

Study on cooperative MRV as a foundation for a potential regional carbon market within ASEAN

Singapore Country Report

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Abbreviations

AFLOU	Agriculture, Forestry and Land Use
ASEAN	Association of Southeast Asian Nations
BUR	Biennial Update Report
CAGR	Compound annual growth rate
CDM	Clean Development Mechanism
CNG	Compressed natural gas
CO₂	Carbon dioxide
CO₂e	Carbon dioxide equivalent
ECA	Energy Conservation Act
EDMA	Emissions data monitoring and analysis
ER	Emissions report
ETS	Emissions trading scheme
FPCB	Fixed-price credit-based
GHG	Greenhouse gases
GWP	Global warming potential
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
LULUCF	Land Use, Land-Use Change and Forestry
M&R	Monitoring and reporting
MP	Monitoring plan
MRV	Measurement, Reporting and Verification
NC	National Communication
NCCS	National Climate Change Secretariat
NDC	Nationally Determined Contribution
NEA	National Environment Agency
PFCs	Perfluorinated compounds
QA/QC	Quality assurance / Quality control
QMF	Quality management framework
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
V&A	Verification and accreditation

Executive Summary

In its Second Biennial Update Report (BUR), Singapore's 2012 greenhouse gas (GHG) emissions totaled 48 MtCO_{2e}. The energy sector accounted for approximately 98 percent of total GHG emissions, with power generation and industry (manufacturing) being the main contributors.

Singapore ratified the Paris Agreement and submitted its Nationally Determined Contribution (NDC), whereby Singapore committed to the target of reducing its emissions intensity by 36 percent in 2030 based on 2005 levels. This target builds on an earlier pledge made at COP15, and emissions are expected to peak around 2030.

Singapore is a small island city-state and its economy comprises a significant manufacturing sector, which includes the production, processing and export of fossil fuels. Thus, the country's key strategy for emission reductions is through improvements in energy efficiency. The lack of land area makes the large-scale development of renewable sources of energy such as solar, wind and nuclear unviable. Despite this, Singapore has announced plans to increase its solar deployment to 350 MWp by 2020 and to 1 GWp beyond 2020, more than 6 times the current deployment of approximately 162 MWp.

Singapore is the first ASEAN country to introduce a carbon tax. In March 2018, the Carbon Pricing Act was passed through the Singapore Parliament and an initial carbon tax rate of SGD 5/tCO_{2e} (approximately USD 3.7/tCO_{2e}) will be charged between 2019 and 2023. This tax will apply without exemption to approximately 40 companies, corresponding to 50 "taxable" facilities, emitting 25,000 tCO_{2e} or more annually and will cover approximately 80 percent of Singapore's national GHG emissions. Facilities emitting 2,000 tCO_{2e} or more annually but less than 25,000 tCO_{2e} will have to submit an emissions report but are not subject to the tax. The carbon tax rate will be reviewed by 2023. The government intends to raise the tax to SGD 10-15 per tCO_{2e} (i.e. from approximately USD 7.3-11 per tCO_{2e}) by 2030. In doing so, Singapore will take into account the progress of domestic emissions mitigation efforts, international climate change developments, and its own economic competitiveness.

The carbon tax will be implemented in the form of a Fixed-Price Credit-based (FPCB) mechanism, where emitters will purchase fixed-priced credits from the government and surrender carbon credits equivalent to their carbon tax liability. The Act covers direct emissions of the following gases: CO₂, CH₄, N₂O, SF₆, PFCs and HFCs.

A system for the measurement, reporting and verification (MRV) of emissions at the facility level was developed by the National Environment Agency (NEA) to support the Carbon Pricing Act. The aim of this MRV framework is to ensure the quality, accuracy, and robustness of GHG emissions data for the purposes of determining the carbon tax. Singapore's facility-level MRV framework was developed based on international standards such as the Greenhouse Gas Protocol (developed by the World Resources Institute and the World Business Council for Sustainable Development), IPCC Guidelines, and global good practices on GHG emissions reporting in other carbon pricing jurisdictions.

The measurement and reporting of GHG emissions commenced in 2013 with the introduction of the Energy Conservation Act (ECA), which required facilities consuming more than 54 TJ of energy per year to report on their energy-use and GHG emissions. To prepare companies for the carbon tax, the ECA was amended in 2017 to include enhanced measurement and reporting (M&R) requirements. Facilities which generate 25,000 tCO_{2e} or more per year will need to submit a Monitoring Plan for the approval of NEA documenting the methods, steps and procedures to accurately measure and report GHG emissions. Facilities are also required to submit an Emissions Report which records the facility's annual GHG emissions, calculated based on the methodologies laid out in the Monitoring Plan. Under the Carbon Pricing Act, taxable facilities are required to have their annual emissions report verified by an accredited third party auditor. The Verification and Accreditation (V&A) requirements, which were developed in 2018, and the M&R requirements have been combined in the MRV Regulations which were gazetted in December 2018.

Clear requirements and guidelines for the M&R of emissions are published by the NEA to assist facilities in complying with the requirements. Monitoring Plan and Emissions Report submissions are performed via the Emissions Data Monitoring and Analysis (EDMA) online portal. This is a centralized portal that the NEA uses for all energy and GHG reporting and data collection. The EDMA portal is also used for data collection related to the national GHG inventory. This data comes from various agencies such as the Energy Market Authority, Land Transport Authority, Maritime and Port Authority of Singapore, Department of Statistics, National Environment Agency, National Parks Board, and Public Utilities Board. For the purposes of the national GHG inventory, the data collected by the NEA through the M&R requirements would only encompass the emissions data for fuel combustion for “energy and transformation” and “industry” (energy sector emissions) and IPPU. Nevertheless, the NEA takes on the role of compiling this data annually from the different responsible agencies.

Although emissions from transport form the majority of emissions not covered under the Carbon Pricing Act, there are already implicit excise taxes charged on the use of transport fuel at the point of import. While these taxes were not solely intended to address GHG emissions, they introduce an implicit price on carbon.

The carbon tax will be implemented for five years before any adjustments are made. This carbon tax will run complementarily to existing and planned mitigation measures. Nonetheless, the Singapore government is open to adjusting this carbon tax based on developments in climate change negotiations. At the same time, and with a view to the future, the Singapore government is studying the feasibility of linking its carbon pricing mechanism with other carbon pricing jurisdictions, and options are being considered both regionally and globally.

1. National Climate Change Context

Singapore is an island state consisting of one main island and more than 60 small ones, with a total land area of 719 km². As of mid-2016, the population of Singapore was estimated to total 5.6 million inhabitants¹, making it one of the most densely populated countries in the world, with approximately 7,800 people per km².

In 2016, the Gross Domestic Product (GDP) of Singapore at current prices totalled SGD 410 billion². Its economy is dominated by five main sectors – manufacturing, wholesale & retail, business services, finance and insurance, and other services – accounting for approximately 75 percent of the GDP. In the 2010-2016 period, Singapore's GDP grew at an annual average rate of 3.8 percent, which compares with 5.1 percent in the whole of ASEAN. Singapore has the highest GDP per capita of ASEAN; 52,983 USD/capita at current prices in 2016, whereas ASEAN's average was 4,034 USD/capita in the same year³.

As reported on its Second Biennial Update Report submitted to the UNFCCC, Singapore's greenhouse gases (GHG) emissions in 2012 totalled 48 Mt CO₂e⁴. According to the same report, from 2000 to 2012, GHG emissions of Singapore have grown at a compounded annual growth rate (CAGR) of 2 percent, which corresponds to an increase of 9.8 Mt CO₂e of the emissions reported in year 2000. In the same period, GDP growth (in real terms, expressed in 2010 USD) exhibited a CAGR of 5.7 percent, which indicates a decoupling of GHG emissions from economic growth.

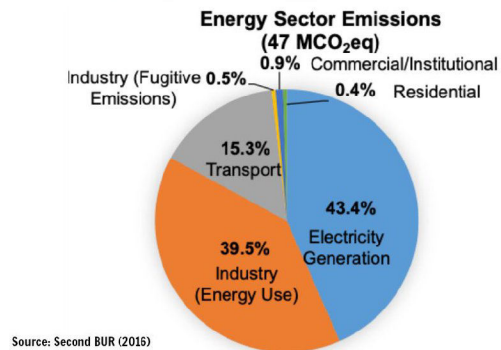
Table 1 presents the breakdown of GHG emissions, by source, in 2012. It may be noted that CO₂ emissions accounted for approx. 97 percent of the total (i.e. 46.5 Mt CO₂e), whereas the major source of emissions originated from the energy sector due to combustion of fuels (47 Mt CO₂e). Figure 1 displays the breakdown of energy sector emissions; it can be observed that fuel consumption for electricity generation, industry use, and transport, accounted for the largest share of emissions in the energy sector. Figure 2 provides a break down of these sub-sectors by fuel type.

Table 1: GHG emissions by source in Singapore, 2012⁵

Greenhouse Gas Source and Sink Categories	CO ₂	CH ₄	N ₂ O	HFCs	PFCs	SF ₆
Energy	46.777	0.041	0.307	-	-	-
Fuel combustion	46.552	0.041	0.307	-	-	-
Energy and transformation industries	20.367	0.009	0.073	-	-	-
Industry	18.611	0.009	0.014	-	-	-
Transport	6.947	0.024	0.220	-	-	-
Commercial-institutional Residential	0.419	-	-	-	-	-
	0.209	-	-	-	-	-
Fugitive fuel emission	0.226	-	-	-	-	-
Oil and natural gas system	0.226	-	-	-	-	-
LULUCF	-0.239	-	-	-	-	-
Industrial Processes	-	-	-	0.038	0.931	0.089
Waste	-	0.046	0.105	-	-	-
Wastewater handling	-	0.046	0.105	-	-	-
Total (Net) National Emissions (Mt CO₂e)	46.538	0.087	0.412	0.038	0.931	0.089

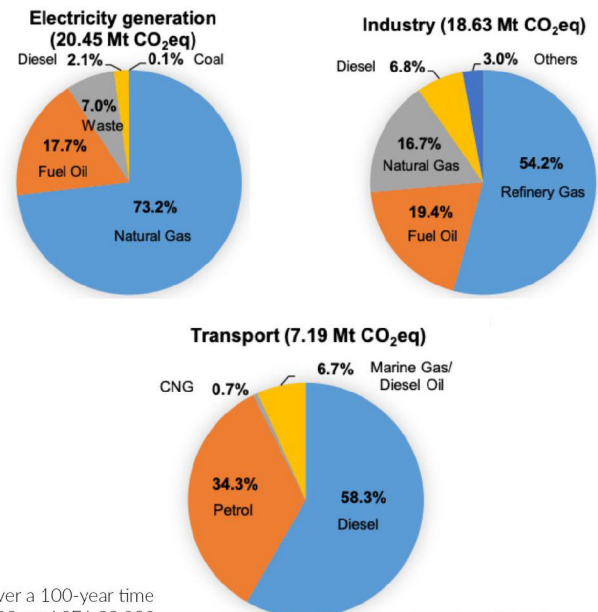
Source: Second BUR (2016)

Figure 1 – GHG emissions by source in Singapore, 2012



Source: Second BUR (2016)

Figure 2 - Share of 2012 GHG emissions by fuel type for three major sources



Source: Second BUR (2016)

1 ASEAN Statistical Yearbook 2016/2017.

2 Ibid.

3 Ibid.

4 Figures displayed were calculated applying 1995 IPCC global warming potential (GWP) factors over a 100-year time horizon, with CH₄ being attributed a GWP of 21, N₂O 310, HFCs 140-11,700, PFCs 6,500-9,200, and SF₆ 23,900.

5 Singapore's Second Biennial Update Report, 2016.

Singapore ratified the Paris Agreement on September 21, 2016, and the national pledge for 2030 is detailed in the Nationally Determined Contribution (NDC) document submitted to the UNFCCC⁶. Singapore's target consists in a 36 percent reduction of GHG emissions intensity in 2030 in relation to year 2005, i.e. from 0.176 kg CO₂e/S\$GDP to 0.113 kg CO₂e/S\$GDP (at 2010 prices). This target builds on an earlier pledge made at COP15 in Copenhagen, 2009, and a peak in emissions is expected to be achieved around 2030.

Singapore's pledge should be understood in light of its specific national circumstances, namely its status as a small island city-state and an economic output which is highly dependent on the production, processing, and export of fossil fuels and associated energy-intensive products. This poses limitations to the adoption of low-carbon and/or more sustainable forms of energy, such as wind, hydropower or nuclear energy. In spite of these constraints, Singapore has prioritized the deployment of solar PV, for instance, by establishing a favourable environment for the technology and supporting research and development programmes. Singapore's NDC states that renewable energy can meet up to 8 percent of peak electricity demand by 2030.

Singapore's key strategy for emission reduction is the improvement of energy efficiency. The Government already promotes the adoption of energy efficient technologies, for instance, through programmes such as the Grant for Energy Efficient Technologies (GREET) for industry, the Green Mark Scheme for buildings, or the energy efficiency national partnership and energy efficiency fund for companies in the high-energy consuming industrial sector.

Singapore intends to achieve its mitigation targets under the Paris Agreement through domestic efforts, but it is open to exploring the potential of international market mechanisms under Article 6 of the Agreement. Singapore has experience in these mechanisms as a host country of CDM projects, given its status as a Non-Annex I Party to the Kyoto Protocol. As of September 2018, six CDM projects had been registered in Singapore, one of which focused on demand side energy efficiency measures for lighting systems in buildings.

Singapore's approach to climate change mitigation is reflected in a number of national policies, strategies and programmes, both sectorial and cross-sectorial. Low-carbon development and enhanced environmental sustainability underpin all major national government documents. For instance, the transition to a more carbon-efficient economy is recognized as a priority in the National Budget for FY2018⁷.

Table 2 summarizes the main national policies on climate change in Singapore. The most recent development in Singapore's GHG mitigation strategy is the implementation of a carbon tax from 2019 onwards. The Carbon Pricing Act was passed by Parliament on March 20, 2018, and it will target the largest GHG emitters, or approximately 80 percent of total GHG emissions. Details are explored further in section 2 of this report.

Table 2: Main policies and strategies on climate change mitigation in Singapore

Carbon Pricing Act (2018)⁸	• Lays out a framework for the implementation of a nation-wide carbon tax, which will apply uniformly to all economic sectors from 2019 onwards.
Climate Action Plan (2016)⁹	• It consists of two separate documents, one for mitigation the other for adaptation. The mitigation document identifies 4 main strategies for reducing GHG emissions: i) improving energy efficiency; ii) reducing emissions from the power generation; iii) development and demonstration of low-carbon technologies; and iv) encouraging "collective action" through education and behavioural change. • Some key targets on climate change mitigation are detailed, such as "greening" 80% of buildings by 2030, achieve a national recycling rate of 70%, and achieve 75% public transport use by 2030.
Sustainable Singapore Blueprint (2015)¹⁰	• Lays out several sustainability targets for Singapore, which are structured around 5 thematic areas: i) an active and gracious community; ii) towards a zero-waste nation; iii) "eco-smart" endearing towns; iv) a leading green economy; and v) a "car-lite" Singapore.
National Climate Change Strategy (2012)¹¹	• Key elements of Singapore's climate strategy are outlined, including GHG emission reductions across sectors, enhancing adaptation capabilities, harnessing green growth opportunities, and establishing partnerships on climate change action.

⁶ Singapore's Intended Nationally Determined Contribution (INDC) and Accompanying Information, 2015.

⁷ Budget 2018, A Better Future, 2018, pp. 8

⁸ Carbon Pricing Act 2018.

⁹ Singapore's Climate Action Plan: Take Action Today, For a Carbon-Efficient Singapore, 2016.

¹⁰ Sustainable Singapore Blueprint, 2015.

¹¹ National Climate Change Strategy, 2012.

2. Analysis of National MRV systems

2.1 Carbon pricing status and outlook

Singapore is the first country within ASEAN to adopt an explicit carbon pricing mechanism for the economy as a whole. The Carbon Pricing Act, passed by Parliament on March 20, 2018¹², formally introduces a carbon tax which will apply evenly to all economic sectors from January 1, 2019, onwards.

The tax is intended to provide a price signal to the largest emitters in Singapore to factor the costs of their GHG emissions into their business decisions and encourage them to improve their energy efficiency. At the same time, the tax will support Singapore in achieving its 2030 pledge under the Paris Agreement and prepare companies for a low-carbon economy. The tax will function as a complementary instrument to enhance both existing and planned mitigation efforts.

The rationale underpinning the introduction of this carbon pricing mechanism is that, for a relatively small domestic market like Singapore, it would be more practical to start with a simple tax. The tax will cover approximately 80 percent of Singapore's GHG emissions, and is payable by facilities emitting 25,000 tCO_{2e} or more per year. No exemptions or free carbon allowances will be provided to covered emitters. There are approximately 50 such facilities, owned by 40 companies, which are designated as "taxable facilities" under the Act. The threshold for taxable facilities was set at 25,000 tCO_{2e} per year, as analyses carried out revealed that a lower threshold would not substantially increase the coverage to justify the increase in the costs associated with MRV. The remaining 20 percent of national GHG emissions not covered by the tax originate from more dispersed sources and their reduction will be carried out through other means.

From 2019 to 2023, the carbon tax charged will amount to SGD 5 per tCO_{2e} (approximately 3.7 USD/ton). The government intends to raise it to SGD 10-SGD 15 per tCO_{2e} (i.e. from approximately 7.3-11 USD per tCO_{2e}) by 2030. The carbon tax rate will be reviewed by 2023. In doing so, Singapore will take into account the progress of domestic mitigation efforts, international climate change developments, and its own economic competitiveness. The foreseen carbon tax revenue in the first five years of the programme is estimated at SGD 1 billion. The government is prepared to spend more than what will be collected in the initial five years (i.e. more than SGD 1 billion) to support worthwhile projects which deliver the necessary abatement in emissions. The impact of the tax to end-users is expected to be "modest", and is estimated to be about a 1 percent increase in total electricity and gas expenses on average (SGD 1.70 to SGD 3.30 per month or USD 1.25 to USD 2.4 per month)¹³.

The carbon tax takes the form of a Fixed-Price Credit-based (FPCB) mechanism, in which emitters pay the carbon tax by surrendering carbon credits equivalent to their carbon tax liability. The tax will be paid in the form of carbon credits, which need to be purchased from the National Environment Agency (NEA) at a fixed price (equivalent to the tax rate) in the given year. Each credit corresponds to 1 tCO_{2e} and the payment of the tax is made by surrendering the credits equating to the GHG emissions of the compliance year through an online credit registry managed by the NEA. Every credit surrendered for compliance is then removed from the registry account of that facility and the tax is considered paid. While international credits will not be allowed in the initial phase, the FPCB mechanism sets in place the building blocks for future linking to other carbon markets.

The design of the carbon tax takes into account the result of several consultations carried out with the public and the industry, in particular entities directly targeted by the tax. For example, in 2013-2014, the government consulted 29 large industry emitters on the impacts to competitiveness in case of the introduction of a carbon price. Since the formal announcement of the tax as part of Singapore's 2017 national budget, the government has carried out additional public consultations.

The scope and coverage of Singapore's carbon tax are captured in the table on the following page.

¹² Carbon Pricing Act 2018, Ibid

¹³ Channel News Asia, 5 things you need to know about how the carbon tax works, 2018.

Table 3: Scope and coverage of Singapore's carbon tax**Scope and coverage of Singapore's carbon tax**

a) Gases covered	<ul style="list-style-type: none"> >> CO₂, CH₄, N₂O, SF₆, PFCs, and HFCs; >> Global warming potential of gases based on Second Assessment Report of the IPCC (1996); >> CO₂ emissions from biogenic sources and NF₃ emissions are “non-reckonable” (i.e. they do not count for the definition of the emissions threshold of the facility or for the purposes of levying the tax), but must be monitored and reported.
b) Sectors covered	>> Industrial facilities with GHG emissions that exceed the emissions threshold, except those emitted on activities related to Agriculture, Forestry and Other Land Use (AFOLU), and from using any vehicle to transport any person or goods.
c) Threshold for included enterprises	<ul style="list-style-type: none"> >> Two-level threshold based on GHG emissions level: <ul style="list-style-type: none"> • Entities emitting 25,000 tCO₂e or more per year need to submit a monitoring plan for approval by NEA, submit an emissions report based on the approved monitoring plan, and pay tax on the third party verified emissions. They are designated as taxable facilities under the Carbon Pricing Act; • Facilities emitting between 2,000 tCO₂e and 25,000 tCO₂e per year need to submit an annual emissions report, similar to the requirements of the Energy Conservation Act. However, they do not need to submit a monitoring plan, their emissions report is verified by NEA (i.e. they do not need to engage a third party to verify their emissions report), and do not have to pay the carbon tax.¹⁴ They are designated as reportable facilities under the Carbon Pricing Act.
d) GHG accounting boundary	>> Restricted to the boundaries of the facility.
e) GHG emission sources	<ul style="list-style-type: none"> >> Only direct emissions (Scope 1) (emissions attributed to the purchase of electricity do not need to be reported by the facility); >> Emitters / facilities are currently not allowed to use international offsets against their tax liability.

Facilities covered under the Carbon Pricing Act are required to adopt specific monitoring and reporting procedures to support the computation of the amount of taxable emissions. These procedures are specified in the Measurement, Reporting and Verification (MRV) Regulations under the Carbon Pricing Act. MRV requirements were developed based on international good practice on GHG emission reporting, in particular the Greenhouse Gas Protocol¹⁵ and the IPCC, and take into account five core principles for ensuring the quality of data reported: accuracy, completeness, consistency, relevance and transparency. Further details are provided in section (ii) below.

2.2 MRV at facility level

An MRV system was developed by NEA to support the Carbon Pricing Act and applies to all taxable facilities. MRV requirements for taxable companies are much stricter as they aim to ensure the quality, accuracy and robustness of GHG emissions-related data for the purposes of determining the tax to be levied. These processes are described below, and are based on the Measurement and Reporting (M&R) Guidelines and the Verification and Accreditation (V&A) Guidelines, which have been published by NEA.

Monitoring and reporting of GHG emissions commenced in 2013 with the Energy Conservation Act (ECA), which laid out a set of requirements that needed to be followed by covered entities. These requirements were enhanced as part of an amendment to the ECA in 2017, in preparation for the carbon tax implementation in 2019. In tandem with the Measurement and Reporting (M&R) requirements, a set of guidelines were issued to support their implementation. While the requirements are legislated into law and state the minimum standard that must be followed, the guidelines contain details as to how regulations have to be met. The guidelines offer some flexibility for companies (e.g. by enabling them to choose the most cost-effective monitoring method, as long as it is compliant with the standard of the regulations), but can be used as a reference in case of legal disputes¹⁶.

¹⁴ Energy reporting under the Energy Conservation Act will serve as a basis to check whether facilities emitting more than 2,000 tCO₂e report their emissions. This will be based on a threshold of 54 TJ of energy consumption per year, which is considered a reasonable approximation for identifying facilities emitting more than 2,000 tCO₂e per year. Approximately 200 such facilities exist in Singapore.

¹⁵ World Business Council on Sustainable Development & World Resources Institute, The GHG Protocol: A corporate reporting and accounting standard (Revised Edition), 2004.

¹⁶ Singapore's GHG Measurement and Reporting (M&R) Guidelines are available for consultation [here](#).

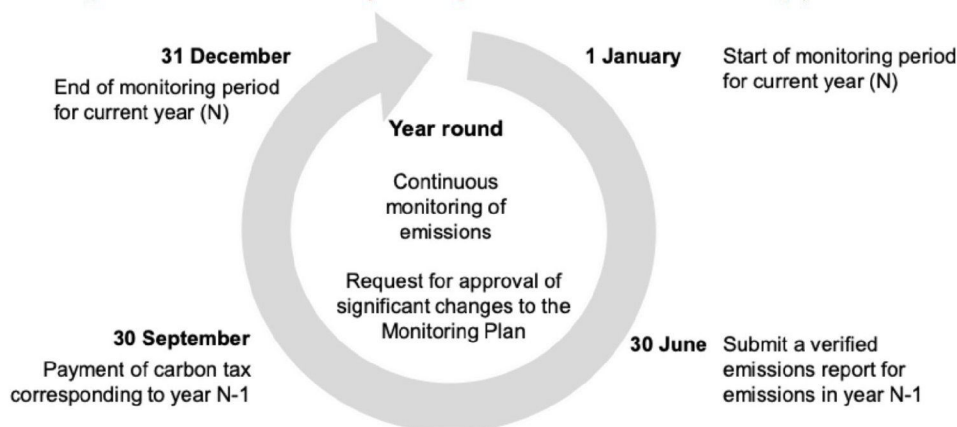
An important component of the MRV framework is the Emissions Data Monitoring and Analysis (EDMA) system, which is the online platform used for formal submissions of energy and GHG emission related data, such as monitoring plans and emissions reports. EDMA had been used for the submission of energy management reports under the ECA, and is thus a platform with which taxable facilities were already familiar.

The main processes of the MRV framework for taxable facilities are as follows:

- Submission of a monitoring plan (MP) documenting the methods, steps and procedures to accurately measure and report GHG emissions;
- Approval of the Monitoring Plan by NEA;
- Submission of an Emissions Report (ER) that records the facility's annual GHG emissions, which are calculated based on the methodologies proposed in the approved MP. The emissions report must be verified by an independent accredited third party.

The figure below illustrates the annual compliance cycle for a taxable facility:

Figure 3 – Annual MRV compliance cycle for taxable facilities in Singapore



The Verification and Accreditation (V&A) Guidelines were published in January 2019. The main objective of the V&A requirements is to ensure that the verification process is robust and conducted by qualified verifiers, and the requirements are based on international standards and good practice from several jurisdictions worldwide that have adopted carbon pricing instruments.

The V&A guidelines have been developed by NEA in consultation with third party verifiers, and the accreditation process is expected to be conducted along three stages:

- **Stage 1:** document check to ensure there is a rigorous “independence & competency framework” in place by the verification company;
- **Stage 2:** interviews to evaluate the competency of the verification company and its lead verifiers and independent reviewers;
- **Stage 3:** visit to the premises of the verification company to check how the “independence & competency framework” is implemented, records, and other documents, as necessary.

Additional details of the MRV processes and requirements for taxable facilities are captured in table 4 on the following page. They follow the GHG M&R requirements, and only pertain to direct emissions of GHG from fuel combustion and industrial processes and product use (IPPU).

Table 4: MRV requirements at the facility level for taxable facilities**Measurement and monitoring of emissions**

- a) GHG emissions quantification methods/approaches**
- >> The facility is given the flexibility to decide on the most appropriate emissions computation methods and tiers to quantify GHG emissions. However, these need to be justified and substantiated with supporting documentation, which are to be submitted along with the monitoring plan (see point d) below).
 - >> Three methods can be used for GHG emission quantification: i) calculation approach, ii) material balance, and iii) direct measurement:
 - Calculation approach: GHG emissions are calculated from activity data and appropriate conversion factors. Conversion factors can be either default factors based on IPCC guidelines, or site-specific ones that can properly justified with supporting documents/evidence.
 - Material balance: GHG emissions are calculated based on the balance of the carbon content of the feedstock entering the process and the carbon content of the products exiting the process (this is generally applied to IPPU sources).
 - Direct measurement: GHG emissions are measured at the point of release, e.g. through a Continuous Emissions Monitoring System (CEMS).
- b) Data requirements**
- >> **Four tiers** are distinguished for the estimation of activity data and conversion factors. The higher the tier adopted, the higher the accuracy of data and lower the uncertainty. The M&R requirements do not mandate a particular or minimum tier, but the covered entity is expected to select the most appropriate tier to ensure accuracy in the calculation of emissions;
 - >> **Activity data tiers:** Tier 1: engineering estimate; Tier 2: measurement using typical industry approach; Tier 3: invoiced quantity; Tier 4: measurement with an instrument meeting a specific standard;
 - >> **Conversion factors:** they are either IPCC defaults or site-specific conversion factors:
 - Tier 1: IPCC default factors or site-specific conversion factors specified by the facility;
 - Tier 2: site-specific conversion factors derived from measurement and analysis which is carried out less than once per year;
 - Tier 3: site-specific factors derived from measurement and analysis conducted at least once per year or more frequently;
 - Tier 4: representative analysis, whereby site-specific conversion factors are derived from the analysis of one or more samples that are representative of the material property;
 - >> Facilities are required to specify at least an alternative measurement approach in case the primary approach becomes no longer suitable due to a certain scenario or event.
- c) Monitoring plan**
- >> The preparation of a monitoring plan is mandatory for taxable facilities and needs to be approved by the NEA. The NEA may require the monitoring plan to be assessed by an external auditor in case the Agency disagrees with any matter set in the plan or if specific technical knowledge is required to assess any process at the facility;
 - >> The monitoring plan must identify and describe the facility's GHG emission sources and streams, emissions quantification methods and quality management procedures;
 - >> For each facility, it is required the appointment of at least one GHG Manager to be responsible for the preparation and submission of the Monitoring Plan and Emissions Report;
 - >> In exceptional cases (e.g. a new technology for which the NEA does not have the technical know-how to assess), the NEA may request third-party validation of the monitoring plan.
- d) Support tools**
- >> A monitoring plan template is available and needs to be followed by the facilities. The plan is downloadable from the Emissions Data Monitoring and Analysis (EDMA) portal;
 - >> An emissions report template is currently under preparation by the NEA and will be released in early 2019.

Reporting of emissions

- a) Reporting system and format**
- >> Key elements of the reporting system: **emissions report** and **registry account through EDMA portal**.
 - Emissions report:**
 - >> Needs to be submitted to NEA by each taxable and reportable facility;
 - >> The emissions report needs to be prepared based on the monitoring plan of the facility, which has to be approved beforehand by NEA;
 - >> Submission of the report to NEA requires third party verification by an accredited external auditor.
 - Registry account:**
 - >> For each taxable facility, NEA must open a registry account in the Carbon Credits Registry, which is part of the EDMA portal;
 - >> Every carbon credit surrendered for tax compliance is removed from the registry account of the taxable facility, with the tax considered paid.

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- b) Reporting procedures**
- >> Record keeping: the taxable facility and external auditors are required to keep and maintain accurate records of information and supporting documentation, which must be made available for inspection by any authorized officer;
 - >> Relevant information and documents must be kept for at least 5 years counted from the data they are submitted.
- c) Reporting period**
- >> Calendar year during which the direct GHG emissions are measured (January 1 to December 31).
- d) Reporting timing**
- >> Monitoring plan needs to be submitted by December 31 of the year following which GHG emissions exceed 25,000 tCO₂e;
 - >> Emissions report shall be submitted by June 30 of the year following the reporting period;
 - >> For taxable facilities, the tax must be paid by September 30 of the year immediately following the reporting period.
- Verification**
- a) Reporting system and format**
- >> NEA is responsible for accrediting third-party verifiers through a three stage process: i) document check by NEA; ii) interviews; and iii) visit to premises to check independency & competency framework.
- b) QA/QC and uncertainty assessment**
- >> Each facility is required to have a quality management framework (QMF) in place for the collection, calculation and reporting of GHG emission data.
 - >> Quality control (QC) activities need to be reported in the QMF, and these should be described for the different QMF elements. Specific procedures need to be reported with regards to the following stages of the inventory development: i) inventory preparation and management; ii) data gathering, input and handling; iii) data documentation, reporting and review.
 - >> An uncertainty assessment is required as part of the monitoring plan. The uncertainty assessment is focused on the statistical uncertainty of the parameters used in the quantification of GHG emissions. Default uncertainty values for activity data and conversion factors are available in the M&R guidelines.
- c) Enforcement and penalties for non-compliance**
- >> Fines and penalties apply in case of failure to submit a monitoring plan in accordance with the Carbon Pricing Act, register a business facility with NEA, submission of unverified emissions report, failure to comply with any direction provided by NEA regarding emissions reports and monitoring plans, and failure to pay tax;
 - >> For taxable facilities, a financial penalty of 5% applies to the amount of tax which remains unpaid;
 - >> In case the tax remains unpaid beyond 60 days of the deadline, an additional financial penalty of 1% is charged on the amount of tax that remains unpaid for each additional month. The penalty shall not exceed 3 times the amount of the tax remaining unpaid;
 - >> A person that fails to pay the tax specified in the demand note, shall also be guilty of an offence and shall be liable on conviction to a fine that is triple the amount of tax specified in the demand note as being outstanding.
- d) Verification requirement procedures**
- >> NEA authorized officers are vested with the power to carry out inspections to taxable facilities
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2.3 Sectoral and policy-level MRV

The focus of this study, as well as all country reports prepared under it, is on sectors that are more suitable to the introduction of a carbon pricing instrument, this includes the energy, industry and transport sectors. MRV of major emitters in the energy and industrial sectors is covered under the Carbon Pricing Act, analysed in the section above. Emissions from the transport sector are excluded from the Act, but excise duties are levied on diesel, petrol and CNG. In fact, these duties “implicitly” introduce a price on CO₂ emissions from the transport sector, but their motivation was to address some other negative externalities, such as high traffic congestion. These duties are levied “upstream”, at the point of import, but the cost is passed through to the final consumer.

More specifically, the excise duties for petrol/gasoline amount to SGD 0.71 and SGD 0.64 per litre for leaded and unleaded petrol, respectively. For diesel, the levied excise duty corresponds to SGD 0.1 per litre. For all fuels and CNG, a goods and service tax of 7 percent is also levied¹⁷. Based on calculations made by NCCS, the existing excise duties for transport fuels correspond to an implicit carbon price of SGD 37-281 per tCO₂e¹⁸.

Additionally, as reported in the Second BUR, each government agency is responsible for monitoring, measuring and documenting the progress of the mitigation policies under its purview, which includes internal QA/QC processes. Subsequently, information collected by the agencies is consolidated by the Long Term Emissions and Mitigation Working Group Secretariat on an annual basis. This Working Group will then assess progress in implementation of the various policies and track Singapore's progress in meeting its mitigation goals¹⁹.

2.4 National GHG inventory and MRV processes

The preparation of national GHG inventories is a process led by the NEA with the involvement of multiple agencies. Inventories are updated on an annual basis, even if only officially reported when NCs or BURs are submitted to the UNFCCC. Four main stages can be identified in the inventory preparation: i) data collection and QA/QC conducted by government agencies in charge of the sector the data pertains to (who play a role as “data owners”); ii) data from the different ministries is received and compiled by the NEA, which subsequently conducts a quality control check on the computation of emissions; iii) quality assurance by an independent team within the NEA on the computation of emissions; and iv) endorsement by MRV Taskforce.

With regard to stage i), the data required for the compilation of the inventory is collected by various government agencies, for instance through surveys, legislation, or regulations. The table below indicates the data collection responsibility in relation to each sector as defined by the IPCC:

Table 5: Responsibilities on data collection for the preparation of Singapore's national GHG inventory

IPCC Sector	Data Owner
Energy	
Power generation	>> Energy Market Authority
Industry	>> Energy Market Authority >> National Environment Agency
Land transport	>> Energy Market Authority >> National Environment Agency >> Land Transport Authority
Marine transport	>> Maritime and Port Authority of Singapore
Commercial	>> Department of Statistics
Residential	>> Department of Statistics
Industrial Processes and product use	>> National Environment Agency
LULUCF	>> National Parks Board
Waste	
Waste incineration	>> National Environment Agency
Wastewater handling	>> PUB – Singapore's national water agency >> Food and Agriculture Organization of the United Nations (FAO)

The compilation of the data from the different data owners is made through the Emissions Data Monitoring and Analysis (EDMA) system. This is the same system through which facilities emitting more than 25,000 tCO₂e have to report their emissions. For the purposes of the national GHG inventory preparation, the EDMA was designed to receive input and activity data from different data sources, generate emissions estimates and enable QC checks. EDMA also functions as a data management system, enabling record keeping and storage of documentation, including reference materials, methodologies and data sources. QC is conducted by the data owners, who are required to follow a number of procedures, while QA is carried out by an independent team within each agency.

With regards to stage ii), the computation of GHG emissions is carried out by NEA based on the data submitted by the various agencies. This step involves a number of QC checks, and also the analysis of key categories of emissions. This is followed by stage iii), during the course of which an independent team under the NEA performs QA checks. The final stage is the review of the QA/QC procedures - already conducted by the different agencies - by an inter-agency working committee (or “MRV Taskforce”), which eventually endorses the national GHG inventory.

¹⁷ Customs (Duties) Order, Singapore Statutes Online (August 31, 2009).

¹⁸ Figure provided to authors during consultations in Singapore on September 6 and 7, 2018.

¹⁹ Singapore's Second Biennial Update Report, 2016.

At present, most data collected by NEA as part of the M&R requirements is not used in the preparation of the inventory. An exception is the data collected from the IPPU sector as well as certain emissions from fuel combustion in industries (energy sector emissions), in relation to which the NEA fulfils the role of data owner. As the carbon tax mechanism evolves, it is expected that more facility-level data can be used for the purposes of the national inventory.

For the compilation of the 2012 Inventory, Singapore's emissions of CO₂, CH₄ and N₂O were estimated based on the Revised 1996 IPCC Guidelines for National GHG Inventories. Tier 1 methods were applied for most emission estimates using default conversion and emission factors provided in the Guidelines. Tier 2 methods were used for estimating emissions of CH₄ and N₂O from the combustion of petrol and diesel in land transport, in combination with vehicle statistics.

In addition, GWP values used in the preparation of the inventory were based on IPCC's Second Assessment Report. Some work is currently being performed to shift to values from the Fourth Assessment Report, where the main difference is the GWP of methane. However, as methane contributes to only a small proportion of the total emissions in Singapore, updated GWP values would have a marginal impact on the final figures.

2.5 Other initiatives and future developments

Singapore will be the first ASEAN country to introduce an explicit carbon pricing instrument economy-wide. The carbon tax will initially complement existing policies on climate change mitigation in Singapore, and the first five years of implementation will serve as testing ground for future developments. At the same time, the Government is open to adjusting its carbon tax based on the progress of climate change negotiations and an increase in ambition of other Parties on their commitments under the Paris Agreement.

Among these, an option under consideration is to allow the use of international offsets for compliance purposes. This modality is not, however, expected before the end of the first five years of the carbon tax. The government will also be studying the feasibility of transitioning to a linked ETS in the future. The main rationale for starting with a FPCB was to support laying out the building blocks for a future ETS, such as the establishment of a credit registry and a robust MRV framework, which will give the flexibility to transition towards a linked ETS at a later stage, in case the government decides to do so.

3. Concluding remarks and future outlook

Singapore is the first ASEAN country to introduce an explicit carbon pricing instrument targeting the economy as a whole. Designed in the form a fixed-price credit-based mechanism, the tax was set at SGD 5/tCO_{2e} and will be implemented from January 1, 2019. The Government will review the carbon tax level periodically and has intentions to increase the tax gradually to between SGD 10 - SGD 15/tCO_{2e} by 2030. To support the implementation of the tax, the National Environment Agency has developed a facility-level MRV framework based on standards and good practices from several jurisdictions globally, in particular the Greenhouse Gas Protocol, so as to ensure the accuracy, completeness, consistency, relevance and transparency of the emissions reported.

The credit-based carbon tax and MRV framework could serve as foundational blocks for Singapore to link its carbon pricing mechanism with those of other jurisdictions, especially emissions trading systems. However, no concrete plans have been announced and the Government of Singapore is currently studying different options. Elements of Singapore's MRV system which could be further assessed vis-à-vis potential linkages with other systems include:

- a) Harmonization of accounting methodologies on major GHG emitting sectors/sub-sectors with those of the jurisdictions in relation to which linkages are considered;
 - b) Alignment of uncertainty/accuracy level requirements for GHG emission calculations as reflected, for example, in the tier system and quality management framework of the M&R requirements;
 - c) Alignment of the annual compliance cycle for participating entities, e.g. on the dates for the submission of verified emissions reports and the surrendering of credits (or allowances, in the case of an ETS being considered for linkage);
 - d) Alignment of web-based platforms for GHG emission reporting, especially in order to ensure consistency among systems and avoid double-counting risks;
 - e) The consistency in the tools and support materials available as part of the GHG reporting systems under consideration (e.g. monitoring plans and emissions reports).
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