Initiative for Climate Action Transparency (ICAT):

Improving Thailand's MRV System for Climate Change Mitigation

Final Report on MRV for the Building Sector - Annexes

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Initiative for Climate Action Transparency - ICAT -

Improving Thailand's MRV System for Climate Change Mitigation

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Annex 1. Green Mark Scheme for Buildings, Singapore

1. Introduction

As a resource constrained country, Singapore depends on the imported fuel for all of its energy needs. It has limited access to the renewable energy sources. Therefore, the energy efficiency forms a core part of its Clean Energy Strategy, which features a national target of greening at least 80 percent of its buildings by 2030. The main initiative under this building energy efficiency strategy is the Green Mark Scheme, a rating system to evaluate the environmental impact and the buildings performance based on the internationally-recognized best practices.

2. Key program features

Scope	All residential, commercial and industrial buildings
Mechanism	Issuance of certification based on the level of energy efficiency of a building in comparison with the benchmarked performance
Participation	Mandatory and supported with incentives
Performance benchmarking	Standards are updated and revised at regular intervals by the Building and Construction Authority (BCA) of Singapore
Certification validity	3 years
Monitoring, Reporting and Verification	Monitoring and annual reporting is done at facility level. The building performance must be verified by the third-party verification agency before issuance of certification

3. Legal framework

The building sector is well-regulated in Singapore. The Code for Environmental Sustainability of Buildings was first published in 2008 and adopted as the compliance standard under the Building Control (Environmental Sustainability) Regulations. It sets out the mandatory environmental sustainability standard providing a baseline to drive and integrate green building design into the mainstream building practices. The Code covers various key sustainability aspects delineated by the established Green Mark criteria framework including the energy efficiency, water efficiency, use of sustainable materials, waste reduction, sustainable construction, indoor environmental quality and use of other green features, practices and technologies. From 2008, all the new buildings and the existing buildings with the gross floor area (GFA) above 2000 m^2 that undergo major retrofitting works must meet the Green Mark Certification standard.

Under the Building Control Act 2012 Amendment, the annual submission of energy consumption data is also required via the Building Energy Submission System (BESS) online portal. These requirements were implemented in stages starting with the hotels, retail buildings and office buildings.

There is also an Energy Conservation Act enacted in 2013 which mandates the companies consuming more than 15 GWh of energy per year to:

- Appoint a trained Energy Manager

- Monitor and report energy use within the company
- Submit the energy efficiency improvement plans

In 2014, it became mandatory for the building owners to conduct periodic energy audits and achieve the minimum Green Mark certification when updating or retrofitting their cooling system.

4. Scheme design

The Singapore Green Mark Scheme was developed in January 2005 by the Building and Construction Authority (BCA) of Singapore and supported by the National Environment Agency (NEA) to build more environment-friendly buildings. It intends to promote sustainability in the building environment and raise environmental awareness among the developers, designers and builders to eventually deliver ‘‘healthier’’ products to end-users. It uses a benchmarking approach to achieve a sustainable building environment by incorporating the best practices in the environmental design & construction and the adoption of the green building technologies. Incentives (monetary and grant of additional floor area above Gross Plot Ratio (GPR)) are given to the developers/projects that meet the requirements of the Green Mark certification.

The scheme comprises a number of distinct rating tools which comprehensively rate a building for its environmental performance. The rating tool covers the following buildings types:
- New buildings: non-residential, residential, data centers and landed housing
- Existing buildings: non-residential, residential, data centers and schools
- User centric: office interior, retail, supermarket, restaurant and laboratories
- Beyond buildings: districts, parks and infrastructure

Figure A.1.1 provides the simple process flow of Green Mark scheme.

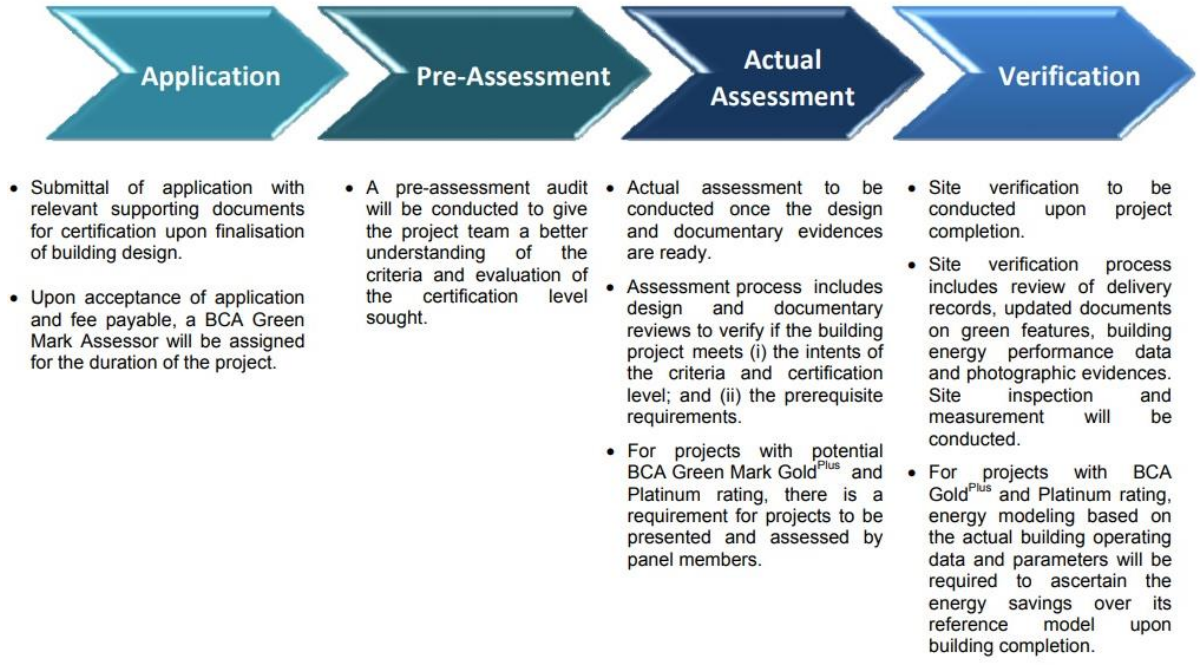

Figure A.1.1. Process flow of Green Mark scheme

The scheme rates the buildings according to five key criteria:
- Energy efficiency

- Water efficiency
- Environmental protection
- Indoor environmental quality
- Other green and innovative features that contribute to the better building performance

Based on the overall assessment, a building is awarded one of the following Green Mark certification based on the ratings:

- Green Mark Certificate (for rating from 50 to 74)
- Green Mark Gold (for rating from 75 to 84)
- Green Mark Gold Plus (for rating from 85 to 89)
- Green Mark Platinum (for rating from 90 and above)

The buildings are awarded a maximum of 140 points for the residential category and 190 points for the non-residential category. The scheme sets parameters and establishes indicators to guide the design, construction and operation of the buildings towards increased energy efficiency and enhanced environmental performance. Figure 2 represents the general schematic of green mark certification process.

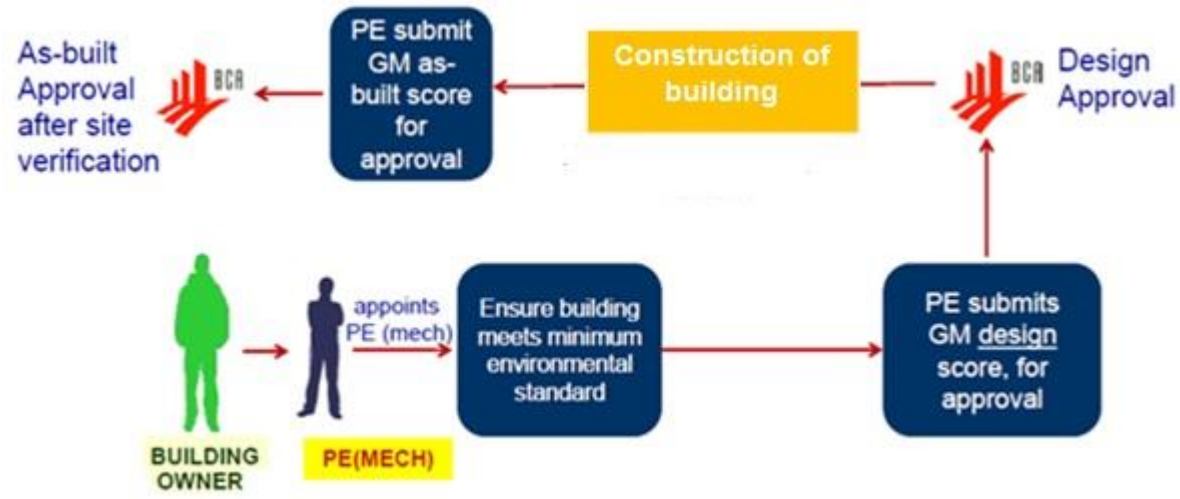

Figure A.1.2. Schematic of Green Mark certification process for buildings

Initially, the participation in the scheme was voluntary for the existing buildings in the private sector. However, a 2008 regulation requires all new buildings and all existing buildings undergoing major retrofitting to meet at least the minimum Green Mark standards. The public sector is held to higher requirements. All new public buildings must achieve Platinum rating and all existing public buildings must achieve Gold Plus rating by 2020. The achievement of higher Green Mark ratings is also a land-sales condition in key growth areas.

The certified Green Mark buildings are required to be re-assessed every three years to maintain the certification status. The new buildings certified are subsequently be re-assessed under the existing buildings criteria. Before the beginning of the assessment process, a project developer must submit an application form to the BCA. After that, the BCA team conducts a meeting with the project team to specify the criteria and request for the documentary proofs to substantiate the submissions. The actual assessment includes the design and the documentary reviews as well as the site verification. The documentary evidences should be submitted at the end of the assessment. When the assessment is fully completed, a letter of award (Certification) is sent to the project developer.

5. Incentive schemes

Several incentive schemes have been introduced particularly to encourage the private sectors to actively involve and support the green vision of Singapore. The SGD 20 million Green Mark Incentives Scheme for New Buildings (GMIS-NB) was initially introduced by the BCA in 2006, followed by a SGD 100 million Green Mark Incentives Scheme for Existing Building (GMIS-EB) as well as the Green Mark Incentives Scheme for Gross Floor Area (GM GFA) in 2009.

To encourage innovation in the green building development, the Green Mark Incentives Scheme for Design Prototype (GMIS-DP) worth SGD 5 million (≈ 3.65 million USD) was introduced in 2010. In 2011, the BCA implemented the Pilot Building Retrofit Energy Efficiency Financing (BREEF) Scheme. Another incentive scheme was then applied in 2014 for Existing Building and Premises (GMIS-EBP). These incentive schemes were one of the success factors of the green building implementation in Singapore encouraging the private sectors to participate and succeed in the green vision of the country.

6. Methodology

Under the Green Mark scheme, the building owners are required to provide basic building information such as the GFA, building activity and building systems. The electrical energy consumption data is obtained directly from the utility companies. The other data such as the fuel consumption, building information, etc., are submitted by the building owners. The following information are required under the mandatory submission of building information:

- Ownership and activity type (ownership, occupancy type, activity type, etc.)
- Building data (GFA, air-conditioning floor area, renovation/retrofitting works, etc.)
- Service information (lifts, air conditioning and mechanical ventilation (ACMV), lightings and hot water systems)
- Energy consumption (electricity, diesel, etc.)

The Building Energy Submission System (BESS) facilitates seamless data collection by drawing electricity data directly from the utilities. The building owners are only required to update any changes to the building information as they arise and review the energy consumption data prior to completing the submission. The building owners have to submit their energy consumption details every year through this online portal.

The electricity is the main source of energy used in Singapore buildings and the other energy sources were excluded in the computation of EUI. The EUI is measured by the total electricity used within a building in a year, expressed as kilowatt hour (kWh) per gross floor area (m^2).

$$Energy\ use\ intensity\ (EUI) = \frac{Total\ energy\ consumption\ (kWh)\ in\ a\ year\ y}{Gross\ floor\ area\ (m^2)}$$

Where,

Total energy consumption in a year y	=	Energy consumed by the building (excluding energy generated by the renewable energy sources)
Gross floor area	=	All covered floor areas of a building, except otherwise exempted and uncovered areas for commercial uses, are deemed the gross floor area

of the building. Generally, car parks are excluded from gross floor area computation.

The EUI is used as an index by the building owners and the facility managers to compare their building's annual energy performance against the similar building types. The total number of energy intensive buildings trended each year are updated to reflect the newly added buildings and the existing buildings that have completed major renovation. A study was conducted to compare the Green Mark certified building energy savings with the non-green mark buildings by the BCA. It found that the Green Mark buildings has less energy use intensity (EUI) than the non-Green Mark buildings and during 2008 to 2017, the annual electricity consumption of buildings has increased at a slower rate by 25%, compared with the growth of the GFA at 40%. However, the EUI of energy intensive buildings have improved to 11% over these period.

7. Measurement, reporting and verification (MRV)

The MRV of the building performance are set within the certification process of the program. The three key elements in the Green Mark certification of the existing buildings and the MRV involved are detailed as below.

7.1. Minimum Green Mark Certification standard for the buildings with GFA of at least 15,000m^2

Figure 5 provides the schematic of certification process for the existing buildings that renovates the chiller unit.

Figure A.1.3. Schematic of Green Mark certification process for existing building that renovates the chiller unit

The building owners are required to meet the minimum environmental sustainability standard at the time of construction or installation of chiller units. They must engage a Professional Mechanical Engineer (PE) registered with the BCA to carry out an evaluation of their building design in accordance with the prescribed code and submit the necessary documents to the BCA. The BCA will provide a design approval to continue with the construction or installation. Once the works are complete, the application must be submitted with the PE assessment of final building to the BCA for review and issuance of the Green Mark certification.

7.2. Three-yearly energy audit on the building cooling system for the buildings with GFA of at least 15,000 m^2

Figure 6 shows the schematic of three yearly energy audit process.

The building owners must engage a PE or an Energy Auditor registered with the BCA to carry out an energy audit on their premises in accordance with the prescribed code and submit the necessary documents to the BCA. This is to ensure that a building cooling system continues to operate efficiently and comply with the minimum standards throughout its lifetime.

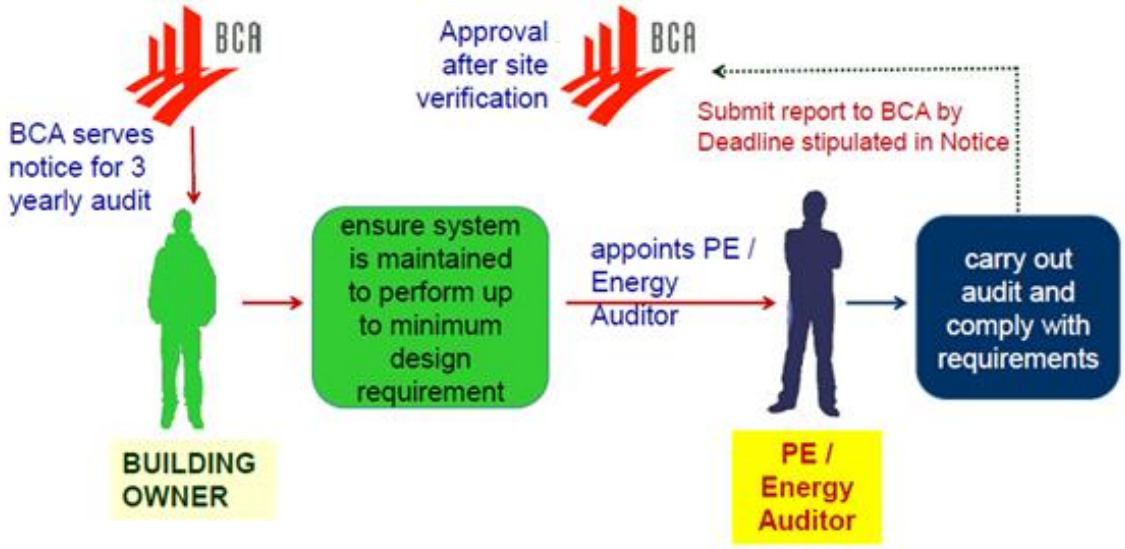

Figure A.1.4. Schematic of three yearly audit process

7.3. Annual mandatory submission of the building information and energy consumption data

The building owners must submit the building information and energy consumption data annually through an online submission portal. The submitted data forms the basis of the national building energy benchmarks, which is shared with the building owners to encourage them to improve the energy performance of their buildings. The Building Energy Submission System (BESS) facilitates data collection by drawing electricity consumption data directly from the power supplying units. The building owners are only required to update any changes to the building information as they arise and review the energy consumption data prior to completing the submission. The BESS also includes access to downloadable self-help tools such as a user submission manual, technical guides and training and demonstration videos.

At the close of the submission period, the data collected through the BESS is checked for any inconsistencies or data entry errors. Once all the data has been verified, the national energy benchmarks for the commercial buildings are carried out and the findings are shared with the building owners via the BESS and the BCA Building Energy Benchmarking Report (BEBR).

It must be noted that a security deposit of 50% of the market value of the allowable GFA is retained by the BCA upon application of the GFA incentive and there are significant financial penalties for failing to achieve the agreed level of compliance, which may exceed the security deposit value.

The BCA has focused training programs aimed at equipping professionals with new skills, to deepen their professional skills and expertise in the area of environmental sustainability. These include the Certification courses for the Green Mark Managers (GMM), the Green Mark Facility Managers (GMFM) and the Green Mark Professionals (GMP).

8. Implementation status

The Green Mark scheme was launched in 2005 to rate the environmental sustainability of buildings. Since then, it has evolved to cover 17 different types of buildings such as data centers, retail outlets, supermarkets, parks, homes and offices. Table 3 provides the list of different building types considered for Green Mark certification.

Table A.1.1. Green Mark categories

Building type	Categories
New buildings	• New non-residential Buildings • New residential Buildings • Landed houses
Existing buildings	• Existing non-residential Buildings • Existing residential buildings • Existing schools
Within buildings	• Office Interior • Restaurants • Retail Outlets • Supermarket • Data Centers
Beyond buildings	• Existing parks • New parks • Infrastructures e.g. barrages, bridges, road construction etc. • Rapid Transit Systems (RTS) • Districts e.g. improving energy efficiency in district cooling, heating, waste management etc.

As of July 2018, more than 3,300 buildings or 36% of the buildings by gross floor area have achieved Green Mark standards[1]. This scheme has also been adopted outside of Singapore with certified projects in Indonesia, Malaysia, Thailand and China. To date, close to 50

[1] Super low energy technology road map, BCA, 2018

Singapore-based firms are involved in over 300 overseas Green Mark projects in 14 countries[2].

9. Lessons learnt

Starting with a strong commitment from the policy maker to set and achieve the green vision, the BCA has been endorsed and fully supported by the NEA to develop and manage the Green Mark scheme.

- Public sector leading the change: The public sector took the lead and provided good examples in greening both the new and existing public sector buildings. The government is very active in trying to forge interaction among the various stakeholders. In the process of refreshing its master plan and legislation, BCA calls upon an international panel of experts to provide their feedback and engages stakeholders through consultation sessions to review their plans and standards.

- Strong incentive schemes for the private sector: The Government provides incentive schemes to encourage the private sectors to green their new and existing buildings. The government also provides adequate support for the green building research and trainings in raising 'green' awareness among the public and the industry.

- Green building features are still expensive: The high cost of a green building is related to provisions of green materials and technology which typically cost more than the conventional ones. The tenants of a green building are seen to have more benefits compared to the builder who have to fork out the premium costs. The lack of information of green products, system and technologies put the builders in difficult position to execute a green building.

- Difficulty in coping up with the rapid technology changes: As the codes and regulations of the green buildings are getting more complex, the builders find difficulties in estimating the costs to comply with the codes and regulation. The use of materials which are not environmentally friendly by local contractors is still found in practice. The public awareness of the latest technologies and benefits of green buildings is also found insufficient.

Applicability for Thailand

The certificate has validity 3-year period with annual mandatory submission of the building information and energy consumption data. Thus, the validity period could apply for BEC building in Thailand as well as mandatory submission on building information.

[2] https://www.bca.gov.sg/newsroom/others/PR_GMA2018.pdf

Annex 2. Energy Star Program for Buildings, United States of America (USA)

1. Introduction

The Energy Star is a voluntary program which was initiated by the United States Environmental Protection Agency (EPA) in 1992 to drive the economy towards an energy efficient and cost -effective path. Initially, the program started with star labelling of energy efficient products and over the years was expanded to include all major appliances, office equipment, lighting, home electronics, new homes and commercial & industrial buildings and manufacturing plants. Through its Energy Star label, the program provides a simple, credible and unbiased product information to the end users for decision making.

2. Key program features

Scope	All major appliances, office equipment, lighting, home electronics, new homes and commercial & industrial buildings and manufacturing plants
Mechanism	Issuance of certification based on the level of energy efficiency of a product or building in comparison with the benchmarked performance
Participation	Voluntary
Performance benchmarking	Revised every four years with the latest data to compare the product or buildings energy performance
Certification validity	12 months
Monitoring, Reporting and Verification	Monitoring and reporting is done at the facility level. The product or building performance must be verified by the third-party verification agency before issuance of certification

3. Legal framework

The Energy Star program was established by the EPA under the Clean Air Act, 1963 which was amended in 1977. In 1993, the EPA piloted the Energy Star Buildings program with 23 building owners to showcase an approach. Later in 2005, the Energy Policy Act directed the EPA and the Department of Energy (DoE) to implement a voluntary program to identify and promote energy efficient products and buildings in order to reduce the energy consumption, improve energy security and reduce pollution.

The regulation mandates use of Energy Star labelled products such as the lighting fixtures and the bulbs in all the federal buildings and the procurement of energy efficient appliances for installations in the public housing. All federally owned buildings are required to track and report their energy use under the Energy Star program. Also, the federal agencies may not lease space in any building that has not earned the Energy Star label in the most recent year.

Countries like Canada, Japan, Iceland, Liechtenstein, Norway, Switzerland and Taiwan have included the Energy Star standards in their own policies through the formal agreements with the EPA.

4. Scheme design

Figure A.2.1 shows the simple schematic of the Energy star certification.

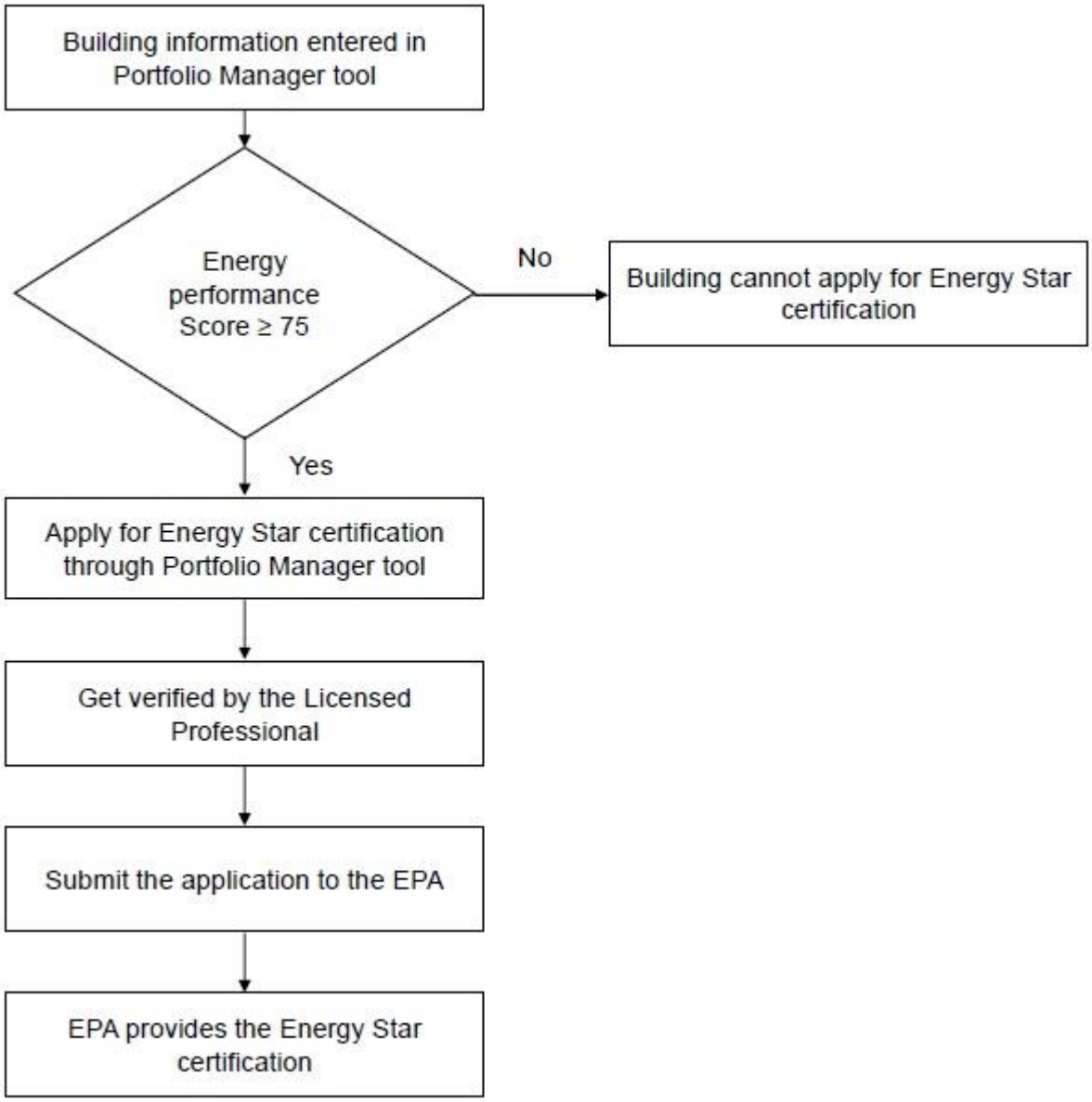

Figure A.2.1. Schematic of Energy Star certification

The Energy Star program is intended to promote sustainability in the building environment and raise environmental awareness among the developers, designers and builders and eventually deliver ‘‘healthier’’ products to the end-users.

The energy performance score system of the program provides the building managers a standardized, comparable metric for improving the building energy efficiency. The building managers need to enter the building operating characteristics and a year of utility bills into the EPA’s online benchmarking tool - Portfolio Manager, to receive a 1-to-100 score indicating

how the building compares to similar buildings nationwide. A score of 75 or higher is eligible to earn the Energy Star certification.

The Portfolio Manager tool obtains the energy consumption data of the buildings from the energy service providers over the web services directly. It helps to measure and track the energy use, water use and GHG emissions of the buildings through online. It can also be used to identify under-performing buildings, set investment priorities, verify efficiency improvements and receive the Energy Star certification.

The Energy Information Administration (EIA) under the Department of Energy conducts a nationwide survey to gather data on the building characteristics and the energy use from thousands of buildings for every four years. This Commercial Building Energy Consumption Survey (CBECS) is the only national-level source of data on the characteristics and energy use of the commercial buildings. The Portfolio Manager tool compares the individual building performance against this building survey performance benchmarks and provides the score for that respective building.

The energy performance scores are available for 15 different types of buildings a listed below representing over 50% of the commercial building space in the US.

- Bank/Financial institution
- Courthouse
- Data centers
- Hospital
- Hotel
- House of worship
- School
- Medical office
- Municipal wastewater treatment plant
- Office
- Residence hall/Dormitory
- Retail store
- Senior care
- Supermarket
- Warehouse

Once the building is registered in the Portfolio Manager tool, the following steps are used to compute the score for a building:

i. Computation of actual source EUI
ii. Computation of the predicted source EUI
iii. Computation of the efficiency ratio comparing the actual EUI with the predicted EUI
iv. Assigning the score based on how the ratio compares with the national performance benchmarks

5. Incentive schemes

A tax deduction of up to USD 1.80 per square foot is available to the owners or designers of the commercial buildings or systems that save at least 50% of the heating and cooling energy

as compared to that of the ASHRAE Standard 90.1-2007[3]. The deduction is available for the buildings or systems placed in service before December 31, 2017.

The Federal Energy Policy Act of 2005 established tax credits of up to USD 2,000 for the builders of new energy-efficient residential buildings. However, this tax credit was stopped in December 2017.

6. Methodology

The commercial buildings consume energy from different sources such as electricity, natural gas, fuel oil, district steam and many others. The energy consumption at the site is the net energy use which does not include the generation efficiency and transmission/distribution losses occurred during the conversion from the primary source energy. To evaluate energy performance for these buildings, the source energy is the most equitable unit of evaluation and enables a complete assessment of the energy efficiency. The Energy Star program considers only the primary energy (source energy) of the buildings for the performance evaluation.

The main aim of the Energy Star program is to provide comparisons of the building EE relative to a national peer group and therefore it is more appropriate to employ the national-level source-site ratios. As the Portfolio Manager tool is available in both the United States and Canada, country-specific source-site ratios are used. For each country, there is only one national source-site ratio for each of the primary and secondary fuels in the Portfolio Manager tool, including the grid purchases of electricity.

The source-site ratios computed and applied in the Portfolio Manager tool depends on several characteristics including the quality of the fuels, the average efficiency of conversion from primary to secondary energy and the distribution efficiency. Therefore, the ratios are expected to change in due course of time as the national infrastructure and fuel mix evolve. The characteristics that impact the ratios do not change drastically from one year to the next ,but may be expected to change over time. Therefore, the ratios for all fuels are reviewed every three to five years and updated accordingly. Additionally, the specific ratios may be updated as needed to reflect new information, methodologies or policies.

6.1. Source-site ratio for different primary and secondary energy use

Electricity from grid

The source-site ratio for the grid electricity is calculated from the Energy Information Administration's (EIA) Monthly Energy Review (MER). The MER report includes the information about the electricity generation in the US from the fossil fuels, nuclear and the renewable energy systems. The source-site ratio for the grid electricity is calculated as follows:

$$Source - site\ ratio = \frac{Total\ energy\ consumed\ in\ the\ electricity\ generation}{Net\ electricity\ generation - Transmission\ and\ distribution\ lossses}$$

The source-site ratio can be calculated separately for any given year and the average of past five years of source-site ratio is considered for the estimation.

Electricity from the renewable sources

[3] The American Society of Heating, Refrigerating and Air-Conditioning Engineers

The electricity generated from the renewable energy sources such as solar photovoltaic panels, wind turbines, etc., at the building site are considered as a secondary form of energy. There is no conversion loss from these renewable energy sources, because electricity is derived from the sun or the wind directly. In addition, as the electricity is converted on-site, there are no transmission or distribution losses too. Hence, the source-site ratio for the on-site solar or wind electricity is considered as 1.0.

Wood

Wood is a type of primary energy that is combusted on site to produce heat and/or electricity. There is no transmission or distribution losses associated with the delivery of wood to a site. Therefore, the source-site ratio for wood is considered as 1.0.

Coal

Coal is a type of primary energy that is burned on-site to produce heat and/or electricity. There is no direct quantifiable loss of coal that occurs when it is stored, transported or delivered to a building. Therefore, the source-site ratio for coal is taken as 1.0.

Natural gas

The EIA publishes an annual report on the natural gas energy generation and consumption, losses occurred in the pipeline, etc. The source-site ratio is calculated from the data published in the annual report. The source-site ratio accounts the losses incurred in pipeline transmission and distribution of natural gas from the provider to the customer. This source-site ratio indicates the total amount of gas that is used at the distribution plant or lost in transmission for each unit of gas that is delivered to a consumer. The source-site ratio for the natural gas is calculated as follows:

$$Source - site\ ratio = \frac{\binom{Gas\ delivered\ to}{the\ customer} + \binom{Gas\ consumed\ at\ the\ plant}{and\ at\ pipeline\ distribution}}{Gas\ delivered\ to\ the\ customer}$$

Petroleum products

The petroleum products include the fuel oil, diesel and kerosene. The source-site ratio takes into account the losses incurred in fuel distribution, storage and dispensing. The EIA does not produce an annual report that quantifies the losses associated with the fuel oil distribution, storage and dispensing. A Lifecycle Emissions Study (LEM) conducted by the University of California is considered for the source-site ratio calculation.

The LEM study identified that for every 100 units of oil use by end consumer, the distribution and storage losses is around 0.8 units and losses in the fuel dispensing is around 0.2 units. Thus, the source-site ratio for petroleum products is considered as 1.01 (i.e., (100+0.8+0.2) /100)

District steam

The district steam is a type of secondary energy that is generated off-site and delivered to a building. The district steam is generated using both the conventional boiler technology and the combined heat and power (CHP) technology. Both systems are incorporated into the source-site ratio to accurately reflect the steam market. Properties of district systems, including ranges

for the production and distribution efficiencies are taken from “District Energy Services: Commercial Data Analysis for EIA’s National Energy Modelling System” report.

In the case of conventional boiler steam generation, the source-site ratio is calculated as follows.

The boiler efficiency at full load condition is calculated as,

$$Boiler\ efficiency_{\ full\ load\ condition} = \begin{pmatrix} Average\ of\ the\ typical\ boiler\ efficiency \\ range\ taken\ from\ the\ EIA\ report \end{pmatrix}$$

The boiler efficiency at part load condition is calculated as,

$$Boiler\ efficiency_{\ part\ load\ condition} = \begin{pmatrix} Maximum\ boiler\ efficiency\ at\ part\ load \\ condition\ taken\ from\ EIA\ report \end{pmatrix}$$

Based on the boiler efficiency at full load and part load condition, the production efficiency is calculated as,

$$\begin{pmatrix} Production \\ efficiency \\ (\%) \end{pmatrix} = \\ \left(Boiler\ efficiency_{\ full\ load\ condition}\right) X \left(Boiler\ efficiency_{\ part\ load\ condition}\right)$$

The heat losses from the boiler are taken from the EIA report.

$$\begin{pmatrix} Heat\ losses \\ from\ the\ boiler\ (\%) \end{pmatrix} = \begin{pmatrix} Average\ of\ the\ typical\ boiler\ losses \\ range\ taken\ from\ the\ EIA\ report \end{pmatrix}$$

Accordingly, the overall efficiency of boiler system is calculated as,

$$\begin{pmatrix} Efficiency\ after\ heat\ losses \\ from\ the\ boiler\ (\%) \end{pmatrix} = \begin{pmatrix} Production \\ efficiency\ (\%) \end{pmatrix} - \begin{pmatrix} Heat\ losses\ from\ the\ boiler\ (\%) \\ \times \\ Production\ efficiency\ (\%) \end{pmatrix}$$

From above parameter, the source-site ratio is calculated as,

$$Source - site\ ratio = \frac{1}{Efficiency\ after\ heat\ losses\ from\ the\ boiler\ (\%)}$$

In the case of the CHP steam generation, a separate nation-wide study was conducted by the EIA. It is found that the average CHP district system produces 33.2 units of steam and 25.6 units of electricity for every 100 units of input energy. This is equivalent to a system-wide conversion efficiency of 59%.

$$Conversion\ efficiency = \frac{Steam\ and\ electricity\ output}{Total\ input\ energy}$$

The input for the steam in CHP technology is compared with the conventional boiler system to produce the same amount of steam. The ratio of the steam input to the total input for the traditional systems is multiplied by the total CHP input energy of 100 units to get the input energy associated with steam generation for the CHP system.

For example, assuming a conversion efficiency of 82.5% for traditional steam and 32% for traditional electricity, 40.2 units of input energy would be needed to produce the same amount of steam and 80.0 units of input energy would be needed to produce the same amount of electricity in the CHP system. Then, the total input energy for the traditional systems would be 120.2. The percent breakdown in the input energy for the traditional systems can be used to equitably divide CHP input energy between the steam and electricity. The ratio of the steam input to total input for the traditional systems (40.2 units / 120.2 units = 33.5%) can be multiplied by the total CHP input energy of 100 units to get the input energy associated with steam generation for the CHP system of 33.5.

The production efficiency is calculated as,

$$\begin{pmatrix} Production \\ efficiency \end{pmatrix} = \frac{Steam\ output\ from\ the\ CHP}{Input\ energy\ for\ steam\ generation\ in\ CHP} = \frac{33.2}{33.5} = 99.2\%$$

Accordingly, the overall efficiency of boiler system is calculated as,

$$\begin{pmatrix} Efficiency\ after\ heat\ losses \\ from\ the\ boiler\ (\%) \end{pmatrix} = \begin{pmatrix} Production \\ efficiency \\ (\%) \end{pmatrix} - \begin{pmatrix} Heat\ losses\ from\ the\ boiler\ (\%) \\ \times \\ Production\ efficiency\ (\%) \end{pmatrix}$$

The source-site ratio for the CHP system from the production efficiency is calculated from the formulae similar to the conventional boiler system as mentioned below.

$$Source - site\ ratio = \frac{1}{Efficiency\ after\ heat\ losses\ from\ the\ boiler}$$

At the national level, the district steam source-site ratio is calculated by the weighted average of the CHP and non-CHP ratios found using the above mentioned formulae.

Other fuels/energy sources

The Portfolio Manager tool includes the source-site ratio for many types of fuels, each of which falls into one of the preceding categories. In the event that a building using a different fuel on-site (e.g., waste biomass), then a user may select the “Other” category. In these situations, because the primary fuel source is not reported, it is not possible to quantify losses associated with conversion, transportation or distribution. Hence, the source-site ratio is considered as 1.0.

6.2. Energy Use Intensity (EUI)

The building energy consumption is estimated using the source-site ratio in the Portfolio Manager tool. The building owners enter the secondary energy consumption data which is converted into the primary energy form in the Portfolio Manager tool. The Portfolio manager tool presents the total primary energy consumption of the building to the owners which makes them aware and encourages them to further improve the building energy efficiency.

The total primary energy consumption in the building is given as,

$$\begin{pmatrix} Total\ primary\ energy \\ consumption\ in \\ the\ building \end{pmatrix} = \left(\begin{array}{l} \left(\begin{pmatrix} Energy\ consumed \\ from\ the\ fuel\ type\ 1 \\ in\ the\ building \end{pmatrix} \times \begin{pmatrix} Source - site\ ratio \\ of\ fuel\ type\ 1 \end{pmatrix} \right) \\ + \\ \left(\begin{pmatrix} Energy\ consumed \\ from\ the\ fuel\ type\ 2 \\ in\ the\ building \end{pmatrix} \times \begin{pmatrix} Source - site\ ratio \\ of\ fuel\ type\ 2 \end{pmatrix} \right) \\ + \\ \ldots \end{array} \right)$$

The performance of the buildings is presented in terms of Energy Use Intensity (EUI). The EUI is measured by the total energy consumed within a building in a year (measured in kBtu or GJ) per gross floor area (ft^2). For the purpose of benchmarking, the EUI is used as an index for the building owners and the facility managers to compare their building's annual energy performance against similar building types.

The EUI is calculated as,

$$Energy\ use\ intensity\ (EUI) = \frac{Total\ energy\ consumption\ (kBtu\ or\ GJ)\ in\ a\ year\ y}{Gross\ floor\ area\ (ft^2)}$$

Where,

Total energy consumption in a year y	=	Sum of all source energy consumed by the building, kBtu or GJ
Gross floor area	=	All covered floor space, ft^2 (whether within or outside a building and whether or not enclosed) measured between party walls including the thickness of external walls (excluding the areas such as exterior spaces, balconies, decks, terrace, exterior loading docks, driveways covered walkways, outdoor courts and parking)

7. Measurement, Reporting and Verification (MRV)

To qualify for the Energy Star certification, a building should be benchmarked in the Portfolio Manager tool and achieve a score of 75 or higher accounting for all its energy use. If the building achieves the score of 75 or higher, the owner can apply for the Energy Star certification through the Portfolio Manager tool.

The owner must engage a Licensed Professional (LP) who is accredited by the EPA. The LP makes a site visit and verifies the information provided in the application. Once the verification process is complete, the owner has to upload the LP signed application form in the Portfolio Manager tool and submit it to the EPA. The EPA reviews the application and provides the Energy Star certification to the building.

The Energy Star certification is valid for 12 months and the buildings will be notified before the certification gets expired. The buildings must undergo the same procedure as mentioned above whenever it has to get the certification.

The following documents can be generated from the Portfolio Manager tool which summarizes the important energy information and building characteristics. These documents will provide transparency and accountability to demonstrate strategic use of funding and the energy savings for an individual building.

- Statement of energy performance
- Energy Star scorecard
- Progress & goals report
- Data verification checklist
- Statement of energy design intent

8. Implementation status[4]

Since 1992, the Energy Star program (including Energy Star products, Energy Star for commercial, residential buildings and industrial plants) helped US to save more than USD 450 billion and over 3.5 trillion kilowatt-hours of electricity while also achieving broad emission reductions through this voluntary action.

For commercial buildings

The Energy Star program for the commercial buildings helped the businesses and organizations save nearly USD 10 billion in energy costs in 2016, contributing to cumulative energy cost savings of over USD 150 billion since 1992. Most of the commercial buildings use EPA's Energy Star Portfolio Manager tool to measure, track, assess and report on their energy and water consumption.

More than 9,500 buildings earned the Energy Star certification in 2017, bringing the total to more than 32,000. On an average, the Energy Star certified buildings use 35% less energy than typical buildings nationwide.

Studies found that Energy Star certified buildings command a premium of up to 16 percent for the sales prices and rental rates. At the end of 2018, 29 local governments, three states and one Canadian province rely on the EPA's Energy Star Portfolio Manager tool as the foundation for their energy benchmarking and transparent policies.

For new and existing residential buildings

The Energy Star certified new residential buildings program helped homeowners save USD 360 million in energy costs in 2016, contributing to the cumulative energy cost savings of USD 3.1 billion since 1995. More than 100,000 Energy Star certified single-family and multifamily residential buildings were built in 2017 alone with for a total of nearly 1.9 million houses certified since 1995.

As of 2017, nearly 90% of the US top homebuilders build Energy Star certified homes. One out of every 10 single-family residential buildings in 2017 was Energy Star certified. The Energy Star certified buildings are at least 10% more energy efficient than the buildings built to code and achieve a 20% improvement on average, while providing homeowners with better quality, performance, and comfort. The Home Performance program which was managed by the corporate sponsors/organizations with Energy Star program completed 91,000 energy efficiency improvement projects on the existing buildings in 2017.

[4] https://www.energystar.gov/about/origins_mission/energy_star_numbers

9. Lessons learnt

The key lessons learnt from the program implementation are:

- Interactive support in data reporting and analysis: The Portfolio Manager tool is one the key success factor for the US Energy Star program. It provides a direct user interface for the building owners to input and analyze the energy performances. The tool can be used to compare one building against itself over time, compare one building against a national sample of similar buildings. It can be also used to set priorities and targets for the use of limited resources or investment capital. Over the period, the tool has evolved as the industry standard for analysis of energy performance. Importantly, all of the EPA's tools and resources under the program, including Portfolio Manager, are free to use.

- Revision of benchmarks in line with the rapid technology changes: The revision of benchmark standards once in every three to five years through national level survey is another a success factor since it provides greater flexibility for revisions to occur quickly without waiting for the minimum standards to be revised. This flexibility to revise benchmark performance ensures that the program adapts and accurately reflects the quickly changing markets and increasing penetration of energy efficient technologies.

- Rigorous accreditation procedures for the third party verifiers: The use of third-party verification partners help the EPA guarantee the integrity of compliance reports without needing to dedicate significant government resources to support implementation and enforcement. The program has very stringent accreditation requirements which ensure the quality and capabilities of third-party verification partners.

- Increasing participation by building awareness and market confidence: Though the participation is voluntary, more and more buildings have opted for the Energy Star certification due to the awareness created and the market competition for the energy efficient buildings. A study conducted by the EPA confirms that the Energy Star certified buildings are at least 20% more energy efficient than the ordinary buildings. The purchasers of Energy Star certified buildings are more likely to recognize and pay the increased building value resulting from the decreased energy use and increased net operating income.

Applicability for Thailand

The certificate has validity 12-month period, meaning that the building must submit all required information and energy consumption every year for renew the certificate. Thus, the validity period could apply for BEC building in Thailand as it has not been clear yet.

Annex 3. Tokyo Emission Trading Scheme, Japan

1. Introduction

The Tokyo Metropolitan Government (TMG) launched the Tokyo Emission Trading Scheme (ETS) in 2010 as an initiative to reduce the GHG emissions and mitigate the risks of climate change. This program is not only the first cap-and-trade scheme in Japan, but also the world's first urban cap-and-trade scheme which specifically targets large facilities of the commercial sector. The commercial and residential buildings in Tokyo city accounted for more than 72% of the energy-induced CO_2 emissions in 2013[5].

2. Key program features

Scope	All the energy intensive commercial and industrial facilities within the jurisdiction of Tokyo city
Mechanism	Cap and trade the emission allowances similar to the European Union Emission Trading Scheme (EU ETS)
Participation	Mandatory for commercial and industrial facilities with the annual energy consumption above a set threshold limit
Target setting	Each participating facility is provided with a GHG reduction target (allowance) - in fixed percentage unit from its baseline emission 1st compliance period: 8% or 6% reduction below base-year emissions 2nd compliance period: 17% or 15% reduction below base-year emissions 3rd compliance period: 27% or 25% reduction below base-year emissions 4th compliance period: 35% (tentative) reduction below base-year emissions
Target period	5 years, with the progress reported at the end of each financial year 1st compliance period: Year 2010 to 2014 2nd compliance period: Year 2015 to 2019 3rd compliance period: Year 2020 to 2024 4th compliance period: Year 2025 to 2029
Measurement, Reporting and Verification	Measurement and reporting is done at the facility level. Emission reduction must be verified by a third party verification agency before issuance of credits
Penalties	Any non-compliance of targets or misconducts in reporting will lead to imposition of penalties

3. Legal framework

[5] Urban Efficiency II, Seven Innovative City Programmes for Existing Building Energy Efficiency, C40 cities and TMG

In 2002, the TMG launched the “Tokyo Carbon reduction reporting program for the large-scale buildings and businesses in the industrial and commercial sectors”. Under this program, the large facilities have to mandatorily report their emissions and potential emission reduction plans to the TMG. However, the implementation of emission reduction plan was kept voluntary.

In 2006, the TMG set a target to reduce emissions to 25% below 2000 levels by 2020[6]. The Tokyo Climate Change Strategy and Tokyo Metropolitan Environment Master Plan were passed in 2007 to set a framework for achieving this target. Based on the framework, the cap-and-trade (or emission trading scheme) system was launched in 2010 enforcing the mandatory GHG emission reduction by the large facilities.

In parallel, the “Tokyo’s carbon reduction reporting program for the small and medium facilities” was launched in 2010, which mandates the commercial buildings and other facilities to report their emissions (but the emission reduction is voluntary).

4. Scheme design

Figure A.3.1 shows the schematic for the issuance of credits in this program.

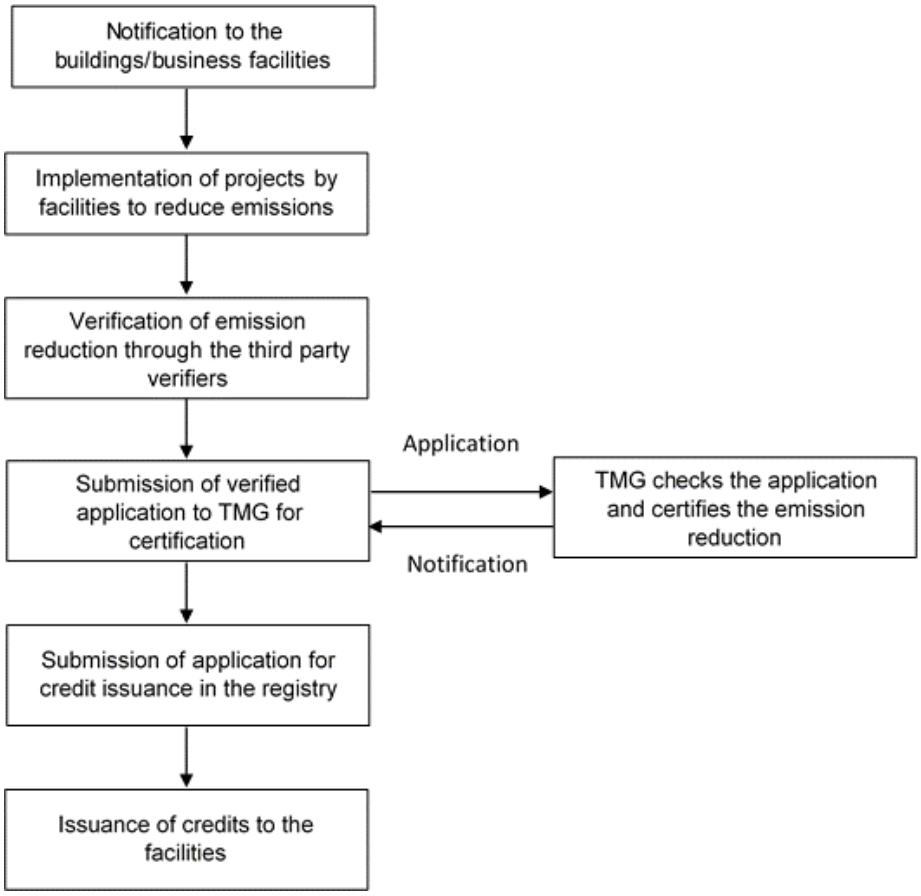

Figure A.3.1. Schematic of Tokyo Emission Trading Scheme

Based on the energy usage data submitted by the facilities covered under the “Tokyo carbon reduction reporting program for the large facilities” at the end of March 2010, a total of 1,332 facilities were designated and subjected to the mandatory emission reduction under the ETS.

[6] Tokyo Cap and Trade Program, Bureau of Environment, TMG

The scheme envisages to cap emissions at 10.44 million tCO_2 in 2020 out of which 9.7 million tCO_2 is expected from the existing facilities and the remaining is assigned for the new entrants.

The scheme is based on absolute cap set at the facility-level. It is composed of two five-year compliance periods, with first compliance period spanning from 2010 to 2014 and the second compliance period from 2015 to 2019. The base year emission is the average CO_2 emissions from any three consecutive years between 2002 and 2007 that a covered facility selects.
First compliance period (2010-14): The scheme set two different emission reduction targets (compliance factors) among the covered facilities. A target of 8% GHG reduction is set for the office buildings, district heating and cooling plants. A target of 6% GHG reduction is set for facilities that use at least 20% of their energy from the district heating and cooling plants, factories, water and sewage facilities and waste processing facilities.

Second compliance period (2015-19): In this compliance period, a target of 17% GHG reduction is set for the commercial buildings, district heating and cooling plants and 15% is set for the facilities that consume at least 20% of their energy from the district heating and cooling plants.

The TMG plans to roll out the third compliance period from 2020 – 2022. The target for this compliance period is yet to be determined.

The business facilities/buildings are notified by the TMG to participate in the ETS. Upon notification, the facilities calculate the baseline emissions from any of the three consecutive financial years from 2002 to 2007. The facilities must implement projects to reduce the emissions from the baseline. The emission reduction are estimated for each financial year and verified by engaging a third party verification agency. The verified application is submitted to the TMG for approval through the registry. Once the TMG checks and approves the application, credits will be issued to the facilities.

Threshold limit

The large-scale facilities such as the commercial buildings, industrial facilities, waste processing units, etc., that consume ≥ 1,500 kl of crude oil equivalent (COE) annually, must submit five-year emission reduction plans and annual progress reports.

The medium/small-scale energy intensive facilities must submit an annual energy efficiency report if they belong to a corporation that annually consumes over 3,000 kl of COE. However, the emission reductions are not mandatory for such facilities.

A facility may leave the ETS if its energy consumption from the previous year is below 1,000 kl of COE or if the energy consumption from the three prior years is below 1,500 kl of COE or if the installation is shut down or suspended. More than 100 facilities have left the program after reducing emissions below the threshold. As of January 2015, 1,232 facilities had obligations to report their emission reductions under the ETS.

For large facilities

The ETS covers 40% of the industrial and commercial sectors' CO_2 emissions, which equates to 20% of all of Tokyo's CO_2 emissions[7]. The ETS covers both indirect and direct CO_2 emissions from the energy use (electricity, heavy oil, heat and other fuel). The ETS regulates at the facility level which includes office buildings, commercial buildings, educational facilities,

[7] Tokyo Cap and Trade Program, Bureau of Environment, TMG

medical facilities, art facilities, public facilities (such as gymnasiums, public bath, jails, funeral halls, social welfare facilities), district cooling/heating plants, factories, water and sewage facilities and waste processing facilities.

In case of buildings with more than 5,000 m^2 of rented/leased space or with more than 6 million kWh per year consumption, the tenants must create their own emission reduction plan and submitted it through the building owner. Each tenant is not specifically required to cap their emissions. If no individual tenant exceeds these energy consumption limits but a single building as a whole does, the tenants are required by law to cooperate with the building owner in reporting of emissions although the final report is submitted by the building owner.

For small and medium facilities (SMFs)

The SMFs that spread across the Tokyo city may have a number of buildings, factories, etc. If the cumulative energy consumption per annum of all the buildings within the facility is over 3,000 kl of COE but no single building or facility consumes over 1,500 kl of COE per annum, then the company must submit an energy efficiency plan every year. Although these SMF companies are not required to cap their emissions, the TMG aims to help the companies understand their (i) energy consumption profile and (ii) methods to lower their emissions.

If the consumption of an entire company is less than 30 kl of COE per annum, then there is no obligation to submit a report for their facility, but the TMG welcomes such micro facilities with interest in lowering the emissions to submit plans for energy efficiency on a voluntary basis.

There are also monetary incentives within the residential sector for the heat pump water heaters and solar power, as well as for appliance with the energy efficient labelling. For the small and medium scale emitters, free energy audits are available and the energy efficiency investments are 50% tax deductible[8].

Top-level facility

The ETS legislation provides an extra incentive to reduce the emission target by defining the concept of "*top-level facility*", by certifying those businesses and facilities that make significant progress to reduce their emissions and meet the ETS requirements. Such facilities can apply for a "*top-level facility*" certification at the end of September each year. There are two categories of certification and benefits:

- Outstanding progress: a facility's compliance factor is reduced to half
- Excellent progress: a facility's compliance factor is reduced to three-quarters

These certified facilities receive a lower compliance factors in accordance with their rates of progress. The reduced compliance factor is applicable from the consecutive financial year and will be effective for the duration of that entire compliance period. If the progress of a certified facility declines, its certification will be cancelled or downgraded.

5. Methodology

[8] The World's Carbon Markets: A Case Study Guide to Emissions Trading, Environment Defense Fund and International Emission Trading Association

In Tokyo ETS, the boundary is decided according to the area of the building or facility. Multiple facilities or buildings are also considered as a single building/facility if the following conditions are satisfied:

- All those facilities are provided with one single integrated energy management system
- Facilities are located adjacent to each other and owned by a common owner

5.1. Base year emissions

The scheme freely distributes allowances at the beginning of each compliance period. The allowances are allocated to the covered facilities based on their historical emissions. The base year emissions are calculated as the average of actual emissions of three consecutive years between the financial years of 2002-2007, as chosen by each facility.

A certain quantity of allowances are set-aside for new entrants. The new entrant in the scheme can select the baseline emissions as the average of three consecutive years between the financial years 2002-2007 if they had data of the past emissions of the facility or based on the emission intensity standards given by the TMG.

The baseline emissions for a facility is calculated as,

$$Base\ year\ emissions = Average\ of\ consecutive\ three\ years'\ total\ emissions$$

The total emissions for any year from the facility is calculated as,

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

Recalculation of base year emissions

The scheme provides flexibility to recalculate the baseline emissions of the facility in the second compliance period. This is due to the fact that the emission factor used in the first compliance period for the electricity and the fuel used may not have a significant impact on the emission reduction in the second compliance period. Hence, in the second compliance period, the following methods can be considered for calculating the base year emissions of the facility.

i) Primary method A: Recalculating using the latest emission factor values

In this method, the latest emission factor for the electricity and the fuel consumed are used to recalculate the baseline emissions of the facility.

$$\begin{pmatrix} Baseline\ emissions \\ of\ the\ facility \end{pmatrix} = \begin{pmatrix} Electricial\ energy \\ (kWh) \end{pmatrix} \times \begin{matrix} Emission\ factor\ estimated\ in \\ the\ second\ compliance\ period \end{matrix} \left(\frac{tCO_2}{kWh}\right)$$

$$+\left(\begin{pmatrix}Energy\ consumed\\ from\ the\\ fossil\ fuel\ (TJ)\end{pmatrix}\times\begin{pmatrix}Emission\ factor\ of\ that\ fuel\\ in\ the\ second\ compliance\ period\\ \left(\frac{tCO_2}{TJ}\right)\end{pmatrix}\right)$$

ii) Primary method B: Recalculating the baseline emissions using the factor set by the TMG

The factor is provided by the TMG based on average of the rate of increase of base-year emissions of all facilities due to the revision of the CO_2 emission factor.

$$\begin{pmatrix}Baseline\ emissions\\ of\ the\ facility\end{pmatrix}=\begin{pmatrix}Baseline\ emissions\\ considered\ in\ the\ first\\ compliance\ period\ (tCO_2)\end{pmatrix}\times Factor\ given\ by\ the\ TMG$$

iii) Method C: Recalculating the baseline emissions using the factor based on power and heat consumption (exceptional)

The facilities are also allowed to choose exceptional method C, if the recalculated baseline emission value is more favorable to them.

$$\begin{pmatrix}Baseline\ emissions\\ of\ the\ facility\end{pmatrix}=\begin{pmatrix}Baseline\ emissions\\ considered\ in\ the\ first\\ compliance\ period\\ (tCO_2)\end{pmatrix}\times\begin{pmatrix}Emissions\ calculated\ with\\ compliance\ factor\ for\ the\\ second\ compliance\ period\\ \hline Emissions\ calculated\ with\\ compliance\ factor\ for\ the\\ first\ compliance\ period\end{pmatrix}$$

5.2. Compliance factor

The cap is set on the total emission reduction as a percentage of total GHG emissions (noted as compliance factors) among the covered facilities. Table A.3.1 gives the compliance factor for the facilities/business entities that are covered under the ETS. Each compliance period of the ETS is for 5 years. During the compliance period, the facilities must report their annual GHG emissions every financial year to the TMG. These reports should be verified by the registered verification agency designated by the TMG.

As a special provision for the second compliance period to establish and promote more significant CO_2 reduction, the TMG has set the compliance factor of first compliance period for the facilities that are newly included into the scope of reduction obligations in the second compliance period.

Table A.3.1. Compliance factor for the different group of buildings

No.	Group	Compliance factor	
		1st compliance period (FY 2010 – FY 2014)	**2nd compliance period (FY 2015 – FY 2019)**
1	**Group I -1**	8%	17%

No.	Group	Compliance factor	
		1st compliance period (FY 2010 – FY 2014)	2nd compliance period (FY 2015 – FY 2019)
	Office buildings, government buildings, department stores, restaurants, hotels, schools, hospitals, museums and libraries, district heating and cooling plants (except covered under Group I-2) etc.		
2	**Group I -2** Facilities that receive 20% or more of their total energy consumption from the district heating and cooling plants	6%	15%
3	**Group II** Business facilities other than stated in Group I-1 and I-2.	6%	15%

5.3. Allocated allowances for each building

The base year emissions of a building is multiplied by the compliance factor (set by the TMG) and then by the length of the compliance period to obtained the allowances for the GHG emissions for the respective compliance period.
The allocated allowances for a facility is calculated as,

$$Allocated\ allowances = \left(\begin{matrix}Base\ year\\ emissions\end{matrix}\right) \times (1 - Compliance\ factor) \times \left(\begin{matrix}length\ of\\ compliance\ period\end{matrix}\right)$$

5.4. Compliance assessment

At the end of each compliance period, the total GHG emissions are calculated. The emissions must be within the allocated allowances. Figure 2 represents the approach of Tokyo's ETS.

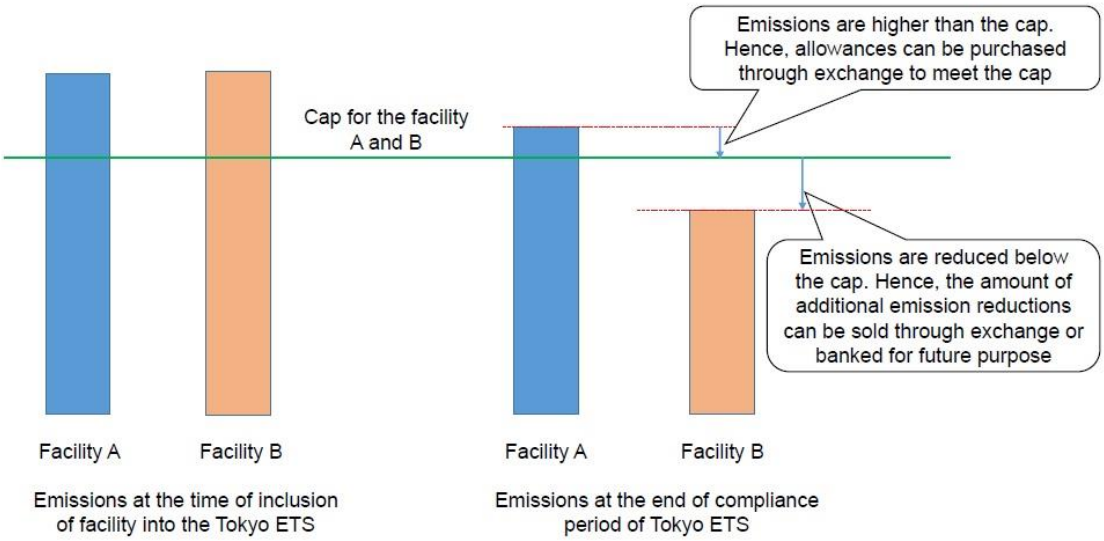

Figure A.3.2. Schematic representation of Tokyo ETS approach

The compliance assessment is conducted at the end of each compliance period. The covered facilities under the ETS are only allowed to sell their emission allowances that are remaining after a facility's annual emissions are accounted for. The Japan Climate Exchange and the Tokyo Stock Exchange are the platforms used for trading credits within the Tokyo ETS.

6. Measurement, Reporting and Verification (MRV)

The covered facilities are required to submit an annual report on the previous year's emissions and their emission reduction plans by the end of November of the following year. The report must cover GHG emission of all types (CO_2, CH_4, N_2O, PFC, HFC and SF_6).

A verification report issued by a registered independent verification agency must be attached to the emission data report. The verification is mandatory at the following stages:

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

Table A.3.2 provides the different verification segments and its respective contents. The auditing and verification of emissions is required under the Tokyo ETS and the cost of auditing is borne by the facility. The verification is carried out on a segmented basis. There are several different private auditing companies within Tokyo that are licensed to verify the emission reduction. Each auditing firm is registered to verify different segments.

Table A.3.2. Different verification segments and their contents

No.	Verification segments	Verification contents
1	GHG/baseline emissions	• Annual GHG emission verification

No.	Verification segments	Verification contents
		• Verification of baseline for achievement of the emission reduction goals
2	Emission reductions inside and outside the city	• Small and medium sized facility credit verification inside the city • Credit verification outside the city
3	Verification of environmental value retention through electricity consumption changes	Verification of renewable energy mix in the electricity consumption, etc.
4	Category 1-A: Office buildings, public facilities, commercial buildings, lodging, educational facilities, medical facilities, etc.	Certification of baselines and emissions
5	Category 1-B: Buildings in which air conditioning/heating from district cooling/heating plants make up more than 20% of energy consumption	Certification of baselines and emissions

The TMG is responsible for the maintenance and data management of the electronic registry. The registry includes three types of accounts: compliance accounts (to track emission reduction status of the covered facilities), trading accounts (to transfer credits) and surrender accounts (record credits surrendered for compliance). The registry is used to manage and record the trading of credits for each capped facility, as well as the brokers and entities that wish to participate (but are uncapped) within the system.

Annual emissions and actual reductions are disclosed every year on the TMG website. At the end of each compliance period, the Governor of Tokyo checks the final status of the compliance obligation. If the total emission reduction exceeds the obligation, the excess reductions may be carried over to the next compliance period as banked credit.

A facility will be accused of market misconduct if it submits a fraudulent application, receives credits in the registry account through illegal actions or engages in actions that obstruct the TMG's investigations into submitted applications. If any market misconduct is suspected, the TMG will first provide guidance to the participant and later apply penalties if necessary.

In the case of non-compliance, the facility will receive an order to reduce their emissions by the amount of the shortfall multiplied by 1.3. If facilities fail to meet this order, the violation will be published for public viewing and the facility will have to pay a fine of up to JPY 500,000[9] (≈4,500 USD). In this specific case of failing to comply with the order, the TMG purchases the reduction shortage, records them and registers that the reduction target has been fulfilled. Thereafter, the cost of TMG's purchase is billed to the facility. Once the fines are settled by the facilities, they must reduce their future emissions as previously mandated.

7. Offset credits

[9] The World's Carbon Markets: A Case Study Guide to Emissions Trading, Environment Defense Fund and International Emission Trading Association

To comply with the targets, the facilities can choose to reduce the emissions at their facility or reduce emissions by purchasing offset credits. There are five types of offset credits:

a) Excess emission reduction credits
b) Small and midsize facility credits
c) Renewable energy credits
d) Outside Tokyo credits and
e) Saitama credits

The facilities which generate emission reductions to sell offset credits are required to apply for certification to the TMG before such credits can be issued.

a) Excess credits

When a covered facility reduces emissions by more than its compliance obligation, it can apply for credit issuance within a given period after the emissions are determined. In this instance, the facility can sell its excess credits amounting up to one-half of its base year emissions. The credits obtained during the first compliance period could be banked until the end of the second compliance period (but not to the third period). The CO_2 emission reductions are only considered as the carbon credits in the ETS.

b) Small and midsize facility credits

When small and midsize facilities reduce their emissions through energy-saving measures below their base-year emissions, they can apply for the emission reduction credits. The base year emission has to be one financial year out of the most recent three consecutive financial years before the measures are implemented. There is no limit on the use of these credits. The credits can be issued for up to five years from when emission reduction measures were undertaken. The eligible measures are limited to measures completed in or after the financial year 2005. In principle, the applications are submitted according to an entire building's energy consumption. However, if the energy use can be monitored separately, individual tenants could apply separately for the credits.

c) Renewable energy credits

The local and national renewable energy programs which generate renewable energy and reduce emissions are eligible. Depending on the source of renewable energy, the quantity of renewable energy certificates (REC) will vary. For electricity from wind, solar, geothermal and small-scale hydropower, one ton of CO_2 reduction receives one-and-a-half (1.5) times the certificates as the emission reductions from other sources of renewable energy such as biomass, etc. The use of RECs is unlimited. The REC is only eligible if the issued certificates indicate that their purpose is to be used in compliance with the Tokyo ETS.

d) Outside Tokyo credits

The emission reduction from the energy-saving measures by large facilities outside the Tokyo city are eligible only if they do not negatively impact the reduction effort within Tokyo. The covered facilities can use these credits for up to one-third of their compliance obligation if they meet the following two requirements:

- The emission reductions come from a large facility outside Tokyo with a minimum energy consumption of 1,500 kl of COE in a base-year and with base-year emissions of 150,000 tCO_2.

- The estimated total reduction rate must be at least 6% at the initial application and when applying for the emission reduction certification.

e) Saitama credits

Saitama is a city in Japan which established its own ETS in April 2011 as part of the Saitama Prefecture Global Warming Strategy Promotion Ordinance. The Saitama ETS is bilaterally linked to the Tokyo ETS. If the Saitama ETS confirms that the reduction target has been achieved, then these credits can be used in the Tokyo ETS. The use of credits is unlimited as long as they are derived from the facilities with base year emissions of at least 150,000 tCO_2.

8. Implementation status

The first compliance period of the Tokyo ETS came to an end in December 2014 and achieved an emissions reduction of 23% compared to the base year emissions during the five years. In 2013, the accumulated CO_2 emission reductions were 880,000 tCO_2, just below the planned accumulated emission reductions of 1.08 million tCO_2. By February 2015, over 90% of the covered facilities had surpassed their reduction targets for the first compliance period and 69% of facilities had already exceeded their second compliance period targets of 15-17% reductions[10].

During the first compliance period, the majority of the participants purchased excess credits and RECs to comply. According to a TMG survey released in November 2014, the estimated excess credit supply was 420,000 (73.7% of overall supply) and the REC supply was 140,000 (24.6% of overall supply). According to another survey carried out by the TMG in October 2014, the price ranges for these credits were (i) JPY 5,000 - 6,000 per tCO_2 for RECs and (ii) JPY 4,000 - 5,000 per tCO_2 for excess credits[11].

In 2017, the emissions from the covered facilities amounted to 12.04 million tones, achieving a 27% reduction from the base emission as a result of continuous energy efficiency efforts[12].

9. Lessons learnt

The experience of the Tokyo ETS since 2010 clearly demonstrates how it has been very effective as an instrument to promote reductions in GHG emissions among the largest facilities in the city. A number of lessons can be drawn that would be of relevance to any city considering an ETS of its own:

- Mandatory reporting: The availability of data for Tokyo ETS began with the mandatory reporting program in the years prior to the design and implementation of the ETS. Such data is essential to design an ETS and to ensure robust monitoring, reporting and verification (MRV) throughout. In addition, these reports gave the TMG a large database of information concerning not only the overall GHG emissions of a company, but also the detailed breakdown of each individual energy consuming source at each facility. This had a positive effect in stakeholder consultations as the TMG was able to respond to the stakeholders who thought it is difficult to achieve energy efficiency targets.

[10] The World's Carbon Markets: A Case Study Guide to Emissions Trading, Environment Defense Fund and International Emission Trading Association

[11] Tokyo: An emission trading case study, Environmental Defense Fund, CDC climate research, International Emission Trading Association

[12] Results of Tokyo Cap-and-Trade Program in the 8th Fiscal Year for the covered Facilities Continue Reducing Emissions in Second Compliance Period, TMG

- Simple reporting system: Many companies had complained that they do not have the technical capacity to develop an emissions report each year. The development of a simple reporting system that relied on the existing data from electricity, gas, and fuel bills and equipment inventory lists was one of the most important elements for gaining acceptance for the ETS while also obtaining reliable data. This was considered appropriate, since the dominant emitter of GHGs is the commercial building sector in Tokyo.

- Development of incentive mechanism: The Tokyo CO_2 voluntary emission reduction program provides the TMG an opportunity to learn about creating incentives for the facilities. This voluntary program initially shows only minimum achievements of emission targets. Hence, the TMG undertook measures to strengthen the program by introducing guidelines for target setting and reduction measures, evaluation and public announcement of results of mitigation efforts and submission of progress reports. The development of incentive mechanisms for the emission reduction program rose the participating facilities to 4.8% among 1,255 facilities and almost 98.5% of the facilities obtained ratings with the implementation of basic measures requested by the TMG within their facilities.

- Flexibility on selection of base year: The Tokyo ETS provided covered facilities with some degree of flexibility, such as with the selection of the base year for emissions. The special provisions for calculating emissions following the earthquake also provided facilities the opportunity to avoid being penalized by the consequences of that unexpected natural disaster. Such flexibility is important for ensuring stakeholder buy-in for continued smooth implementation of the ETS.

- Predictable rules and frameworks: The Tokyo ETS operates within a clear and predictable rules based framework. The TMG has provided a framework for long-term goal setting by indicating the estimated emissions reductions that would be required in the second compliance period. This in turn enables participating facilities to plan and execute their emissions reduction activities well in advance, taking the long-term view and planning for investment as necessary.

Applicability for Thailand

This cap and trade scheme could be a scheme that help Thailand to meet the GHG emission reductions target. Thus, this scheme would be one mechanism indicated in the Thailand Climate Change Act that being developed.