An Analysis of Singapore's Market-Based Tools for Energy Policy

Foreword

Two years after the widely acclaimed Paris COP21 Climate agreement, the scope, modes and monitoring mechanisms of how to finance a low-carbon transition are still widely debated. As direct subsidisation of renewable energies has been more and more criticised due to distorting incentives and high fiscal burdens for the consumer, carbon taxation and market-oriented solutions like Emission Trade Systems (ETS) are now considered as the most effective instruments for the decarbonisation of energy systems.

To contribute to the latter discussion, Konrad-Adenauer-Stiftung has launched a new regional project on Energy Security and Climate Change in Asia-Pacific (RECAP). Based in Hong Kong since 2015, it aims at increasing the flow of ideas between Europe and Asia in the field of energy politics and climate change mitigation and adaptation.

With now more than 35 countries, 15 states and provinces, and 7 cities having implemented ETS, this instrument has gained momentum in Asia – not least to China's proposed national ETS – and amply experiences around the world can already be found and discussed.

Against this background, KAS RECAP commissioned two studies on essential aspects of Singapore's energy transformation, not least due to the fact that global cities like Singapore now play an ever-greater role in global climate change diplomacy.

It is encouraging that Singapore has joined about 170 countries, including China, Japan and South Korea, in having ratified the Paris Agreement. The country has reaffirmed its commitment to address climate change and reduce emissions effectively. Among other instruments, a carbon tax is considered as the "most efficient and fair way to reduce greenhouse gases".

The introduction of a carbon tax is an, but not the only, important milestone on Singapore's energy transformation. Since 2012, a comprehensive framework legislation has paved the way for an ambitious programme to increase energy efficiency as the "first fuel" (IEA).

I thank the author of the two studies on Singapore's recent energy policy, Professor Dr. Maria Francesch-Huidobro, for her valuable insights and clear recommendations. I hope that her findings will contribute to a public debate among different stakeholders in Singapore and beyond on accelerating the energy transformation.

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Singapore's Prospective Carbon Taxes
An Analysis of the Policy Context

Policy Analysis n. 1

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Key Points

- Singapore's power mix is dominated by gas (95.5%). The establishment of an LNG regasification plant in 2013 has expanded its access to global sources and, thus, increased energy security. Total dependence on piped gas is to end by 2030.

- Given geographical and geological constraints, the deployment of renewables and civil nuclear is limited. Currently, PV (by EDB and HDB *SolarNova*; and by PUB and EDB *Floating Solar PV*) and WtE (NEA's Integrated Waste Management Facility 2024) are the major sources of RE for electricity generation amounting to about 4% (2016).

- Energy Efficiency (EE) in industry, buildings, transport, household, water and waste (by EDB and NEA) is, thus, Singapore's key strategy for reducing GHG emissions. Yet, a government regulatory approach to EE may incur high costs and unintended social consequences.

- The deployment of carbon taxes was announced in 2017 as '*the most economically efficient and fair way to reduce greenhouse gas emissions so that emitters will take the necessary actions'* (2017 Budget).

- Pricing carbon through a carbon tax has now been placed at the foundation of the EE strategy. It is anticipated that taxes will encourage changes in consumption, provide market incentives for the adoption of EE technologies, and stimulate the growth of green industries.

- Carbon taxes will be applied upstream, that is, to about 40 direct emitters with yearly emissions of/or above 25,000tCO_2eq.Emitters can opt to improve energy efficiency and reduce emissions or pay taxes. Consumers can opt to use less electricity and save energy (but taxes will not apply downstream). Tax revenue will fund transitional costs as well as measures taken by industries to reduce emissions.

- Thus, it is expected that energy efficiency, low-carbon technology, and reduced emissions will in future 'grow' out of carbon taxes (see Figure 4).

1. The Policy Context

Understanding the policy context within which policy instruments are deployed in the delivery of public policy is essential in assessing the pros and cons a particular instrument may encounter and its success in achieving its intended goal.

Singapore has decided to implement carbon taxes as a market-based instrument to reduce GHG emissions. The policy context of this decision relates to:

1. 1. Trends in Singapore's economic and energy policy;
1.2. Trends in energy demand (buildings, industry, and transport) and supply (primary oil & gas and power sector);
1.3. The nationally determined contributions (NDCs) Singapore has pledged for 2020 (in 2009 Copenhagen) and for 2030 (in 2015 Paris);
1.4. Singapore's GHG emissions;
1.5. Singapore's carbon footprint.

These are discussed.

1.1. Trends in Economic and Energy Policy

Economic Overview

Given its robust services-oriented economy, Singapore's gross domestic product (GDP) is expected to increase from 405 US$ billion PPP[1] in 2020 to 505 US$ billion in 2040 (World Bank 2015; APERC 2016: 280). Due to its projected population growth from 5.7 million in 2020 to 6.2 million in 2040, the total final energy demand (TFED) (2013-2040) will increase by 15% (from 20Mtoe[2] to 23 Mtoe) (Singapore Statistics 2017; APERC 2016).

The city-state is 100% dependent on imports of oil and gas for domestic consumption, including power generation and supplies to its three oil refineries that export refined products. High levels of renewables (including hydro, solar, wind, geothermal, biomass and marine) are unsuitable to a compact, highly urbanised, low wind, tropical locality. Nuclear energy has been excluded given its safety risks.

The domestic TFED utilised in buildings, industry and transport (20 Mtoe in 2013) is significantly smaller than the total primary energy supply (TPES) (23 Mtoe). This substantial gap is due to the fact that a large proportion of the oil supplied (imported) is refined and re-exported (52Mtoe in 2013) as well as utilised by the international shipping and aviation industries that demand large quantities of bunker and jet fuels (IEA 2016; APERC 2016).

Energy-related emissions were 47MtCO_2e in 2013 and are projected to rise to 53MtCO_2e in 2040 and stabilise thereafter (ibid.).

[1] PPP: purchasing power parity
[2] Mtoe: million tonnes oil equivalent

While the refinery sector is a large source of revenue, it creates a situation of embedded emissions in products that are processed by not consumed domestically. This is a challenge in calculating the city's GHG emissions and in setting 'effective' reduction targets.

Energy Policy: The Energy Policy Group and the National Energy Report 2007

In 2007, Singapore took a 'whole of government' approach to energy policy with the establishment of the Energy Policy Group (EPG). Ministries and agencies with portfolios touching on energy were institutionally brought together to formulate, coordinate and implement an energy policy framework and study a wide-range of energy related issues in the power, transport sectors, energy efficiency, climate change, energy industry, R&D, and regional and international cooperation.

Under the leadership of the Ministry of Trade and Industry (MTI), EPG includes the ministries of Environment and Water Resources (MEWR), Foreign Affairs (MFA), Transport (MOT), and Finance (MOF) and agencies such as the Energy Market Authority (EMA), the Economic Development Board (EDB), National Environment Agency (NEA), Land Transportation Authority (LTA), and Building and Construction Authority (BCA).

In the same year, EPG published the Singapore National Energy Report: Energy for Growth (NER 2007) with the objective of balancing energy security, economic competitiveness, and environmental sustainability. To operationalise these objectives, five strategies were devised:

1) Promoting competitive markets;
2) Diversifying the fuel mix;
3) Enhancing energy efficiency;
4) Developing the energy industry by investing in energy R&D, and;
5) Upscaling international cooperation.

These strategies are resulting, among others, in an end of total dependence on piped-gas imports from Malaysia and Indonesia and, instead, reliance on global imports of liquefied natural gas (LNG) that is regasified locally.

They have also resulted in: a) the deployment of photovoltaic (PV) under the *SolarNova and Floating PV programmes* for government buildings, public spaces and reservoirs that are used as test beds for the potential deployment in the private sector; b) the intensification of energy efficiency to support Singapore's commitment to reducing carbon intensity -36% from 2005 levels by 2030; and c) investing in R&D by 'building a clean energy ecosystem with a critical mass of companies, skilled manpower, and R&D capabilities' (MTI 2015).

It is under the promotion of competitive markets strategy that market-based instruments (carbon taxes) have been considered with the decision to introduce them made in the 2017 Budget (C6-C10) (see Section 2).

1.2. Trends in Energy Demand and Supply

Following a business as usual scenario (BAU)[3] with the purpose of outlining likely energy futures, Singapore's energy trends are as follows (APERC 2016, Vol. II: 282):

- In the buildings and industry sectors, a continued efficiency improvement due to programmes in place;
- In the domestic transport sector, a continued expansion of light rail (MRT) and discouraged growth of private vehicles;
- In the energy supply mix, a continued increase of oil and gas imports and increase in global LNG to end the 100% reliance on piped gas;
- In the power mix (electricity), a discontinuation of coal, deployment of limited PV, increasing trends in waste-to-energy (WtE), and no nuclear;
- In the overall access to renewable energy (RE), WtE (from incineration) will remain the main RE fuel together with a PV penetration of 600 megawatts peak demand (MW_p);
- In ensuring energy security, the requirement of having 60 days-worth of fuel reserves to be held by generation companies (gencos) remains;
- Finally, with regards climate mitigation, policymakers thinking is that there is limited room for reducing CO_2 emissions due to the city's heavy dependence on imported fossil fuel energy because of the absence of local resources.

The limitation of the BAU is that it assumes a continuation of current energy demand and supply trends, does not factor in improved efficiency, high renewables, or a diverse fuel mix (electricity generation) other than a high reliance on gas.

Demand

According to APERC 2016, following the same BAU, the overall trend is that TFED is set to increase by 15% (from 20Mtoe in 2013 to 23Mtoe in 2040) with the non-energy sector (oil refineries) being the major contributor. The industry and buildings share of TFED will also increase while in the transport sector it will decrease due to a strong policy of discouraging private vehicular ownership.

In the building sector, energy demand will grow from 24Mtoe (2013) to 30Mtoe (2040) due to factors such as population growth, rising living standards and consequential use of more appliances and electronic devices, and GDP growth. Commercial buildings take the bulk of the demand (74%) while the share of residential demand will decrease by about the same percentage. The fuel mix in buildings will see a decrease in the share of electricity due to fuel efficiency and an increase of gas that accounts to 95.5% of the power mix. Several legislative instruments will continue to contribute to greater energy efficiency in buildings: Building Control Regulation 2008; Building Control Act 2012; Building Control Regulation 2013 (setting Green Mark Standards for new builds and retrofits with regards energy efficiency, water efficiency; environmental protection; indoor environmental quality; and others).

[3] BAU is defined here as one where current policies and trends will continue (APECR 2016, Vol. II: 1). The Singapore's Government definition of BAU may be different.

In the industrial manufacturing sector (chemical, petrochemical, shipbuilding, biomedical, electronics), there will also be an increase in energy demand from about 5.9Mtoe in 2013 to about 7.6Mtoe in 2040. This growth is attributed to an improvement in the sector's energy intensity from 17toe per USD million in 2013 to 15toe per USD million in 2040 (APERC 2016: 284). Energy efficiency in this sector is currently supported by government policies such as: Energy Efficiency National Partnership (EENP); Energy Efficiency Improvement Assistance Scheme (EASe), and Grant for Energy Efficient Technologies (GREET) for SMEs. Since 2013, the government has required all industrial companies consuming 54TJ/yr of energy or more to comply with the Mandatory Energy Management Requirements (MEMR). The chemicals and petrochemicals industry are the single largest industrial manufacturing consumers that will experience an increase in energy demand from 2.2 Mtoe in 2013 to 3 Mtoe in 2040. This is reflective of Singapore's very stable industry structure. Energy demand in all industrial manufacturing (pharma, biotech, electronics, environment and water) will also see growth from 3.6 Mtoe to 4.5Mtoe during the same period (ibid.).

In the domestic transport sector energy demand is projected to decline from roughly 3Mtoe in 2013 to 2.6Mtoe in 2040. This is the result of several government initiatives like decreasing the role of private vehicles and light-duty vehicles, and increasing the millage of light rail (MRT). But energy sources stay steady with oil seeing a slight decrease in the domestic transport demand (from 2.5 Mtoe to 2.1Mtoe), electricity increasing slightly from 0.2 Mtoe to 0.42Mtoe as the MRT expands, and gas experiencing a small share taken mainly by a fuel switch (to liquefied petroleum gas- LPG) in light-duty vehicles (ibid.).

Supply

Total energy imports are expected to increase from 73Mtoe in 2013 to 101Mtoe in 2040. Oil share (64Mtoe) is expected to remain steady till 2040. Gas shares are expected to rise from 8.9Mtoe to 12Mtoe (APERC 2016).

Oil imports delivered via tankers navigating in protected sea lanes will be derived from an increasingly large pool of countries to ensure energy security. These will continue to be intended for the export market as refined products will remain a significant source of revenue.

Gas imports, on the other hand, are intended for domestic consumption, mainly, in the power generation sector where gas accounts for 95.5% of the power mix (EMA 2015a). These are projected to increase from 8.9Mtoe in 2013 to 12Mtoe in 2040 (APERC 2016).

1.3. Singapore's Nationally Determined Contributions (NDCs)

Providing the driving force to the EPG and the NER 2007 mentioned above are the NDCs. In 2016, the city pledged to reduce energy emissions intensity -36% from 2005 levels by 2030[4] and to stabilise its carbon emissions to 65 $MtCO_2e$[5] at current rates by 2030. Although Singapore is one of the least carbon-intensive economies ranking 123 out of 140 countries

[4] The St. Petersburg Declaration (2012) introduced an aggregate energy emissions intensity aspirational goal for all APEC economies of -45% from 2005 levels by 2035.
[5] $MtCO_2e$ million tonnes of carbon dioxide equivalent.

(if embodied GHG of imported goods, shipping and aviation are excluded), its per capita emissions ranks 26 out of 142. This means an increase of 143% from 1994 emissions level (Climate Action Tracker: Singapore).

Climate Action Tracker rates Singapore's 2020 (Copenhagen) and 2030 (Paris) pledged targets as 'highly insufficient'. Saying: 'The "Highly insufficient" rating indicates that Singapore's climate commitment in 2017 is not consistent with holding warming below 2°C, let alone limiting it to 1.5°C as required under the Paris Agreement, and is instead consistent with warming between 3°C and 4°C: if all countries were to follow Singapore's approach, warming could reach over 3°C and up to 4°C. This means Singapore's climate commitment is not in line with any interpretation of a "fair" approach to the former 2°C goal, let alone the Paris Agreement's 1.5°C limit. If [we] were to rate Singapore's projected emissions levels in 2017 under current policies, Singapore would also be rated "Highly insufficient"' (Climate Action Tracker: Singapore).

Table 1: Singapore's Climate Commitments (Source: Climate Tracker 2016)

Copenhagen pledge	
2020 target	7-11% below BAU by 2020 (unconditional) [138-168% above 1994 by 2020] 16% below BAU by 2020 (conditional) [100% above 1994 by 2020]
Conditions	Conditional to legally binding international agreement
Paris Agreement target	
Ratified	Yes
2030 target	-36% of emissions intensity below 2005 by 2030 [143% above 1994 by 2030]
Coverage	Economy-wide, all gases covered
Emission peak target	2030
Long term goal(s)	
Long-term goal(s)	-45% of emissions intensity below 2005 by 2035 **(Aspirational goal)**

It is important to note too that, despite the five-prone strategy approach, reduction targets are mostly to be met by energy efficiency (EE) measures in various sectors under the *Energy Conservation Act* implemented since 2013 (Chapter 92C, latest amendment 2014; See also policy paper n. 2 Francesch-Huidobro 2017). The Act mandates energy management requirements for large emitters: Part III domestic & industrial; Part IV transport sector (Singapore Statues Online 2014).

1.4. Singapore's GHG Emissions

Although it is difficult to access Singapore's GHG emissions data (sources included and methodologies greatly vary between International Energy Agency (IEA), US National Energy Information Administration, Carbon Dioxide Information Analysis Centre, official communications of Singapore to the UNFCCC, etc), the per capita emissions in Singapore are about 8.5 tonnes CO_2 (ranking 26th highest out of 142 countries) which accounts for 0.11% of

global emissions (UNFCCC 2015; Climate Action Plan p. 6, Singapore's GHG Emissions Profile (primary & secondary emissions).

The share of direct emissions per sector and the indirect emissions for each sector's electricity usage is (NCCS 2016: 6 (data of 2012):

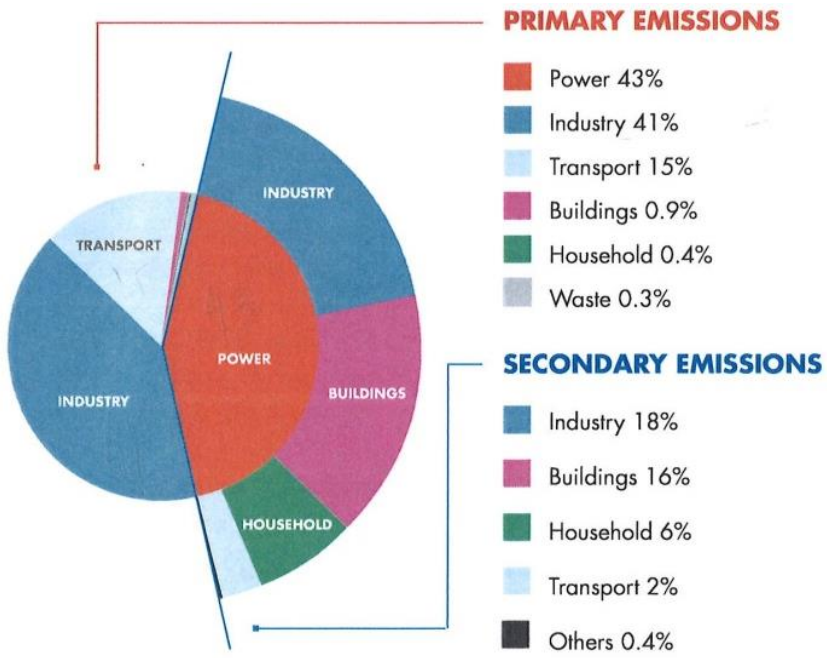
Primary emissions:

- Power 43%
- Industry 41%
- Transport 15%
- Buildings 0.9 %
- Household 0.4 %
- Waste 0.3%

Secondary emissions (from electricity use):

- Industry 18%
- Buildings 16%
- Household 6 %
- Transport 2%
- Others 0.4%

Figure 1: Singapore Emissions Profile 2012 (Source: NCCS 2016: 6)



When combined, they represent the total GHG emission by sector (i.e. industry 59%). Total emissions were 49MtCO_2e (2012).

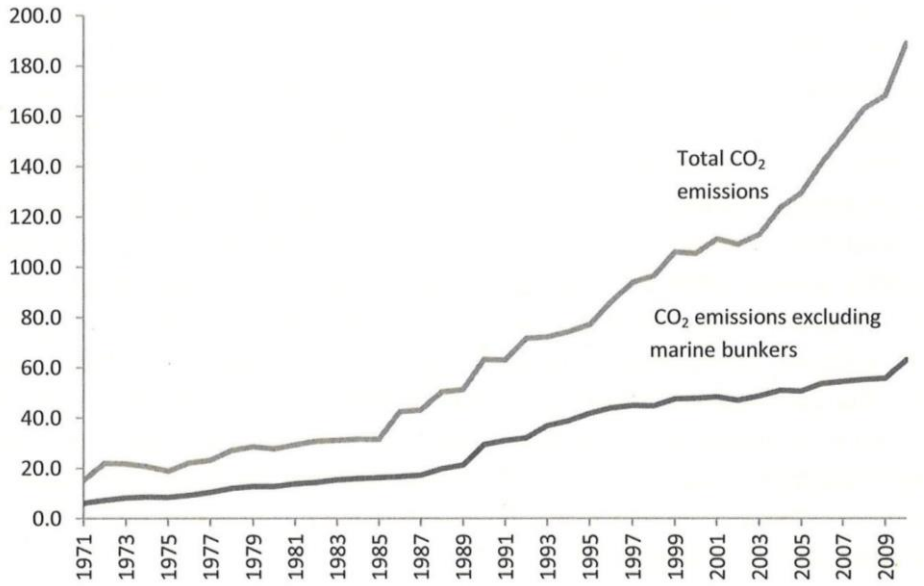
With limited possibility of increasing RE and the unsuitable development of civil nuclear within its 719 Km^2 land area Singapore is totally dependent on fossil fuels.

According to APERC's Energy Outlook 2016 (p. 292), 'total energy related CO_2 emissions under the BAU will grow by 14% from 43MtCO_2e (2013) to 53MtCO_2e (2040). [6]

1.5. Singapore's carbon footprint (embodied carbon in imported goods)

As an economically open city-state, Singapore's accounting of emissions and calculation of its carbon footprint[7] is challenging. Shall *direct* emissions from activities on the territory be counted (i.e. domestic sales of locally-manufactured products) only, or should those emissions emanating from upstream activities (*indirect*) be included (i.e. import of fuels for power generation), or even the export of these indirect emissions (i.e. import of refined oils)?

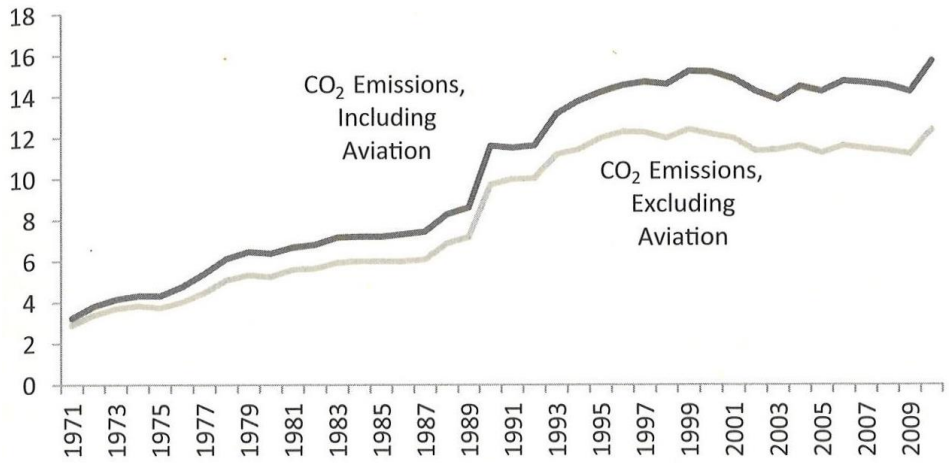
Figure 2: CO_2 Emissions with and without Marine Bunkers (million tonnes) (Source: Doshi 2015: 124)



[6] Singapore government anticipates emissions will peak in 2035 to 65Mt$CO_{2\text{-}e}$

[7] Carbon footprint is the total GHG emitted by individuals, events, and products expressed in carbon dioxide equivalent.

Figure 3: CO_2 Emissions with and without Jet Fuels (tonnes per capita) (Source: Doshi 2015: 147).



In Schulz' (2010) accounting, the volume of indirect emissions was high (80MtCO_2e to 130MtCO_2e in between 1995-2005), with Singapore reporting to the UNFCCC 26.5MtCO_2e in 1994 (ibid. p. 4851). Indirect GHG emissions embodied in products traded in Singapore, exceeded direct emissions by a factor of 4-5 (in between 25Mt to 325 MtGHGe[8] (ibid. p. 4851). Exports of indirect emissions were generally lower but in a similar order of magnitude between 3-4 times the direct emissions (ibid. p. 4853).

These findings (summary Table 2 Schulz 2010: 4852) 'are important in assessing the usefulness of using an urban scale emissions account and its value in identifying the most effective climate mitigation potential if only direct emissions are accounted for'.

Singapore's paradox is that its compact structure and well-planned and regulated transport system, results in its per capita energy use and emissions being low (as mentioned). But the actual direct emissions data varies greatly per source and is quite high due to its international trade volume (shipping and aviation) and to the international bunkers involved (shipping bunker and aviation fuel) although bunker oils are a separate category according IMO and its accounting should not be allocated to individual countries (email communication NEA to CCA).

2. The Carbon Tax

Where do carbon taxes fit in the context of these economic and energy policy trends, trends in energy demand and supply, Singapore's NDCs, GHG emissions and carbon footprint?

Why the choice of market-based instruments at this point? How do these differ from traditional command and control regulation?

[8] Million tonnes greenhouse gas equivalent

2.1. The 2017 Budget on Carbon Tax

In February, Budget 2017 announced:

> *'Singapore has joined more than 130 countries, including China, Japan and South Korea, in having ratified the Paris Agreement, re-affirming our commitment to address climate change and reduce emissions. It is in our own interest to support the international coordination required to deal with an issue that affects all countries, and in particular, small-island states like ours (C.6).*
>
> *There are different ways to reduce emissions. One is to ensure consumers understand the effects of their actions. So we have* ***energy efficiency labels****, like ticks on air-conditioners or refrigerators. Another is to regulate for higher standards. Singapore has good* ***environmental protection standards*** *and the Ministry of the Environment and Water Resources continues to ensure that our regulations are up-to-date.* ***But the most economically efficient and fair way to reduce greenhouse gas emissions is to set a carbon tax, so that emitters will take the necessary actions (C.7).***
>
> *Singapore has studied this option for several years. We intend* ***to implement a carbon tax on the emission of greenhouse gases.*** *We will consult widely with stakeholders, and aim to implement the carbon tax* ***from 2019****. The tax will generally be applied upstream, for example, on power stations and other large direct emitters, rather than electricity users (C.8).*
>
> *We are looking at a* ***tax rate of between $10 and $20 per tonne of greenhouse gas emissions[9].*** *This is in the range of what other jurisdictions have implemented. It will create a price signal to incentivize industries to reduce their emissions, complementing the regulatory measures which we are also introducing. It will help us to achieve our commitments to reduce emissions under the Paris Agreement, do so efficiently and at as low a cost to the economy as possible. This may also spur the creation of new opportunities in green growth industries such as clean energy. Revenue from the carbon tax will help to fund measures by industries to reduce emissions. The impact of the carbon tax on most businesses and households should be modest (C.9).*
>
> *The Government has started* ***industry consultations*** *and will continue to reach out. Public consultations will begin in March. The final carbon tax and exact implementation schedule will be decided after our consultations and further studies. We will take into consideration the lessons from other countries and prevailing economic conditions in Singapore in implementation. We will also provide appropriate measures to ease the transition'* (MOF Budget 2017: Moving Forward Together, C.10).

[9] The price per tonne was ultimately settled at $5 for the first 5-year deployment period (2019 to 2023). https://www.mewr.gov.sg/topic/carbon-emissions (accessed 27 June 2018)

Budget 2017 also announced a carbon tax at a rate of between **S$18-20 per tonne of GHG[10].** This will be equivalent to a rise in electricity price between 0.43-0.86 cents KWh or S$2.1-4.3 **rise in electricity from an average of S$72/month (per 4 bedroom household) to S$76/month**. The carbon tax is **mainly targeting between 20-30 power stations** that will be required to begin paying taxes by **2019[11].** It is linked to the Paris Agreement ratified in 2016 as the 'most economically efficient and fair way' to mitigate emissions (National Climate Change Secretariat (NCCS). The Singapore government anticipates the co-benefit of carbon taxes to be in the form of promoting clean energy growth as revenue collected will help fund measures by industries to reduce emissions (NCCS).

Singapore's *Climate Action Plan* (2016) sets out four strategies to achieve its pledge: a) improving energy efficiency, a) reducing carbon emissions from power generation, c) developing and deploying cutting-edge low-carbon technologies, and d) encouraging collective action among government agencies, individuals, businesses, and the community.

NCCS affirmed that with regards emissions reduction: 'A carbon tax will enhance Singapore's existing and planned mitigation efforts under our Climate Action Plan, and stimulate clean technology and market innovation. A tax on greenhouse gas (GHG) emissions will incentivize emitters to factor in the costs of their GHG emissions in their business decisions. This would encourage companies to improve their energy efficiency and innovate to reduce their GHG emissions' (NCCS 2016: 25).

Who will be covered?

The carbon tax will be applied upstream, for example, on power stations and other large direct emitters. For stationary emissions, the government is looking at a proposed threshold of 25,000 tCO_2e of greenhouse gas (GHG) emissions annually. This is equivalent to emissions produced by the annual electricity consumption of 12,500 Housing Development Board (HDB) 4-room households. Based on current data, there are around 30-40 of such large direct emitters (NCCS FAQ online):
(1) Three refineries and petrochemical facilities: Royal Dutch Shell, Exxon Mobil, Singapore Refining Company;
(2) Fifteen power generation licensees by the Energy Market Authority. List here: https://www.ema.gov.sg/Licensees_Electricity_Generation_Company.aspx;
(3) Bulk and specialty chemicals manufacturers. List here: http://singapore-companies-directory.com/Categories/singapore_chemicals.htm#Singapore Chemicals Companies;
(4) Semiconductors and wafer manufacturers. List here: http://www.singapore-companies-directory.com/Categories/singapore_semiconductors.htm#Singapore Semiconductors Companies, etc)
(5) Shipbuilding companies. List here: http://www.singapore-companies-directory.com/Categories/singapore_ship_building.htm#Singapore Ship Building, Ship Repair Companies
(6) Biomedical and biotechnology manufacturers. List here: http://singapore-companies-directory.com/Categories/singapore_biotechnology.htm#Singapore Biotechnology Companies
(7) Electronics manufacturers. List here: http://www.singapore-companies-directory.com/Categories/singapore_electronics.htm#Singapore Electronics Companies

[10] Refer to Footnote 9 p. 13
[11] Other sectors of the industry that are large direct emitters such as petrochemicals and refineries, semiconductor manufacturers, and biotechnology manufacturers will also be taxed.

Petrol, diesel and compressed natural gas (CNG) is exempted as these commodities are already excised.

What GHG will be covered?

The six greenhouse gases that will be covered under the carbon tax are: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulphur hexafluoride (SF_6) (ibid.).

What is the expected impact on business: economic efficiency and fairness?

The increase in operating cost from S$10-20/t$CO_2$e carbon tax is equivalent to US$3.5-7.0/barrels (bbl) increase in crude oil prices[12]. This represents a 6.4% to 12.7% increase from current oil prices (2016), compared to historical quarterly oil price fluctuations which have ranged from -29% to +35% from 2011 to 2016. Companies will receive greater government support for industrial energy efficiency. Possible forms of support include more information about energy efficiency improvement opportunities, enhancing existing energy efficiency incentives, and providing capability-building for companies to put in place better energy management systems. The government is also studying different modes of assistance to help businesses with the transition. Views from companies and the public were sought via industry consultations and public consultations which began in March and were completed in May 2017 (ibid.) (see NCCS, Public Consultations, Annex).

How will it be operationalised?

Given the fact that the National Environment Agency (NEA) is communicating with industry regarding carbon taxes, this tool will be operationally linked to the promotion of energy conservation and efficiency which are NEA's core tasks, via the Energy Efficiency Programme Office (E^2PO), a multi-agency committee lead by NEA in collaboration with Energy Market Authority (EMA).

Two new tools will be supporting the deployment of carbon taxes:

- ***Energy Efficiency Opportunities Assessment*** (EEOA) by which any company using more that 54TJ of energy will have to be assessed by 2021. Companies using more that 500TJ will be assessed every 6 years, while those using between 54 and 500TJ will be assessed every 3 years.

Companies are to appoint energy assessors. EEOA Assessors' role would be to identify energy efficiency opportunities, recommend energy efficiency opportunities, and prepare assessment reports at ISO50002 standards. Assessors will have to be certified yearly according to a given criteria.

- ***Measures Report Verification System*** (MRVS). MRVS applies to all industrial sector firms with emissions of more than 25,000t CO_2 per year. There are two elements of MRVS:

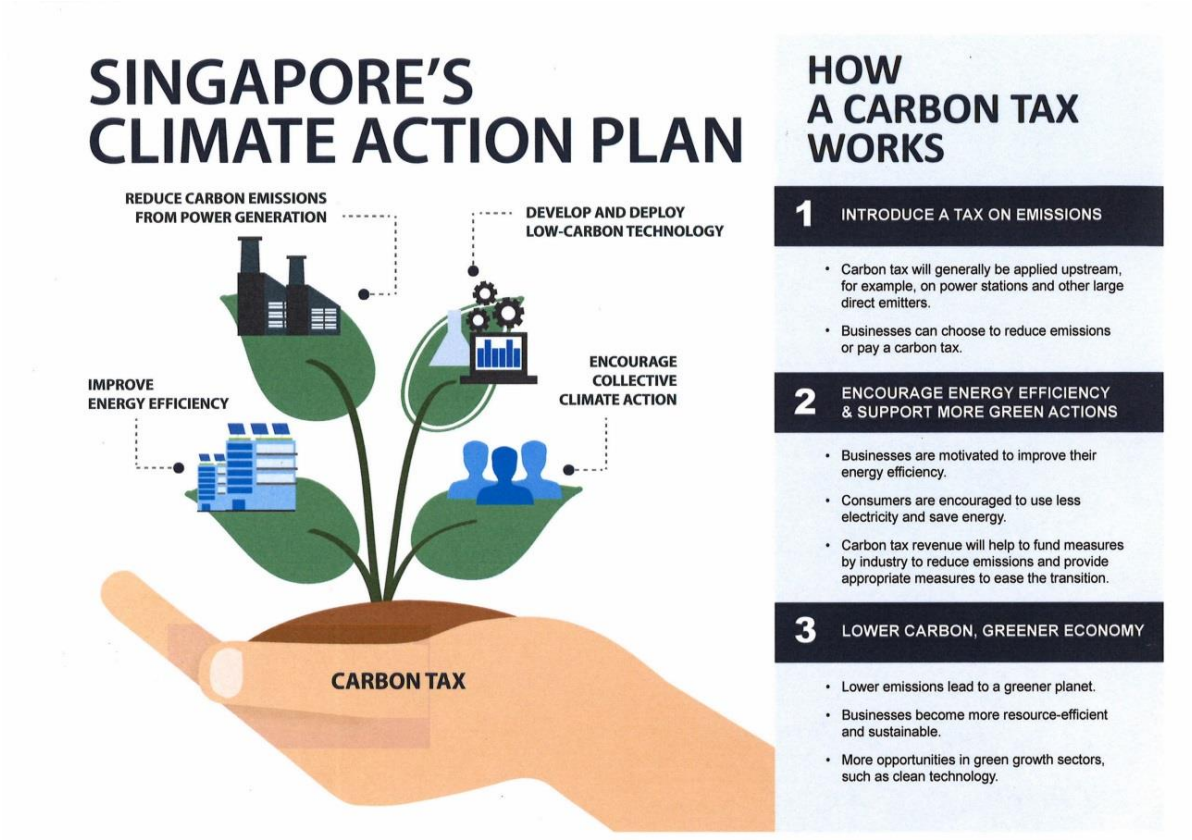
[12] Refer to Footnote 9 p. 13

- A ***Monitoring Plan*** (MP) that discloses how a firm calculates (computation) its GHG emissions and the methodology it uses, and;

- An ***Emission Report*** (ER) that summarises the company's emissions including comments from third-party verification which should be audit firms and/or certification companies with a lead auditor certified to ISO14065 standards. ER will require each firm to appoint a GHG manager that must be in-house.

The National Energy Policy 2007 and Climate Action Plan make explicit connections between the introduction of taxes, the encouragement of energy efficiency, and the low carbon economy (cleaner production and consumption) (Figure 4).

Figure 4. Carbon Taxes and Singapore's Climate Action Plan (Source: NCCS 2016).



2.2. What are the advantages/disadvantages of market-based instrument versus command and control tools?

Carbon taxes use government regulation determining its deployment and market signals linking the value of goods and services to their 'true' cost, including externalities[13]. They have the following *advantages* (Doshi 2015: 173-178):

[13] The cost or benefit that affects a party that did not choose to incur such cost or benefit.

- Correct market failure leading to economic efficiency as GHG emissions are an unpriced externality;
- Allow flexibility for firms to determine how to best achieve reduction targets depending how much it will cost them;
- Raise revenue by definition;
- Establish a carbon price creating market incentives to reduce emissions by developing and investing in cleaner technologies;
- Exemptions/surcharges can have the effect of further mitigating undesirable social or economic behaviour in consumption and production patterns.

But taxes also have potential *disadvantages*:

- Taxes fix the price of carbon but allow emissions' levels to vary. Reduction of GHG emissions cannot be pre-determined as may be the case with cap-and-trade which fixes emissions reduction and allows costs to be determined by market;
- If fiscal regimes vary greatly with the government of the day, taxes become a very unpredictable tool in curbing emissions. In the case of Singapore, given the political continuity provided by its one-party-dominant system, taxes are 'safe';
- The compliance flexibility for firms is not very high: a firm needs to yearly budget how much to mitigate and how much to pay in taxes;
- Tax law and tax administration can be slow in responding to rapid economic conditions and may become obsolete, as such;
- Although taxes are relatively simple to administer there can be strong lobbies calling for exemptions (but not the case in Singapore, as of now).

On the other hand, the *advantage* of using government regulation (i.e. permits, prohibitions, standards, enforcements, etc) is that desired actions can be prescribed to achieve a specific objective in case of serious environmental impact (i.e. handling of radioactive waste). Regulation also has the advantage of being simple to administer (i.e. by setting technical installation standards of abatement that do not require regular measurement and monitoring).

The *disadvantage* of using regulation that applies across the board is that it increases costs for firms with high mitigation costs that have to make the same reduction as those with low mitigation costs. As information about such costs is very difficult to obtain by governments, the result is the unfair application of rules without differentiating their effects on those to whom they apply. This can have unintended consequences like dissuading foreign investors and adding cost of living to citizens.

3. Conclusion & Recommendations

Singapore's strategic location between the Indian and Pacific Oceans has made it a leading financial, transport, and oil trading centre. It now also aspires to be an LNG hub. Trends suggest that its economy will continue to grow in the foreseeable future. The city will continue to be dependent of imported fuels and room for more RE penetration will remain limited. Nuclear is, for now, out of the question. Energy demand will continue to be much lower than supply given that much of what is supplied is exported as refined products. This

poses questions about the city's calculation of its GHG emissions and setting of reduction targets. GHG emissions will continue to grow but eventually stabilised.

Energy policy has been institutionalised across government in the form of the Energy Policy Group and the national strategy announced in 2007 (Energy for Growth: National Energy Report – NER). The NER included the deployment of market-based instruments and, thus, carbon taxes will be deployed from 2019. Carbon taxes are being explicitly linked to the key reduction strategy of energy efficiency which, up to now, has been driven by strong government regulation with its potential high costs and unintended social consequences.

With no room to 'improve' the fuel mix in electricity generation, EE will remain the main stay of any carbon reduction future but will be less reliant on government regulation by pricing carbon through the deployment of carbon taxes. These are intended to internalise environmental externalities. In a one-party political system, the support from the industry in up-taking carbon taxes is almost guaranteed given the predictability of the fiscal regime, tax laws and tax administration. Yet, high emitters may find reductions too burdensome and economically difficult to bear.

This policy analysis is intended as a contribution to ongoing debates on energy security and climate change mitigation in Asia-Pacific. Besides facilitating collaboration between industry, governments and citizens, the analysis can help raise awareness through dialogue and policy analysis to:

- Ensure that levels of carbon taxes are comparable to international experience and that they drive companies to set up reduction targets;
- Make companies aware that their reduction targets are contributing to Singapore's NDCs;
- Continue to monitor IMO[14] and ICAO[15] emissions reduction developments;
- Engage the Singapore government on the question of embedded emissions;
- Persuade publicly listed companies to share their Emissions Report via the Singapore Exchange (SGEX) to encourage constructive benchmarking and public scrutiny;
- Consider how carbon taxes can be supplemented by other instruments such as allowing high emitters for whom reductions will be too costly to offset their emissions by purchasing internationally accredited carbon credits;
- Take account of results of the industry and public consultations 20 Mar to 20 Apr 207 regarding the proposed carbon taxes.

[14] In 2011, IMO adopted mandatory technical and operational energy efficiency measures which are expected to reduce the amount of CO_2 emissions from international shipping. These mandatory measures (EEDI/SEEMP) entered into force on 1 January 2013. In 2012, international shipping was estimated to have contributed about 2.2% to the global emissions of carbon dioxide (CO_2). Further improvement of its energy efficiency and effective emission control is needed as sea transport will continue growing apace with world trade (http://www.imo.org/en/OurWork/Environment/PollutionPrevention/AirPollution/Pages/Default.aspx

[15] ICAO adopted new emissions standards for aircraft https://www.icao.int/Newsroom/Pages/ICAO-Council-adopts-new-CO2-emissions-standard-for-aircraft.aspx

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Key Agencies

- International Energy Agency (IEA) – Paris http://www.iea.org/
- Asia Pacific Energy Research Centre (APERC) – Tokyo http://aperc.ieej.or.jp/
- Building and Construction Authority (BCA) – statutory body- building standards and regulations
- Economic Development Board (EDB) – statutory body- global operations and corporate development
- Energy Market Authority (EMA) – statutory body- regulator
- Inter-ministerial Committee on Climate Change (IMCCC) (Resilience, International Negotiations, Long Term Emissions and Mitigation Working Groups - develops Singapore climate pledges)
- Land Transport Authority (LTA) – statutory body- planning design, building and maintenance of land transport
- Ministry of Environment and Water Resources (MEWR) – environmental protection and water security
- Ministry of Finance (MOF) – fiscal policy
- Ministry of Foreign Affairs (MFA) – international relations/negotiations
- Ministry of Trade and Industry, Energy Division (MTI) – industry and trade development
- Ministry of Transport (MOT) - mobility
- National Climate Change Secretariat- Prime Minister's Office (NCCS-PMO)
- National Environment Agency (NEA) – statutory body - promotion of energy efficiency (E_2PO)
- Public Utilities Board (PUB)- gas & water policy
- UNFCCC, Climate Change Secretariat, Emissions Summary for Singapore

Key Energy Efficiency Government Schemes (Climate Action Plan 2016: 14)

- ***Capacity Building:***

Singapore Certified Energy Manager (SCEM)
Energy Conservation Act (ECA)
Energy Efficiency National Partnership Programme (EENP)

- ***Financing:***

EE Financing Pilot Programme

- ***Incentives:***

Resource-Efficient Design S$600,000 per project (cap)
Energy Audits co-funded by NEA S$200,000 per project (cap)
Retrofit Projects for energy efficient equipment and technologies, 20% co-funded by EDB and NEA
Grants and tax deductions under Accelerated Depreciation Allowance Scheme (ADAS)

Energy Efficiency (EE) in a Non-Subsidies Energy Regime: Singapore's EE Measures and the Uptake of Carbon Taxes

Policy Analysis n. 2

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Key Points

- Energy efficiency in industry is Singapore's key strategy for reducing emissions;
- The EE strategy translates into the deployment of 'command and control' measures and, from 2017, also into market-based instruments, carbon taxes (to start 2019);
- Energy efficiency measures apply to supply side (by means of engineering and technology process) and to end-use demand side (by means of mandatory standards, labels, etc);
- Singapore's energy efficiency measures support Singapore's goals of energy security, higher labour productivity, and enhanced economic development;
- The energy efficiency 'gap' should not be underestimated and the market barriers to the uptake of energy efficient investments should be identified;
- In a no-subsidies energy regime, energy efficiency is limited by the 'true' cost conditions. Under such conditions, there are no incentives to reduce energy use as doing so does not affect cost.

1. Energy Efficiency

1.1. What and Why?

Described as the proportion between the benefit gained (i.e. heating) and the energy used (i.e. tonnage of oil), **energy efficiency (EE)** refers to the ratio of benefits to expenses in the conversion of energy supplied or in the end-use of energy demanded.

EE policies began to develop as a result of the 1970s oil crisis. Policies have included not only engineering measures (i.e. LED lighting) but also institutional and behavioural measures (i.e. subsidies, mandatory standards, labelling and information). Since the year 2000, the emissions mitigation potential of EE has been part of the UNFCCC drive to mitigate climate change due to human activity (UNFCCC, Summary for Policymakers 2016).

Driven by concern with energy security in the face of scarce resources, since the 1980s, global trends have been to reduce **energy intensity (EI)** (the amount of primary energy demand (PED) needed to produce one unit of GDP) by including energy efficiency measures in strategic plans. Wealthier countries tend to now have lower energy intensity levels, and, in general, energy intensity has fallen (i.e. between 1980 and 2010, China's energy intensity fell fivefold (Doshi 2015: 208- 209). Other countries, especially rapidly industrializing Asian economies, show no EE improvements. For example, Singapore has had from the 1980s an average 0.200 kg of oil equivalent per constant 2005 international $, showing no improvements in EI trends (ibid.).

Consistently, the IEA has promoted through its long- term forecasts EE as more significant than RE or nuclear in contributing to climate mitigation (IEA Market Report Series, Energy Efficiency 2017). The co-benefits of EE have also been highlighted, for example, the aggregate achievement of reducing intensity and consumption through energy efficiency (Doshi 2015: 208).

IEA has compiled comprehensive databases of EE policies and measures undertaken by governments in OECD and non-OECD economies under the categories of economic instruments; policy support; regulatory instruments; information and education; voluntary approaches; R&D and deployment in the buildings, appliances, transport and industry sectors (IEA 2015; Doshi 2015: 210).

IEA often refers to EE as the 'first fuel', positing that it offers the benefits of a clean, domestic, energy source for emerging economies (IEA E4 Programme 2016). These benefits include improved energy security, higher labour productivity and enhanced economic development.

Given that **energy demand** (ED) in emerging economies is projected to grow significantly over the next decades[16] , improving energy efficiency in these countries is more crucial than ever. Energy use will also be one-third higher than previously under the IEA New Policies

[16] Primary energy demand (PED) in Southeast Asia by 2040 is projected to be 1,084 Mtoe. China's PED is projected at 3,892Mtoe by the same year (IEA E4 Programme 2016),

Scenario[17]. This scenario forecasts that emerging economies will account for more than 90% of global net energy demand growth by 2035 (IEA 2013).

UNFCCC Summary for Policy Makers (SPM) (2016) posits that energy is the largest contributor to GHG emissions and these will continue to increase due to economic growth and higher use of coal (p. 25). Yet, global energy related CO_2 emissions were flat in 2014 although GDP grew by 3%[18]. **This was the first time since records began when a decoupling of emissions and the global economy was perceived in the absence of economic crisis.**

There is, nevertheless, potential for more reductions. For example, use of carbon-free energy from sources such as RE and nuclear, carbon capture and storage (CCS), enhanced EE in production distribution and consumption.

Policy options in the pursuit of best practices continue to focus on 'traditional' standards-setting for appliances, tax incentives, performance standards and certification programmes for buildings, and greater efficiency in industry. But more emphasis is now placed in introducing **Energy Management Systems ISO50001.** The UNFCCC initiated the Energy Management Campaign during the 7th Clean Energy Ministerial 2016 stating that: 'if 50001 certificates could be given by 2020, the aggregate energy savings would be 63 exajoules[19] by 2030 and cost savings could amount to US$600 billion, with GHG reduction amounting to 6,500Mtoe' (UNFCCC SPM 2016: 26).

1.2. Pros and Cons of Energy Efficiency as tool for GHG reduction: The Energy Efficiency 'Gap'

EE is intended to cut energy demand cost effectively but studies find that 'only a small part of its economic potential is exploited' (cited in Doshi 2015: 219). This has led to the, so called, energy efficiency gap or 'the difference between the level of efficiency actually achieved and the level judged to be optimal at prevailing prices' (ibid.). This gap is often created by the ineffective implementation of EE measures and practices, the haphazard deployment of supporting instruments such as carbon taxes, and the reluctance to invest in new EE technologies and operations. But, what are the barriers to making best economic choices?

First, in a scenario of no economic downturn, barriers range from credit unavailability, high initial capital costs, lack of information about the benefits of new technologies, lack of operational capacity (training of labour) to handle these technologies, lack of foresight regarding future energy savings – the, so called, myopic behaviour- uncertainty about future

[17] New Policies Scenario serves as the IEA baseline scenario. It takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce GHG emissions and plans to phase out fossil-energy subsidies, even if the measures to implement these commitments have yet to be identified or announced (IEA https://www.iea.org/publications/scenariosandprojections/).

[18] On 13th November 2017, it was reported that carbon emissions are likely to surge by 2% in 2017, mainly due to coal increase in China. This will be total global carbon emissions to 41 billion tonnes in 2017 (Nature News 13th Nov 2017) https://www.nature.com/news/world-s-carbon-emissions-set-to-spike-by-2-in-2017-1.22995

[19] An exajoule (EJ) is equal to 10^{18} (one quintillion) joules and 10^{12} terajoules (TJ). Yearly U.S. energy consumption amounts to roughly 94 EJ.

fuel prices, *ex ante* miscalculations about the payoff time of recovering the cost of investing in new technologies (i.e. building insulation retrofits, etc), or, simply, inertia.

Second, the use of mandatory standards that restrict choices but increase EE (i.e. use of particular building materials, and of types of vehicles with improved fuel economy, etc) has been found to be costly to manufacturers and suppliers but has not been found to be particularly effective in modifying consumer behaviour towards EE.

Third, labels are intended to provide information about EE. Information asymmetry by which one party to an agreement (i.e. an estate developer) has better information than the other party (i.e. a flat purchaser) results in the former foreseeing an inability to recover the costs of EE features by passing them to the latter, thus, failing to invest in such features. For example, in the absence of features such as smart meters or pre-installed programmable thermostats that could help raise awareness of actual consumption and savings in electricity bills, EE efficient behaviour is restricted.

Other barriers such as that the competitive environment of low electricity prices would provide few opportunities for substantial investments in energy efficiency (NCCS responses to public consultation March- May 2017).

2. Singapore's Energy Efficiency Policy

2.1. Objectives

Since 2012, E^2PO, a 'one stop' shop to promote EE was created under the National Environment Agency (NEA) leadership. E^2PO is 'a multi-agency committee led by the National Environment Agency (NEA) and the Energy Market Authority (EMA) and comprises 11 other agencies'[20].

E^2PO has five strategic **objectives** to improve energy efficiency:

- **Promote energy efficiency** through regulation and standards, incentives and open information.
- **Develop human and institutional capabilities** by developing local knowledge base and expertise in energy management and collaborating with Institutes of Higher Learning (IHLs)
- **Promote emerging energy efficient technologies and innovation** through supporting the research development and demonstration of new energy efficient technologies, innovations and business process improvements

[20] Economic Development Board (EDB), Land Transport Authority (LTA), Building and Construction Authority (BCA), Housing and Development Board (HDB), Infocomm Authority of Singapore (IDA), Agency for Science, technology and Research (A*STAR), Urban Redevelopment Authority (URA), Jurong Town Corporation (JTC) and National Research Foundation (NRF). The Ministry of the Environment and Water Resources (MEWR) and Ministry of Trade and Industry (MTI) are also represented in the committee http://www.e2singapore.gov.sg/About_Esup2/supPO/Objective_and_Members.aspx

- **Profile and promote energy efficiency internationally** through various platforms such as Singapore International Energy Week (SIEW), Asia-Pacific Economic Cooperation (APEC) and East Asia Summit (EAS)
- **Benchmark Singapore's energy efficiency initiatives** against other countries and international frameworks

In 2013, Singapore enacted the *Energy Conservation Act* (Chapter 92C- 2014 1st amendment), mandating any industrial sector businesses using more than 54 terajoules (TJ) of energy per year to put in place energy management measures (i.e. appoint an energy manager, monitor and report energy use and GHG emissions, and prepare and submit yearly to NEA energy efficiency plans) (Singapore Statues Online 2014, Ch. 92C, Part III: Energy Conservation Measures domestic & industrial, Division 2: management practices).

Following the results of an 2014 energy efficiency study, commissioned by the National Climate Change Secretariat (NCCS) and the ministries of trade and industry (MTI) and environment and water (MEWR), which was conducted by ICF international together with EDB and NEA, it was found that the potential for increased energy efficiency in the industry sector could be in the range of 20% by 2030 (in 2015 industrial EE was 0.6% with now plans to improve it annually by 1-2%) (NCCS, Speech 10th Singapore International Energy Week Oct 2017 https://www.nccs.gov.sg/news/speech-deputy-prime-minister-teo-chee-hean-10th-singapore-international-energy-week-23-october).

As a consequence, the *Energy Conservation Act* was amended in April 2017 requiring: 'periodic reporting of energy use by every registered corporation regarding: energy consumption, energy production, GHG emissions' (Singapore Statues Online 2017, Ch. 92C, Part III: Energy Conservation Measures domestic & industrial; Division 2: management practices, n. 27 a-c).

In 2015, Singapore had committed to reduce **emissions intensity** (GHG emissions per unit of GDP) by 36% from 2005 levels by 2030 and have them peak by 2030 to around 65MtCO_2e (NCCS 2016). The switch from fuel oil to natural gas (Singapore uses 95.5% of natural gas for electricity generation) has achieved emissions intensity reductions of 'around 7.6 MtCO_2e from 2000-2010' (ESI-NUS 2017, 18: 2). In the absence of energy subsides, industry is incentivized to apply energy efficiency measures to save costs. Both these measures - changes to the fuel mix and a 'true cost' approach to energy prices - have resulted in an absolute emissions increase from 2000-2010 of only 18% while the GDP during the same period grew by 76%. In terms of emissions intensity, this has resulted in a reduction of 33% during the same period (ibid.)[21].

In 2017, EE capacity building, financing and 'transition' schemes (described below) were brought together under the *Energy Efficiency Fund* (E2F) http://www.e2singapore.gov.sg/Incentives/Energy_Efficiency_Fund.aspx

The purpose of E2F is to support large, medium and small industrial sector businesses' plans to retrofit their operational and technical systems and/or products in order to increase

[21] Note that the emissions intensity reduction Singapore is aiming at for 2030 is 36% from 2005 levels.

efficiency and reduce emissions. The fund is administered by the National Environment Agency (NEA)[22], a statutory body (http://www.nea.gov.sg/grants-awards/energy-efficiency).

In October 2017, during the 10th Singapore International Energy Week (SIEW), an announcement was made about the setting up of the National Energy Transformation Office (NETO) within the Energy Market Authority (EMA). The purpose of NETO is 'to synergise our efforts across agencies and steer Singapore's efforts towards our long-term energy objectives. NETO will adopt a whole-of-government perspective in planning and coordinating energy Research, Development and Demonstration (RD&D) funding and initiatives, and enabling policies for the adoption of transformational energy solutions'. The Singapore government has set aside US$600 million in support of the Research, Innovation and Enterprises (RIE) 2020 plan (NCCS https://www.nccs.gov.sg/).

Singapore has been playing an 'indirect' role in the global pursuit of more energy efficient production and consumption patterns. As an Associate Member of IEA since Oct 2016, Singapore hosts the IEA-Singapore Training Hub, an initiative of IEA and Singapore's energy regulator, the Energy Market Authority (EMA). In July 2017, the hub hosted the first IEA Energy Efficiency Emerging Economies (E4) Training Programme providing capacity building to Southeast Asian energy engineers and managers
https://www.iea.org/topics/energyefficiency/e4/

2.2. General Measures

Despite its no-subsides approach to greater energy efficiency and low carbon transitions in the industrial sector, the Singapore government, in collaboration with private sector partners, has deployed a series of fiscal and financial **measures** to support companies (especially SMEs) with the costs of transition:

Capacity Building:

- Singapore Certified Energy Manager (SCEM) Training Grant – voluntary, education & development
- Energy Conservation Act (ECA) Amendment 2017 – legislation, mandatory energy management requirements, energy consumption calculators, etc
- Energy Efficiency National Partnership Programme (EENP) – E_2PO Initiative- voluntary, learning network & resources, incentives, recognition

Financial:

- Productivity Grant – funds up to 30% of qualifying costs for certain manufacturing companies projects;
- EE Financing Pilot Programme - voluntary, pilot; 100% upfront capital investment for EE projects in manufacturing companies;

Fiscal:

- Resource-Efficient Design (DfE), 50% of qualifying costs or S$600,000 per project (cap)

[22] NEAs remit is surprisingly wide: besides energy efficiency, pollution control, solid waste management, radiation prevention and nuclear safety, prevention and control of vector-borne diseases, public hygiene and cleanliness, hawker center management, meteorological services, and public-private-people partnerships are all part of NEA's portfolio.

- Grant for Energy Efficient Technologies (GREET) Energy Audits co-funded by NEA S$200,000 per project (cap)
- Retrofit Projects for energy efficient equipment and technologies, 20% co-funded by EDB and NEA
- One-year Accelerated Depreciation Allowance Scheme (ADAS) – grants and tax deductions for replacement of equipment
- Energy Efficiency Financing (EEF) Scheme, a third-party financier (Sustainable Development Capital (Asia) Ltd, provides companies with upfront capital to implement energy efficiency projects, and the energy savings are shared between the various stakeholders

2.3. Sectoral Measures: Technology Roadmaps

Intended to provide technological support to the EE objectives and measures, technology roadmaps were published by the NCCS and the National Research Foundation (NRF) between 2014 and 2016 for the power, manufacturing industry, transport and building sectors.

Sector	Initiative	Description
Power	Solar PV Roadmap	- Identifies solar PV as feasible RE to introduce to the fuel mix - Targets 350MWp for 2020 (5% of projected peak electricity demand) - From 2014 to 2017, capacity was 125MWp Challenge: how to manage PV intermittency into the main grid.
Buildings	Building Energy Efficiency Roadmap	- Green Mark Certification for all new and retrofitted residential and commercial buildings - Triennial audits of all buildings' cooling systems - Regular reporting of all buildings' energy use Challenge: no clear understanding of what the incentives to make the EE transition are.
Transport	Electric Mobility Roadmap	- EV car-sharing programme has been launched mid-2017 - EV car-charging and sharing will be available in all HDB estates by 2020 Challenge: more R&D to decide electrification for all fleet-based

		operations.
Manufacturing	Industry Energy Efficiency Roadmap	- 30 emerging, next generation technologies identified with potential energy savings of 5.7 % by 2030 (on top of existing technologies savings of 13.1%).

2.4. Market Mechanisms: Carbon Taxes and Energy Efficiency

Besides the above mentioned measures, the Singapore government has decided to introduce market-mechanisms to upscale its energy efficiency objectives (refer to policy paper n. 1 Francesch-Huidobro 2017)[23]. This was announced in the 2017 Budget:

> *"There are different ways to reduce emissions (…).* ***But the most economically efficient and fair way to reduce greenhouse gas emissions is to set a carbon tax, so that emitters will take the necessary actions (C.7).***
>
> *Singapore has studied this option for several years. We intend* ***to implement a carbon tax on the emission of greenhouse gases.*** *We will consult widely with stakeholders, and aim to implement the carbon tax* ***from 2019****. The tax will generally be applied upstream, for example, on power stations and other large direct emitters, rather than electricity users (C.8)".*

Budget 2017 also announced a carbon tax at a rate of between **S$18-20 per tonne of GHG.** This will be equivalent to a rise in electricity price between 0.43-0.86 cents KWh or S$2.1-4.3 rise in electricity **from an average of S$72/month (per 4 bedroom household) to S$76/month**. The carbon tax is **mainly targeting between 20-30 power stations** that will be required to begin paying taxes by **2019.**

3. Is Singapore Energy Efficient?

By not providing subsidies for energy fuels, the true cost of imported fuels to generate electricity is passed to the consumer. The retail transport fuel costs (after excise taxes) are as high as those of Europe or Australia. Thus, room for energy efficiency is limited under such cost conditions.

Any calculation of the costs and benefits that new EE schemes has to be 'fair' not to impose unnecessary burdens on business (and consumers) and, as Doshi 2015: 226 argues, 'the guiding principle to policy interventions is that it must improve societal welfare. Accordingly, EE should not be considered a goal in itself, but a means to achieving economically efficient, resource allocation'.

Over and above a cost benefit analysis (CBA), potential barriers in the rolling out of EE schemes should be clearly identified. Here the Singapore government has done its 'homework' and the capacity building, financing and fiscal incentives it has put in place

[23] It explains who will be covered, what GHG will be covered, what is the expected impact on businesses, and how it will be operationalised.

should be incentives but market failure in deploying these tools should not be underestimated.

Thus, the question remains as to whether business leaders may be sufficiently motivated to spend money, time, and energy in EE schemes as these may not be 'important' in contrast to the overall decisions and operations of their business. The deployment of taxes will complement earlier EE efforts but the constant monitoring of their effectiveness overtime should provide a more conclusive picture of their role in the EE strategy.

4. Conclusions & Recommendations to Singapore's deployment of Carbon Taxes, Energy Efficiency and Climate Change Strategy

Energy efficiency in industry is Singapore's key strategy for reducing emissions. The EE strategy translates into the deployment of 'command and control' measures and, from 2019, will also include market-based instruments, carbon taxes. Singapore's energy efficiency measures support Singapore's goals of energy security, higher labour productivity, and enhanced economic development. Nevertheless, the energy efficiency 'gap' should not be underestimated and the market barriers to the uptake of energy efficient investments should be identified. In a no-subsidies energy regime, energy efficiency is limited by 'true' cost conditions. Under such conditions, there are no incentives to reduce energy use as doing so does not affect cost.

In view of this, this policy analysis has general and specific recommendations on Singapore's policy approaches to energy efficiency.

4.1. General Recommendations

The analysis contributes to our knowledge on current and upcoming international EE practices and Singapore's climate mitigation and energy efficiency objectives, policies and regulations. It also raises awareness at to where the 'energy efficiency gap' lies in the Singapore context. Thus, the analysis intends to facilitate policy dialogue among industry, government, scientists and citizens, assist the Singapore government by positioning itself at the heart of discussions on existing and upcoming EE policy instruments, and analyze the opportunities and threats that various policies may present to business.

4.2. Specific Recommendations

Having studied the results of the public consultation on carbon taxes published by NCCS[24] this policy analysis has the following specific recommendations for non-state decision makers (think tanks, NGOs, business chambers, etc):

On Growing the Green Investments and Green Labour Sector

- ✓ Contribute to the National Environment Agency (NEA) training programme Singapore Certified Energy Manager (SCEM) and expand it to include professionals other than engineers;

[24] Results Public Consultation March-May 2017, NCCS https://www.nccs.gov.sg/public-consultation),

- ✓ Provide advice as to how best carbon tax revenue will be used. For example, carry out a study on labour productivity and how it contributes to EE. Rather than investing revenue in subsidising retrofits or R&D (other government schemes are taking care of that), investing in labour capability may be a powerful way to convince taxed emitters and citizens of the benefits of carbon pricing;

Carbon Tax levels

- ✓ Monitor and evaluate that the uniform carbon price of S$10-20t$CO_2$e and the 25,000t$CO_2$e emissions cut off level result in quantifiable EE outcomes overtime. Ascertain the price is comparable with international levels and sufficient to drive companies to voluntarily set up reduction targets[25];

- ✓ Evaluate tax price levels against the cost their deployment and administration will bring to the industry and, therefore, the potential government support that industries may require during the transition;

- ✓ Lead and participate in public engagements to raise business awareness that their reduction targets are contributing to Singapore's NDCs;

Implementation of Carbon Taxes

- ✓ Analyse all Singapore existing emissions taxes to ascertain no 'double-taxation' occurs (i.e. carbon emissions-based vehicle scheme (CEVS) ending 31 Dec 2017, new vehicular emissions scheme from 1 Jan 2018; diesel taxes, etc);

- ✓ Based on international experiences, monitor developments on the integration of solar PV into the grid and ensure that PV is not taxed. This will require that power generation companies (gencos) disclose what portion of their fuel mix is solar so as to deduct it from the taxable fuel;

Operationalisation of Measurement, Reporting and Verification (MRV): Monitoring Plan (MP) and Emissions Report (ER) tool

- ✓ Contribute to compiling a database on the EE performance of Singapore's public and private companies with the objective of disclosing information as a means for individual companies to know where they stand in relation to their peers. This has the potential to ensue healthy competition towards greater EE;

Impact on Businesses

- ✓ Engage NEA regarding the creation of a carbon repository portal of publicly listed companies to encourage constructive benchmarking and public scrutiny with the

[25] Carbon taxes in European polities range from S$35t$CO_2$e (France, UK, Demark, Ireland) to S$187t$CO_2$e (Sweden).

view of, ultimately, requiring all publicly listed companies to share their Emissions Report (ER) via the Singapore Exchange (SGX);

- ✓ Study how carbon taxes can be supplemented by other instruments such as allowing high emitters for whom reductions will be too costly to offset their emissions by purchasing internationally accredited carbon credits;

- ✓ Monitor the effect of carbon taxes on SMEs and their operational capacity to access the Energy Efficiency Fund (EEF) and devise a system of rewards (i.e. tax concessions) for 'pioneering SMEs';

Impact on Citizens

- ✓ Lead and participate in public engagement exercises that educate the consumer about the overall benefits of EE and how a carbon tax (that will ultimately be passed to the consumer via electricity tariffs) contributes to supporting Singapore's climate mitigation efforts, increases the city's resilience, and reduces its vulnerability;

- ✓ Monitor the trickling down effect of carbon taxes and how this may burden the weakest citizens and widen the inequality gap;

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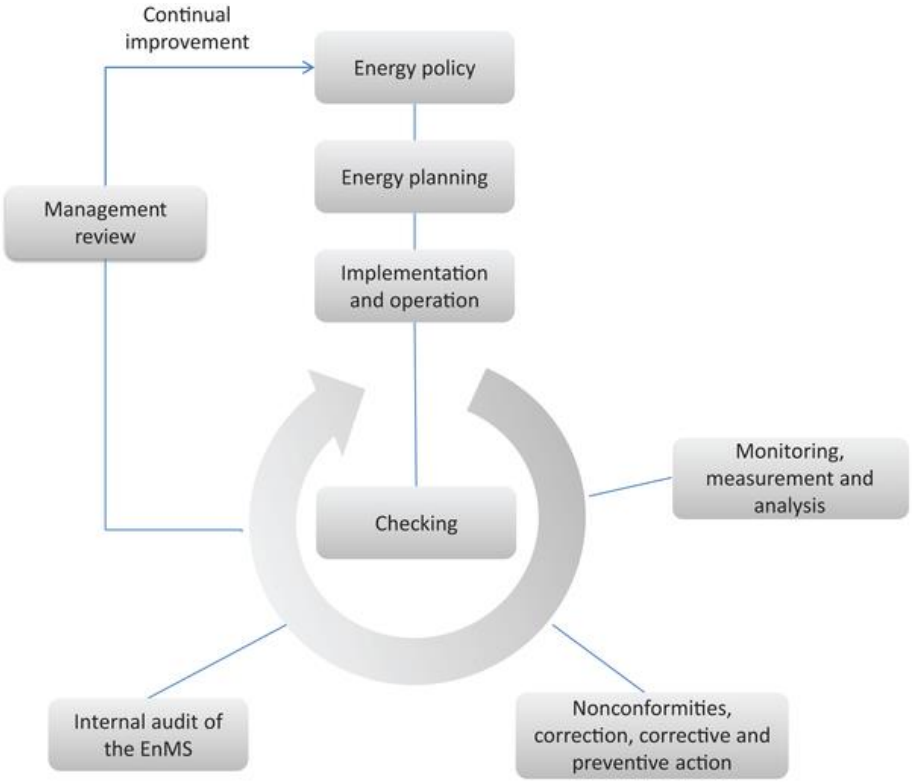
Key Agencies

- Economic Development Board (EDB) - attract businesses to Singapore
- Energy Efficient Singapore E_2PO Initiative (by EDB, NEA, EMA) – 'one stop shop' multiagency - energy efficiency
- Ministry Environment and Water Resources (MEWR) – environment & water remit
- Ministry of Finance (MOF) - carbon tax, fiscal policy remit

- Ministry of Trade and Industry (MTI) – trade & industry remit
- National Climate Change Secretariat (NCCS) - climate diplomacy remit; public consultations
- National Environment Agency (NEA) - energy efficiency remit;
- Monetary Authority Singapore (MAS) – green bonds

Figure 1: Energy Management Systems ISO50001 (Source: iso.org)



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