government policy measure taken to reduce its GHG emissions by 30% below its BAU scenario by 2020 thereby meet its commitment laid out in the Copenhagen Accord of 2009. The KETS covered around 600 industrial entities in Phase I (2015-2017) from 23 business categories across five sectors. The KETS has also planned for further Phase II (2018-2020) and Phase III: (2021-2025) implementations.
For MRV of this program, all activities covered by the KETS, detailed calculation methods, outlining the requirements under all tiers are defined by the regulation. The participating entities have to compile an annual monitoring plan (MP). The authorities check and approve the MP. They also keep track of the progress made by the entities in their sector throughout the compliance period. The entities must estimate and report the direct and indirect emissions from their respective facilities. The report must also include a distinction between emissions at the corporation level, business site level, facility level and activity level. A tier system, which is comparable to the system under the EU-ETS, has been established, allowing both, calculation and direct measurement approaches. In parallel, entities are classified into groups based on the type of categories and size of the installation to meet the minimum requirement of uncertainty level (tier) in emission estimation.

MRV of this scheme is identified as follows:

Measurement: The covered factories measure and record all relevant data as per their monitoring plans

Reporting: The covered factories have to develop an annual emission report (AER) on annual basis.

Verification: The AER is verified by accredited third party. The covered factories submit the verified AER to the Ministry of Environment for review.

c) UK Climate Change Agreement (CCA) for Food Sector

The CCAs implemented by the United Kingdom (UK) are voluntary agreements through which the energy-intensive entities commit themselves to energy savings or emission reduction targets and receive a discount from the Climate Change Levy (CCL) upon fulfilling their commitment. Phase I of CCA scheme was for the period from 2001 till March 2013. Phase II of the scheme is being administered from April 2013 to March 2023. The Phase II applies to 51 sectors covering around 9,900 facilities. The second phase is expected to achieve 11% energy efficiency improvement across the UK's most energy intensive industries by 2020.
For MRV of this program, the CCA has set up rules and processes for measurement and enforcement. At the end of each target period, energy consumption, production and other related data for every site of an operator must be reported through the online register. Audits on selected sites and sector associations are carried out to verify eligibility and performance. This selection of site is made by either a risk-based approach or random selection. The assessment may be desktop-based or a full-site audit. A set of workbooks is available to assist the operators with the calculations needed for reporting and to present performance data in a standardized format. The operators who meet or overachieve their target are automatically re-certified for the next certification period. Overachievement is converted into a carbon dioxide equivalent (CO_2e) which is banked on the register for that operator. This banked CO_2e can be used by the operator in the subsequent target periods to offset any underperformance.

MRV of this scheme is identified as follows:
Measurement: The participating factories measure and record all relevant data as per their monitoring plans
Reporting: The participating factories have to report their data through the online register on annual basis.
Verification: The GHG emission report is verified by accredited third party.

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

5.3.1. Strong and supportive legal framework

The first and foremost requirement for any national level MRV system is the legal backing for enforcement of the rules and regulations. The legal framework must clearly define the stakeholders, their roles, mechanisms to prevent and manage role conflicts and conflict of interest, and thus must lay a good foundation for a sound institutional mechanism and scheme design.

The legal framework followed in some of the case study programs is discussed below.

a. Perform, Achieve and Trade (PAT) Scheme, India: The base regulations for energy efficiency improvements in the country were defined in the Energy Conservation Act (ECA), 2001. However, the 2010 amendment to the ECA 2001 provided the legal mandate to the PAT scheme with the provisions for issuance of energy efficiency certificates (ESCerts) and the imposition of penalty for non-compliance of energy efficiency targets. The regulation included provisions to identify the highly energy intensive industrial entities (called as "designated consumers") based on their historic energy consumption and set energy efficiency targets for them. Following these rules and regulations, the first PAT cycle was launched in 2012.

b. Korea Emissions Trading Scheme (KETS): The potential role of an Emissions Trading Scheme (ETS) for mitigating the GHG emissions of South Korea was in discussion since 2010 as part of its Framework Act on Low Carbon Green Growth. After several discussions and consultations, the legislation enabling the KETS, the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances (ETS Act) and the associated presidential decree, were established only in November 2012. Further to implement the ETS Act, the Master Plan for the Emissions Trading Scheme and the National Allowances Allocation Plan (Phase I) was announced in 2014 based on which the KETS was launched in January 2015.

c. Climate Change Agreement (CCA), United Kingdom: The program follows a stick and carrot approach. The legal basis for the CCA was provided by the Finance Act 2000, which first introduced the Climate Change Levy (CCL) – a tax on the consumption of electricity (excluding renewable electricity and combined heat and power (CHP), but including nuclear), coal, natural gas and liquefied petroleum gas (LPG). Further the law proposed the voluntary MRV program - Climate Change Agreements (CCAs) in which energy-intensive industries can commit to energy efficiency or carbon-saving targets and receive a discount from the CCL upon fulfilling their commitment. The agreements made by the participating industrial entities under the CCAs have concrete MRV and enforcement provisions. Once the industrial entities have opted for it, the CCA is considered legally binding for them.

It can be observed from the best practice case studies that one of the key requirements for the enforcement of MRV practices is the introduction of penalties or legal actions against the non-compliance of the reporting mandates and/or the energy efficiency targets achievement.

5.3.2. Transparent and effective institutional arrangement

Successful implementation of any MRV system requires contribution and support from a number of stakeholders including the government ministries, departments/regional authorities, industrial associations, industrial entities, third party verification bodies, etc. The institutional framework must bring transparency in the roles and responsibilities among different stakeholders to ensure credibility of the MRV system.

The institutional arrangement followed in selected case study programs is discussed below.

a. Perform, Achieve and Trade (PAT) Scheme, India: The overall operation of the scheme is managed by the Bureau of Energy Efficiency (BEE), a dedicated organization set up under direction of the Ministry of Power (MoP) to promote the energy efficiency improvement initiatives in the country. The BEE is supported by the State Designated Agencies (SDA) in monitoring the participating industrial entities within their region. The BEE co-ordinates with the other ministries and departments in engaging the industrial entities from different sectors.

b. Korea Emissions Trading Scheme (KETS): The responsibilities related to allowance allocation, the compliance process and communication with the participating industrial entities are distributed among four sectoral ministries - (i) Ministry of Trade, Industry and Energy, (ii) Ministry of Land and Infrastructure Transport, (iii) Ministry of Environment and (iv) Ministry of Agriculture, Food & Rural Affairs. Each ministry is responsible for managing and mitigating its respective sector level emissions. The Ministry of Finance and Strategy (MOSF) takes care of the allocations, trading and compliance review of the participating industrial entities. The

Ministry of Environment (MOE) is responsible for managing the overall co-ordination of the scheme's operation.

c. Climate Change Agreement (CCA), United Kingdom: The Department of Business, Energy and Industrial Strategy (BEIS) and industry sector associations negotiate and sign the umbrella agreements. Together they agree the energy efficiency targets for a sector – the sector commitment. The sector associations then manage MRV of all the participating industrial entities (through underlying agreements) within their sector. For example, Food and Drink Federation (FDF) of UK manages the CCA for the food and drink sector and acts as the key point of contact for negotiations between the industrial entities in the sector and the BEIS. It plays a crucial strategic role to ensure that the CCA rules for the food and drink sector are fair and reasonable for the participating industrial entities and that the MRV requirements are implemented by the participating industrial entities in an appropriate way.

In summary, there are different approaches in designing the institutional arrangement and the most appropriate one can be selected based on the existing institutional set up and available resources in the country. The institutional arrangement selected must also be supported by the legal framework as discussed in section 5.1.

5.3.3. Comprehensive procedure for boundary setting and facility monitoring

Industrial sectors often cover a wide range of processes and product types. Also, within an industrial facility, the energy will be consumed in productive processes, supportive processes (vehicles for internal material transfer, air compressor loads, etc.) and administrative areas (office canteen, car parking, etc.). Other than the GHG emissions from energy use, there will be GHG emissions such as Carbon-di-oxide (CO_2), Methane (CH_4), Hydrofluorocarbon (HFC), Perfluorocarbon (PFC), Sulphur hexafluoride (SF_6), etc., from the production processes & product use and wastewater treatment within a facility. Therefore, clear identification of facility boundary is necessary so that the benchmarking of energy or emissions is possible among the similar types of processes and product types. The monitoring and reporting requirements will depend on this boundary setting only. The operations manual and guidebook for the MRV program must detail these procedures so that all stakeholders are aware of the MRV requirements.

Table 5-1 provides the general emission sources covered in defining the facility boundary.

Table 5-1 Emission sources within facility boundary[21]

No.	Type of emission source	Examples
	Direct emissions	
1	From energy use in fixed combustion installations	Boilers, furnaces, kilns, flares, central heating systems
2	From energy use in mobile combustion units	Forklifts, generators, heating devices, cars, trucks, bus, trains, planes, ships

[21] Korea Environmental Policy Bulletin (KEPB), 2012

3	From production process and product use	Cement production, metal production (iron and steel, aluminum, magnesium, etc.), chemical industries, pulp & paper, food processing
4	Leakage emissions	Mining, treatment and storage of coal, crude oil products, natural gas
5	Waste treatment processes	Biological treatment or landfill of solid waste, wastewater treatment and incineration of waste
	Indirect emissions	
6	Electricity and heat/steam use from outside	Grid electricity, steam from district heating system

The key procedures in identifying the facility boundary and monitoring of energy & production under the selected case study programs are discussed below.

a. Perform, Achieve and Trade (PAT) Scheme, India: The boundary is set for whole of a production facility. The target for the facility is the overall energy consumption (in tons of oil equivalent (TOE)) in any financial year. This requires monitoring and reporting of energy consumption from all regions (productive, non-productive & administrative) of the facility. When there are multiple product outputs, then the energy consumption must be converted to one single major product for reporting purpose. The scheme has developed several normalization factors in estimating and reporting the overall energy consumption of the facility considering all these aspects.

b. Korea Emissions Trading Scheme (KETS): The KETS requires the participating entity to estimate and report the direct (fossil fuel energy use, processes emissions, leakage and waste treatment) and indirect emissions (electricity from grid) (as in table 5-1) from their industrial processes in terms of "Allowances" (1 allowance = 1 tCO_2). The reporting must also include a distinction of emissions between the corporate level, business site level, facility level and activity level. A tier system for accuracy level has been established, which is comparable to the system under the European Union (EU) ETS, allowing both the calculation and direct measurement approaches for the monitoring parameters. The participating industrial entities are classified into several groups based on the type of categories and size of the installation to meet the minimum requirement of accuracy level (tier) in the emission estimation.

c. Climate Change Agreement (CCA), United Kingdom: Only a part of the energy consumption of a facility that is directly connected with the production process is covered under the program. The participating industrial entities cannot claim for any reductions out of this production process. Metering and monitoring of energy use must be separately done for the production process and the other areas and the same must be reported at the end of the monitoring period. The CAA program also has detailed the procedure for reporting the energy consumption when multiple products are involved within a single production facility boundary.

The boundary setting is the basis for accurately monitoring and reporting the energy consumption or emissions from an industrial facility. It will also help in improving the creditability by avoiding double counting of energy savings or emission reductions claimed from a program.

5.3.4. Centralized program database management and reporting requirements

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 national level MRV program requires a nation-wide program database that is accessible to multiple stakeholders from multiple locations to report, review, rectify, extract and publish monitoring results as applicable to roles of each stakeholder. This also helps in building the reliability of the program achievements. The international best practice is to use a centralized electronic database with differential access provided to each stakeholder as per the requirement. The data monitoring and reporting procedure must also include the quality assurance (QA) and quality control (QC) aspects to ensure the accuracy level of data reported. The requirement will also include the standards of continuous emissions monitoring system (CEMS), database of emission factors & calorific values to be used at national level or regional level or facility level and other measuring devices related to the emission calculation.

The database management followed in different case study programs is discussed below.

a) Perform, Achieve and Trade (PAT) Scheme, India: The scheme requires the participating industrial entities to report their data through a central electronic database known as PATNET online portal. Clear guidelines are provided on the data to be reported and template to be used at the end of each financial year, at the end of monitoring period, for verification by third party auditor and submission of compliance to the BEE, along with deadline for each report submission.

b) Korea Emissions Trading Scheme (KETS): Since 2010, South Korea had designed and operated the GHG and energy Target Management System (TMS) to manage industries that are both large GHG emitters and large energy consumers. The TMS was a temporary system that was put in place as a tool to build capacities within industries and local governments and prepare for the database management and reporting under the ETS. This approach helped the stakeholders to understand and report their monitoring data at the international standards even before implementation of actual ETS. The scheme has also defined different level of tiers (accuracy levels for measurement or estimation of emission data) for the emission calculation and reporting under the program.

c) Climate Change Agreement (CCA), United Kingdom: The program requires the energy consumption and production data of every participating industrial entity to be reported via the online register. A set of workbooks is available to assist participating industrial entities with the calculations needed for reporting and to present performance data in a standardized format. Following the principle of individual accountability and ensure transparency, individual facility performance data is also made public for review by any stakeholder.

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.

From the above case studies, it can be observed that the country specific conditions, capacity of different stakeholders, institutional structure, etc., must be taken into account in designing the key aspects of legal framework, institutional arrangement, boundary setting and database management for a successful MRV system. The most appropriate approach for the Thailand industrial scenario can be selected after careful evaluation of different international best practices against the existing practices in the country.

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.

6. BARRIERS, GAPS AND OPPORTUNITIES

Ideally, effective MRV systems will allow the 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 ICAT 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 designated building measure, GHG emission reductions can be calculated from the energy efficiency improvement 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 lack of complete baseline emission data for the industrial sector. Without this data, it is challenging to develop reliable and practical baselines.
(5) It is quite difficult and high investment for monitoring equipment at all monitoring points to identify the Specific Energy Consumption (SEC) data. This is because each factory has many product types and sizes, some products are partly or fully produced in the same production line. The energy source is from the same supply source (central utility such as steam boiler, lighting, etc.) which is cannot clearly separate for each product type/size.
(6) Regarding the NDC Roadmap and NDC Action Plan (Energy sector), there are some mitigation measures that will promote/apply to non-designated factory. It is not clear on how to engage the non-designated factory to submit the required data on annual basis until 2030 (end of NDC period). Note that this type of factories consumes rather significant amount of energy and emit GHG emissions. However, in the current energy management system, this type is not covered.
(7) Comparing to the Perform, Achieve and Trade (PAT) Scheme (India), it is found that the scheme is based on a cap-and-trade of energy saving. However, Thailand has yet set target groups or cap of energy saving for each factory.
(8) Based on the comparison with the Korean Emissions Trading Scheme (Republic of South Korea), it is found that the scheme is based on a cap-and-trade system for emission allowance. Thailand has yet set the target group or cap of emission allowance for each factory.

(9) Comparing to the UK Climate Change Agreement (United Kingdom), the program participants commit themselves to energy savings or emission reduction targets and receive a discount from the Climate Change Levy (CCL). It is found that Thailand has not set the baseline / energy saving / emission reduction target for each factory as well as the regulation on tax fuel discount yet.

(ii) Opportunities

(1) As the industrial 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 factories, there is an opportunity to expand the reporting requirement to capture wider group of factories.
(3) 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, industries, and other relevant stakeholders developing their own GHG reporting systems. 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 factories to take parts in newly developed MRV system for building.
(4) 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 industry. This will enable factory operators 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.
(5) 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 industrial sector for both GHG inventory and mitigation measures is based on the current institutional arrangement and the existing reporting practice of the designated factories. The steps in the proposed MRV practice is as follows:

1. Owner of the designated factory implements the energy conservation measure
2. The activity data of the designated factory is compiled and verified 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) approves the GHG emissions as included in the National Communication (NC) and Biennial Update Report (BUR)/ Biennial Transparency Report (BTR)

The proposed MRV practice in industrial sector is shown in Figure 7-1

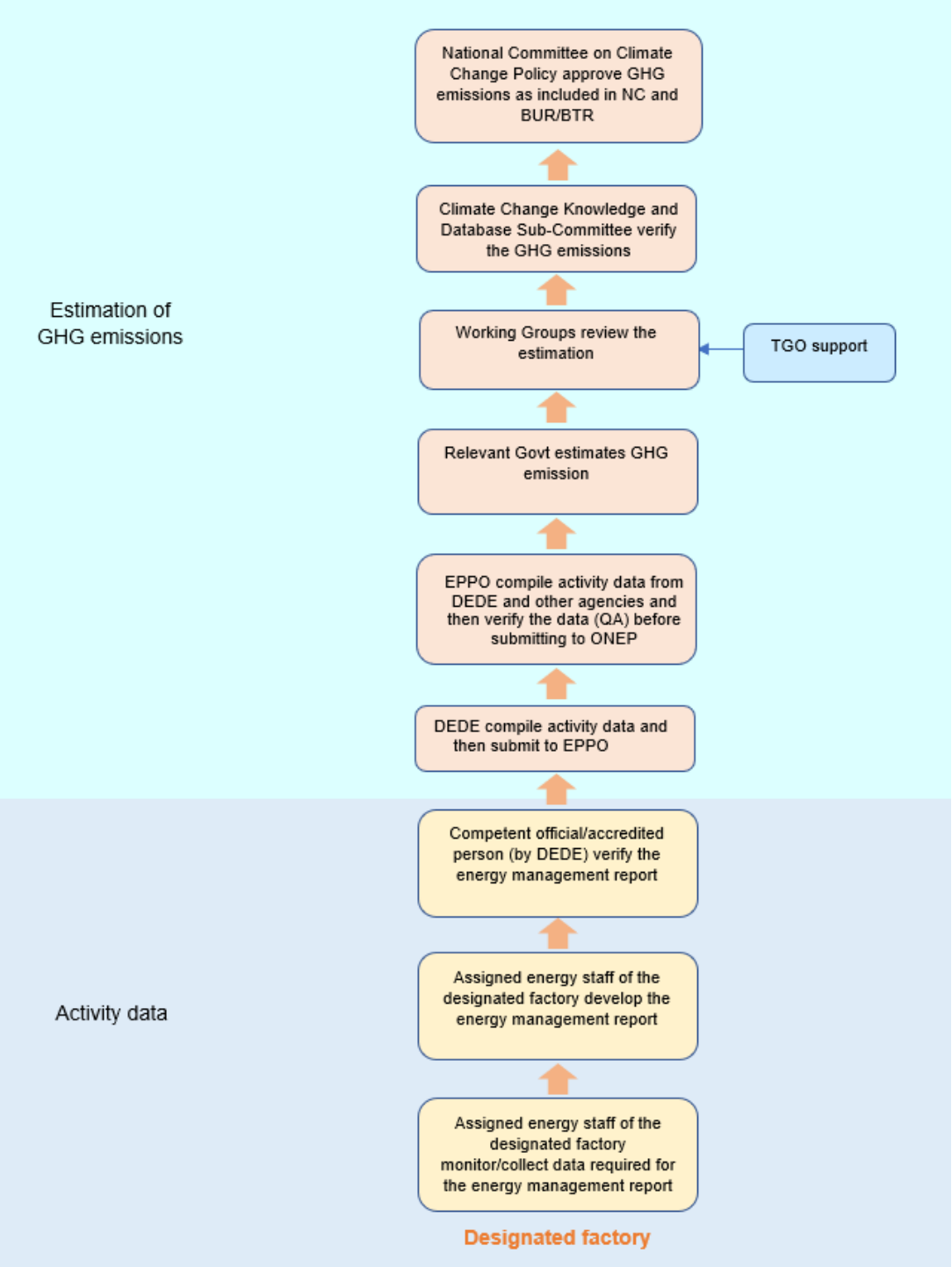


Figure 7- 1 Proposed MRV practice in industrial sector[22]

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

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

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

Agency name	Roles and responsibilities
Owner of designated factory	- Support the national policy on energy efficiency/GHG emission reductions - Collect energy consumption and emission data from their factory - Prepare the energy management report in the required template - Submit to competent authority/accredited person to review and approve the data by providing the energy audit and certification report - Submit these reports to the DEDE
Department of Alternative Energy Development and Efficiency (DEDE)	- Collect activity data from the designated factory - Verify the required data for GHG emission estimation
Thailand Greenhouse Gas Management Organization (Public Organization) (TGO)	- Develop GHG methodologies - Design 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 industrial sector

(1) At present, the designated factory is mandated to submit an energy management report on annual basis. This report contains almost data required for the GHG calculation, but it

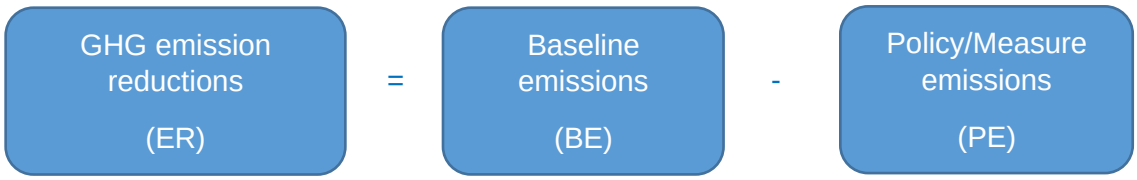
is not generally reported in term of GHG inventory or emission reduction data. It needs to be further calculated as the GHG inventory or emission reduction data. Thus, GHG report is required to be developed on annual basis for the best MRV practice.

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

(3) The data of Label no.5 should be separately identified in the energy management report for avoiding on double counting issue.

(4) The recommendation on the GHG emission methodology is provided below;

The principal to calculate GHG emission reductions is shown as following;



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)

Therefore, the GHG emission reductions in term of specific energy consumption is shown as below;

$BE_y = \sum(SEC_{BL,i,y} \times P_{PJ,i,y}) \times EF_{EC,y} \times 10^{-3}$
$PE_y = \sum(SEC_{PJ,i,y} \times P_{PJ,i,y}) \times EF_{EC,y} \times 10^{-3}$
$ER_y = \sum(SEC_{BL,i,y} - SEC_{PJ,i,y}) \times \sum P_{PJ,i,y} \times EF_{EC,y} \times 10^{-3}$
$SEC_{A,i,y} = EC_{A,i,y} / P_{A,i,y}$ (A is Baseline or Policy/Measure/Project/Activity)

Where:

ER_y = Emission reductions in year y (tCO_2/year)
BE_y = Baseline electricity consumption in year y (kWh/year)
PE_y = Policy/Measure/Project/Activity electricity consumption in year
$SEC_{BL,i,y}$ = Baseline specific energy consumption for industrial type i in year y (kWh/Unit of Product)
$SEC_{PJ,i,y}$ = Policy/Measure/Project/Activity specific energy consumption for industrial type i in year y (kWh/Unit of Product)
$EC_{BL,i,y}$ = Baseline electricity consumption for industrial type i in year y (kWh/year)

$EC_{PJ,i,y}$= Policy/Measure/Project/Activity electricity consumption for industrial type i in year y (kWh/year)
$P_{BL,i,y}$ = Baseline unit of product in year y (unit of product / year)
$P_{PJ,i,y}$ = Policy/Measure/Project/Activity unit of product in year y (unit of product / year)
EF_{ECy} = CO_2 emission factor (tCO_2/MWh)

(5) Generally, the GHG emission inventory and the GHG emission mitigation measure are reported on annual basis, thus the GHG emission inventory and GHG emission mitigation measure report should be reported in the same period basis. Since the GHG reporting format has not been created so far, then it should be created by all relevant agencies e.g. TGO, DIW, DEDE, ONEP and Energy Working Group. The GHG report could be reported via online submission for ease of convenience to the related agencies.
(6) 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. The verification guideline should be determined by all relevant agencies e.g. TGO, DIW, DEDE, ONEP and Energy Working Group as appropriate for the industrial sector.

7.3 Specific recommendations for the food sector

(1) There are many types of food factories and one food factory may have many products. Therefore, the baseline SEC should be identified SEC for all product types and sizes. The guidelines for data collection, product data boundary for monitoring and reporting by the operators and verification guideline for accredited third party need to be determined in the same product type of boundary.
(2) The data of Label no.5 should be separately identified in the energy management report for avoiding on double counting issue.
(3) For the GHG emission mitigation measures in non-designated factories participating in the DEDE's promotion/mitigation measures, it should have a reporting system to submit the report on annual basis until year 2030. The report should cover all relevant data for the GHG emission calculation.
(4) In order to improve the SEC data quality in the energy management report, guideline and building capacity for data collecting, data boundary for each product are required.

Initiative for Climate Action Transparency (ICAT):

Improving Thailand's MRV System for Climate Change Mitigation

Final Report on MRV for the Industrial Sector - Annexes

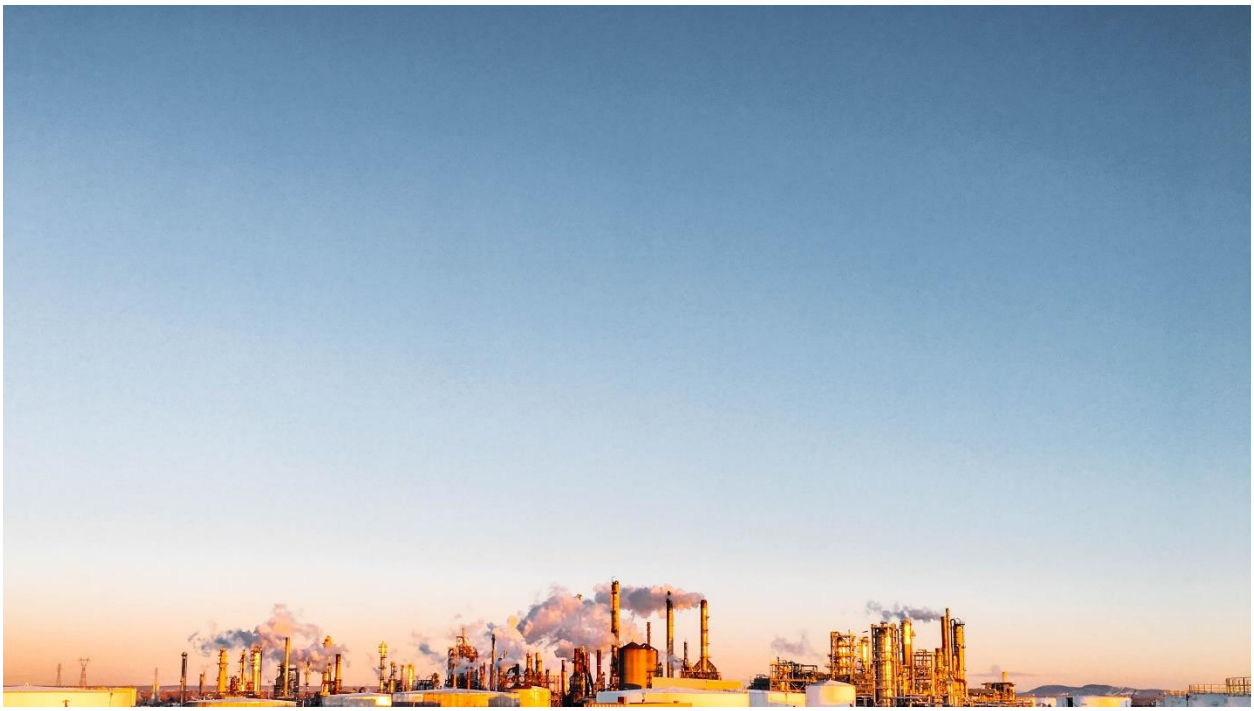


Photo by Chris Liverani on Unsplash

Initiative for Climate Action Transparency - ICAT -

Improving Thailand's MRV System for Climate Change Mitigation

Deliverable #1

AUTHORS

The Global Green Growth Institute

Date of the deliverable 27 September 2019

PUBLISHED BY

Office of Natural Resources and Environmental Policy and Planning (ONEP), Thailand's Ministry of Natural Resources and Environment

PREPARED UNDER

Initiative for Climate Action Transparency (ICAT) project supported by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the Children´s Investment Fund Foundation (CIFF), the Italian Ministry for Environment, Land and Sea Protection, and ClimateWorks

The ICAT project is hosted by the United Nations Office for Project Services (UNOPS)

TABLE OF CONTENTS

Annex 1. Perform, Achieve and Trade (PAT) Scheme, India

1. Introduction

The Perform, Achieve and Trade (PAT) scheme is an innovative, market-based trading program implemented by India under its National Mission on Enhanced Energy Efficiency (NMEEE) within the National Action Plan on Climate Change (NAPCC). It aims to improve energy efficiency in the industrial sectors by capping energy consumption of the energy intensive industries and trading the energy efficiency certificates thus generated. The scheme improves the energy efficiency performance of the identified energy intensive industries by reducing their specific energy consumption (SEC) through carrying out energy efficiency measures (EEMs). The energy savings obtained due to the reduction in SEC over and above a set target can be quantified and traded as the Energy Saving Certificate (ESCerts; 1 ESCerts = 1 ton of oil equivalent (TOE)).

2. Key program features

Scope	Major energy intensive industrial sectors
Mechanism	Cap and trade of energy savings (in terms of ton of oil equivalent)
Participation	Mandatory
Target setting	Energy reduction target for each facility based on the overall sector level energy savings needed
Target period	Three years
Monitoring, Reporting and Verification	Monitoring and reporting are conducted at facility level. Energy reduction claimed is verified by a third-party verifier and re-checked by the administrating agency
Penalties	Any non-compliance of targets leads to the imposition of fixed and variable penalties

3. Legal framework

The Energy Conservation Act (ECA), 2001 put in place the policies, rules and regulations to improve energy efficiency in the energy intensive industries. The 2010 amendment to the ECA 2001 included a legal mandate to the PAT with the provisions for issuance of ESCerts, imposition of penalty for non-compliance and the trading of ESCerts.

The Ministry of Power (MoP) and the Bureau of Energy Efficiency (BEE) were responsible for the PAT implementation. A new institution, Energy Efficiency Services Limited (EESL) was established to administer the trading of ESCerts.

4. Scheme design

Figure A.1.1 represents the schematic process flow of the PAT scheme.

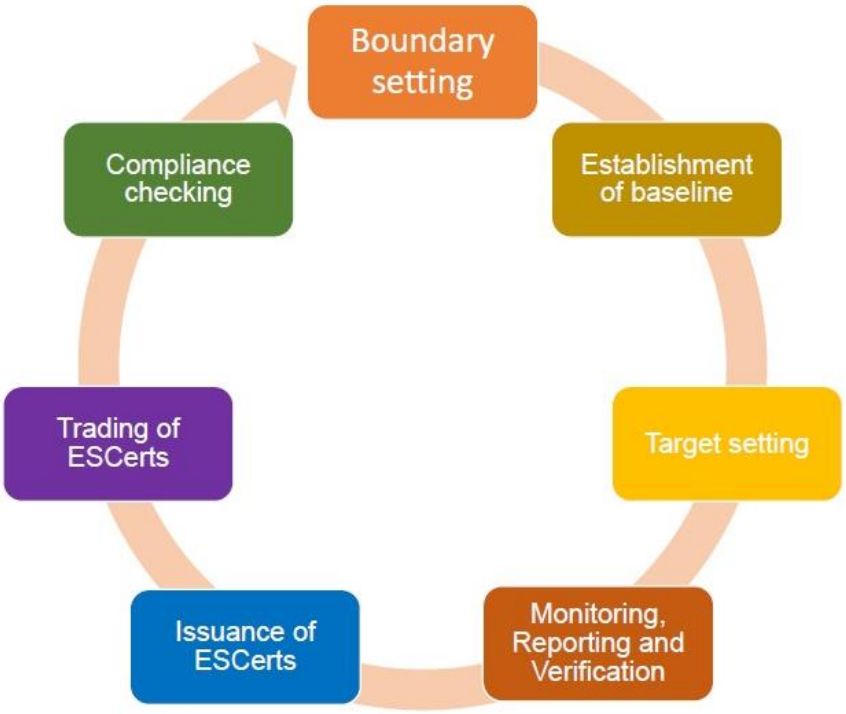


Figure A.1.1 Schematic process flow of the PAT scheme

The PAT scheme is a unique policy instrument and stands out from the pool of several ongoing initiatives across the globe targeted at the GHG emission reduction. The uniqueness of the scheme lies in the overall objective of improving the efficiency of the production process to achieve the ultimate target of energy savings. This approach towards energy saving is a major shift from the emission reduction directives followed in several developed and developing economies which, in general, aim for reduction in absolute number of emission/fuel consumption units. Thus, the reduction in energy consumption, once achieved through the PAT will be far more realistic (pointing towards a more efficient and less energy intensive economy) than those reported through other methodologies where the absolute reduction of emission/energy consumption units may be influenced by the commercial and/or political factors.

The scheme establishes facility-specific targets rather than a sectoral target. The scheme imposes mandatory SEC targets to the energy intensive industrial consumers, identified as “Designated Consumers (DCs)”, with less energy efficient facilities having a greater reduction target than the energy efficient ones. A DCs baseline is determined by its historic SEC. The DCs making greater reduction than their targets receive “ESCerts” which can be traded with the other DCs that are having trouble meeting their targets or banked for future use. The key steps involved are as follows:

- Specification of SEC norm for each DC in the baseline year and in the target year
- Verification of the SEC of each DC in the baseline year and then in the target year by an accredited verification agency
- Checking of compliance and issuance of ESCerts to those who exceed their target SEC at the end of the 3-year period. In case of non-compliance, a financial penalty is due.
- Trading of the ESCerts with the other DCs’ who are unable to meet their target SEC at the end of target period

Table A.1.1 shows the significant phases in overall implementation of the scheme. All the activities are focused toward the DCs. The implementation of each PAT cycle will go through all of these phases.

Table A.1.1. Phases of overall scheme implementation within a target period

Target setting phase	• Establishment of baseline SEC • Review of baseline SEC • Finalization of SEC reduction targets • Consultation with the facilities
Notification phase	• Recommendation by the BEE to the MoP • Notification by the MoP on launch of target period • Formal intimation on individual targets
Implementation phase	• Reporting of action plan by the DCs to the BEE and the State Designated Agencies (SDAs) • Implementation of monitoring at the facilities of the DCs • Engaging the Empanelled Accredited Energy Auditor (EmAEA) by the DCs and conducting energy audit at their facilities
Monitoring , Reporting and Verification (MRV) phase	• Receipt of the monitoring and verification (M&V) report from the EmAEA by the DCs • Submission of the reports to the SDA & BEE and claiming of the ESCerts by the DCs • Issuance of the ESCerts by the BEE • Conduct of check verification by the BEE through an appointed EmAEA

5. Institutional arrangement

The legal frameworks including the ECA 2001, its subsequent amendments and regulations and the PAT Rules, 2012 collectively put in place a robust institutional arrangement for the program. Figure A.1.2 shows the institutional arrangement for the PAT scheme.

The arrangement clearly defined the stakeholder roles, mechanisms to prevent and manage conflict of interest and thus laid a good foundation for a sound institutional mechanism and scheme design.

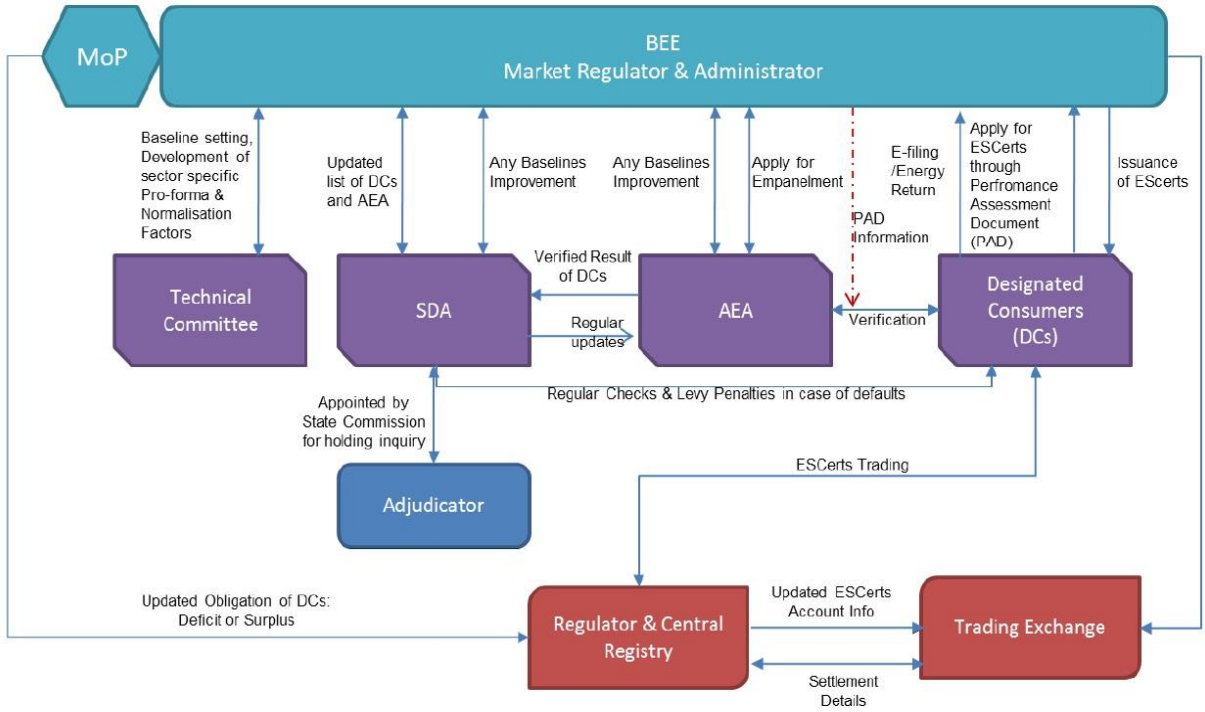


Figure A.1.2. Institutional arrangements for PAT scheme[1]

The MoP provides the overall direction to all the stakeholders involved such as the BEE, SDAs, EmAEAs and DCs. The MOP, after considering the reports submitted by the BEE, specifies the energy consumption norms and standards for every DC's facility. The BEE co-ordinates with the DCs, SDAs, Sectoral technical committee and other agencies to administer and monitor the PAT Scheme. It provides the recommendations to the MoP on the norms and standards required to be notified. It is responsible for empanelment of EmAEA firms as verifiers under the scheme. It is also responsible for the overall capacity building of the SDAs, EmAEAs and DCs.

The SDAs are responsible for the inspection and enforcement of the MRV system. They review and validate all the documents submitted by the DCs within their region before sending it to the BEE. The SDAs appoint the adjudicating officer to hold enquiry on any non-compliance by the DCs and impose penalty.

The EmAEAs are responsible for verification of the DCs compliance with energy consumption norms and target achievement through energy audits. They conduct energy audit in the DC facility and provide a verification report as per the reporting template issued by the BEE.

The DCs in consultation with the EmAEA implement the energy consumption reduction measures in their facilities and put in place a transparent and credible monitoring & verification arrangement in line with the regulations under the PAT scheme. The DCs also facilitate the verification and check-verification works carried out by the EmAEA and the SDAs at their facilities.

6. Methodology

Before the implementation of the PAT scheme, there was an extensive consultation was carried out with all relevant stakeholders. The sector studies were commenced in 2008 to identify the

[1] AEA = Accredited Energy Auditor or Empanelled Accredited Energy Auditor (EmAEA)

DCs by organizing nationwide workshops. The draft document was widely circulated and discussed at the sectoral and regional/state meetings. In addition, frequent letters were sent to the DCs on state and sectoral meetings. The technical committees considered inputs from the DCs before developing the normalization rules.

The nationwide baseline data collection process began in 2009 for the target setting. The target setting methodology and the targets were discussed with various stakeholders for a wide coverage of the program.

6.1. Estimation of energy consumption and production

The total energy consumption in tons of oil equivalent (TOE) of a DC is calculated as follows:

$$\begin{pmatrix} Total\ energy \\ consumption \\ TOE \end{pmatrix} = \left\{ \begin{pmatrix} Electrical\ energy\ from\ the\ grid - \\ (Electricity\ generated \\ by\ the\ captive\ plant + \\ Electricity\ generated\ by\ the \\ RE\ source + \\ Electricity\ export\ to\ others) \end{pmatrix} \times \begin{pmatrix} conversion\ factor \\ for\ MWh\ to\ TOE \end{pmatrix} \right\} + \left\{ \begin{pmatrix} Type\ of\ fuel\ used \times \\ calorific\ value\ of\ that\ fuel \end{pmatrix} \times \begin{pmatrix} Conversion\ factor \\ for\ MJ\ to\ TOE \end{pmatrix} \right\}$$

Each DC in the sector will produce different end products by consuming different energy sources. Hence, the scheme considers all these products to be converted into one single equivalent product. i.e., conversion of minor products to a one major product. The conversion factors of minor products will be same in the baseline year and in the assessment year.

The conversion factor for any minor product to major product is estimated as,

$$\begin{pmatrix} Conversion\ factor\ from \\ minor\ to\ major\ product \end{pmatrix} = \frac{SEC\ of\ the\ minor\ product}{SEC\ of\ the\ major\ product\ in\ the\ sector}$$

For example, let us consider that a DC produces 3 different end products viz., P1, P2 and P3. If the product P1 is identified as the major product in the sector, the product P2 and P3 is converted into equivalent product of P1. Then the total equivalent production by that DC in terms of major product is (P1) is calculated as,

$$\begin{pmatrix} Total\ equivalent \\ production\ in\ tons \end{pmatrix} = \left(P1 + \left(P2 \times \frac{SEC\ of\ product\ P2}{SEC\ of\ product\ P1} \right) + \left(P3 \times \frac{SEC\ of\ product\ P3}{SEC\ of\ product\ P1} \right) \right)$$

6.2. Estimation of baseline SEC

The total energy consumption and production data of the recent three financial years is considered for the baseline SEC setting of a DC. The BEE collects these data from the DCs and calculates the baseline SEC. The calculated baseline SEC will be fixed for the entire period of the respective PAT cycle. Figure A.1.3 gives the conditions in setting the baseline SEC for the DCs.

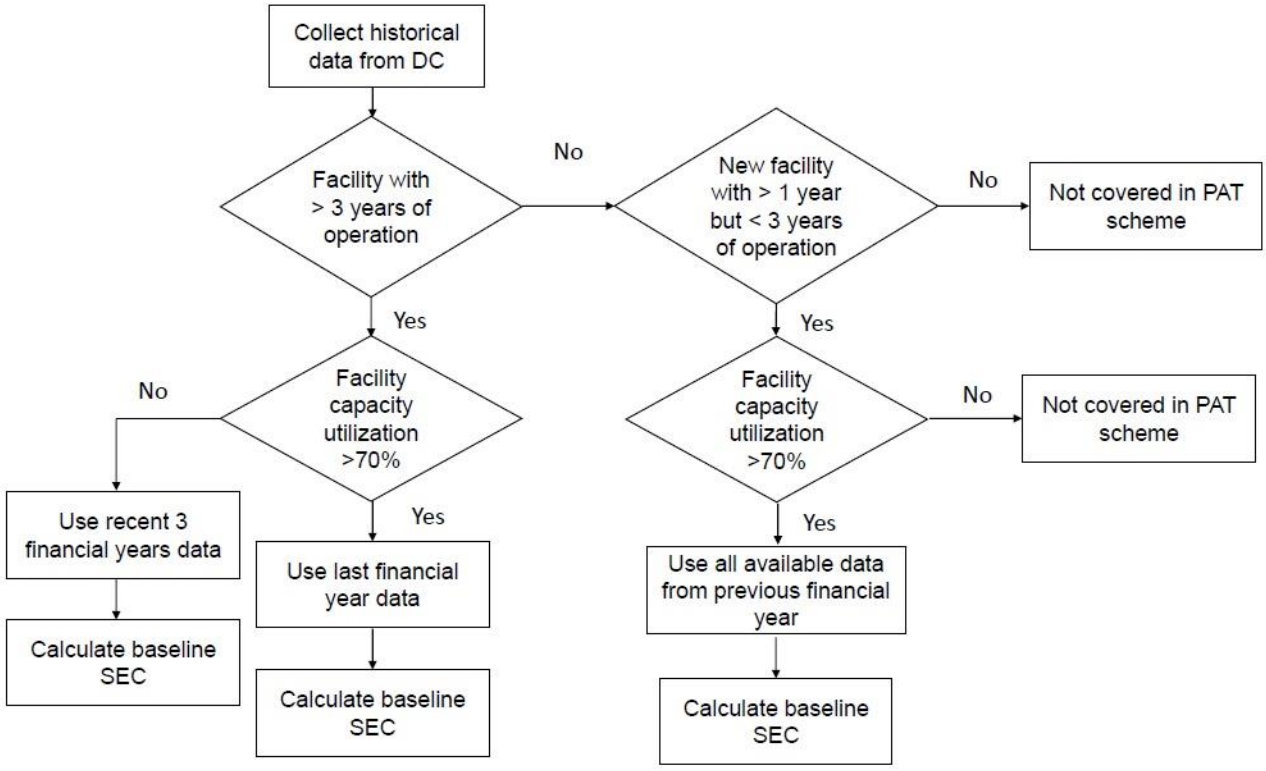


Figure A.1.3. Procedure for the baseline SEC setting

The baseline production of a DC is calculated as,

$$Baseline\ production = (Average\ of\ last\ three\ financial\ year\ production\ in\ tons)$$

The baseline total energy consumption of a DC is calculated as,

$$\begin{pmatrix} Baseline\ total\ energy \\ consumption \end{pmatrix} = \begin{pmatrix} Average\ of\ total\ energy\ consumption\ (TOE) in \\ last\ three\ financial\ year \end{pmatrix}$$

The baseline SEC of a DC is calculated as,

$$Baseline\ SEC = \left(\frac{Baseline\ total\ energy\ consumption\ (TOE)}{Baseline\ production\ (tons)}\right)$$

Where

Baseline total energy consumption	=	Sum of electrical energy and thermal energy consumed by the DC (excluding the energy generated from the renewable energy sources, alternate fuels, etc.) in TOE
Baseline production	=	Sum of all minor product converted into one single major equivalent product (tons)

In case of green field facilities, a minimum of one year data is needed for setting the baseline SEC.

6.3. Setting of target SEC

The target is defined in the 'percentage' form. It is the percentage reduction of SEC for each DC from its baseline value to that of the target year. The methodology for setting target SEC for the DCs is transparent and has no room for any arbitrariness. Figure A.1.4 provides the general steps in target setting for each DC from breaking down the national level target to the sector target and then to the individual level.

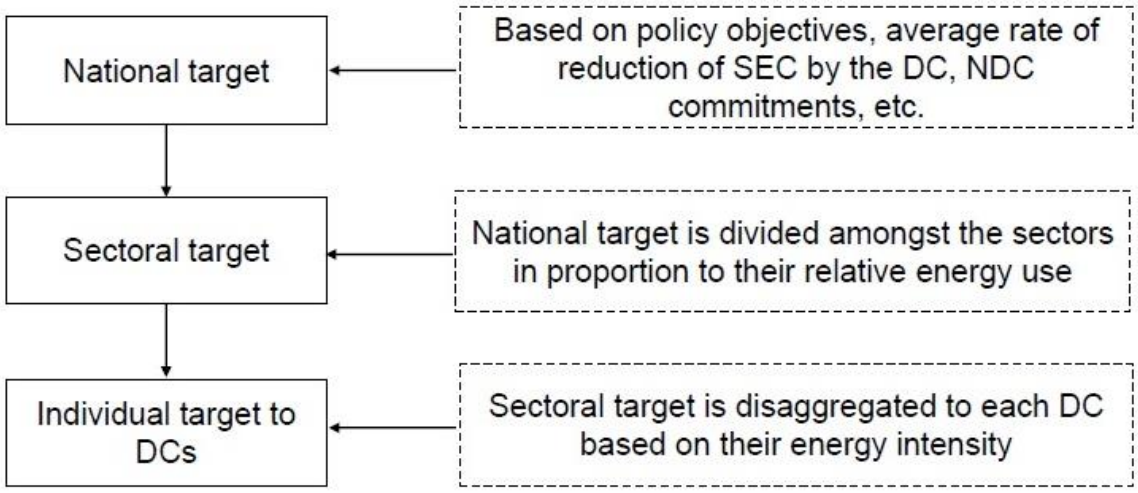


Figure A.1.4. Target setting procedure under PAT scheme

The general steps in the target setting are:

1. The national level target is set based on the average rate of reduction in SEC by the DCs and the policy objectives such as the Nationally Determined Contributions (NDC) and sector target of the country.

2. The national target is divided amongst the sectors in the proportion to their relative energy use to ensure that the sectoral reduction is appropriate. For example, if the national energy savings target is estimated as 10 million TOE and the cement sector shares around 1.5% of total energy consumption, then the energy savings target for the cement sector is 150,000 TOE (= 10,000,000 * 1.5%).

3. The sectoral reduction target would be disaggregated to each DC identified within the sector. Given the diversity of DC configurations within a sector and their vintages, it is being proposed to apply gate-to-gate approach for each DC in defining the target SEC

4. The target will be a certain percentage improvement over a DC's baseline SEC. The target SEC will need to be achieved over a three year period.

5. The methodology is based on the expectation that all DCs will reduce their SEC. The less energy-efficient DCs within a sector will be required to achieve a greater reduction in their SEC than the energy-efficient DCs. The SEC targets will be determined with a statistical analysis followed by the stakeholder consultation in each sector.

The sectoral targets will be disaggregated among the DCs taking into account the historical energy consumption (average of previous 3 financial year energy consumption), potential of energy saving in the DC, sustainability of trading market and other related issues. The lowest % target would be given to the best performing DC whereas the others will be assigned based on the concept of relative SEC.

Therefore, if the best performing DC has X % target, then the targets for the other DCs would be (DC SEC ÷ Best SEC) times of X %. The X can be numerically calculated taking into account the total energy saving goal in that target period. The general equations to set the target for an individual DC under the PAT scheme is given below.

Step 1: Collection of historical data and establishing the baseline SEC of DCs

$$Baseline\ SEC = \left(\frac{Baseline\ total\ energy\ consumption\ (TOE)}{Baseline\ production\ (tons)}\right)$$

Step 2: Calculation of total energy consumption of DCs

$$Total\ energy\ consumption\ (TOE) = (Baseline\ SEC \times Baseline\ production)$$

Step 3: Calculation of relative SEC of DCs

$$Relative\ SEC = \frac{Baseline\ SEC\ of\ the\ DC}{Minimum\ SEC\ of\ the\ DCs\ in\ the\ sector}$$

Step 4: Calculation of % target reduction for the sector

$$\%\ target\ savings = \left(\frac{Sum\ of\ total\ expected\ savings\ from\ individual\ DCs}{Sectoral\ energy\ savings\ needed}\right)$$

Step 5: Target for each DC

$$\underset{(TOE/ton)}{Target\ for\ each\ DC} = (1 - \%target\ savings) \times Baseline\ SEC$$

For example, let us consider that there are 5 DCs in a sector. Table A.1.2 shows the sample target setting for 5 DCs.

Table A.1.2. Sample target setting procedure under the PAT scheme

Parameter	DC 1	DC 2	DC 3	DC 4	DC 5
Baseline production (tons) (A)	369,939	358,967	178,530	79,587	37,635
Baseline SEC (TOE/ton) (B)	1.274	1.364	1.400	1.428	1.780

Parameter	DC 1	DC 2	DC 3	DC 4	DC 5
Total energy consumption (TOE) (C = A * B)	471,302	489,631	249,942	113,650	66,990
Minimum SEC of the DC in the sector (D) (i.e. min. of B)	1.274				
Relative SEC (E = B/D)	1.000	1.071	1.099	1.121	1.397
% target reduction (F)	X				
Expected energy savings (TOE) (G =C*E*F/100)	4,713 X	5,242 X	2,746 X	1,273 X	935 X
Total expected energy savings (H) (sum of all DCs)	= (4,713 + 5,242+ 2,746 + 1,273 + 935) X = 14,912 X				
Sectoral energy savings target (TOE) (I)	104,000				
% target reduction (F=H/I)	X = 104,000/14,912 X = 6.97%				
Target reduction for each DC from baseline (J = F*E)	6.970%	7.467%	7.664%	7.817%	9.744%
Target SEC for the DC (K= J*B)	1.185	1.262	1.293	1.316	1.607

6.4. Estimation of assessment year SEC

The DCs have to monitor the parameters and report their energy consumption in the prescribed format given by the BEE. The assessment year SEC i.e. the final year of PAT cycle will be calculated from the reported data submitted by the DCs at the end of each PAT cycle. However, the DCs also need to submit the annual monitored data to the BEE.

The assessment year SEC is calculated as,

$$Assessment\ year\ SEC = \left(\frac{Total\ energy\ consumption\ (TOE)\ in\ the\ assessment\ year}{Production\ (tons)} \right)$$

6.5. Estimation of energy savings at the end of target period

The absolute energy saving at the end of assessment year will be estimated as:

$$Energy\ savings = \left(SEC_{base\ year} - SEC_{assessment\ year}\right) \times Production_{base\ year}$$

If there is change in the production of a product, then the normalization factor will be applied for the production in the assessment year.

Figure A.1.5 shows the schematic of estimation of energy savings and the issuance of ESCerts based on energy reductions achieved.

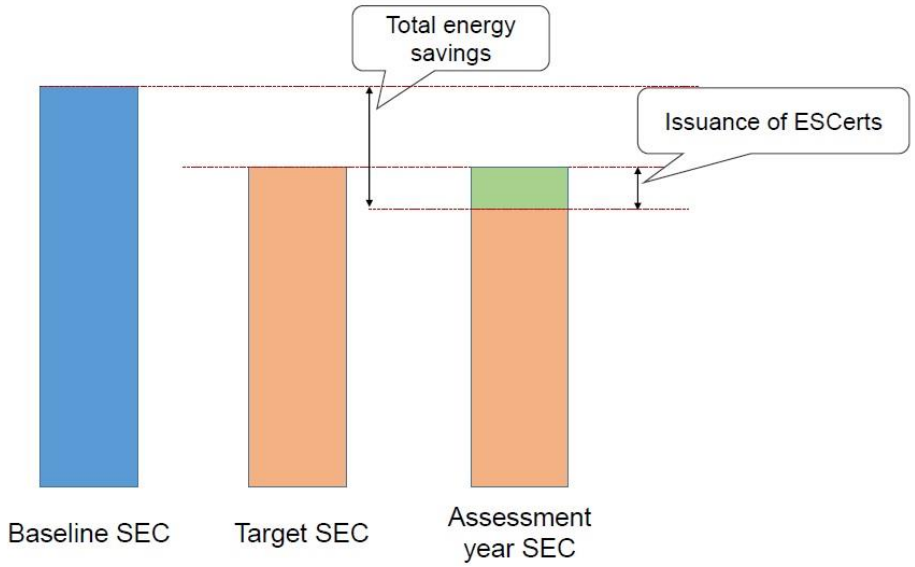


Figure A.1.5. Schematic of estimation of energy savings and issuance of ESCerts

6.6. Application of normalization factors

There are many factors, which can influence the SEC of a DC and the normalization factor is applied to ensure that all the DCs are at the same level. Several aspects are taken into consideration for the normalization of production and energy consumption under the PAT scheme. This is to avoid the undue advantage or disadvantage that could be imposed on a DC. Various aspects for which normalization factors are applied for the DCs are given below.

- Start & stop of the furnace
- Product mix
- Import & export of intermediary product
- Normalization for scrap use
- Power mix (imported & exported from/to the grid and self-generation from the captive power plant)
- Fuel quality in captive power plant and cogeneration
- Others
    - Environmental concern (additional environmental equipment requirement due to major change in government policy on environment)
    - Fuel replacements

- Project activity phase
- Unforeseen circumstances
- Renewable Energy Certificate (REC) normalization

7. Measurement, Reporting and Verification (MRV)

Figure A.1.6 shows the process flow of issuance of ESCerts under the scheme.

The DCs have to monitor the parameters and report their energy consumption in the prescribed format given by the BEE through the PATNET online portal. The portal was established and maintained by the BEE. The energy consumption data are submitted to the BEE through PATNET and in hardcopy within 3 months at the end of every financial year.

The DCs have to monitor the parameters such as raw material usage, final product output, fuel and electricity consumed, energy generation and consumption from captive power plant and waste heat recovery, etc. These parameters are monitored continuously or hourly or daily or weekly or monthly depending upon the monitoring plan. The DCs should also provide the reports, documents and information to the energy auditors during verification. They also have to submit the performance assessment document within 3 months from the end of assessment year (i.e. the final year of PAT cycle) to the SDA and the BEE.

After the target period, the BEE will appoint an EmAEA to conduct Check Verification. The DCs will provide all the information necessary for the verification process, including supporting documents and access to the plant site. The EmAEA will assess and verify that the activities performed by the DCs. The EmAEA in-charge of check-verification will report the results of the assessment in a check-verification report to the BEE.

The DCs who had not achieved the target (under achiever) are entitled to buy the ESCerts from the power exchanges. As per the ECA 2001, a fixed penalty of maximum INR 1 million (≈ 14,300 USD) and variable penalty[2] for the energy reduction that is not achieved by the DCs[3] as specified in EC rules 2012 is applicable. If not paid, it will be recovered as an arrear in land revenue.

[2] Considering average market price of one TOE of fossil fuel for each units of energy savings not met
[3] PAT scheme Normalization document

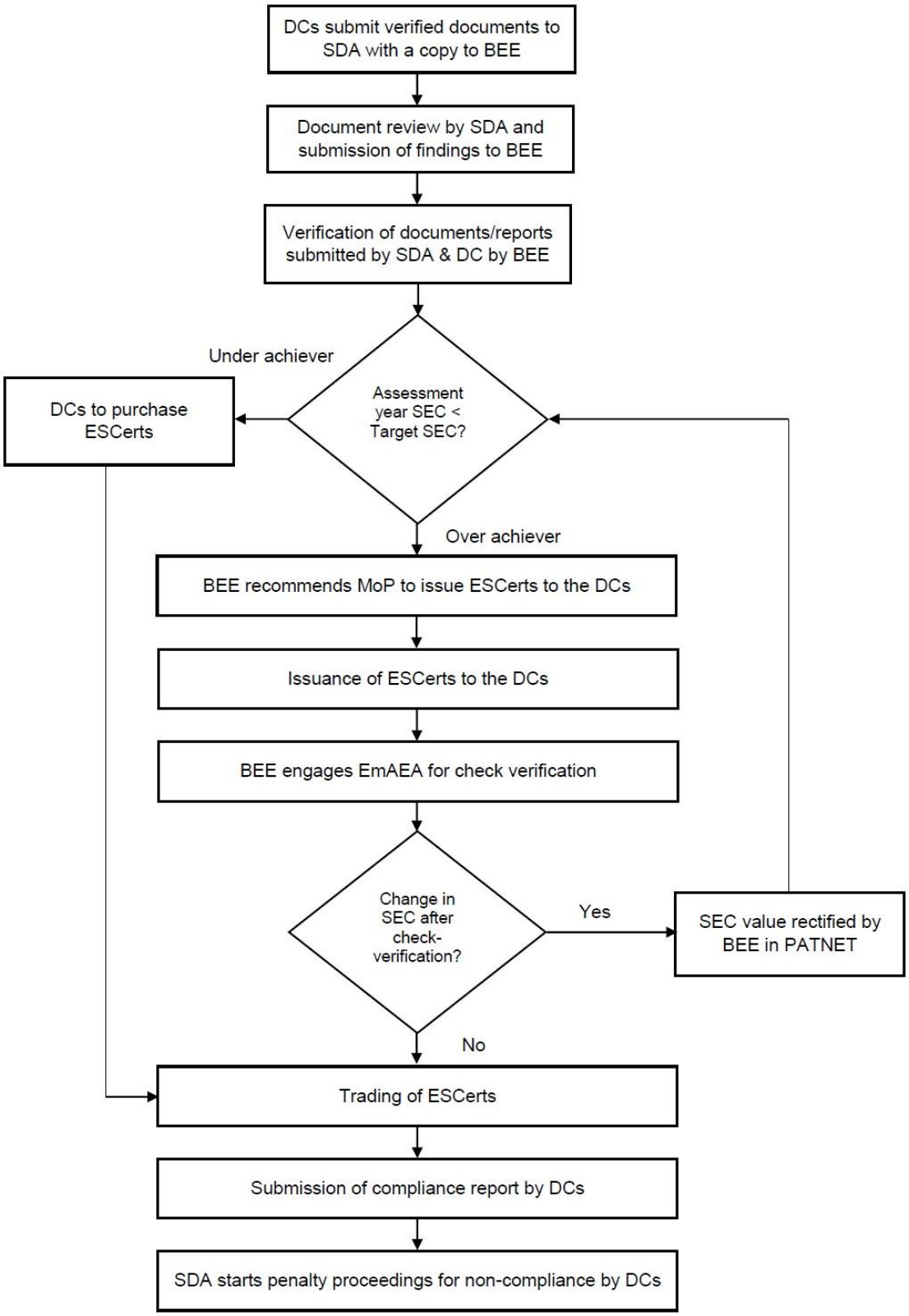


Figure A.1.6. Process flow for issuance of ESCerts

Table A.1.3 gives the list of forms and their submission authorities under the PAT scheme.

Table A.1.3. Different reporting forms under PAT scheme

No.	Name of the form	Submitted by	Time of submission	Submission authority
1	Form 1 – Energy consumption data and sector specific Pro Forma – to calculate notional energy for normalization	DCs	Within 3 months at the end of every year in PATNET portal and in hardcopy	BEE
2	Form A – Performance assessment documents	DCs	Within 3 months from the end of target year	SDA & BEE
3	Form B – Certificate of verification by EmAEA	DCs	Within 3 months from the end of target year	SDA & BEE
4	Form D – Status of compliance	DCs	Within in 5 months from the submission of Form A	SDA & BEE
5	Form C – Check verification report and certificate	EmAEA	Within 6 months after issuance of ESCerts or within 1 year of submission of Form D	BEE

8. Implementation status

The targets for the PAT Cycle I (2012-2015) were notified to 478 DCs under 8 sectors (Aluminium, Cement, Chlor-Alkali, Fertilizer, Iron and steel, Pulp and paper, Thermal power plant and Textiles). The PAT cycle I envisaged energy saving of 6.686 million TOE (4.08% reduction in the total energy consumption).

At the end of PAT cycle I, it had achieved energy savings of 8.67 million TOE which is 27% higher than what was envisaged under the cycle I. This energy savings resulted in a reduction of 31 million tCO_2. The government issued 3.825 million ESCerts to 306 DCs while 110 DCs purchased 1.425 million ESCerts for their compliance under the PAT cycle I[4]. These certificates are tradable at two energy exchanges viz. Indian Energy Exchange and Power Exchange India.

The PAT cycle II was rolled out for the period 2016 – 2019 covering 621 DCs from 11 sectors (which includes eight existing and three new sectors viz. Railways, Refineries and DISCOMS). The PAT cycle II is envisaged to reduce energy consumption in industries by 8.889 million TOE.

The BEE issued notification for PAT cycle III (2017-2020) under which 308 DCs from already notified sectors have been identified for baseline verification and inclusion. Of these, the

[4] https://beeindia.gov.in/content/pat-read-more

verification of 273 DCs has been completed and 116 new ones have been included with a target energy savings of 1.01 million TOE[5].

The targets for the PAT cycle IV (2018-2021) have been notified in March 2018. Total of 109 DCs are covered from the existing and two new sectors (petrochemical and buildings (hotels)) with an overall energy savings target of 0.699 million TOE.

The PAT scheme sets threshold limits based on the sectoral energy consumption pattern. It has strategic advantages for setting benchmarks at sector and even at process level in future. The DCs are notified when they consume energy greater than the threshold limit as mentioned in the regulation. Table A.1.4 gives the threshold limit for the thirteen sectors covered so far under the PAT scheme.

Table A.1.4. Threshold limit for the industrial sectors[6]

No.	Name of the sector	Threshold limit
1	Thermal power plant	>30,000 TOE/y
2	Fertilizer	>30,000 TOE/y
3	Cement	>30,000 TOE/y
4	Iron and steel	>30,000 TOE/y
5	Chlor-Alkali	>12,000 TOE/y
6	Aluminium	>7,500 TOE/y
7	Textile	>3,000 TOE/y
8	Pulp and paper	>30,000 TOE/y
9	Railways	• All zonal railways having traction annual energy consumption of > 70,000 TOE/y and • Workshop/production units having annual energy consumption of >30,000 TOE/y
10	DISCOMS	Aggregate Technical and Commercial loss (AT&C) of 1,000 million units (MU) or >86,000 TOE/y
11	Petroleum refineries	>90,000 TOE/y
12	Petrochemical	>1,00,000 TOE/y
13	Buildings	>1,000 TOE/y

[5] http://www.teriin.org/article/taking-pat-road-leaner-meaner-industries
[6] Deepening and Widening of PAT scheme and provisions of EC Act applicable to DCs

9. Lesson learnt

The lessons learnt from the implementation of the PAT cycles so far are summarized as below.

- Stakeholder inclusion in the scheme design: There was an extensive consultation process in the design and implementation phase, which aided acceptability. The draft document was widely circulated and discussed in 96 sectoral and regional/state meetings. In addition, frequent communications were made with the DCs at the state and sectoral meetings. The technical committees considered inputs from the DCs before developing normalization rules. Inputs were assessed and key changes were made in the design and in enhancing ownership of mechanism.

- Creditability of reported energy savings: Auditing and check auditing by third-party auditors (EmAEA), accredited through an open process by the BEE, built credibility and fairness.

- Strong legal backing: For this, an amended ECA 2001 was passed by the Indian parliament in 2010. While the earlier version already included specification of DCs, energy consumption norms and third-party assessment by accredited auditors, the amendment provided the legal mandate for issuance of certificates for excess savings and their trading.

- Need for stringent targets: Over achievement of the target in first PAT cycle led to reflection that the targets were not stringent enough. A methodology for tightened targets was thus called for. When the results of the second and third PAT cycles come in, they will be able to serve as inputs for future design and implementation of this unique scheme[7].

- Clarity and stability of trading mechanism: When trading began, more than 3 million ESCerts were available against a demand for 1.45 million ESCerts by the companies. At the outset, it was assumed that each ESCert would cost around INR 10,000 (≈ 145 USD) which is the average price of coal, oil, gas and one unit of electricity for the industrial sector (in terms of TOE). However, when trading started in September 2017, the opening price of 1 ESCert was INR 1,200 (≈ 17 USD) almost 10 times lower than expected. As more industries registered on the trading site, the number of ESCerts available for purchase steadily increased. The price of ESCerts gradually declined due to the impact of low demand in the market. By November 2017, the price was as low as INR 200[8] (≈ 3 USD).

- Timeliness in enforcing the penalties: The facilities that did not achieve their targets would be liable to pay an additional penalty of INR 1 million (≈ 14,300 USD) if they failed to purchase ESCerts. In the case of continued failure to meet targets, further penalties would be levied. However, there is no clarity on enforcement or timelines for defaulters to make these applicable[9].

[7] http://www.teriin.org/article/taking-pat-road-leaner-meaner-industries
[8] https://www.thehindubusinessline.com/opinion/pats-path-to-energy-efficiency/article23751019.ece
[9] https://iasbaba.com/2018/05/iasbabas-daily-current-affairs-prelims-mains-focus-3rd-may-2018/

Annex 2. Korean Emissions Trading Scheme (KETS), Republic of South Korea

1. Introduction

South Korea's Emissions Trading Scheme (KETS) is the second largest carbon market after the European Union Emissions Trading Scheme (EU-ETS) and roughly covering two-third of the country's total emissions. It is the first nationwide emission trading scheme in Asia covering all the energy intensive industries and other facilities. The KETS is the government policy measure taken to meet its commitment laid out in the Copenhagen Accord of 2009. Under this Accord, South Korea pledged to reduce its GHG emissions by 30% below its BAU scenario by 2020.

2. Key program features

Scope	Wide sectoral coverage including the industries, buildings, transport, aviation and waste
Mechanism	Cap and trade of emission allowances similar to European Union Emission Trading Scheme (EU ETS)
Participation	Mandatory for the entities with the annual energy consumption above a set threshold limit
Target setting	Each participating entity is provided with a target GHG emission (allowances[10]) based on its historic baseline emissions
Target period	Varies from three to five years for different phases
Monitoring, Reporting and Verification	Monitoring and reporting is done at facility level. Emission reduction must be verified by third party verification agency before issuance of credits
Penalties	Any non-compliance of targets will lead to proportionate imposition of penalties (administrative fine not exceeding three times the average market price per unit of tCO_2e for that year. The maximum penalty is KRW100,000 per tCO_2e)

3. Legal framework

The KETS was implemented through the Act on Allocation and Trading of Greenhouse Gas Emissions Allowances, enacted in November 2012 by the Presidential decree. The details of the KETS were then elaborated in the Master Plan for the Emissions Trading Scheme, prepared by the Ministry of Strategy and Finance (MOSF) and the National Allowances Allocation Plan Phase I), prepared by the Ministry of Environment (MOE), which were introduced in 2014. Together, these legal documents outlined the key elements of the KETS design for the first commitment period (2015–2017) and enabled the launch of scheme in January 2015.

[10] Each allowance represents 1 ton of carbon dioxide equivalent (tCO_2e) that are permitted to be emitted

4. Scheme design

The KETS caps GHG emissions of the covered entities within the scheme and involves the issuance of a corresponding number of emission allowances.
Figure A.2.1 gives the simple process flow of the scheme.

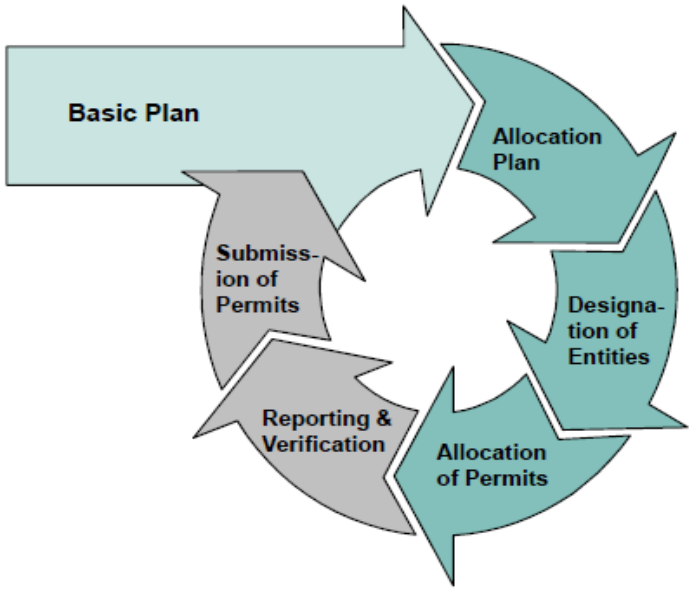


Figure A.2.1. Simple process flow of KETS scheme[11]

At the beginning of each phase, the government establishes an allocation plan, in which it defines how emission allowances are to be allocated. The allowance allocation is detailed by sector and by business category, which creates the basis for each participant's allocation. Allowances can be either allocated for free or auctioned within the KETS.

After the allocation plan, the KETS identifies the sectors/entities that are to be included in the scheme. The KETS covers wide range of sectors such as power generation, industries, buildings, transportation, aviation and waste. Once the participating sectors are selected, participation thresholds (i.e. total emissions in a year) need to be confirmed to identify emitters that have to comply with the system. The participation thresholds are primarily based on each entity's contribution to the national GHG emissions; however, their capacity to measure GHG emissions and participate in the system are also taken into consideration.

The KETS requires mandatory participation from all entities within the covered sectors with the average annual GHG emissions equal to or greater than 125,000 tCO_2e over three consecutive years or business sites with the annual average GHG emissions equal to or greater than 25,000 tCO_2e over three consecutive years. In addition, regardless of its emission levels, any entity may apply for the voluntary participation also. The allowances will be allocated to each entity based on its historical emissions.

[11] Presentation on Korean Emission Trading Scheme, Korea Environment Corporation, Nov 2013.

The emission cap provides an upper limit of the aggregated GHG allowance for the covered entities. The emission cap is established in line with the national emission reduction targets. Table A.2.1 shows the emission reduction target for different sectors covered in the KETS.

The covered entities must measure and report their annual emissions and surrender the allowances to cover their emission responsibility. Entities those who emit less than their allocation can sell their excess allowances through the Korea Stock Exchange (KRX).

Table A.2.1. Emission reduction targets for different sectors

Category	Industry	Transport	Building	Agriculture, Forestry, Fishing	Waste management	Public sector
Sectoral reduction rate compared to 2020 BAU emission	18.5%	34.3%	26.9%	5.2%	12.3%	25%

The entities which do not have enough allowances to cover their annual emissions will need to buy from the KRX. This creates the direct economic incentive for the emission reduction. At the same time, the cap limits the GHG reductions to target levels. The KETS was implemented in phases to allow a progressive evaluation and revision to its design, which was reflected in the updated master plans.

Participants are also allowed to bank allowances for an unlimited period of time. The companies or individuals not subject to emission caps under the KETS, except for a couple of Korean government owned banks, are restricted from trading the allowances in the KETS.

5. Institutional arrangement

Figure A.2.2 shows the institutional arrangement for the KETS scheme.

The MOE is responsible for managing all aspects of the scheme's operation. The MOSF communicates with the line ministries and regulates the volume of allowances in the carbon market. The responsibilities related to allowance allocation, the compliance process and communication with the participants were in turn distributed among four sectoral ministries (Ministry of Trade, Industry and Energy, Ministry of Land and Infrastructure Transport, Ministry of Environment and Ministry of Agriculture, Food and Rural Affairs) with each being responsible for its respective sector emissions.

In 2018, a market maker role was also introduced - an institution that is designed to enhance the stability of the KETS. These include three banks: the Korea Development Bank, the Export–Import Bank of Korea and the Industrial Bank of Korea.

The KETS is supported by the National Greenhouse Gas Inventory System, managed by the Greenhouse Gas Inventory & Research Centre (GIR) for Korea. It tracks GHGs emitted by the entities and provide the data required for measuring, reporting and verifying the same in line with the international standard.

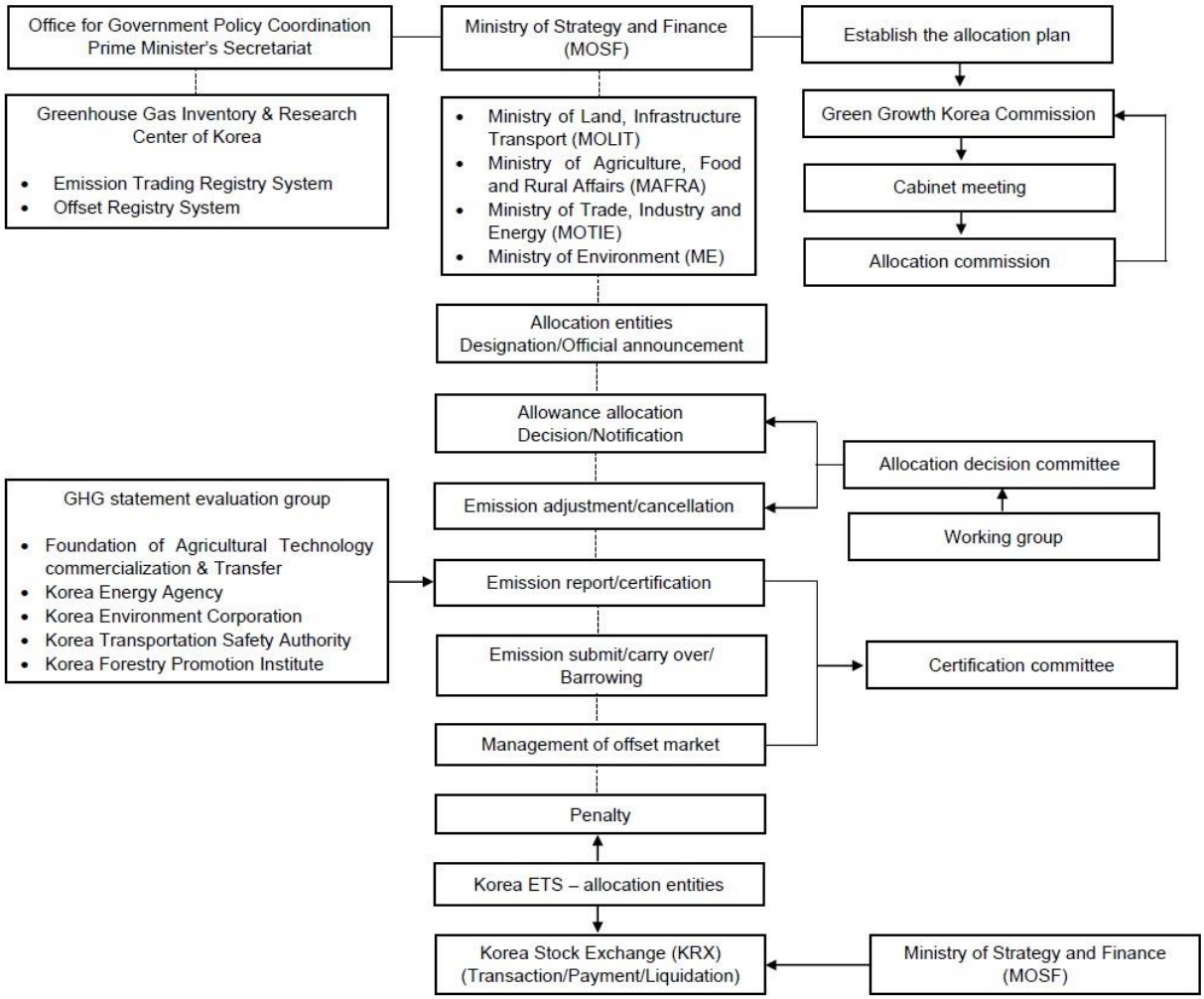


Figure A.2.2. Institutional arrangement for KETS[12]

6. Methodology

Since 2010, South Korea had operated the GHG and energy Target Management System (TMS) to manage industries that are both large GHG emitters as well as large energy consumers. The TMS was a temporary system that was put in place as a tool to build capacities within the industries and local governments and prepare for the KETS. The KETS was built on the approaches set under the TMS. Even now, the data collected under the TMS is used for compilation of the national inventory.

6.1. Target setting

After a rigorous analysis and consultations with various stakeholders, the target for the program was defined against a BAU scenario. The overall commitment of a 4% emission reduction compared to 2005 levels was turned into a 30% emission reduction compared to the 2020 BAU

[12] Republic of Korea: An emission trading case study, Environment Defense Fund (EDF), International Emissions Trading Association (IETA), Climate change research institute of Korea (CRIK)

levels. The KETS cap for different sectors (as given in the table 1) were then established in line with the national emission reduction target.

6.2. Allocation of allowances

The Government of Korea provided 100% free allowances in the KETS Phase I to all the covered entities to ensure a smooth introduction of the system and not to cause excessive economic burden on the industries involved. The overall cap was set at 1,687 million tCO_2e in Phase I. The allowances were allocated based on the historical emissions of individual entities.

Figure A.2.3 gives the allowances allocated for the different industrial sectors under the KETS in Phase I.

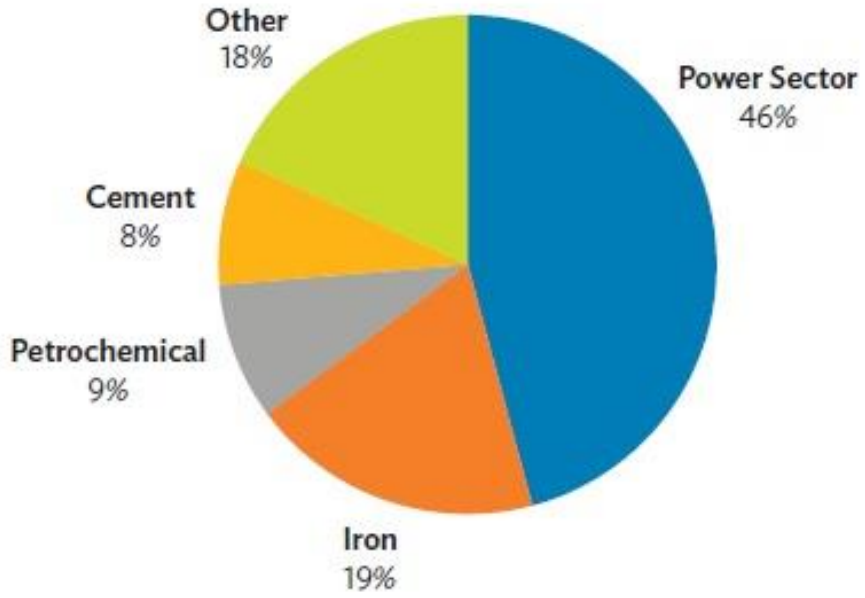


Figure A.2.3. Allocated allowances under the KETS in Phase I

These free allowances are planned to reduce in the subsequent phases i.e., in Phase II 97% allowances will be distributed freely and 3% will be auctioned and in Phase III 90% allowances will be distributed freely and 10% will be auctioned.

The allowance auctions for the Phase II began in 2018 and are open to all KETS covered entities. The MOE prepares and publishes the list of eligible bidders. The auctions are held monthly and a number of conditions are imposed to keep the price within reasonable limits. Particularly, the auctioned allowances are subject to a floor price and no bidder is allowed to purchase more than 30% of the auctioned amount in any auction. The latter provision was added to avoid speculation on the market.

6.3. Emissions reductions and trade of allowances

The total emissions from the each entity is calculated using the formulae

$$\begin{pmatrix} Total\ emissions \\ from\ the\ year\ i \end{pmatrix} = \begin{pmatrix} Electricial\ energy \\ (kWh) \end{pmatrix} \times \begin{matrix} Emission \\ factor \end{matrix} \left(\frac{tCO_2}{kWh}\right) + \left(\begin{pmatrix} Energy\ consumed \\ from\ the \\ fossil\ fuel\ (TJ) \end{pmatrix} \times \begin{pmatrix} Emission\ factor \\ of\ that\ fuel \\ \left(\frac{tCO_2}{TJ}\right) \end{pmatrix} \right)$$

The emission allowances can be sold at the ETS once the entity reduce its emission below the allowances issued by the government. Figure A.2.4 depicts the schematic of the KETS methodology, considering that entities A & B have same amount of emissions in baseline, have same allocated allowance and show different performances at the end of the compliance period.

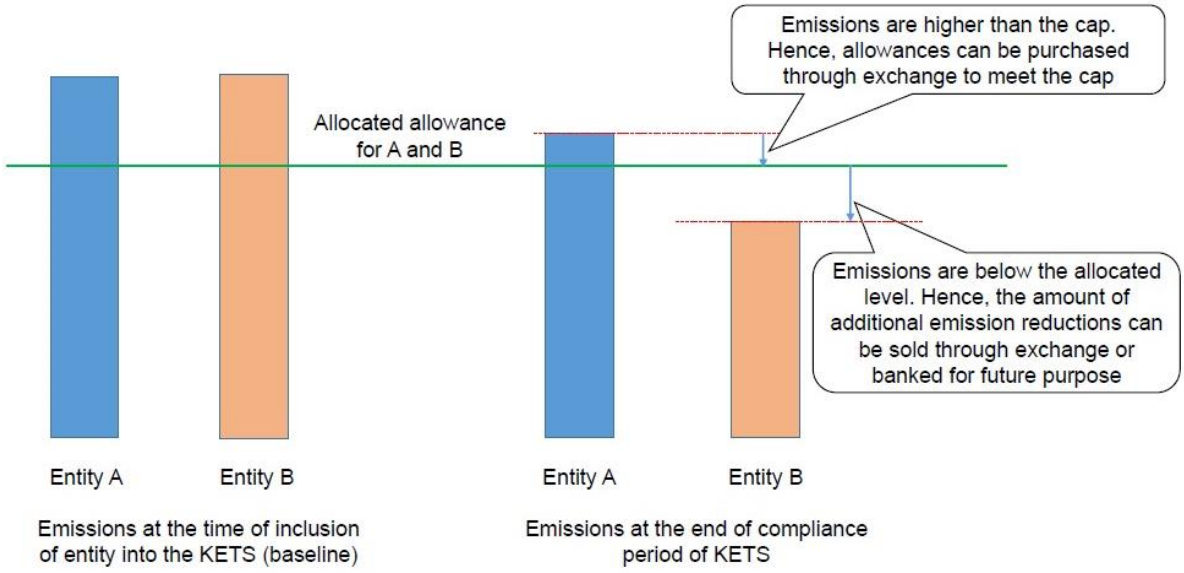


Figure A.2.4. Schematic of KETS methodology

7. Measurement, Reporting and Verification (MRV)

Figure A.2.5 provides the simple schematic of the KETS MRV.

For all activities covered by the KETS, detailed calculation methods, outlining the requirements under all tiers[13] are defined by the regulation. At the star of compliance period, the participating entities have to compile an annual monitoring plan (MP) that includes the following:

- Organizational boundaries
- List of facility emissions, activities and source streams
- Quality assurance (QA) and Quality control (QC) measures
- Monitoring methodologies for each monitored activity
- Explanation of compliance with requested tiers and planned actions in case tiers could not be met.
- Alignment of test result and maintenance report of continuous emissions monitoring system (CEMS), flow meter and other measuring devices related to emission calculation

[13] Tiers' are defined as data accuracy levels of each parameter needed for the determination of emissions

The MP is prepared annually and submitted to the authorities who are responsible for the respective sector. The authorities check and approve the MP. They also keep track of the progress made by the entities in their sector throughout the compliance period.

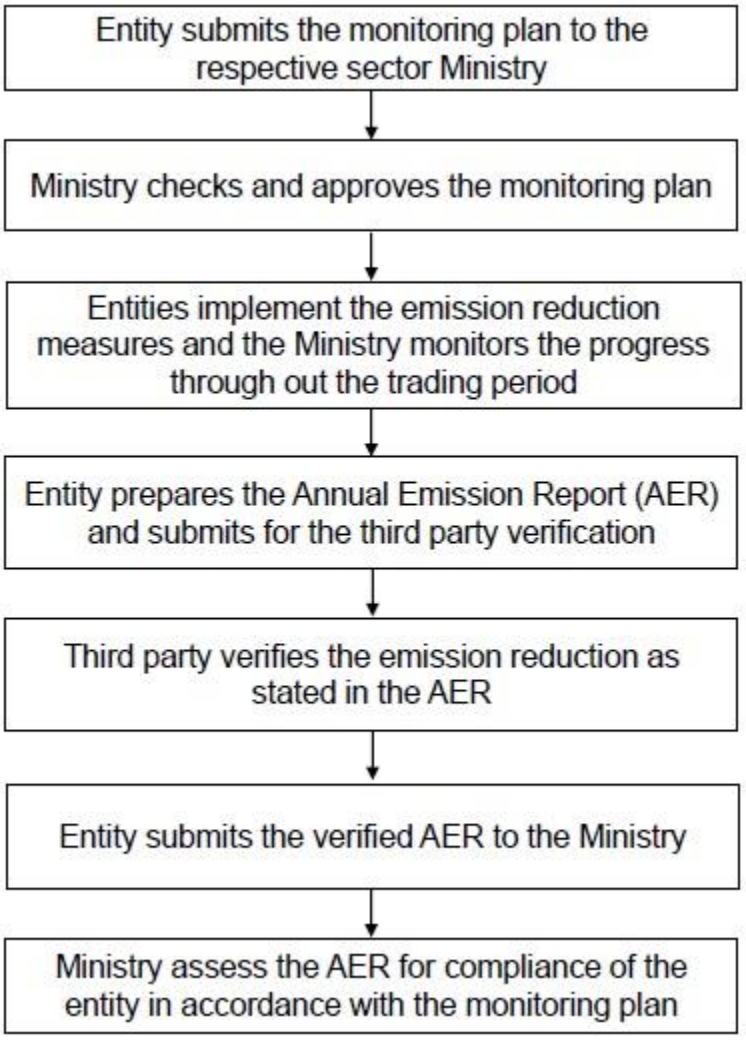


Figure A.2.5. KETS MRV process flowchart

The entities must estimate and report the direct and indirect emissions from their respective facilities. The report must also include a distinction between emissions at the corporation level, business site level, facility level and activity level. A tier system, which is comparable to the system under the EU-ETS, has been established, allowing both, calculation and direct measurement approaches. In parallel, entities are classified into groups based on the type of categories and size of the installation to meet the minimum requirement of uncertainty level (tier) in emission estimation.

The entities conduct quality control (QC) activities on data collection, estimation of GHG emissions, uncertainty management and data management to increase the accuracy of calculation.

At the end of each year (Jan – Dec), each entity must compile an Annual Emission Report (AER) detailing its emissions from all covered emission sources. This report has to be verified by an accredited third-party verifier and submitted to their respective ministry within 3 months from the end of the reporting year. This report is then reviewed by the MOE's Certification Committee. If an entity fails to report its emissions correctly, then the Certification Committee may decide to disqualify the report.

Once the report is approved, the entity may proceed to surrender the allowances to cover its GHG responsibility. This can be done with allowances received through free allocation, purchased on the carbon market, borrowed from the following compliance period or banked from previous compliance years.

The penalty for noncompliance with the KETS is an administrative fine not exceeding three times the average market price per unit of tCO_2e in that year. The maximum penalty is KRW 100,000 per tCO_2e or approximately USD 91 per tCO_2e.

The MOE selected 24 verification bodies, through an accreditation process, to provide third party validation/ verification service under the KETS. By mandating entities to comply with international standard (under the Korean GHG and energy TMS) from the start, they became better prepared to participate in both the KETS and other international carbon markets.

Under the KETS, an information technology (IT) based register, called the GHG Information Registry (GIR) was established and managed by the MOE to record allocation, trading and transfer of emission allowances. In principle, all emission reports are made public.

8. Implementation status

The KETS covers GHGs such as carbon dioxide, methane, nitrous oxide, hydro fluorocarbons, per fluorocarbons and sulphur hexafluoride. It also covers the indirect emissions from the electricity consumption. The KETS is implemented in three phases - Phase I: Three years (2015-2017); Phase II: Three years (2018-2020) and Phase III: Five years (2021-2025). For Phase I, 100% of allowances have been freely allocated. In Phase II, 97% of allowances are freely allocated and in Phase III 90% or less allowances will be freely allocated.

For Phase 1, there were 534 entities from 23 business categories across five sectors selected for mandatory participation in the system. The number of entities in 2016 increased to 603, and subsequently reduced to 599 by the end of Phase I (2017).

During the first year of the KETS, approximately 12.9 million tCO_2e credits were traded (representing 2.3% of the 2015 cap) and the sum of the value traded in the Korea Stock Exchange (KRX) and Over-the-Counter exchange market (OTC) was approximately KRW 200 billion.

9. Lessons learnt

The following are the key lessons learnt and takeaway from the KETS scheme.

- Stakeholder inclusion in scheme design: It took the Government of South Korea over 2 years to gain agreement from the industry to launch the KETS. Extensive stakeholder consultation was done to gain support from the private sector. Input was sought when developing the system from more than 100 stakeholder consultations stakeholders from all sectors.

- Developing strong institutional framework: The KETS institutional arrangement went through a number of transformations in an attempt to find the most beneficial way to manage and oversee the system. The responsibilities were variously aggregated and disaggregated and involvement of several government bodies resulted in unclear or even conflicting policy signals.

- Continuous stakeholder engagement: The stakeholder engagement methods are incorporated during introduction of major changes of the system. Public hearings and industry consultations continue to be frequently organized to provide support for KETS participants. The four sectoral ministries organize technical support seminars dedicated for specific industries. In cooperation with the government, a consulting center for small and medium-sized enterprises is operating. In addition to this, the GIR of Korea is conducting annual stakeholder surveys covering approximately half of the KETS participants in each sector to gain their feedback and suggestions related to the system operation. The results are thoroughly reviewed by the government with the intention to implement improvements where it is feasible and reasonable.

- International co-operation and knowledge sharing: As a part of sharing their carbon pricing experience, the People's Republic of China, Japan, and the Government of South Korea held a forum where they explored ways for cooperation and possible options for linkages of the regional markets. In addition to the options for linkages of markets, the Government of South Korea is cooperating with the EU ETS authorities for carbon pricing experience sharing. As a result of this cooperation, in July 2016, the EU–Republic of South Korea (ROK) cooperation project was launched to support the implementation of the KETS. This project aims to share the EU experience and knowledge on ETS operation with key stakeholders in the South Korea.

Annex 3. UK Climate Change Agreement (CCA) for Food Sector

1. Introduction

The Climate Change Agreements (CCAs) implemented by the United Kingdom (UK) are voluntary agreements through which the energy-intensive entities commit themselves to energy savings or emission reduction targets and receive a discount from the Climate Change Levy (CCL) upon fulfilling their commitment. The CCL is a tax on the consumption of electricity (excluding renewable electricity and combined heat and power (CHP), but including nuclear), coal, natural gas and liquefied petroleum gas (LPG).

Although the CCA is a voluntary program, the non-participating entities will have to pay the full tax amount that was imposed for their energy usage. As a tool in a climate-policy-instrument mix, the CCAs mainly correspond to the category of 'energy efficiency and consumption' policy because their focus has been primarily on energy efficiency improvement, rather than the direct carbon emission reductions.

The food and drink processing industry is the fourth biggest industrial energy consumer in the UK. In 2010, it consumed nearly 37 TWh and emitted around 11 million tCO_2 into the atmosphere. Thus, it is one of the key sector under the CCA.

2. Key program features

Scope	Wide sectoral coverage including the industries, buildings, food processing, animal farming, etc.
Mechanism	Carbon pricing (tax) and energy reduction based tax relief
Participation	Voluntary, but non-participation leads to full taxation
Target setting	Two tier in each sector (in terms of energy consumption reduction) – one at sector level and another at facility level
Target period	Two years
Monitoring, Reporting and Verification	Monitoring and reporting is done at facility level. Energy reduction claimed is validated by the sector association and re-checked by the administrating agency
Penalties	Any non-compliance of targets leads to the cancellation of tax relief

3. Legal framework

The legal basis for the CCA is provided by the Finance Act 2000 (as amended), which introduced the CCL and prescribed changes to the excise duties, value added tax, income tax, corporate tax, stamp duty and capital gains tax, etc. Besides introducing the CCL, the Act also outlined the legal foundation for the CCA. In addition, a series of ministerial regulations such as Climate Change

Agreements (administration) Regulations 2012 (as amended), the Environmental Permitting Regulations 2010 (as amended) and the Climate Change Agreements (eligible facilities) Regulations 2012 (as amended) provide detailed guidance and rules for the implementation of the CCA. Table A.3.1 provides the CCL rate for different fuels (as of April 2019).

Table A.3.1. Climate Change Levy rates for different fuels

No.	Fuel type	CCL rate
1	Electricity	0.00847 (£/kWh)
2	Natural gas	0.00339 (£/kWh)
3	Liquefied Petroleum Gas (LPG)	0.02175 (£/kg)
4	Other commodities	0.02653 (£/kg)

The agreements made by the entities under the CCAs have the force of a public law agreement and there are concrete monitoring and enforcement provisions. Once the entities have opted for it, the CCA is considered legally binding for them.

4. Scheme design

Figure A.3.1 gives the simple schematic of CCA.

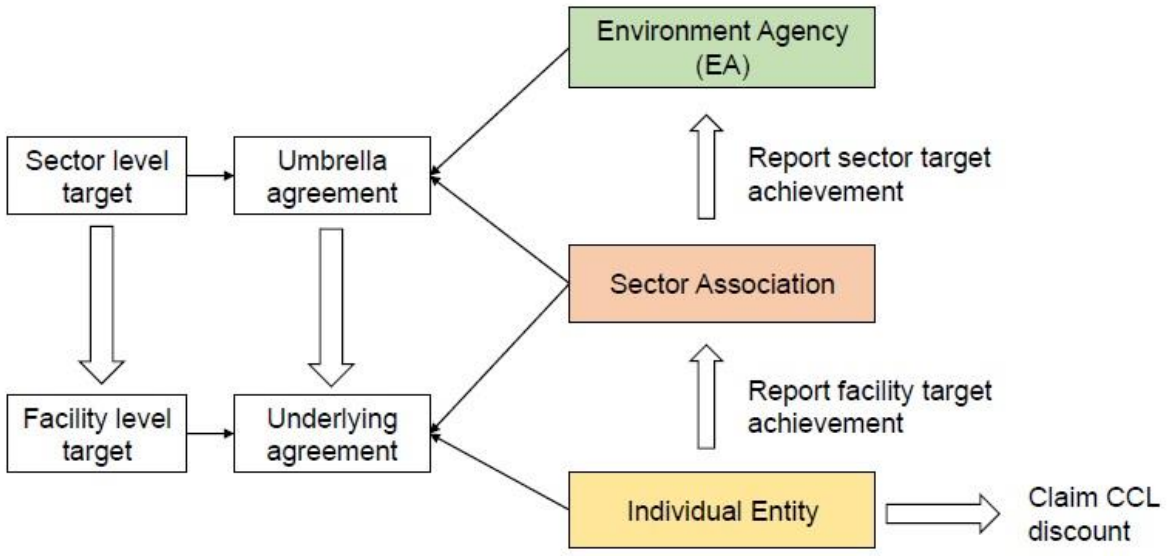


Figure A.3.1. Schematic of CCA scheme

Under this program, voluntary agreements are made between the industrial sector association and the Environment Agency (EA) to the reduce energy use and carbon dioxide (CO_2) emissions in that respective sector. In return, the entities (operators) in that sector will receive a discount on the CCL on fulfilment of the commitment. For operators who hold a CCA, the CCL will be reduced by:

- 90% on electricity bills
- 65% on other fuels

The CCAs are available for a wide range of industry sectors from the major energy-intensive processes such as chemicals, paper and supermarkets to agricultural businesses such as intensive pig and poultry farming. The CCAs are a combination of two types of agreements, following a two-tier structure:

- Umbrella agreements set commitments for eligible industrial sectors ('sector commitments').
- Underlying agreements allow individual operators to set targets for their target units comprising one or more specific facilities (industrial commitments).

The EA and the industrial sector association negotiate and sign the umbrella agreements. Together they agree on the energy efficiency targets for a sector – the sector commitment. The Umbrella agreements also list the processes within the sector that are eligible for a CCA.

The sector associations manage the underlying agreements for operators in their sector. An operator who wants to enter into a CCA must apply to its sector association. An underlying agreement is signed covering a site or group of sites owned by an operator within a particular sector. The agreement contains the energy savings or carbon reduction targets appropriate for their type of operation.

The CCA targets are set and tracked through two-year periods called Target Periods. The Certification Period is the time during which an operator is certified to receive the CCL discount. The discount is given prospectively upon entering into an agreement. If the targets for a given target period are not met by the end of it, the discount is not renewed for the next two-year period (i.e., in the consecutive certification period).

The CCA scheme has four target periods and five certification periods. Each target period is for two calendar years. A target is set for each of these target periods with reference to the operators' base year performance.

The certification period is the two financial years that an operator is certified to receive the CCL discount. The first certification period is based on an operator holding an agreement, even though the operator has yet to meet a target. At the end of a target period, if a target unit meets its target or uses the buy-out mechanism to make good any underperformance against its target, it will remain certified within the CCA scheme for the next certification period. Therefore, the next certification period starts once reporting is complete for the previous target period. If the target is met for the last target period (ending 31 December 2020), the target unit remains certified for the final certification period and eligible to receive the appropriate CCL discount until the end of the scheme in March 2023. Target units that pay the buy-out will also remain certified for the final certification period.

Figure A.3.2 gives the target and certification period for the Phase 2 CCA scheme.

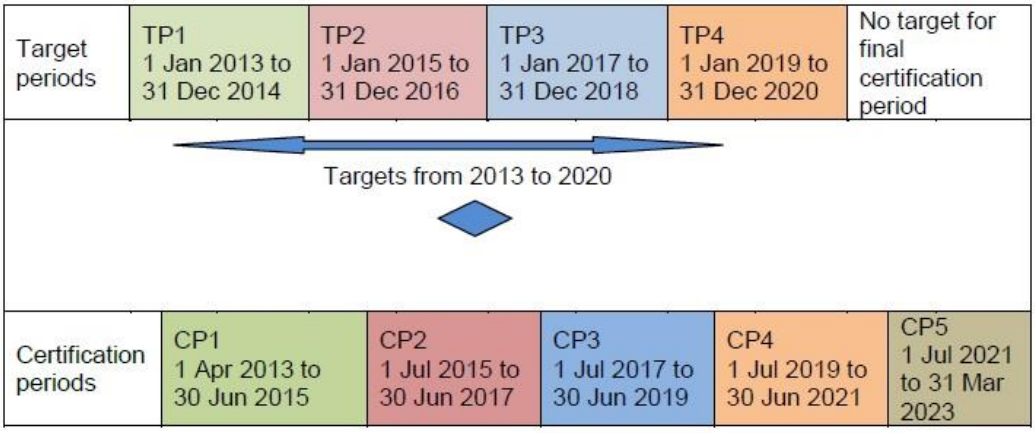


Figure A.3.2. Target and certification period for the CCA scheme (Phase 2)

5. Institutional arrangement

Figure A.3.3 provides the institutional arrangement for the CCA scheme.

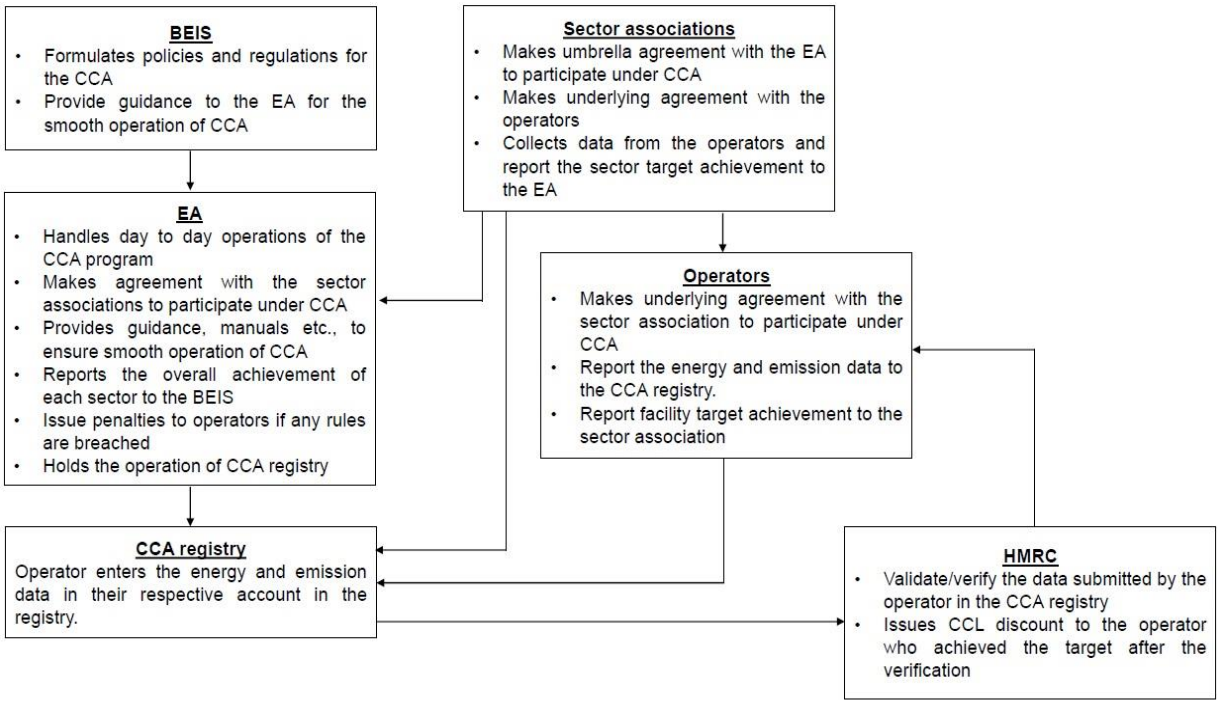


Figure A.3.3. CCA institutional arrangement

A number of different organizations play important roles in the operation of CCA. The key players are as follows:

Department for Business, Energy and Industrial Strategy (BEIS) is the government department responsible for the CCAs. They have the responsibility for policy development and decisions regarding the CCAs and for target negotiations.

Environment Agency (EA) administers the CCAs on behalf of the BEIS. It is responsible for the day to day operation of CCAs, using the policy set by the BEIS. It is responsible for registering every CCA and ensuring that every operator complies with the requirements of the CCAs. It is also responsible for issuing penalties to any operator who have breached the rules set in the CCAs.

Her Majesty's Revenue and Customs (HMRC) are responsible for checking proper claiming of the CCL discount.

The BEIS and the EA are supported by a Technical Consultant to validate/verify the eligibility information in application forms and the energy data submitted by the operators under the CCA.

The Government has set up the CCAs based on the "industry sector groups". There are separate CCAs for each main industrial sector. This approach allows the CCA targets to be customized to the circumstances of each industrial sector. A "lead body" in each sector, usually the relevant sector association, is responsible for operating their sector's CCA. The sector associations play the following role:

- Negotiate the sector targets and sign umbrella agreements with the EA
- Facilitate the negotiation of underlying agreements for operators in their sector
- Collect and report required data bi-annually, including checking the quality of the data submitted by the operators in their sector

There are currently 51 separate sector covering around 10,000 individual sites under the CCA[14].

The **Food and Drink Federation (FDF)** manages the CCA for the food and drink sector and acts as the key point of contact for negotiations between the sector, the BEIS and the EA. They play a crucial strategic role to ensure that the CCA rules are fair and reasonable for operators in the food and drink sector and that the targets are set in a fair and appropriate way.

The role of entities in the sector (operators) are:

- Work with their sector association to develop appropriate targets
- Measure and report its energy use and carbon emissions against agreed targets
- Collect and report data bi-annually
- Take measures to meet its own targets

In order to carry out the detailed administration of the umbrella targets under the sector associations, a technical consultant is engaged. The consultant is responsible for all the "day to day" activities such as processing applications, dealing with variations, gathering annual energy and production data from each operator and ensuring operators who fail to meet a target are given appropriate information so that they can take the actions to retain the CCL discount. The consultant also provides on-going technical and administrative support to the operators via a telephone help desk and a dedicated CCA website page.

6. Methodology

Figure A.3.4 depicts the flowchart for the methodology followed in the CCA.

6.1. Defining the site boundary

[14] A list of sectors under the CCA is given in the below link.
https://www.gov.uk/climate-change-agreements--2#sector-associations-with-ccas

In CCA, a site managed by the operator is defined as an area of land falling within a continuous boundary which encloses the land used in connection with a production process. For this purpose, however, an area of land can still be regarded as a single site even if it is dissected by a road, railway line or river. Other non-contiguous parcels of land would not, however, constitute a single site.

6.2. Calculation of energy consumption

Activities on the site are divided into three categories in terms of their energy consumption viz. Stationary Technical Unit (STU), Directly Associated Activities (DAA) and other activities. Figure A.3.5 shows the three key activities on the site in terms of their energy consumption.

The energy consumption is calculated and divided based on the site's primary energy consumption. The STU and DAAs together form the eligible installation or process. Activities that are directly associated with the eligible process (STU) and on the same site as the STU must be included in the installation and the energy consumed by all such activities must, therefore, be reported. It is to be noted that energy consumption by any processes that are already covered under any other GHG reduction program such as EU ETS, must not be included under the energy consumption of the site.

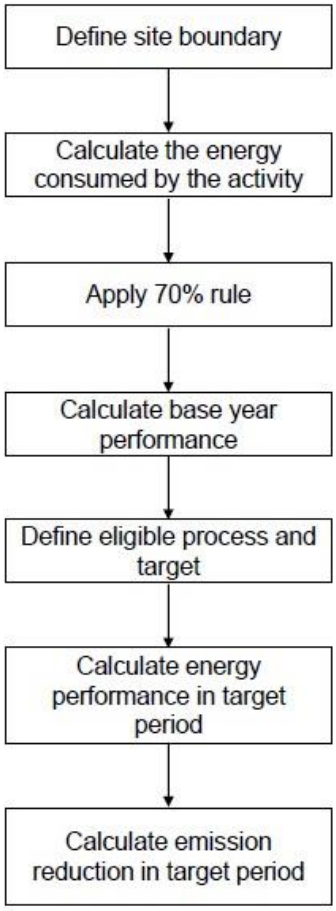


Figure A.3.4. Methodology followed in the CCA scheme

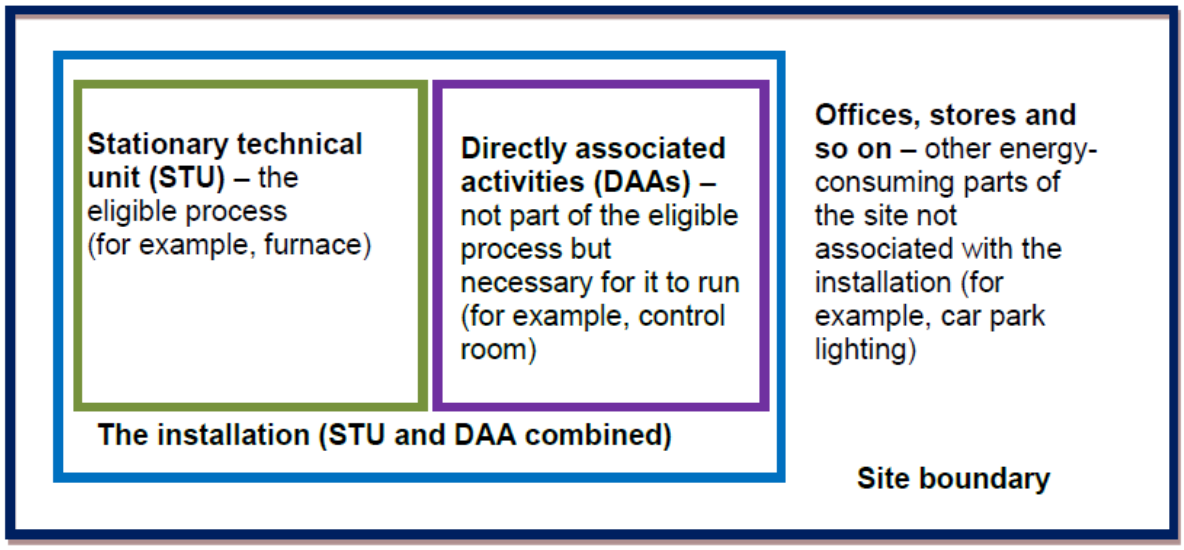


Figure A.3.5. Activities at site for energy consumption monitoring

The energy consumption at the site is calculated using the formulae below:

a) Fossil fuel consumption

The energy consumed from different fossil fuel use is calculated as,

$$\begin{pmatrix} Fossil\ fuel \\ consumption \\ (kWh\ of\ fuel) \end{pmatrix} = \begin{pmatrix} Quantity\ of\ fuel\ type\ 1\ \times \\ Gross\ calorific\ value\ of \\ type\ 1\ fuel \end{pmatrix} + \begin{pmatrix} Quantity\ of\ fuel\ type\ 2\ \times \\ Gross\ calorific\ value\ of \\ type\ 2\ fuel \end{pmatrix} + \cdots n$$

b) Electricity import

For the electricity import, the primary energy (fossil fuel) consumed in generating that electricity is considered as stated below.

$$\begin{pmatrix} Fossil\ fuel \\ consumption \\ (kWh\ of\ fuel) \end{pmatrix} = \frac{\begin{pmatrix} Quantity\ of\ electricity\ consumed\ through\ grid, \\ RE\ and\ captive\ power\ plant\ (kWh\ of\ fuel) \end{pmatrix}}{\begin{pmatrix} Efficiency\ of\ power\ generation\ \ and \\ from\ each\ of\ the\ source\ distribution \end{pmatrix}}$$

c) Heat generation from the renewable energy (RE) and waste fuel sources

The thermal energy consumed from different RE and waste fuels is calculated as,

$$\begin{pmatrix} Heat\ generation\ by \\ RE\ and\ waste\ fuels \\ (kWh\ of\ fuel) \end{pmatrix} = \begin{pmatrix} Quantity\ of\ fuel\ consumed \\ (kg) \end{pmatrix} \times \begin{pmatrix} GCV\ of\ the\ fuel \\ (kWh/kg) \end{pmatrix}$$

In case of mixed fuel use i.e., RE sources mixed with the fossil fuel sources,

$$\begin{pmatrix} Heat\ generation \\ by\ mixed\ fuels \\ (kWh\ of\ fuel) \end{pmatrix} = \left(\frac{\begin{matrix} Quantity\ of\ energy \\ consumed\ in\ a\ facility \end{matrix}}{\begin{matrix} Total\ energy \\ generated \end{matrix}} \right) \times \begin{pmatrix} total\ quantity\ of \\ fuel\ consumed \end{pmatrix} \times \%\ of\ fuel\ mix$$

d) Combined heat and power (CHP)

Three scenarios were considered if the site utilizes energy from CHP.

- CHP – where all fuel input is non-renewable
- CHP – where all fuel input is renewable
- CHP – where fuel input is a mix of renewable and non-renewable

When all fuel input is non-renewable:

- Where all the electricity or heat outputs from a CHP plant (located within the site or outside) are consumed within the target site, the energy to be reported must be calculated on the basis of total energy input to the CHP plant.

- Where a target site is served by a CHP plant that serve a number of consumers, the energy input to the CHP must be allocated to each consumer of the heat or the electricity and the energy input for the target site must be taken in to account.

When all the fuel input is renewable:

If the fuel input to the CHP is 100% renewable, all of the electricity and heat outputs of the CHP must be considered as RE. This means that consumption of all of this electricity will be treated as grid electricity. Consumption of CHP heat will lead to the reporting of primary energy consumption (in the form of some of the input fuels), but this energy consumption will be zero rated for carbon.

For a CHP where the fuel inputs are 100% renewable, the primary energy for CHP heat is calculated as follows:

$$\begin{pmatrix} Primary\ energy\ for \\ CHP\ heat \\ (kWh\ of\ fuel) \end{pmatrix} = \begin{pmatrix} Total\ fuel\ input \\ to\ CHP \\ (kWh\ of\ fuel) \end{pmatrix} - \begin{pmatrix} Total\ power\ output \\ from\ CHP \\ (kWh) \end{pmatrix} \times 2.6$$

When fuel input is a mix of renewable and non-renewable energy sources:

If the fuel input to the CHP is not 100% renewable, then a proportion of the electricity/heat output must be treated as renewable and the balance as non-renewable. The proportion of the electricity/heat output that is treated as renewable must be the same as the proportion of the fuel input that is deemed renewable, on an energy content basis.

e) Energy from steam

As energy is accounted for on a primary energy basis in the CCA scheme, it is the fuel used to generate the steam consumed in the eligible process that is accounted for, rather than the energy content (enthalpy) of the steam itself.

f) Accounting for Oxygen

The energy equivalent (provided by the CCA guidelines) is used for the Oxygen, when it is generated within a site for consumption in the eligible process. When Oxygen is imported for consumption in a site, then its energy content is considered as zero.

g) Accounting for Liquid nitrogen or solid CO_2 used for cooling

When liquid nitrogen or solid carbon dioxide (CO_2) is imported to perform a cooling function in a site, an energy equivalent (provided by the CCA guidelines) is used for the imported liquid nitrogen or solid carbon dioxide. The energy will be considered as zero when the imported liquid nitrogen or solid carbon dioxide is used for other than the cooling function.

h) Accounting for transport fuel

It is optional to include the transport fuel in total energy consumption of the site. When choosing to include fuel used by vehicles in the eligible process, the operators should take into account the following.

- Once the choice has been made to include fuel consumed by vehicles in the base year data, this fuel must be reported at future target periods and vice versa.
- Only fuel consumed by vehicles operating on site can be included.
- Operators must therefore be able to distinguish between fuels consumed by vehicles when they operate on site from that consumed if they operate off site.
- If the operator feels unable to meet any of these requirements, fuels consumed by vehicles should be left out of the eligible process energy consumption.

The energy content from the following scenarios are not accounted under the CCA:

- Fuel used as a chemical feedstock
- Heat recovered from exothermic reactions
- Electricity generated from recovered heat

6.3. Applying the 70% rule

Figure A.3.6 depicts the procedure for applying 70% rule in CCA.

The basic principles of the 70% rule is as follows:

- If the eligible process consumes 70% or more of the site's total primary energy, an operator is allowed to include 100% of site's energy consumption under the CCA.

- If the eligible process consumes less than 70% of the site's total primary energy, an operator is allowed to claim the eligible process energy consumption, plus energy consumed by other processes on site up to a value equal to an additional $3/7^{th}$ of the eligible process energy consumption under the CCA. However, both the eligible process and any additional energy claimed under the $3/7^{th}$ provision must be separately sub-metered.

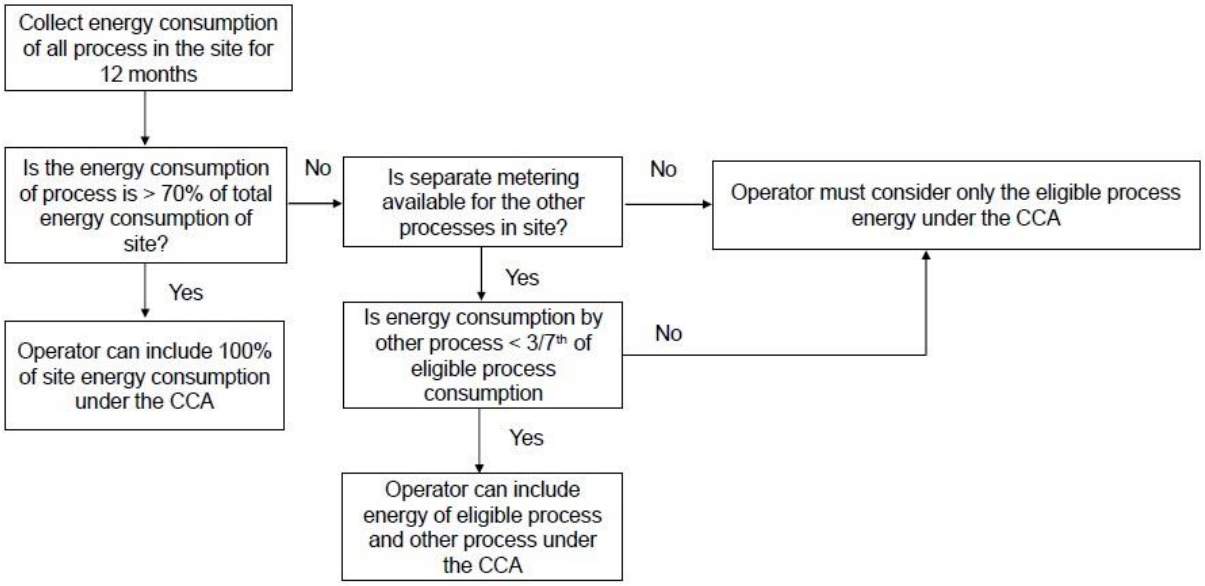


Figure A.3.6. Procedure for 70% rule in CCA

Before applying to the CCA scheme, an operator should estimate the energy consumed by the installation over the previous 12 months using any existing sub-meters, spot metering or calculation based on the equipment rating and the operating hours. The methodology for any estimation must be site-specific and set out clearly when the site eligibility application in the CCA register is completed.

6.4. CCA target setting for a site

Under the CCA scheme, two level of targets are fixed i.e., at the sector level (sector commitment) and at the operator level (target unit target). The sector commitments are agreed between the BEIS and the sector associations in 2012 and form the overall energy consumption or emission reduction percentage improvement until 2020. The commitment for each sector is stated in the sector's umbrella agreement. All operators who hold an underlying agreement have a target for their sites.

The CCA scheme may express the target in terms of energy or emission units. Therefore, four types of targets are possible in the CCA scheme and are as follows:

1. relative energy (for example, kWh/m^2)
2. absolute energy (for example, MWh)
3. relative carbon (for example, kgC/ton)
4. absolute carbon (for example, tons of Carbon)

For the energy targets, kWh is the most commonly used unit because it is the unit most frequently used in metering the main types of energy (electricity and gas). Target for the operators must be the same type (carbon or energy) as the sector commitment (or sub-sector commitment where a sector has sub-sectors). For example, where a sector commitment is in relative energy terms (kWh/m^2), an operator must choose either a relative energy or an absolute energy (MWh) target but can't choose a carbon target.

The operators should work with their sector association in selecting a suitable target for their operation. Once the underlying agreement is signed, it is not possible to request a change to the type of target.

The sector commitment (or sub-sector commitment if applicable) is used to set the percentage improvement target for a site when,

- A site or group of sites is entirely new to the scheme and becomes a target unit.
- A site formerly covered by the umbrella agreement of a different sector is moved into a new sector and becomes a target unit in that new sector.

The new site that comes under CCA with 2008 as the base year are expected to adopt the target profile agreed for the sector as a whole. The target profile is based on reporting performance at the end of each 24-month target period to 2020. For example, the sector target profile could be 3% by 2014, 7% by 2016, 11% by 2018 and 15% by 2020. When a facility is joining the CCA scheme in 2017 with 2008 as a base year, then the site will have a target of 11% by 2018 and 15% by 2020.

The target profile for new sites that don't have 2008 as their base year is calculated differently. For example, if base year was 2015 for a site, it will be assumed that the site has already reached the required savings for the sector from 2008. Using the example sector target profile from above, 2015 is midway between the 2014 (3%) and 2016 (7%) targets, that is, 5% savings from 2008 is set as a target for that facility. The remaining targets are calculated by linear interpolation for the sites.

New entrants cannot join the scheme during the last two months of a target period. This means that all new entrant applications have to be processed by the administrator on or before the 31st October of every target period. Any new entrant applications which cannot be processed by this date will have to wait until start of next target period to be able to join the scheme.

The CCA scheme has 'Target calculator' workbook tool to calculate the target for the any site. The operators can use Novem methodology to calculate the target when a mix of products are produced in a site. In Novem method the energy used for the actual production in the target period is compared with the energy that would have been used if the same level of production and mix of products had been produced in the base year, but with the base year's level of energy efficiency. The procedure for the target calculation in Novem methodology is given below.

The baseline energy consumption of the site is calculated as,

$$\begin{pmatrix} Baseline\ energy \\ consumption \end{pmatrix} = \begin{pmatrix} Individual\ energy \\ consumption\ for\ product\ 1 \end{pmatrix} + \begin{pmatrix} Individual\ energy \\ consumption\ for\ product\ 2 \end{pmatrix} + \cdots n$$

The target year energy consumption of the site is calculated as,

$$\begin{pmatrix} Target\ year\ energy \\ consumption \end{pmatrix} = \begin{pmatrix} Individual\ energy \\ consumption\ for\ product\ 1 \end{pmatrix} \times \begin{pmatrix} percentage\ target\ of \\ product\ 1 \end{pmatrix} +$$

$$\begin{pmatrix} Individual\ energy \\ consumption\ for\ product\ 2 \end{pmatrix} \times \begin{pmatrix} percentage\ target\ of \\ product\ 2 \end{pmatrix} + \cdots n$$

The target energy reduction of the site is estimated as,

$$\begin{pmatrix} Target\ energy\ reduction \\ \% \end{pmatrix} = 1 - \left(\frac{Target\ year\ energy\ consumption}{Baseline\ year\ energy\ consumption}\right)$$

The actual energy reduction target for the site by Novem method is calculated as,

$$\begin{pmatrix} Actual\ energy\ reduction \\ in\ a\ facility, \% \end{pmatrix} = 1 - \left(\frac{Actual\ energy\ consumption\ in\ target\ year}{Baseline\ year\ energy\ consumption}\right)$$

The CCL discount will be given to the site if the actual energy reduction is greater than the target energy reduction in the target year.

6.5. Calculation of base year performance

Ideally the base year should be the continuous 12-month period from January to December 2008. If not, it should be the next available 12-month period starting during or after 2008. If the operator of a site isn't able to use 2008 as its base year, the operator will need to provide justification. If a structural change has occurred, then the 2008 base year should be reconstructed where possible.

A greenfield site is a special case. A site can apply to join the CCA scheme as a greenfield within 12 months of starting to undertake the eligible process. It will be given an agreement as soon as it is able to commence the collection of data necessary to establish a representative base year performance. This base year data must be complete and made available 12 months after the date of its agreement.

The baseline of the site is calculated in terms of absolute energy as given below:

$$\begin{pmatrix} Baseline\ energy \\ consumption \\ (kWh\ of\ fuel) \end{pmatrix} = \begin{pmatrix} Sum\ of\ primary\ energy\ from \\ fossil\ fuels\ used, electricity \\ and\ any\ other\ primary\ energy \\ associated\ with\ the\ activities \\ within\ the\ site \\ (kWh\ of\ fuel) \end{pmatrix} - \begin{pmatrix} Energy\ consumed\ by\ the \\ processes\ to\ carry\ out \\ activites\ for\ the \\ GHG\ reductions\ in \\ EU\ ETS\ scheme \\ (kWh\ of\ fuel) \end{pmatrix}$$

6.6. Emission calculation

The total number of units of carbon emitted from a target facility during a target period must be calculated by multiplying the units of energy consumed in each fuel used in the target facility during the relevant target period, by the relevant carbon emission factor set out for that fuel.

The total carbon emissions is calculated as,

$$Carbon\ emissions\ (kgC) = Total\ energy\ (kWh) \times carbon\ emission\ factor\ \left(\frac{kgC}{kWh}\right)$$

Figure A.3.7 depicts the procedure for giving CCL discount for achieving the energy reduction by an operator under the CCA scheme.

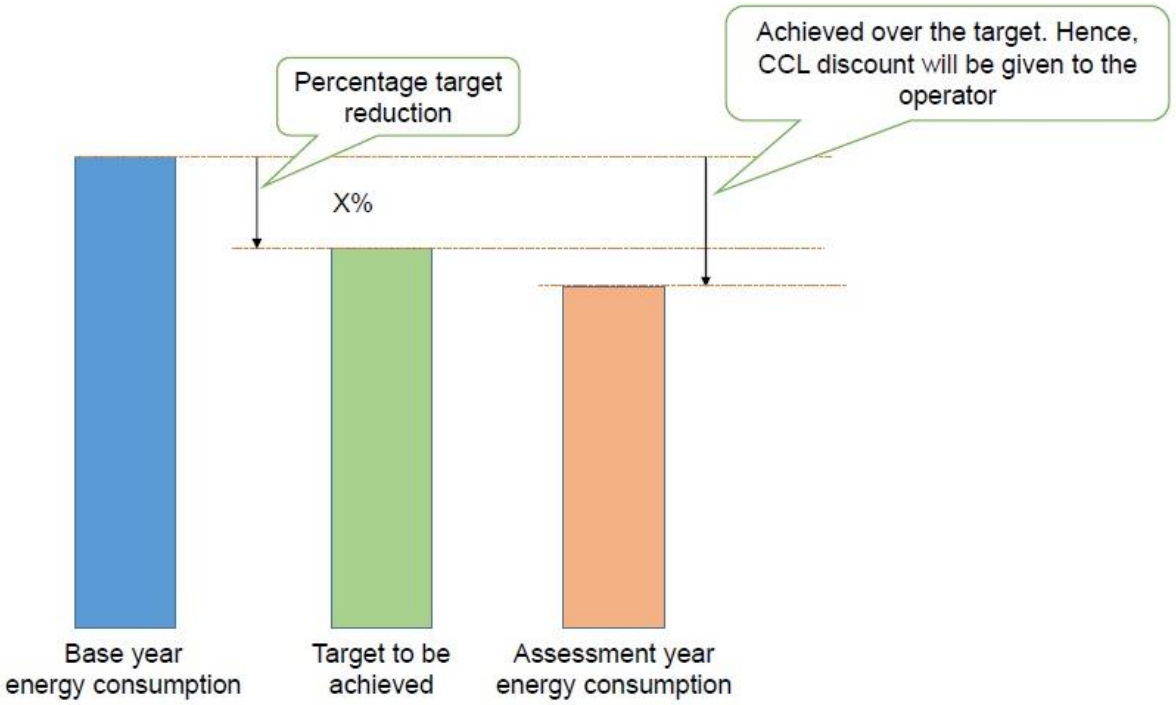


Figure A.3.7. Methodology for CCL discount for an operator

To enhance fairness and accountability, the compliance standards have been set at individual liability, meaning that the operator are required to meet their own targets in order to qualify for compliance, regardless of whether the sector as a whole has met its target or not.

7. Measurement, Reporting and Verification (MRV)

The CCA has set up rules and processes for monitoring and enforcement. At the end of each target period, energy consumption, production and other related data for every site of an operator must be reported through the online register. Audits on selected sites and sector associations are carried out to verify eligibility and performance. This selection of site is made by either a risk-based approach or random selection. The assessment may be desktop-based or a full-site audit.

A set of workbooks is available to assist the operators with the calculations needed for reporting and to present performance data in a standardized format. The reporting of all data for the target period is made through on-line registry and the individual site performance data are disclosed publicly.

The operators who meet or overachieve their target are automatically re-certified for the next certification period. Overachievement is converted into a carbon dioxide equivalent (CO_2e) which is banked on the register for that operator. This banked CO_2e can be used by the operator in the subsequent target periods to offset any underperformance.

An operator that does not achieve its target and cannot fill the gap between actual performance and target performance with previously banked CO_2e, will need to pay for re-certification.

There are also financial penalties for minor infringements, e.g., missed reporting deadlines or inaccuracies in data. For instance, if an operator fails to provide the request information by the

given deadline or fail to inform the government any changes as required by the underlying agreement, a penalty which is the amount of the greater of GBP 250 (EUR 278) or 10% of the annual value of its CCL discount would apply. Furthermore, if an operator provides inaccurate baseline data or target period data, the penalty is based on the extent of inaccuracy i.e., the greater of GBP 250 (EUR 278) or GBP 12 (EUR 14) per ton of CO_2 of the difference would apply.

8. Implementation status

The phase 1 of the scheme was for the period from 2001 till March 2013. The phase 2 of the scheme is being administered from 1 April 2013 until 31 March 2023.

When launched in 2001, the CCA scheme initially covered 44 sectors, around 12,000 sites (5,500 operators) and nearly 44% of total UK industry emissions. In the latest target period reported, 49 industrial sectors encompassing 7,814 sites were covered by the CCA, emitting approximately 25 million tCO_2e in the base year 2008.

The phase 2 of scheme applies to 51 sectors with around 4,300 operators covering some 9,900 sites. This phase 2 of CCA will lead to an energy efficiency improvement of 11% in the UK's major energy intensive industries by 2020. Targets widely vary across the industrial sectors ranging from 2% to 25%. Table A.3.2 shows the emission reductions from the baseline year in phase 1 and phase 2 of the program.

Table A.3.2. Reported emission reductions against baseline emissions

Target period	Emission reduction achieved (million tCO_2/y)
TP1, Phase 1	10.4
TP2, Phase 1	8.9
TP3, Phase 1	7.3
TP4, Phase 1	9.2
TP5, Phase 1	10.5
TP1, Phase 2	3.1
TP2, Phase 2	4.9

The Food and Drink (FDF) Federation's "Ambition 2025", initially launched in 2007, brought together businesses across the food and drink manufacturing sector to work together in reducing their environmental impact by promoting more efficient use of water, reducing packaging, embedding environmental standards in transport practices and eliminating food waste to landfill. Having met its 2020 target over five years early and reporting a 46% reduction in 2015 from a 1990 baseline, a new target of a reduction in emissions by 55% by 2025 against 1990 baseline

levels has now been set[15]. The Ambition 2025 seeks to continue its work and further improve resource efficiencies and address the wider sustainability agenda for the sector i.e., to de-carbonizing the whole food and drink value chain, from farms to manufacturers to consumers.

9. Lessons learnt

Following are the lessons learnt on implementation and operation of UK CCA for food sector:

- A stick and carrot approach: A unique feature that distinguishes the CCA from other voluntary climate policy instruments is its stick-and-carrot approach. Despite its participation being fully voluntary, the CCA is embedded in a broad policy package (i.e. with CCL), where the cost of not participating (i.e. paying full rate under CCL) is a clear, and provides a strong incentive to participate.

- Target structure and setting: Another creative feature of the CCA is its two-tier structure: the combination of sector targets and individual targets. Rather than relying on direct government-company interactions, the sector associations' involvement streamlines communication processes, enhance administrative efficiency and offer sector-specific expertise. Despite these positive effects, cautious attitude must be taken, especially regarding their role in the target negotiations and target setting because they could also play a lobbying role in protecting the companies under them (who wish to avoid 'environmental policy burdens').

- Clear MRV rules and timelines: The CCA has set up a system to monitor and assess target achievements and sanctions for non-compliance, including both disqualification of the levy discount for the following compliance period and financial penalties in case of minor infringements. Besides defining a clear timeline, rules and processes for monitoring and reporting, the government also makes the target assessment results transparent, which increases credibility and accountability. The technical support and service provided by a qualified third-party has proven as key for validating and verifying submitted data and information. In addition, the use of an electronic register further enhances administrative efficiency; reduces costs (for both administrator and participants) and improves the data quality checking process, i.e. automating some data consistency cross checks and identifying missing data.

- Simplification, streamlining and reducing policy overlap: As a policy that works with relatively broad base sectors and a large number of participants, it is important for the CCA to be continuously improved by simplifying, streamlining and addressing policy overlap. Some key examples are as follows:
  - Removing overlaps with the EU Emission Trading System (ETS) and the Carbon Reduction Commitment (CRC)[16];
  - Streamlining the content of agreements, baseline years (i.e., from different baseline year to a single baseline year) and administration (i.e. moving from BEIS to the EA, which already administrates EU ETS and the CRC);

- Effective enabling environment: Besides the 'stick-and-carrot' approach itself, mandatory carbon budgets provide a strong enabling environment for voluntary agreements to perform

[15] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/ 651970/food-and-drink-decarbonisation-action-plan.pdf

[16] The Carbon Reduction Commitment (CRC) scheme of UK is applicable to the organizations that have a half-hourly metered electricity consumption greater than 6,000 MWh per year.

more effectively. The Climate Change Act provides both a statutory long-term target (for 2050) and a set of statutory medium-term targets (over a period five years). It also assigns the Committee on Climate Change (CCC) to produce independent annual progress reports with details on whether or not the government is on track to stay under its carbon budgets. The reports are debated in Parliament and the government has a statutory obligation to respond. This creates a binding process to hold government to account not just to Parliament but to third parties and, potentially, to the courts (i.e. a judicial review).