CARBON MANAGEMENT IN ASIA PACIFIC

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1 Introduction

1.1 Current Climate Situation

Climate change is one of the most pressing issues that the world is facing today. It refers to the long-term alteration of temperature and weather patterns due to the tapping of heat from the release of greenhouse gases (GHG), such as carbon dioxide (CO_2), methane and more, which warms the planet (United Nations, n.d.-b). While climate change can occur due to natural forces, such as a large volcanic eruption, it has become primarily driven by human activities, like the burning of fossil fuels such as coal, natural gas and oil, since the 1800s. As a result of human actions, climate change is progressing at a much faster pace, leading to the increasing number of effects of climate change which can be felt around the globe, such as more extreme weather events and rising sea levels.

The Paris Agreement was then adopted in 2015 and had set long-term goals to guide all nations to reduce emissions by 45% by 2030 and to reach net-zero by 2050 so that global temperature increase would be limited to 1.5 degrees Celsius above pre-industrial levels (United Nations, n.d.-a). Moreover, the Agreement enforces the submission of an updated national climate action plan, also called the Nationally Determined Contribution (NDC), every five years from parties that signed the Agreement. In their respective NDCs, parties would communicate the actions that would be taken in their steps towards the goals of the Paris Agreement.

However, the planet is currently 1.1 degrees Celsius warmer than it was in the late 1800s and with rising emissions, actions need to be taken to ensure a rapid transition to a clean energy economy so as to reduce emissions and reach net-zero by 2050.

1.2 Objective of the Report

This report aims to: (1) conduct a landscape study of the carbon management strategies that are currently adopted in the Asia Pacific (APAC) region with the use of a Structured Assessment Framework (Section 2) before carrying out a Comparative Progress Analysis (Section 3) to provide a comprehensive comparison of a jurisdictions' progress and emissions levels amongst the other jurisdictions and; (2) provide recommendations for two key stakeholders – Regulators/government and Businesses/corporations – on how the carbon management strategies of their jurisdiction can be improved on both the jurisdiction (Section 4) and tier level (Section 5) based on the jurisdictions' chosen carbon management approaches, and their strengths and weaknesses.

The 14 jurisdictions from the APAC region covered in the report are: Australia, China (Mainland), Hong Kong, India, Indonesia, Japan, Malaysia, New Zealand, Philippines, Singapore, South Korea, Taiwan, Thailand and Vietnam.

2 Structured Assessment Framework

This report will be structured around four tiers that form a structured assessment framework to assess the carbon management policies/strategies that are adopted in the 14 jurisdictions. To create the Structured Assessment Framework used in this report, adaptations were made from the IEMA GHG Management Hierarchy (Fisher, 2020) and RMIT Carbon Management Hierarchy (RMIT University, n.d.). 'Eliminate', which is the tier to avoid activities that cause emissions, was not included due to the difficulty in obtaining meaningful indicators to assess and evaluate the tier.

A carbon hierarchical model was used to classify various carbon management strategies under four tiers, whereby the four tiers used in the framework are listed as follows:

1. Reduce: To achieve real and relative (per unit) reductions in carbon by increasing efficiency in operations, processes, fleet and energy management, with the use of technologies to optimise approaches
2. Substitute: Adoption of renewables or low carbon technologies to reduce the carbon GHG intensity of energy use and of energy purchased
3. Sequester: To capture and store emissions from burning fossil fuels and/or ambient air using technologies
4. Compensate: To compensate 'unavoidable' residual emissions through offsets and taxations

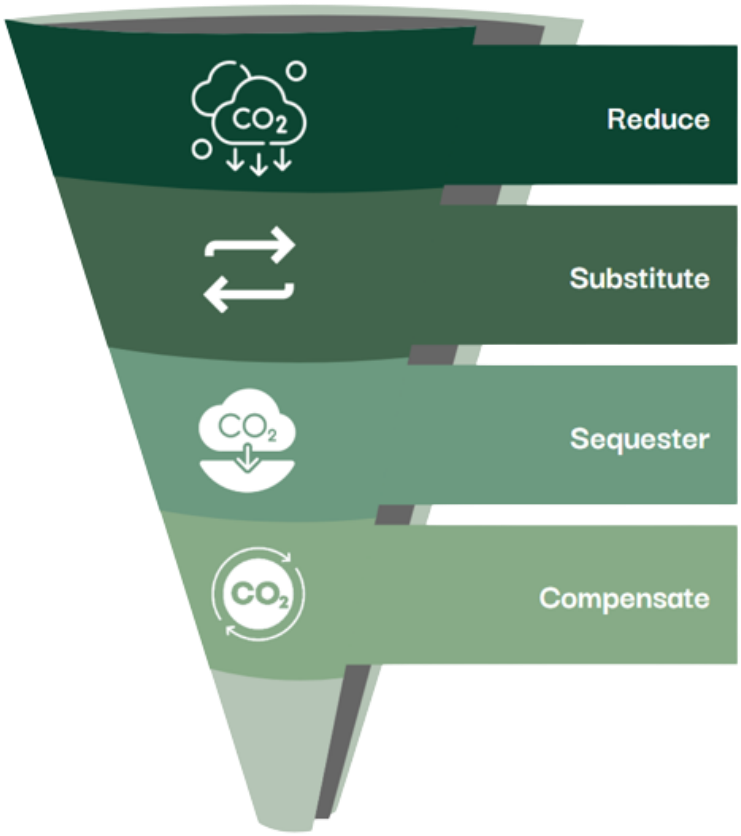

Figure 1: Structured Assessment Framework

A funnel shape was used to highlight the flow of carbon throughout its life cycle from the reduction (Reduce and Substitute) to removal (Sequester and Compensate), and symbolises a reduced preference for the choice of carbon management strategy. As such, emphasis should be placed firstly on 'Reduce', which is through the use of energy efficient practices and technologies to reduce carbon emissions in multiple sectors (Section 2.1).

This is then followed by ‘Substitute’, which involves boosting the adoption of renewables or low carbon technologies in the generation of energy (Section 2.2). The remaining emissions can then be neutralised through ‘Sequester’ by using technologies like Carbon Capture Utilisation and Storage (CCUS) technologies (Section 2.3), and lastly through ‘Compensate’ by using carbon taxation and offsets (Section 2.4).

2.1 Tier 1 - Reduce

2.1.1 Introduction - Energy Efficiency

In the Net Zero Emissions by 2050 (NZE) Scenario, energy efficiency stands out as the most significant measure for mitigating energy demand. It is recognised for offering swift and cost-effective options to curb carbon dioxide emissions, thereby lowering energy costs and fortifying energy security (IEA, n.d.-b). Energy efficiency strategies operate by diminishing the amount of energy required for specific tasks or service provision. These strategies concentrate on optimizing energy utilisation, minimising energy waste, and enhancing the overall energy efficiency of systems and processes. Enhancing energy efficiency emerges as the most economical and often the quickest approach to curb the consumption of fossil fuels (Environmental and Energy Study Institute (EESI), n.d.).

In every sector of the economy, including construction, transportation, business, and energy production, there are significant opportunities to increase efficiency. Strategies typically include the deployment of energy-efficient technologies, implementation of energy management systems, development of supportive policies and regulations, education and awareness campaigns, and energy audits and assessments (Environmental and Energy Study Institute (EESI), n.d.).

In this study, to evaluate the progress of jurisdictions in the Reduce tier, we focused our analysis on three key sectors: Buildings, Industrial, and Transport. Our selection of these sectors was guided by their substantial contributions to the global energy-related or carbon emissions.

2.1.2 Buildings

This section primarily focuses on assessing the carbon management of the Buildings sector within the 14 different jurisdictions. In the year 2022, buildings were responsible for 30% of the world's final energy consumption and 26% of energy-related emissions globally. This comprised 8% of direct emissions within buildings and 18% of indirect emissions stemming from the generation of electricity and heat utilised in buildings (IEA, 2023d).

Given that Buildings stand out as one of the most significant contributors to carbon emissions, we will examine them within these 14 jurisdictions. The criteria used for assessing progress will include building codes applicable to both residential and commercial structures, along with standards for appliances and equipment, as well as labelling programs for appliances and equipment.

We derived these metrics from the 2022 International Energy Efficiency Scorecard by the American Council for an Energy-Efficient Economy (ACEEE) and adjusted them as needed to align with the specifications and scope of our report.

Figure 2 as shown below provides a high-level view of the scoring system used to assess the progress of each jurisdiction in the buildings sector. The maximum points allocated for this sector is 15 points, which is further divided into the 3 indicators as mentioned - fuel standards, labelling and electric vehicles (EV). More weightage is given for the fuel standards as having fuel standards will have a more direct impact on the reduction of carbon emissions as compared to labelling and the adoption of EVs. We will delve into the detailed breakdown of each indicator in the following subsections.

Buildings (15 points)			
Jurisdiction	**Building Codes (6 points)**	**Appliance and Equipment Standards and Labelling Programmes (9 points)**	**Total (out of 15 points)**
Australia	5	4	9.00
China (Mainland)	5.33	3.5	8.83
Hong Kong	5.33	1.5	6.83
India	2.83	2	4.83
Indonesia	3.33	1.5	4.83
Japan	4.33	4	8.33
Malaysia	1.67	2	3.67
New Zealand	2	3	5.00
Philippines	3.66	2	5.67
Singapore	5.34	2	7.33
South Korea	5	6.5	11.50
Taiwan	2.67	2.5	5.17
Thailand	4.33	0.5	4.83
Vietnam	3.66	2	5.67

Overall Effectiveness	**Score**
Less Effective	≤5
Partial	>5 - 8
Effective	>8

Figure 2: High-level comparison of Buildings Sector and overall scoring system

2.1.2.1 Building Codes for Residential and Commercial

In evaluating this metric, our approach involves assigning scores to the jurisdictions based on the presence of national mandatory energy codes and the scope of technical aspects they encompass. In the case of national energy codes, a favourable view is taken if they are mandatory. It is worth noting that many jurisdictions develop model energy codes that can be adopted by states, territories, and local authorities. Jurisdictions demonstrating

high rates of adoption of model codes that cover a significant portion of their population will receive a more positive evaluation compared to those with low adoption rates or voluntary codes (Subramanian et al., 2023). For voluntary codes, we assigned a score of 0 points. Mixed codes were given 0.5 points, and mandatory codes were awarded 1 point.

In terms of assessing the technical aspects of energy codes, our evaluation focuses on whether these codes address six key areas related to both the building envelope and building systems. Regarding the building shell, we verify if the energy code mandates insulation in walls and ceilings, prescribes U-factors, and includes provisions for shading/solar heat gain coefficients for windows and air sealing. For building systems, we assess whether the code requirements encompass efficient lighting, heating, ventilation, and air conditioning systems, as well as efficient water heating (Subramanian et al., 2023). A total of 2 points were allocated for this metric, and the score was prorated based on the number of technical areas addressed by each jurisdiction's building codes.

Impacts

Energy codes in the present day offer a significant improvement, providing approximately 30% more energy savings compared to codes in use a decade ago (Energy Innovation: Policy and Technology & Myers, 2020). Projections indicate that residential and commercial building energy codes are anticipated to result in cumulative energy cost savings of $138 billion in the United States between 2010 and 2040. Additionally, they are expected to help avoid emissions equivalent to those produced by 227 large coal-fired power plants (Office of Energy Efficiency and Renewable Energy, n.d.). The broader adoption of energy codes comes with an array of advantages, such as an increase in property value, enhanced energy security, cost savings in infrastructure, a boost in employment opportunities, improved productivity within the construction industry, reduced pollution, and a stronger commitment to long-term sustainability (Zhou et al., n.d.). Consequently, we consider this metric to be of great importance and have assessed it based on the presence of mandatory energy codes and the number of technical areas they encompass.

Building Codes across Jurisdictions

Drawing information from a variety of sources, we have generated Figures 3, 4, and 5 to assess and score the 14 jurisdictions according to the factors discussed earlier. We determined the adoption rate for each jurisdiction by examining their building codes against the specified indicators. The adoption rate was estimated using the data provided in Figure 3, 4 and 5. In each of the subsections, residential and commercial, a maximum of 3 points were allocated. We consider these factors to be crucial indicators when it comes to assessing the adoption of energy building codes in both the residential and commercial sectors, as they reflect the jurisdiction's commitment to promoting energy efficiency.

Residential Building Codes (3 points)					
Jurisdiction	**Code Type**	**Score (up to 1)**	**Number of technical requirements covered (out of 6)**	**Score (up to 2)**	**Total Score (out of 3)**
Australia	Mixed	0.5	6	2.00	2.50
China (Mainland)	Mandatory	1	5	1.67	2.67
Hong Kong	Mandatory	1	5	1.67	2.67
India	Mixed	0.5	5	1.67	0.67
Indonesia	Mandatory	1	4	1.33	1.00
Japan*	Mixed	0.5	4	1.33	2.50
Malaysia	Voluntary	0	4	1.33	0.33
New Zealand	Mandatory	1	0	0.00	1.00
Philippines**	Mandatory	0.5	4	1.33	1.83
Singapore	Mandatory	1	5	1.67	2.67
South Korea	Mandatory	1	5	1.67	2.33
Taiwan	Mandatory	1	2	0.67	1.00
Thailand	Mandatory	1	4	1.33	2.00
Vietnam	Mixed	0.5	4	1.33	1.83

Adoption rate	**Score**
Minimal Adoption	0 to 1
Partial Adoption	>1 to 2
Widespread Adoption	>2 to 3

**Japan earns points for its voluntary code because it has benefits in place for exceeding the minimum code and strict noncompliance penalties for buildings that have chosen not to adhere to standards.*

*** Philippines given 0.5 due to lack of information on adoption rates*

Sources: GBPN, n.d.; BCAP, 2016a; Yan et al., 2017; Hong et al., 2015; EMSD, 2021; Kwatra & Madan, 2021; BCA, 2021; Department of Standards Malaysia, 2017; Building Regulations 1992 (SR 1992/150) (as at 24 August 2023) – New Zealand Legislation, 2023; DOE, 2020; Socialist Republic of Vietnam, 2017; PEEB, 2019; ACEEE data requests; Subramanian et al., 2023

Figure 3: Scores for Residential Building Codes

Commercial Building Codes (3 points)					
Jurisdiction	**Code Type**	**Score (up to 1)**	**Number of technical requirements covered (out of 6)**	**Score (up to 2)**	**Total Score (out of 3)**
Australia	Mixed	0.5	6	2.00	2.50
China (Mainland)	Mandatory	1	5	1.67	2.67
Hong Kong	Mandatory	1	5	1.67	2.67
India*	Mixed	0.5	5	1.67	2.17
Indonesia	Mandatory	1	4	1.33	2.33
Japan	Mixed	0.5	4	1.33	1.83
Malaysia	Voluntary	0	4	1.33	1.33
New Zealand	Mandatory	1	0	0.00	1.00
Philippines**	Mandatory	0.5	4	1.33	1.83
Singapore	Mandatory	1	5	1.67	2.67
South Korea	Mandatory	1	5	1.67	2.67
Taiwan	Mandatory	1	2	0.67	1.67
Thailand	Mandatory	1	4	1.33	2.33
Vietnam	Mixed	0.5	4	1.33	1.83

Adoption rate	**Score**
Minimal Adoption	0 to 1
Partial Adoption	>1 to 2
Widespread Adoption	>2 to 3

**India has state-led commercial building codes, but few states have chosen to adopt mandatory codes.*

*** Phillipines given 0.5 due to lack of information on adoption rates*

Sources: GBPN, n.d.; BCAP, 2016a; EMSD, 2021; Kwatra & Madan, 2021; BCA, 2021; ERIA, 2021; Building Regulations 1992 (SR 1992/150) (as at 24 August 2023) – New Zealand Legislation, 2023; DOE, 2020; Socialist Republic of Vietnam, 2017; PEEB, 2019; ACEEE data requests; Subramanian et al., 2023

Figure 4: Scores for Commercial Building Codes

Building Codes (6 points)			
Jurisdiction	**Residential Building Codes (3 points)**	**Commercial Building Codes (3 points)**	**Total Score (Out of 6 points)**
Australia	2.50	2.50	5
China (Mainland)	2.67	2.67	5.34
Hong Kong	2.67	2.67	5.34
India	0.67	2.17	2.84
Indonesia	1.00	2.33	3.33
Japan	2.50	1.83	4.33
Malaysia	0.33	1.33	1.66
New Zealand	1.00	1.00	2
Philippines	1.83	1.83	3.66
Singapore	2.67	2.67	5.34
South Korea	2.33	2.67	5
Taiwan	1.00	1.67	2.67
Thailand	2.00	2.33	4.33
Vietnam	1.83	1.83	3.66

Effort	**Score**
Minimal Efforts	<3
Moderate Efforts	3 to <5
Substantial Efforts	≥5

Figure 5: Overall Scores for Building Codes

Within the group of 14 jurisdictions, Australia, China (Mainland), Hong Kong, Singapore, and South Korea stand out as those with notably high adoption rates in both their residential and commercial building codes. Conversely, New Zealand exhibits minimal adoption rates in both building sectors, primarily due to a lack of publicly available information.

Australia Building Codes

Australia's National Construction Code (NCC) includes mixed code types for both its residential (Foster et al., 2022) and commercial (Centre of International Economics, 2018) sectors. This designation signifies that Australia has a strong adoption of model codes that apply to a significant portion of its population. Additionally,

it has successfully addressed all six technical requirements concerning the building envelope and building systems, showcasing its comprehensive approach to developing model energy codes.

China (Mainland) Building

China (Mainland) has instituted mandatory building codes for both its residential and commercial sectors, encompassing five key technical areas (Feng et al., 2015). This indicates a widespread adoption rate in the jurisdiction. Recognising the substantial contribution of buildings and construction activities to more than half of China (Mainland)'s total carbon emissions, the jurisdiction has implemented regulations aimed at enhancing energy efficiency and reducing its carbon footprint. These regulations came into effect on April 1, 2022, as part of China (Mainland)'s efforts to achieve its ambitious carbon reduction targets (Leong, 2022).

Hong Kong Building Codes

Hong Kong's building codes are also mandatory, and similar to China (Mainland), they address five key technical areas. In Hong Kong, the Buildings Energy Efficiency Ordinance (BEEO) plays a pivotal role in enhancing energy efficiency within the city. The adoption of such codes underscores Hong Kong's strong commitment to mitigating climate change and enhancing air quality in the city (Mohammad, 2023).

Singapore Building Codes

Singapore maintains mandatory energy codes for both residential and commercial buildings, addressing four key technical areas. In their commitment to environmental sustainability, Singapore has adopted the BCA Green Mark 2021, an internally recognized green building certification scheme specifically designed for tropical climates. This approach serves as a crucial strategy to fulfil Singapore's international commitments under the Paris Agreement and is an integral part of the city-state's proactive measures in the fight against climate change within the construction sector (BCA, 2021).

South Korea Building Codes

South Korea has established a mandatory building energy code known as the Building Design Criteria for Energy Saving (BDCES) for both residential and commercial buildings (BCAP, 2016b). In the case of residential buildings, it covers 4 key technical areas, while commercial buildings encompass 5 key technical areas. This underscores South Korea's strong commitment to meeting its obligations under the Paris Agreement (International Energy Agency, 2020).

Challenges

In our analysis, it is important to note that we do not assign scores to building codes based on their implementation or compliance. Nevertheless, we fully acknowledge the critical role that implementation and enforcement play in driving energy savings in buildings. We also recognize that these factors can vary significantly across different jurisdictions, and many regions may lack effective enforcement policies and procedures. Regrettably, we currently lack the data needed to assess jurisdictions on their implementation and enforcement efforts. It is essential to keep in mind that while a jurisdiction may have adopted a building code with numerous technical requirements, it does not guarantee that new construction adheres to those requirements. Our scores provide a high-level assessment of adopted building codes, but they do not encompass the complete picture of code stringency and enforcement within each jurisdiction (Subramanian et al., 2023).

It has been observed that certain jurisdictions exhibit relatively lower adoption rates of energy building codes, and this can be attributed to a variety of factors. Firstly, a lack of awareness and understanding of the latest energy codes among both businesses and policymakers can result in unintentional non-compliance and missed

opportunities for energy savings. Additionally, inadequate enforcement plays a significant role as well, often stemming from resource shortages, understaffing, and insufficient training for code officials, which can lead to ineffective enforcement and allow non-compliant buildings to go unnoticed. Furthermore, limited financial resources allocated for education, training programs, and incentives can constrain the resources available for the successful implementation of energy codes. Lastly, the complexity and frequent updates of energy codes can create compliance challenges, with unclear language and conflicting requirements further impeding the implementation process (Utilities One, 2023). Addressing these issues is crucial to improving energy code adoption rates and enhancing energy efficiency in the construction sector.

2.1.2.2 Appliance and Equipment Standards and Labelling Programmes (EES&L)

This metric comprises two components: Appliance and Equipment Standards and Appliance and Equipment Labelling. We allocated up to 5 points for the implementation of relevant appliance and equipment standards and up to 2 points for the implementation of appliance and equipment labelling. Further details on the scoring breakdown would be discussed in the following subsections.

Impacts

A growing number of jurisdictions are increasingly recognizing the advantages of Energy Efficiency Standards and Labelling (EES&L) programs as effective tools for reducing energy costs, stimulating product innovation, generating employment opportunities, and mitigating the costs associated with CO_2 emissions. Notably, EES&L programs in the United States of America (USA) and the European Union are estimated to result in annual reductions of approximately 15% of the total current electricity consumption (IEA, n.d.-a). Furthermore, EES&L initiatives have the potential to accelerate the average rate of energy efficiency improvement in new appliances by two to three times. Consequently, EES&L programs play a pivotal role in assisting governments in achieving their net-zero CO_2 emission targets. The higher the adoption rate of EES&L among jurisdictions, the more significant the impact it has on enhancing energy efficiency standards.

Appliance and Equipment Standards and Labelling Programmes (EES&L) across Jurisdictions

For Appliance and Equipment Standards, the assessment is based on policies mandating Minimum Energy Performance Standards (MEPS). We focused on five appliances and equipment categories with energy-intensive end uses and significant potential for energy savings. We allocated up to 5 points for standards covering these five energy-intensive end-use categories, including space heating, space cooling, water heating, refrigeration, and lighting. To earn these points, jurisdictions were required to have standards in place for each appliance or equipment category specified in Figure 6 (Subramanian et al., 2023).

End Use	Appliance and equipment standards required to receive points
Space heating	Boiler/Packaged Terminal Unit (PTU)
	Furnace/heat pump
Air-conditioning	Central AC/heat pump
	Room AC
	Chiller
Water heating	Instantaneous water heater
	Storage water heater
Refrigeration	Freezer
	Refrigerator (including refrigerator-freezers)
	Walk-in cooler and freezer
	Commercial refrigeration equipment
Lighting	Linear fluorescent
	General service lighting
	HID High intensity discharge (HDS) (including metal halide, high pressure sodium (HPS) and low pressure sodium (LPS))

Source: Subramanian et al., 2023

Figure 6: Standards required to be awarded points for covering energy-intensive end uses

The total number of appliance categories with MEPS was also considered in determining the score for this metric. Up to 2 additional points were awarded for the total number of appliance standards across a broader range of product categories, as shown in Figure 7.

Number of appliance categories with Minimum Energy Performance Standards (MEPS)	Score (up to 2)
>40	2
31-40	1.5
21-30	1
<21	0.5

Source: Subramanian et al., 2023

Figure 7: Point allocation for the number appliance and equipment standards

Figure 8 provides insights into the points awarded to jurisdictions and their efforts in this regard.

Appliance and Equipment Standards (7 points)					
Jurisdiction	**Number of appliances with minimum energy performance standards (MEPS)**	**Score (up to 2)**	**Number of key appliance groups with MEPS**	**Score (up to 5)**	**Total Score (out of 7)**
Australia	20	0.5	2	2	2.5
China (Mainland)	57	2	0	0	2
Hong Kong	0	0	0	0	0
India	9	0.5	0	0	0.5
Indonesia	1	0.5	0	0	0.5
Japan	24	1	2	2	3
Malaysia	9	0.5	0	0	0.5
New Zealand	17	0.5	1	1	1.5
Philippines	9	0.5	0	0	0.5
Singapore	8	0.5	0	0	0.5
South Korea	35	1.5	3	3	4.5
Taiwan	18	0.5	0	0	0.5
Thailand	4	0.5	0	0	0.5
Vietnam	17	0.5	0	0	0.5

Effort	Score
Minimal Efforts	0 to 2
Moderate Efforts	>2 to 5
Substantial Efforts	>5 to 7

Sources: CLASP, 2023; IEA, n.d.-b; Fridley et al., 2016; Energy Commission, n.d.; EECA, 2023; DOE, 2016; NEA, 2023; APEC, 2012; Subramanian et al., 2023

Figure 8: Scores for Appliance and Equipment Standards

As for Appliance and Equipment Labelling, jurisdictions were evaluated based on whether labelling is mandatory, the nature of the labels (categorical or continuous), and the number of appliance category groups covered by these labels. Labelling programs serve to enhance awareness and assist consumers in making informed purchasing decisions by disclosing the energy efficiency of appliances and equipment compared to similar products (Energy Labelling, n.d.). Such labels typically use categorical ratings or continuous scales to display this comparative information. Categorical labels assign distinct rankings or scores to appliance models based on energy use or efficiency, while continuous scales indicate the high and low ends of energy use or efficiency and place each model along this continuum accordingly. We placed a preference on mandatory

categorical labelling, which has demonstrated greater effectiveness than continuous labelling (Australian Government Department of Resources, Energy and Tourism, 2013). Only jurisdictions with mandatory appliance and equipment labelling earned points for this metric while voluntary labels did not earn any points. Specifically, 1 point was awarded for categorical labels and 0.5 points for continuous labels. Additionally, 1 point was given to jurisdictions with labels covering a minimum of 15 appliance category groups and 0.5 points to those with labels covering at least five appliance groups. Figure 9 provides insights into the points awarded to jurisdictions and their efforts in this regard.

Appliance and Equipment Labelling (2 points)						
Jurisdiction	**Mandatory or Voluntary**	**Categorical or Continuous**	**Score (up to 1)**	**Appliance Groups**	**Score (Up to 1)**	**Total Score (Out of 2)**
Australia	Mandatory	Categorical	1	14	0.5	1.5
China (Mainland)	Mandatory	Categorical	1	10	0.5	1.5
Hong Kong	Mandatory	Categorical	1	8	0.5	1.5
India	Mandatory	Categorical	1	7	0.5	1.5
Indonesia	Mandatory	Categorical	1	2	0	1
Japan	Voluntary	Categorical	0	18	1	1
Malaysia	Mandatory	Categorical	1	7	0.5	1.5
New Zealand	Mandatory	Categorical	1	7	0.5	1.5
Philippines	Mandatory	Categorical	1	7	0.5	1.5
Singapore	Mandatory	Categorical	1	6	0.5	1.5
South Korea	Mandatory	Categorical	1	21	1	2
Taiwan	Mandatory	Categorical	1	15	1	2
Thailand	Voluntary	Categorical	0	0	0	0
Vietnam	Mandatory	Categorical	1	14	0.5	1.5

Effort	Score
Minimal Efforts	0
Moderate Efforts	0.5 to 1
Substantial Efforts	1.5 to 2

Sources: Clasp, 2023; IEA, n.d.-a; X. Zhou et al., 2011; Fridley et al., 2016; Energy Commission, n.d.-a; EECA, n.d.; NEA, 2023a; (GMA Consult Group, 2020); Subramanian et al., 2023

Figure 9: Scores for Appliance and Equipment Labelling

By employing the metrics discussed, namely Appliance and Equipment Standards and Appliance and Equipment Labelling, we have compiled a summary of these two metrics in Figure 10. It is our belief that achieving a higher

score on each of these metrics reflects the greater efforts undertaken by each jurisdiction to enhance energy efficiency.

Appliance and Equipment Standards and Labelling Programmes (9 points)					
Jurisdiction	**MEPS score (up to 2)**	**Number of key appliance groups with MEPS score (up to 5)**	**Mandatory or Voluntary; Categorical or Continuous score (Up to 1)**	**Number of Appliance Groups score (Up to 1)**	**Total Score (Out of 9)**
Australia	0.5	2	1	0.5	4
China (Mainland)	2	0	1	0.5	3.5
Hong Kong	0	0	1	0.5	1.5
India	0.5	0	1	0.5	2
Indonesia	0.5	0	1	0	1.5
Japan	1	2	0	1	4
Malaysia	0.5	0	1	0.5	2
New Zealand	0.5	1	1	0.5	3
Philippines	0.5	0	1	0.5	2
Singapore	0.5	0	1	0.5	2
South Korea	1.5	3	1	1	6.5
Taiwan	0.5	0	1	1	2.5
Thailand	0.5	0	0	0	0.5
Vietnam	0.5	0	1	0.5	2

Effort	**Score**
Minimal Efforts	0 to 3
Moderate Efforts	>3 to 6
Substantial Efforts	>6 to 9

Figure 10: Overall Scores for Appliance and Equipment Standards and Labelling Programmes

Among the 14 jurisdictions, the majority are still in the process of developing their EES&L programs and have not yet achieved significant improvements in essential appliance categories. It's worth noting that South Korea stands out as the jurisdiction that has made the most substantial efforts in implementing the program, as indicated by the metrics used. However, our results highlight that in most of these jurisdictions, there is room for improvement in terms of the number of key appliance groups covered by MEPS.

South Korea's EES&L

Since 1992, South Korea has introduced the EES&L which specifically targets products with high energy consumption. This program mandates the display of energy efficiency grades, ranging from the 1st to the 5th grade, and prohibits the production and sale of products that fall below the 5th grade. Presently, South Korea has extended this requirement to cover a total of 35 products, making it mandatory for these products to report their efficiency ratings (Korea Energy Agency, n.d.). This initiative underscores South Korea's commitment to advancing energy efficiency technology and promoting the adoption of energy-saving products by encouraging consumers to make informed choices (Korea Energy Management Corporation & Ministry of Knowledge Economy, n.d.).

Challenges

In this section, it is crucial to emphasise that this metric does not take into consideration the stringency of the standards, the extent of energy consumption covered by the standards, or the level of compliance with these standards. We acknowledge the substantial variations in these factors across different jurisdictions and how they significantly affect the overall effectiveness of energy efficiency standards. Nevertheless, due to the absence of consistent data for many jurisdictions, we are unable to consistently and accurately integrate these factors into our scoring process (Subramanian et al., 2023).

Nevertheless, it is evident that the majority of jurisdictions are still in the process of bolstering their efforts in EES&L programs. Several factors may account for the relatively low scores observed. Firstly, some regions may lack robust policies and regulations, with either minimal or no energy efficiency policies or weak enforcement of existing regulations (Ibrahim, 2023). Secondly, there may be limited awareness and understanding among businesses and policymakers regarding the significance of energy efficiency. Consequently, they may perceive it as inconvenient to incorporate energy-saving practices into their operations.

2.1.3 Industrial

This section focuses on evaluating the carbon management of the industrial sector across the 14 jurisdictions. In the year of 2022, carbon emissions from the industrial sector were reported to be at 9.15 Gt CO_2, contributing 26% of the global CO_2 emissions across the 4 main sectors - power, industrial, transport and buildings (IEA, 2022). Thus, given that the industrial sector is one of the top carbon emitting sectors, we will zoom into the analysis of the industrial sectors across the 14 jurisdictions. The main indicator used to assess the progress would be the use of ISO 50001 standards, which will then be broken down into 3 further components to achieve a more robust comparison.

2.1.3.1 ISO 50001 Energy Management System Standard

For the first indicator, the ISO 50001 standards are voluntary standards for designing, implementing and maintaining an energy management system for all types and sizes of organisations, including industrial sectors. It aims to help organisations improve energy performance and reduce energy consumption (Bigelow, n.d.). ISO 50001 is based on the management system model, which provides a framework of requirements for organisations. These requirements include developing a policy for more efficient use of energy, fixing targets and objectives to meet the policy, usage of data to better understand and make decisions about energy use, measuring the results, reviewing how well the policy works and lastly, continuous improvement of energy management (ISO, n.d.).

Impacts

The main benefits of implementing the ISO 50001 are reduced energy costs, enhanced resilience and reduced environmental impact. The adoption of an energy management system will help an organisation assess its usage

of energy and identify opportunities for reducing energy consumption. With a reduction in energy use, organisations can also better improve their energy planning, protecting them from being vulnerable to risks of energy prices fluctuation. Most importantly, implementing these standards would reduce the organisation's environmental impact as they strive to conserve resources, promoting clean energy. Organisations can implement the standard and obtain the certification to ISO 50001. Thus, to evaluate the performance of each jurisdiction in its efforts to decarbonise the industry sector, we will be looking at the number of valid certificates to ISO management system standards for each jurisdiction. The greater the number of valid certificates a jurisdiction obtains, the more progress they will be credited for this section.

Standards across Jurisdictions

From the ISO Survey of Certifications (ISO, n.d.), an annual survey of the certifications obtained worldwide, we have restructured the data to evaluate every jurisdiction's progress.

A high-level view of the comparison can be seen from Figure 11.

Industrial - ISO 50001 Standards (7 points)							
Jurisdiction	**Number of ISO50001 Certification**	**Certificates score (Up to 3)**	**Number of Sites Covered**	**Sites score (up to 2)**	**Number of Sectors Covered**	**Sector score (up to 2)**	**Total score (out of 7)**
Australia	16	0	17	0	5	0	0
China (Mainland)	7592	3	7620	2	8	0	5
Hong Kong	52	1	98	0	10	1	2
India	894	3	1232	2	25	2	7
Indonesia	97	1	115	1	16	1	3
Japan	10	0	12	0	8	0	0
Malaysia	40	0	55	0	14	1	1
New Zealand	2	0	2	0	2	0	0
Philippines	20	0	59	0	10	1	1
Singapore	87	1	86	0	15	1	2
South Korea	85	1	122	1	12	1	3
Taiwan	456	3	1285	2	30	2	7
Thailand	132	2	166	1	20	2	5
Vietnam	103	2	115	1	18	1	4
Overall Effectiveness							**Score**
Less Effective							0 to 3
Partial							4 to 5
Effective							6 to 7

Figure 11: High-level comparison of Industrial Sector and overall scoring system

There are 3 main areas covered by the survey, the number of ISO 50001 certificates, number of sites covered and number of sectors covered. Firstly, the number of ISO 50001 certificates encompasses the total number of organisations having the certification as they demonstrated conformity to the standard. Secondly, the 'number of sites covered' reflects the number of locations in which the organisations carry out their work or service. Therefore, a greater number of sites would reflect a greater area of the business processes adhering to the standards, and hence a greater amount of emissions can be managed across more locations. Lastly, the 'number of sectors covered' reflects the number of sectors out of the total 39 listed sectors that have at least one certified organisation. This means that the greater the number of sectors covered, the more extensive the jurisdiction's progress is in terms of having standards across a diverse range of sectors. The full list of sectors included can be found in Appendix A.

Using the raw data from the survey, the scoring system is as follows. The maximum total points given for this section is 7 points, which is further divided amongst 3 areas. More weightage is given to the 'number of ISO 50001 certificates' as the impact of decarbonisation of the industry sector will be greater when more organisations are certified in their efforts of establishing their energy management systems. A detailed breakdown of how the scores are tabulated is as shown in Figure 12.

Number of ISO 50001 Certificates		**Adoption Rate**
More than 400 organisations being certified	3	High
Between 100 and 400 organisations being certified	2	Moderate
Between 50 and 99 organisations being certified	1	Minimal
Less than 50 organisations being certified	0	-

Number of Sites Covered		**Site Coverage**
More than 1000 sites covered	2	High
More than 100 sites covered	1	Moderate
Less than 100 sites covered	0	Minimal

Number of Sectors Covered		**Sector Coverage**
Between 20 and 30 sectors covered	2	High
Between 10 and 19 sectors covered	1	Moderate
Less than 10 sectors covered	0	Minimal

Figure 12: Breakdown of scores for industrial sector

With that, across the 14 jurisdictions, it can be seen that India and Taiwan are the best performing jurisdictions in terms of having the most organisations, sites and sectors covered under the ISO 50001 standards.

India's ISO 50001 Standards

A key reason for the wide adoption of the ISO 50001 standards amongst different organisations in India is due to the fact that businesses in India leverage on the fact that the ISO certification can build credibility and trust. As the business environment in India is rather competitive, the ISO certification is crucial in helping businesses to expand and flourish, establishing themselves in a congested market as the business's reputation is promoted due to its adherence to widely accepted standards. The Indian government has also set up the India certification Council (OAC) to promote the standards and is in charge of accrediting certification to organisations operating in India. Encouragement has also been extended to the non-public sector to take on the standards (isocertificationinindia, n.d.). With that, we can conclude that the 2 main reasons for the wide adoption of the standards is due to first, the incentive for businesses in India to adopt these standards to gain customer loyalty and brand reputation and second, the government's efforts in pushing businesses through the set up of the relevant regulatory authority.

Taiwan's ISO 50001 Standards

In support of the adoption of the standards, several authorities are in charge of promoting the standards to get businesses to conserve energy and reduce their carbon impact. These authorities include the Economic Affairs' Bureau of Energy and Industrial Development Bureau in Taiwan. Also, the Taiwan Green Productivity Foundation (TGPF) has also established an energy conservation work to have 600 organisations certified to the standard in 5 years. By establishing these goals, the TGPF works with the Bureau of Energy for funding to embark on encouragement practices including publicity, workshops and the provision of funding for businesses to obtain the certification (Public Sector Assurance, 2021). Thus, it can be seen that Taiwan's great focus and proactive actions on aiding enterprises in getting awarded with the energy management system certificates has led to a widespread adoption of these standards. It has also been reported that through these certifications, a total of 37.87 million kWh of electricity and 752 kLOE (kilo liter oil equivalent) of oil have been saved. This amounted to a saving of NTD 144.82 million in energy costs and an investment of NTD 426.83 million in energy-saving measures (Ministry of Economic Affairs, 2015). Thus, the successful adoption rate of the certifications could be attributed to the government's efforts in promoting the organisations' participation in establishing energy management systems.

Challenges

Other jurisdictions with a low adoption rate of the ISO 50001 standards could be facing the challenge of high initial costs and complexity, as well as the lack of specialised human resources. Implementing and maintaining an energy management system can be very intricate, resulting in a significant upfront investment and would require substantial organisational effort. Hiring and training of relevant persons with specialised knowledge and expertise in energy management is also crucial in effective implementation of the standards. Upon implementation of the relevant energy management systems, to attain the certification, detailed process and procedure documentation is also required as proof. Some businesses would hence be reluctant to go through the process as they find it time-consuming and bureaucratic. Thus, the rigorous process and efforts in attaining the certifications would be especially demanding for smaller or less structured businesses with limited resources (Marin, 2023). A successful adoption of the ISO 50001 standards would hence require regulators' support in aiding businesses to overcome these challenges.

2.1.4 Transport

This section focuses on evaluating the energy efficiency in the Transport sector across the 14 jurisdictions. Transport accounts for 21% of global carbon emissions, being the largest emitter sector in several jurisdictions,

in particular Asia (Brand, 2021). There are 3 main indicators that would be used for evaluation - fuel economy, labelling initiatives and adoption of electric vehicles (EVs).

Figure 13 as shown below provides a high-level view of the scoring system used to assess the progress of each jurisdiction in the transport sector. The maximum points allocated for this sector is 8 points, which is further divided into the 3 indicators as mentioned - fuel standards, labelling and electric vehicles (EV). More weightage is given for the fuel standards as having fuel standards will have a more direct impact on the reduction of carbon emissions as compared to labelling and the adoption of EVs. We will delve into the detailed breakdown of each indicator in the following subsections.

Transport (8 points)							
Jurisdiction	**Fuel Standards**	**Fuel Standards score (up to 4)**	**Labelling**	**Labelling score (up to 2)**	**EV Sales**	**EV Sales score (2 points)**	**Total (out of 8 points)**
Australia	Minimal progress	1	Effective Enforcement	2	Minimal Adoption	0.5	3.5
China (Mainland)	Below target	2	Partial Enforcement	1	Widespread Adoption	2	5
Hong Kong	Minimal progress	1	No Enforcement	0	Substantial Adoption	1.5	2.5
India	Above Target	4	Partial Enforcement	1	Substantial Adoption	1.5	6.5
Indonesia	On Target	3	Partial Enforcement	1	Minimal Adoption	0.5	4.5
Japan	On Target	3	Partial Enforcement	1	Minimal Adoption	0.5	4.5
Malaysia	Minimal progress	1	No Enforcement	0	Minimal Adoption	0.5	1.5
New Zealand	On Target	3	Partial Enforcement	1	Minimal Adoption	0.5	4.5
Philippines	Minimal progress	1	Effective Enforcement	2	Moderate Adoption	1	4
Singapore	On Target	3	Effective Enforcement	2	Minimal Adoption	0.5	5.5
South Korea	On Target	3	Effective Enforcement	2	Substantial Adoption	1.5	6.5
Taiwan	On Target	3	Partial Enforcement	1	Moderate Adoption	1	5
Thailand	Minimal progress	1	Effective Enforcement	2	Moderate Adoption	1	4

Vietnam	On Target	3	Partial Enforcement	1	Minimal Adoption	0.5	4.5

Overall Effectiveness	**Score**
Less Effective	0 to 2
Partial	2.5 to 5
Effective	5.5 to 8

Figure 13: High-level comparison of Transport Sector and overall scoring system

2.1.4.1 Fuel Economy

Fuel economy serves as a gauge of fuel consumption, measuring the distance a vehicle can travel using a specific amount of fuel. In the Transport sector, fuel economy is utilised as an indicator of energy efficiency since the amount of carbon emissions is directly linked to the amount of fuel consumed. Therefore, a higher value of fuel economy would correspond to lower amounts of carbon emissions. It has been reported that improving vehicle fuel economy would result in lower CO_2 emissions, estimated at 0.5 Gt/year by 2025 and 1.5Gt/year by 2050, with total savings of 33Gt by 2050 (Watson, 2016).

One of the key drivers of fuel consumption includes fuel price. Fuel prices are reported to have a positive impact on fuel consumption, as higher fuel prices tend to steer markets toward smaller, lighter and more efficient cars (GEFI, 2019). However, with the recent numbers as seen in Figure 14 below, it can be seen that fuel prices no longer have much impact on fuel consumption as jurisdictions such as Singapore and Hong Kong with the highest gasoline prices have one of the highest carbon intensities in their transport sector.

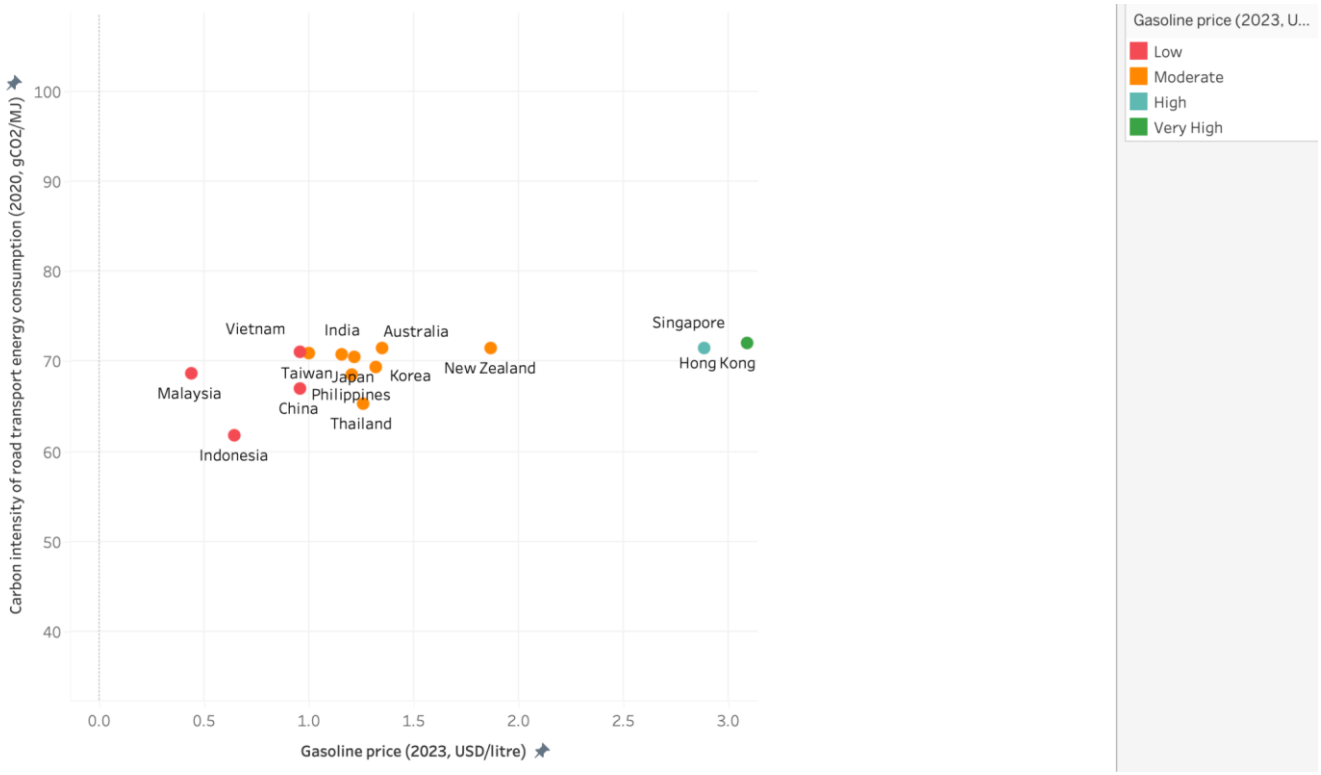

Figure 14: Relationship between Gasoline Price and Carbon Intensity

Hence, we will be looking at 2 other areas - Fuel Efficiency Standards and Vehicle Labelling to evaluate each jurisdiction's progress in its fuel economy.

Impacts

Fuel efficiency standards are one of the strategies adopted by jurisdictions to manage its carbon emissions in the transport sector. Fuel efficiency standards are regulations which set limits to vehicle fuel consumption or CO_2 emissions for new vehicles. These standards have also driven introductions of key technologies driving improvement in Light Duty Vehicles (LDVs) efficiency include hybridization, high-efficiency engine designs, engine downsizing with turbocharging, and improved aerodynamics. Heavy Duty Vehicles (HDVs) are also improving in engine efficiency, reductions in aerodynamic drag, reductions in tire rolling resistance, and hybridization (GEFI, 2019). A supplier that sells more efficient vehicles would be rewarded with 'credits', while suppliers who fail to meet standards would have to incur greater costs by purchasing 'credits' from other suppliers or pay a penalty. Hence, jurisdictions with these standards would give suppliers incentives to sell more vehicles that have lower emissions and to make use of technology to make vehicles more efficient, which eventually help consumers save on fuel costs (Commonwealth of Australia, 2023).

Fuel Economy across Jurisdictions

Gathering from various sources, we noted the current and targeted fuel economy standards for all the 14 jurisdictions as seen below in Figure 15. A detailed breakdown of the sources and tabulations for the relevant values can be found in Appendix B. With the current standards and targets, we then calculated the progress by using the target divided by the current standards. The calculated progress values will then be used to tabulate the points for this indicator. As mentioned in Figure 15, the maximum allocated points for this subsection is 4 points.

Fuel Standards (4 points)				
Jurisdiction	**Current Fuel Economy Standards, 2015 (Lge/100km)**	**Target Fuel Economy Standards (Lge/100km)**	**Progress**	**Score (up to 4)**
Australia	8.5	0	0.00% [Minimal progress]	1
China (Mainland)	8	4	50.00% [Below target]	2
Hong Kong	12.84	0	0.00% [Minimal progress]	1
India	5.8	4.87	83.97% [Above Target]	4
Indonesia	7.3	5	68.49% [On Target]	3
Japan	6.2	3.94	63.55% [On Target]	3
Malaysia	6.6	0	0.00% [Minimal progress]	1
New Zealand	9.132	6.25	68.44% [On Target]	3
Philippines	7.7	0	0.00% [Minimal progress]	1
Singapore	7.2	3.94	54.72% [On Target]	3
South Korea	6.3	3.56	56.51% [On Target]	3
Taiwan	6.55	3.76	57.40% [On Target]	3
Thailand	7.5	0	0.00% [Minimal progress]	1
Vietnam	11.1	7.9	71.17% [On Target]	3

Progress	**Score**
0% - 25% [Minimal Progress]	1
25.1% - 50% [Below Target]	2
50.1% - 75% [On Target]	3
> 75% [Above Target]	4

Figure 15: Breakdown of Fuel standards and scoring system

Across the 14 jurisdictions, those that implemented its fuel efficiency standards include Japan, China, Taiwan, India, Indonesia, Singapore, Vietnam, New Zealand and South Korea. These standards are either based on a

weight classification system or engine size classification system (Feng & Sauer, 2004).

Jurisdictions that have yet to implement any fuel efficiency standards include Malaysia (Xi'an Jiaotong-Liverpool University, 2021), Australia, Thailand, Philippines and Hong Kong. Australia has yet to implement any fuel efficiency standards, however it has been exploring the formulation of these standards in its recent consultation paper on April 2023. Malaysia has also explored the development of respective standards in its National Automotive Policy back in 2014. The Philippines is also exploring the implementation of the standards under the National Energy Efficiency Conservation Plan (Hirose, 2023). Similar for Thailand, standards have been drafted by the Ministry of Energy with Thailand Automotive Institute. Hong Kong has also been reviewing and simulating its fuel economy standards under the Hong Kong Energy Policy Simulator.

China (Mainland)'s Fuel Efficiency Standards

China (Mainland) implemented its fuel-consumption standards with a progressive plan. The first stage was implemented in 2012 which involved 3 groups of vehicles - tractors, straight trucks and coach buses. The second stage was then implemented in 2014, to include 2 more groups - city buses and dump trucks as limits were tightened by up to 14.5%. The third stage was implemented in 2019, with even stringent standards of an additional 12.5% - 15.9% tightening of limits. In the most recent stage, a weight classification system has been adopted to determine the fuel consumption standards. Target has been set at 4.0 Lge/100km by 2025.

Mandatory labels were also required for passenger cars to show their fuel consumption, fuel type, rated power and vehicle weight (IEA, 2021).

India's Fuel Efficiency Standards

India implemented a mandatory corporate average fuel consumption (CAFC) regulation, in which average fuel consumption standards were based on a weight classification system. The average fuel consumption standard was set at 4.77 Lge/100km during phase 2 of the regulations that was implemented from 2022 onwards.

Japan's Fuel Efficiency Standards

Japan first established its mandatory fuel-efficiency standards for HDVs back in 2006, which aimed to reduce CO_2 emissions by 1.2% annually. Reduction targets were then increased to 17% as it was revised in 2017 with more technologies incorporated. New standards were then rolled out in 2019, which required corporate average fuel efficiency of 3.95 Lge/100 km by 2030.

South Korea's Fuel Efficiency Standards

Since 2006, South Korea's fuel economy standards have been in place. Targets had been set at 3.56 Lge/100km by 2030.

New Zealand's Fuel Efficiency Standards

New Zealand has also implemented fuel efficiency standards whereby vehicles entering the jurisdiction must meet an approved emissions standard (Waka Kotahi NZ Transport Agency, 2023). This is regulated under the Clean Car Standard, which began in 2023 with a first year limit of 6.25 Lge/100km, and eventually reaching 2.73 Lge/100km in 2027 (Burgess, 2023).

Indonesia's Fuel Efficiency Standards

In 2019, Indonesia came up with a revised program known as the Low-Carbon Emission Vehicle (LCEV) program. Vehicles are required to emit no more than 120 CO_2g/km and to achieve a fuel economy limit of 5 Lge/100km (IEA, 2021).

Singapore's Fuel Efficiency Standards

Vehicle emission standards are adopted in Singapore, in which the emissions requirements are based on EU, Japan and US standards and test methods (DieselNet, n.d.).

Taiwan's Fuel Efficiency Standards

Under the 'Fuel Economy Standards and Regulations on Vehicle Inspection and Administration' implemented in 2019, the second phrases were rolled out in 2022, in which the fuel economy target for passenger cars, commercial vehicles and motorcycles was 20, 13.7 and 46.1 km/litre respectively (Energy Administration, Ministry of Economic Affairs, 2022).

Vietnam's Fuel Efficiency Standards

Vietnam has set forth its fuel efficiency standards in the Prime Minister's Decision No 49/2011/QD-TTg, in which level 5 standards were applied to manufactured, assembled and imported cars in 2022. These standards are equivalent to the Euro-5 limits provided in the European Union directives (VNS, 2021).

Challenges

It has been noted that some jurisdictions may not have been able to implement its fuel efficiency standards as they do not have the technical capacity to test vehicles and verify the manufacturer's fuel economy ratings in local conditions. This makes it tough for them to develop and enforce any fuel economy standards as they have trouble setting up the reporting systems. Furthermore, the aim of setting fuel efficiency standards is to also allow manufacturers to have the incentive and be more driven in their research and development efforts to meet the standards. However, some jurisdictions may not have the bargaining power to drive a change in the manufacturers' processes. There may even be a risk of manufacturers pulling their products out from these markets when they find that they will not be as profitable after the implementation of the standards (Global Fuel Economy Initiative, n.d.). This is usually the case for non-manufacturing and small jurisdictions. Hence, fuel efficiency standards may not be the most appropriate policy for these jurisdictions to embark on.

2.1.4.2 Labelling

The Vehicle Fuel Economy Labelling Regulations were first published in 2007, and came into effect in April 2008. It is meant for vehicle traders and online vendors to display information about the fuel economy of the vehicles sold. The aim is to allow consumers to make a more informed decision when making a purchase as they can take into account the effect that fuel efficiency has on the environment and fuel costs (IEA, 2017). These labels may vary for different jurisdictions depending on the information that the jurisdiction has decided to disclose.

Impacts

The use of vehicle fuel efficiency labelling has also been reported to help reduce CO_2 emissions from vehicles and push the market uptake of alternative fuel vehicles in several literature reviews and analysis (Asia-Pacific Economic Cooperation Energy Working Group, 2015). Through labelling, it is designed to help stimulate the supply and purchase of more fuel-efficient vehicles. Hence, another area that we will evaluate is the vehicle fuel efficiency labelling adoption rates across the 14 jurisdictions.

Labelling across Jurisdictions

To understand each jurisdiction's efforts in vehicle fuel efficiency labelling, we have further broken down the indicator into - whether labelling is mandatory and whether the CO_2 emissions are displayed on the label, as well as how the points are rewarded, as seen in Figure 16. Sources for the relevant data tabulated can be found in Appendix C. We believe that displaying information with regards to CO_2 emissions would entail that the

jurisdiction is rather transparent in its disclosures. Hence, this would create a greater pressure on manufacturers to keep in mind its vehicles' fuel efficiency and carbon emissions. Thus, a higher score would be credited to jurisdictions that enforce the display of CO_2 emissions.

Vehicle Labelling (2 points)				
Jurisdiction	**Mandatory Vehicle Labelling**	**CO_2 displayed**	**State**	**Score (up to 2)**
Australia[1]	Yes	Yes	Effective Enforcement	2
China (Mainland)[1]	Yes	No	Partial Enforcement	1
Hong Kong[1]	No	No	No Enforcement	0
India[2]	Yes	No	Partial Enforcement	1
Indonesia[3]	Yes	No	Partial Enforcement	1
Japan[1]	Yes	No	Partial Enforcement	1
Malaysia[4]	No	No	No Enforcement	0
New Zealand[1]	Yes	No	Partial Enforcement	1
Philippines	Yes	Yes	Effective Enforcement	2
Singapore[1]	Yes	Yes	Effective Enforcement	2
South Korea[1]	Yes	Yes	Effective Enforcement	2
Taiwan[1]	Yes	No	Partial Enforcement	1
Thailand[1]	Yes	Yes	Effective Enforcement	2
Vietnam[1]	Yes	No	Partial Enforcement	1

State of Enforcement	**Score**
No Mandatory Labelling, No CO_2 displayed [No Enforcement]	0
Mandatory Labelling, No CO_2 displayed [Partial Enforcement]	1
Mandatory Labelling, CO_2 displayed [Effective Enforcement]	2

Figure 16: Breakdown of Vehicle Labelling and scoring system

Across the 14 jurisdictions, 2 of them have yet to enforce mandatory vehicle fuel efficiency labelling - Hong Kong and Malaysia. Although Malaysia has no mandatory labelling, it has established a voluntary vehicle labelling program in place known as the Energy Efficient Vehicle (EEV) Labelling Scheme (MARii, n.d.). On the other hand, Hong Kong has yet to introduce any vehicle labelling initiatives. Considering the widespread enforcement of mandatory labelling in various regions, it is advisable for both Hong Kong and Malaysia to swiftly implement such measures to align with international standards.

Amongst the jurisdictions that have implemented mandatory vehicle labelling, less than half have enforced the disclosures of CO_2 emissions. These jurisdictions include China (Mainland), India, Indonesia, Japan, New Zealand, Taiwan and Vietnam.

Based on our findings, it is still commendable that the majority of the jurisdictions are making commendable efforts to shape consumer preferences towards more efficient vehicles. We believe that if these jurisdictions can go a step further to also enforce disclosures on CO_2 emissions, the influence on consumers' decisions would be much greater.

2.1.4.3 Adoption of Electric Vehicles (EVs)

Electric Vehicles (EVs) have emerged as a pivotal technology in the endeavour to decarbonize road transport. In recent years, the proportion of electric cars in total vehicle sales has witnessed a remarkable surge, more than tripling over three years, from approximately 4% in 2020 to 14% in 2022 (Alsauskas, et al., 2023). The three primary markets of EVs are China (Mainland), Europe and the United States as they dominate global sales. While electric car sales traditionally remained modest beyond these major markets, 2022 showcased notable growth in smaller markets, including India, Thailand, and Indonesia. This growth can be attributed to market trends and policy initiatives, such as government incentive programs and subsidies, which contribute to a promising outlook for electric vehicle sales.

Impacts

Research has shown that electric cars are more eco-friendly as they emit fewer greenhouse gases (GHGs) and air pollutants than petrol or diesel cars. To illustrate, a single electric car on the road has the potential to save an average of 1.5 million grams of CO_2 in over a year, equivalent to the emissions of four return flights from London to Barcelona (EDF, n.d.). Compared to conventional vehicles, EVs generate minimal emissions throughout their lifespan. If the entire global automotive fleet transitioned to electric, nearly one-fifth of global emissions could be effectively reduced. Other benefits also include enjoying fresher air quality, less dependency on conflict-fuelled spikes in oil prices and quieter urban environments (Igini, 2023).

Electric Vehicles across Jurisdictions

Recognizing the positive impact of EVs in reducing carbon emissions, we have assessed the percentage of electric vehicle sales in comparison to the total vehicle fleet across the 14 jurisdictions. The results are depicted in Figure 17 and the detailed sources for each jurisdiction’s electric vehicle sales figure can be found in Appendix D.

Electric Vehicle Sales (2 points)			
Jurisdiction	**EV sales of vehicle fleet in 2022 (%)**	**State**	**Score (up to 2)**
Australia	0.5	Minimal Adoption	0.5
China (Mainland)	22	Widespread Adoption	2
Hong Kong	7.2	Substantial Adoption	1.5
India	5.59	Substantial Adoption	1.5
Indonesia	1	Minimal Adoption	0.5
Japan	2.1	Minimal Adoption	0.5
Malaysia	0.41	Minimal Adoption	0.5
New Zealand	1	Minimal Adoption	0.5
Philippines	2.72	Moderate Adoption	1
Singapore	1.3	Minimal Adoption	0.5
South Korea	6.2	Substantial Adoption	1.5
Taiwan	3.4	Moderate Adoption	1
Thailand	3	Moderate Adoption	1
Vietnam	1	Minimal Adoption	0.5

State of Adoption	**Score**
0% - 2.4% [Minimal Adoption]	0.5
2.5% - 4.8% [Moderate Adoption]	1
4.9% - 7.2% [Substantial Adoption]	1.5
> 7.2% [Widespread Adoption]	2

Figure 17: Breakdown of Electric Vehicles and scoring system

Across the 14 jurisdictions, China (Mainland) is performing the best in promoting EV sales amongst its people, emerging as one of the top 10 market players in the EV market globally as it accounted for nearly 60% of all new electric car registrations globally in 2022 (IEA, 2023). Hong Kong, India and South Korea also perform much better in the adoption of EVs compared to the other jurisdictions. We will hence delve deeper into these 4 markets to evaluate their commitments towards their EV strategies.

China (Mainland)'s Electric Vehicle Strategy

China (Mainland) became a world leader in the production of EVs as it remained as the world's largest market for EVs for the eighth consecutive year. Its rapid growth in EV is also reflected by its EV sales in the last 2 years, in which the number of EVs sold grew significantly from 1.3 million to 6.8 million.

The main driver behind the immense growth of EVs in China (Mainland) is the government's key role in propping up both the demand and supply of EVs. The government played an important role of giving generous subsidies, tax rates, procurement contracts and incentives to grow its own EV brands, cultivating a large group of young

car buyers. These financial support amounted to over 200 billion RMB across the years 2009 to 2022. Although China (Mainland) has gradually phased out its direct subsidy programs, it has been spurring the shift towards a market-based regulation scheme, known as the 'dual-credit' policy. In this policy, manufacturers will gain credits either for reducing the average fuel consumption to below a certain level or producing EVs. Similarly, manufacturers who fail to achieve the reduction targets or even not produce a specified percentage of EVs, will lose credits. This policy has helped to reform the automobile industry in China (Mainland), creating new opportunities with the quasi-carbon market (Yang, 2021). Procurement contracts were also offered to China (Mainland)'s public transportation fleet, creating a new revenue stream for EV manufacturers to survive on.

China (Mainland) also had structural advantages in place in terms of its manufacturing capabilities and cheap commodities. Having a prior supply chain for its gas-car factories, these assets were similarly transferable to support its development in EV manufacturing. With that, the Chinese government started its investment in EV related technologies in the early 2000s, as a priority research and development project in China (Mainland)'s Five-Year Plan. To constantly encourage innovations, the government has also created a favourable market for EVs, attracting foreign companies such as Tesla. This imposes a favourable competition between the foreign and domestic companies as they have to constantly innovate and catch up in areas such as technology advancement and affordability (Yang, 2023).

The government's early efforts in pumping the EV industry through a diverse set of policy tools has thus led them to gain the first mover advantages in the industry, establishing their large market presence for many years.

Hong Kong's Electric Vehicle Strategy

In Hong Kong, the percentage of newly registered electric cars has soared from 6.3% in 2019 to 52.8% in 2022. This large growth can be attributed to the government's efforts in making the cost of adopting EV much lower. An example would be the 'One-for-One Replacement' Scheme in which first registration tax (FRT) concessions arrangement is provided for EVs. Under this scheme, private car owners who decide to de-register their own current private car and then register for a new EV will be able to enjoy a higher FRT concession, capped at $287,500. This is a form of subsidy that encourages more private car owners to switch to EVs.

More concrete plans have also been established in the Hong Kong Roadmap on Popularisation of Electric Vehicles (EV Roadmap), which include strategies such as ceasing new registration of fuel-propelled private cars in 2035, expanding EV charging network and creating a conducive environment for the growth of EVs (Dimsumdaily Hong Kong, 2023).

Hong Kong also has a rather established EV infrastructure system, with 5,300 EV chargers installed by 2022. It has raised its targets to install 7,000 EV charging stations by 2025 after its successful completion last year. The government has also highlighted its plans to extend the technology to its public fleet, as it conducts trials for at least 800 electric commercial vehicles, introducing about 700 electric buses and 3,000 electric taxis (Smith, 2023).

As Hong Kong's government ramps up its efforts in promoting the adoption of EV through financial incentives and the support of creating favourable infrastructures, it has been successful thus far in spurring the growth of the EV industry in Hong Kong.

India's Electric Vehicle Strategy

India has been stepping up its efforts in the EV industry as its EV sales grew from 0.4% to 1.5% in just a year, 3 times faster than the global average (Jaeger, 2023). This reflects the huge growth potential of the EV industry

in India as the market is expected to reach $266 billion by 2030 (Fortune India, 2023). This is attributed to the large presence of the automobile industry in India. The automobile industry is one of the largest employers and exporters in India. As one of the largest manufacturers of vehicles, India has been a highly sought for place amongst foreign investors. In 2022, several U.S. companies have invested a total of $1 billion in Indian EV companies.

The government has also been placing more emphasis on its infrastructures to facilitate the adoption of EVs through initiatives such as the planning of electric highways. These highways will be facilitating the charging of heavy-duty trucks and buses as they are powered by solar energy. Another initiative is also the Production-Linked Incentive Scheme (PLI) for ACC Battery Storage Manufacturing rolled out back in 2021. This scheme will encourage the domestic production of batteries, reducing the dependence on imports, ultimately reducing the cost of production of EVs as the government supports the industry with the requisite infrastructure (Bhardwaj, 2022).

With foreign direct investments and the support extended to build up the necessary infrastructures to drive the growth of the manufacturing of EV vehicles, the Indian government has successfully spurred the growth of EV.

South Korea's Vehicle Strategy

The South Korean government has expressed its plans to invest heavily in the EV industry, with its efforts to move towards its pledged commitment of banning the registration of internal combustion engine cars from 2035. To achieve this, the government has increased electric vehicle subsidies to $4 billion until 2025. Different electric vehicle price tiers will enjoy different discounts as well. On average, South Korean consumers can purchase an electric vehicle in South Korea for a 33% discount.

The government also imposed a sales quota for EV sales, in which car manufacturers have to have 15% of their sales come from EV. Those who sell more than 15% would be able to sell their credits to other companies, creating a quasi-carbon market for the EV industry. By ensuring that manufacturers also put in their weight in driving the demand for EV, it is targeted that 20% of all cars in South Korea would either be battery-electric or fuel-celled cars.

In terms of manufacturing processes and infrastructure, the South Korean government is also investing in its own battery material development infrastructure and expanding its charging stations. As electric battery packs make up the largest cost in an electric vehicle, amounting to 33% of production costs, by investing in its own battery material development infrastructure, cost of production can be lowered, allowing consumers to enjoy a lower price as well. The government has expressed its plans to invest $21 million to build testing infrastructure for its local producers of materials and parts for rechargeable batteries. Looking at the EV infrastructures, the South Korean government has also been proactive in its expansion of the amount of charging stations as it installed 3,000 new fast charging stations for EVs back in 2021. By 2025, the South Korean government is looking at a total of 500,000 EV charging stations (John, 2023).

With a combination of strategies, the South Korean government has been rolling out policies that aim to make the adoption of EVs affordable and user-friendly for consumers.

Challenges

Some challenges that other jurisdictions are facing when adopting EVs revolve around 3 main areas: Purchase Cost, Charging Infrastructure and Grid Capacity. Firstly, the production costs can be rather expensive, primarily due to the significant cost associated with battery technology. Therefore, the production of EVs tends to be

more expensive than gasoline-powered vehicles. Given the necessity for EV batteries to store substantial charges to achieve minimum range requirements, expensive raw materials are essential in the manufacturing process. Consequently, this limits the number of suppliers in the EV industry, as only a few manufacturers can bear the high production costs.

Furthermore, some jurisdictions face challenges in establishing well-developed charging infrastructures for EVs. The absence of robust charging networks can hinder the smooth operation of EVs on roads, leading to concerns related to user range anxiety (Gray, 2022). Users may fear the inability to find charging stations when needed. Given that accessibility and onsite charging play a crucial role in motivating consumers to adopt EVs, the deficiency in charging infrastructure can diminish the demand for EVs, as consumers may lack confidence in the practicality of owning and operating an EV.

Lastly, there would be a need to upscale the grid capacity if jurisdictions opt for a complete transition to EVs. As the adoption of EVs increases, a larger portion of the population would rely on the electric grid in new ways. It has been predicted that there would be an average increase of 38% in electricity consumption by 2050 primarily due to the widespread adoption of EVs. Hence, to accommodate the growing demand driven by the adoption of EVs, some jurisdictions may encounter the obstacle of limited grid capacity, requiring them to explore ways to scale up their infrastructures (EVCS Productions, 2023).

Gathering the results of the buildings, industrial and transport sectors, Figure 18 shows the consolidated results for the final scoring of the progress of the ‘Reduce’ tier across the jurisdictions.

Reduce Tier (30 points)					
Jurisdiction	**Buildings (15 points)**	**Industrial (7 points)**	**Transport (8 points)**	**Total score (out of 30 points)**	**% of 30 points**
Australia	9.00	0	3.5	12.50	42%
China (Mainland)	8.83	5	5	18.83	63%
Hong Kong	6.83	2	2.5	11.33	38%
India	4.83	7	6.5	18.33	61%
Indonesia	4.83	3	4.5	12.33	41%
Japan	8.33	0	4.5	12.83	43%
Malaysia	3.67	1	1.5	6.17	21%
New Zealand	5.00	0	4.5	9.50	32%
Philippines	5.67	1	4	10.67	36%
Singapore	7.33	2	5.5	14.83	49%
South Korea	11.50	3	6.5	21.00	70%
Taiwan	5.17	7	5	17.17	57%
Thailand	4.83	5	4	13.83	46%
Vietnam	5.67	4	4.5	14.17	47%

Overall Efforts Towards Reduce Tier	**Score**
<40% [Minimal Efforts]	1
40% to 55% [Moderate Efforts]	2
>55% [Substantial Efforts]	3

Figure 18: Final scoring of jurisdiction's efforts in carbon management for the Reduce Tier.

2.2 Tier 2 - Substitute

2.2.1 Introduction - Renewable Energy (RE)

Another way many jurisdictions reduce emissions is by turning to renewables. Renewables typically refer to renewable energy sources, which are energy sources that are naturally replenished on a human timescale. They are sustainable and do not run out over time, unlike finite sources such as fossil fuels. The renewables that will be covered in this report include:

1. **Solar Energy**
    - **a.** Solar energy is harnessed by photovoltaic panels which capture sunlight and convert it into electricity. Additionally, Solar thermal systems can also capture the sun's heat for space heating or heating water in residential areas.
2. **Wind Energy**
    - a. Wind energy is harnessed by converting the kinetic energy from moving air into mechanical energy, which can then be transformed into electricity. This conversion is typically achieved using wind turbines.
3. **Hydroelectric Energy**
    - a. Hydroelectricity works by using the potential energy of stored water or the kinetic energy of moving water to spin a turbine, which in turn drives a generator to produce electricity
4. **Tidal Energy**
    - **a.** Tidal energy harnesses the gravitational forces between the Earth and the Moon. This gravitational pull causes water in the oceans to move in predictable patterns known as tides. Tidal energy systems capture this kinetic energy and convert it into electricity.
5. **Geothermal Energy**
    - **a.** Geothermal energy taps into the heat stored beneath the Earth's surface to generate electricity and provide direct heating. Temperatures in the Earth's core can reach over 5,000 degrees Celsius. Geothermal energy systems are subsequently able to tap into this heat by capturing steam or hot water from underground reservoirs to drive turbines or provide direct heating.
6. **Biomass energy**
    - **a.** Biomass energy is derived from organic materials, which can include plants, residues from agriculture or forestry, and the organic component of municipal and industrial wastes. It can be used as a source of heat or converted into electricity or biofuels. Biomass is considered renewable because the growth of new plants or organic matter can replace the biomass that's harvested.

2.2.2 Renewables across Jurisdictions

Australia

In 2021, Australia derived **26.66**% of its energy from renewable sources, making it the **fourth** highest amongst the 14 jurisdictions. Despite this achievement, it's only **33%** of the way towards its 2030 goal of sourcing **82%** of its energy from renewables. Notably, **solar and wind** energies together contribute to almost **80%** of the nation's total renewable energy production. Australia currently has **79** RE projects under construction, encompassing wind, solar, hydro, and bioenergy (Clean Energy Council, 2023). These projects will deliver 12,388MW of new renewable energy capacity. The **largest renewable energy scheme** in Australia would be t**he Renewable Energy Target** (RET) scheme which aims to encourage renewable energy generation. The RET comprises of the following

2 schemes:

1. Large-scale Renewable Energy Target (LRET) which incentivises **large companies** and **electricity retailers** to invest in **wind and solar farms** as well as **hydro-electric power stations**
2. Small-scale Renewable Energy Scheme (SRES) which incentivises **households** and **small businesses** to install small-scale renewable energy systems such as **rooftop solar panels**, **solar water heaters**, and **small-scale wind or hydro systems**.

China (Mainland)

In 2020, RE satisfied **28.55%** of China (Mainland)'s total energy demands, with **hydro energy** being the dominant source, contributing to over **60%** of this figure. This performance positioned China (Mainland) as the **third highest** amongst the 14 jurisdictions in terms of renewable energy utilisation.

China (Mainland)'s advancements in renewable energy are not just limited to hydro. The jurisdiction has set a visionary target: to generate **1,200GW** of energy using **wind and solar** power by **2030**. Notably, China (Mainland) is poised to achieve its goal by **2025**, five years earlier than planned.

By the first quarter 2023, China (Mainland)'s **utility-scale solar capacity** reached **228GW** — a figure surpassing the combined solar energy capacity of **all other nations**. Moreover, ongoing solar farm projects promise to introduce a further **379GW**, a capacity three times that of the US.

China (Mainland)'s prowess in harnessing wind energy is equally impressive. Both offshore and onshore wind facilities in China (Mainland) collectively boast a capacity exceeding **310GW**. To put this in perspective, this capacity equals the combined output of the subsequent top seven nations. China (Mainland)'s ambition in wind energy remains undiminished, with new projects sprouting in Inner Mongolia, Xinjiang, Gansu, and various coastal regions. These projects are projected to introduce an additional 371GW to China (Mainland)'s wind energy capacity before 2025, enhancing the worldwide wind energy fleet by nearly 50%.

Hong Kong

In 2020, Hong Kong was only able to derive 0.24% of its total energy needs from RE, making it by far the lowest ranking amongst the 14 jurisdictions. With that being said, biomass energy accounted for nearly 80% of all of Hong Kong's renewable energy. There are a few reasons why Hong has such a low adoption rate of renewable energy:

1. Hong Kong’s high building density coupled with its mountainous terrain makes it impossible to install large-scale renewable projects such as wind farms or solar fields
2. Lack of information on the technology, the different and complicated safety regulations as well as the non-transparent provider structure are barriers to the further expansion of solar projects in Hong Kong
3. Government prefers fossil fuels and imported Chinese Nuclear energy over renewables
4. Extremely modest RE goals of 3-4% by 2030 as compared to Singapore’s 20%
5. Interests of Hong Kong’s two main power companies: China (Mainland) Light and Power (CLP) and Hong Kong Electric (HKE) are prioritised over RE investments

India

In 2020, RE satisfied **21.03%** of India’s total energy needs, with **hydro energy** accounting for nearly **50%** of India’s total RE output (Birol & Kant, 2022). However, RE is growing at a faster rate in India than any other major economy with its non-fossil fuel capacity having increased by 396% in the last 8.5 years. As of 2022, 40% of India’s power capacity is from non-fossil fuels, which is almost **nine years ahead** of its commitment made at COP 21-Paris Summit. The exponential growth rate of India’s RE output is due to:

1. Solar power plants being cheaper to build than coal ones due to technological developments, steady policy support, and a vibrant private sector
2. Removal of subsidies for petrol and diesel in the early 2010s
3. Introduction of subsidies for electric vehicles in 2019

4. National Green Hydrogen Mission aim to develop green hydrogen production capacity of at least 5 MMT per annum along with a renewable energy capacity addition of around 125 GW in India so as to decrease India's dependency on fossil fuels and increase India's share of clean energy

Indonesia

In 2020, Indonesia sourced 18.84% of its energy from renewable sources, with hydro energy contributing 45% of this renewable output. Indonesia is close to reaching its 2025 goal of having 23% renewable energy, having achieved about 82% of this target by 2020. Indonesia has embarked on several energy projects which include:

1. Eastern Indonesia Renewable Energy Project
2. Java-Bali Power System
3. PLN's Renewable Energy Plans
4. WPP Tenaga Surya Komodo Solar Park
5. Geothermal Power Plants

Japan

In 2021, Japan sourced 21.53% of its energy consumption from renewables, with an overwhelming 82% of that derived from a potent blend of solar and hydro power. This achievement marks a significant milestone, as Japan is already approximately 67% towards its ambitious 2030 target of sourcing 36-38% of its energy from renewable sources.

Japan is advancing its renewable energy efforts with a focus on offshore wind power (Coca, 2023). The jurisdiction currently has nine major offshore wind projects in the works, primarily in wind-abundant regions of central and northern Japan. The government's ambitious goals target 10GW of construction by 2030 and aim for 30–45GW by 2040, potentially making Japan the owner of the world's third-largest offshore wind power fleet. Notable projects in development include the Akita and Noshiro Offshore Wind Farms, boasting a combined capacity of 140 MW. Furthermore, Japan, with its volcanic activity, possesses considerable geothermal energy potential. The jurisdiction is advancing the development of geothermal power plants as a consistent and renewable energy option. The Ministry of Economy, Trade and Industry aims for an 8 GW installed biomass capacity by 2030, meeting five percent of the jurisdiction's estimated power demand. Notable geothermal projects include the Osorezan Geothermal Power Plant and the Takigami Geothermal Power Station. Such initiatives in geothermal energy enhance Japan's energy stability while decreasing its dependence on fossil fuels.

Malaysia

In 2020, Malaysia managed to source 16.2% of its entire energy demand from renewables, with hydro energy dominating by contributing to nearly 90% of this figure (Sustainable Energy Development Authority, 2021). Despite these advances, when compared to the 14 jurisdictions, Malaysia ranked as the 5th lowest in renewable energy adoption. While the nation has embarked on its sustainable journey, its current trajectory indicates it's just over halfway, at 52.3%, towards meeting its 2025 target of having 31% of its total energy derived from renewable sources. Incentivizing green initiatives, the government offers notable tax reductions for businesses in green tech, including renewable energy, EV, and eco-friendly certifications, with MIDA actively promoting these opportunities to foreign firms. Additionally, collaborative projects are in the pipeline:

1. Project H2ornbill with Japanese firms focuses on converting green hydrogen into MCH for Japanese markets
2. Project H2biscus partners with South Korean companies to produce blue and green ammonia from hybrid hydrogen sources in Sarawak for export to South Korea.

New Zealand

New Zealand stands as a beacon in the renewable energy landscape, showcasing an exemplary commitment to green energy adoption. In 2021, the island nation sourced a remarkable 85.09% of its total energy requirements from renewables. The lion's share of this, about 65%, was harnessed from hydro energy, making New Zealand the undisputed leader among 14 jurisdictions in terms of renewable energy utilisation. Beyond these impressive numbers, the nation's trajectory towards a sustainable future is evident in its progress towards its 2030 ambitions. New Zealand is already 87% on track to achieve its audacious target of powering the jurisdiction entirely with renewable energy by 2030. Despite New Zealand's stellar progress in its journey to 100% renewable energy adoption, it still has several RE projects in the pipeline including:

1. The Waipipi Wind Farm in South Taranaki and the Tarakohe Wind Farm in Golden Bay are enhancing its wind energy capacity.
2. The Tauhara II project is focused on boosting the jurisdiction's geothermal energy capabilities
3. Additionally, even though hydro energy is already a significant source for New Zealand, new initiatives, including potential storage projects like Lake Onslow, are underway to further leverage this resource.

Philippines

In 2020, the jurisdiction managed to fulfil 21.22% of its total energy demands through renewable sources. Impressively, geothermal energy, leveraging the nation's unique volcanic topography, accounted for nearly half of this renewable energy contribution. This is indicative of the Philippines' effective utilisation of its indigenous energy assets. Looking forward, the jurisdiction is on a promising trajectory, having already achieved 60% of its 2030 target to source 35% of its total energy from renewables. The Philippines has been actively working on several renewable energy projects, given the nation's commitment to expanding its renewable energy portfolio. Here are some notable future projects and areas of focus in the Philippines:

1. **Geothermal expansion**: As the second-largest geothermal electricity producer globally, the jurisdiction is furthering its geothermal capacity, with the Luzon Geothermal Project being a significant initiative
2. **Wind energy** is gaining traction, highlighted by developments like the Rizal Wind Farm in Luzon
3. **Hydroelectric energy** growth is evident in projects such as the Kaliwa Dam and the modernization of the Agus-Pulangi Hydropower Complex

Singapore

In 2020, Singapore, constrained by its urbanised and compact geography, sourced only 1.39% of its energy from renewables, with solar contributing nearly 67% of this figure due to its equatorial position. Despite ranking second lowest among 14 jurisdictions, Singapore is steadily progressing towards its green objectives, having already achieved 31% of its goal to derive 3% of its total energy from renewables by 2030. Singapore's future RE efforts are spearheaded by the SG Green plan 2030. Under the SG Green Plan 2030, Singapore aims to deploy 1.5 GWp of solar energy by 2025, fulfilling roughly 2% of its anticipated electricity needs. By 2030, the target will increase to 2 GWp, addressing around 3% of its projected electricity demands. The SolarNova Programme, an initiative to consolidate solar PV demand across government entities, is set to produce approximately 420 GWh of solar energy annually, covering about 5% of the nation's total energy consumption. Furthermore, SembCorp and PUB have inaugurated the SembCorp Tengeh Floating Solar Farm, a 60 megawatt-peak floating solar system located in the Tengah Reservoir.

South Korea

In 2021, South Korea could muster just 6.88% of its energy requirements from renewable sources, with solar energy contributing to nearly 60% of this figure. Such metrics placed South Korea as the 4th lowest amongst the 14 jurisdictions in terms of renewable energy adoption. While the jurisdiction has been making efforts, its progress towards a sustainable future remains somewhat slow-paced; it has achieved only 34.7% of its target

to have 21.6% of its total energy derived from renewable sources by 2030. This emphasises the need for South Korea to accelerate its renewable energy initiatives to catch up with global standards and its own set ambitions. Some of South Korea's upcoming RE projects include:

1. The Solar City Seoul Project (2022) aims to equip one million households with solar PV panels, targeting 1 GW capacity
2. The Anma Offshore Wind Project plans to produce 1400GWh of renewable energy annually by 2027
3. Meanwhile, the Jocheon-eup Green Hydrogen Production Plant in Jeju City, operational from 2025 to 2030, intends to produce 1.2 tonnes of hydrogen annually, powering 200 cleaning vehicles and 300 buses in Jeju
4. The government will invest 240bn won ($192.7m) to establish six "hydrogen cities" in South Korea, emphasising blue hydrogen from fossil gas with carbon capture
5. Additionally, three South Korean firms are collaborating on a $1 billion green hydrogen and ammonia production facility in the UAE, aiming for 200,000 tonnes of green ammonia yearly
6. Domestically, a partnership between SK E&S, Koen, and SK Plug Hyverse will focus on green hydrogen and ammonia projects, with Koen intending to utilise them in its coal and gas power plants

Taiwan

Taiwan sourced a mere 5.32% of its energy requirements from renewable sources during the year. Dominated by solar energy, which contributed almost 83% to this figure, the jurisdiction also saw a notable contribution from hydro energy. Yet, when compared with 14 other jurisdictions, Taiwan ranked as the third lowest in terms of renewable energy adoption. The jurisdiction's current trajectory indicates that it has achieved only 23.3% of its aspiration to power the nation with 27-30% renewable energy by 2030.Taiwan's renewable energy strategy emphasises wind and solar photovoltaic (PV) power. By 2030, offshore wind power capacity is targeted at 13.1 GW, escalating to 40-55 GW by 2050. Solar PV aims are set at 30 GW by 2030 and 40–80 GW by 2050, with a focus on diverse land applications. Hydrogen energy is spotlighted as a pivotal tool for net-zero emissions, used in industry, transportation, and power generation. Combining imported green hydrogen with domestic production will necessitate the construction of hydrogen infrastructure. Additionally, Taiwan is exploring innovative energy avenues, emphasising geothermal, ocean energy, and advanced biomass energy technologies. The goal for such forward-looking energy sources is to achieve an installed capacity of 8–14 GW by 2050.

Thailand

In 2020, the nation achieved 16.33% of its energy demands from renewable sources. Intriguingly, biomass energy, tapping into the jurisdiction's agricultural strengths, made up a dominant 56% of this renewable contribution. These figures place Thailand firmly on its path towards sustainability, having accomplished nearly 55% of its ambitious 2030 target, which aims to meet 30% of its total energy needs through renewable sources. Some of Thailand's RE projects and initiatives include:

1. **Biomass and Biogas**:
    - Korat Waste-to-Energy Plant: Located in Nakhon Ratchasima, this plant is designed to convert municipal waste into energy.
    - Chaiyaphum Biogas Project: An initiative to convert agricultural waste, particularly from tapioca production, into biogas.
2. **Solar Energy Projects:**
    - Lopburi Solar Power Plant: One of the largest solar power plants in Thailand, it's a prime example of the nation's thrust into solar energy
    - Sirindhorn Dam Solar Project: A significant hydropower-solar hybrid project at the Sirindhorn Dam

3. **Hydropower Expansion**:
    - Nam Ngum 2 Hydropower Project: A collaboration between Thailand and Laos, this project is designed to supply electricity to Thailand's power grid

Vietnam

In 2020, Vietnam derived 35.45% of its energy from renewables, with hydro energy accounting for 86% of this contribution, ranking it as the 2nd highest compared to the 13 other jurisdictions. Notably, Vietnam has already reached its 2030 goal of sourcing 30-39% energy from renewables, marking its position as a renewable energy leader a decade ahead of its target. Under the Draft Eighth Power Development Plan, Vietnam aims to amplify its solar and wind power generation to 31-38 gigawatts by 2030, targeting these sources to constitute 50.7% of its electricity by 2045. The National Strategy for Climate Change outlines objectives to bolster renewable energy infrastructure by 2050, emphasising a range of sources, including hydro plants, central and rooftop solar plants, land-based and offshore wind power, biomass, hydrofuel, ammonia fuel technology, and tidal/wave energy. By 2050, renewables are projected to form 55% of the nation's total energy output. Additionally, there's an emphasis on integrating renewable energy in supply chains and cold storage systems.

2.2.3 Overall scoring for the Substitute Tier

Initially, the overall efforts for a jurisdiction in the Substitute tier was graded only based on their progress towards their future RE targets. However, we decided that it was not entirely fair to discount the current RE % as a share of a jurisdiction's total energy needs. For example, even though a country as such New Zealand, which has access to a wide variety of natural resources such as large water bodies to harness hydro energy or large open spaces to build wind turbines would surely fare better than a jurisdiction like Singapore with practically no spare land or access to natural resources in the Substitute tier, we still had to take into account that the jurisdiction made a conscious effort to invest money and resources to harness those natural resources, and utilise them as renewable energy sources. Therefore, our final metric was to allocate a maximum of 3 points for a jurisdiction's initial RE share of their total electricity produced and a maximum of 6 points to a jurisdiction's progress towards its future RE targets, ensuring that all jurisdictions, regardless of their landmass or natural resources are graded equally based on their efforts in the 'Substitute' tier.

Electricity Output from Renewable Sources as % of Total Electricity Produced (3 points)								
Jurisdiction	**RE as % of Total Energy Needs**	**Solar Energy**	**Wind Energy**	**Hydro Energy**	**Tidal Energy**	**Geothermal Energy**	**Biomass Energy**	**Score (out of 3 points)**
Australia (2021)	26.66%	10.44%	9.24%	5.72%	NA	NA	1.26%	3
China (Mainland) (2020)	28.55%	3.38%	6.01%	17.45%	0.00% (negligible)	0.00% (negligible)	1.71%	3
Hong Kong (2020)	0.24%	0.05%	0.00% (negligible)	NA	NA	NA	0.19%	1

India (2020)	21.03%	4.00%	4.40%	10.49%	NA	NA	2.14%	2
Indonesia (2020)	18.84%	0.06%	0.16%	8.34%	NA	5.33%	4.95%	2
Japan (2021)	21.53%	8.79%	0.98%	8.81%	NA	0.30%	2.66%	2
Malaysia (2020)	16.2%	1.28%	NA	14.36%	NA	NA	0.56%	2
New Zealand (2021)	85.09%	0.46%	6.05%	55.46%	NA	19.16%	3.96%	3
Philippines (2020)	21.22%	1.35%	1.01%	7.07%	NA	10.57%	1.22%	2
Singapore (2020)	1.39%	0.93%	NA	NA	NA	NA	0.46%	1
South.Korea (2021)	6.88%	3.89%	0.52%	1.11%	0.08%	NA	1.28%	1
Taiwan (2020)	5.32%	2.18%	0.86%	2.21%	NA	0.00% (negligible)	0.07%	1
Thailand (2020)	16.33%	2.80%	1.80%	2.61%	NA	0.00% (negligible)	9.12%	2
Vietnam (2020)	35.45%	3.99%	0.41%	30.36%	NA	NA	0.69%	3

Overall scoring for Renewable Share as % of Total Electricity Produced	
<10% of Total Energy Needs supplied by RE - 1 Point	1
Between 20-25% of Total Energy Needs supplied by RE - 2 Points	2
>25% of Total Energy Needs supplied by RE - 3 Points	3

Note: All data in this table was from IEA

Figure 19: Electricity Output from Renewable Sources as % of Total Electricity Produced

Comparison of Jurisdictions' progress towards individual RE Targets (6 points)				
Jurisdiction	**Target**	**Current State**	**Current State / Target**	**Score (out of 6 points)**
Australia	82% of TE supplied by RE by 2030	27%	32.9%	4
China (Mainland)	RE capacity of 1.2TW by 2030	0.538TW from Solar and Wind energy alone	44.83%	4
Hong Kong	7.5-10% of TE supplied by RE by 2035	0.24%	3.2%	2
India	50% of TE supplied by RE by 2030	21% as of 2020	42.0%	4
Indonesia	23% of Total Primary Energy Supply supplied by RE by 2025	18.84% as of 2020	81.9%	6
Japan	36-38% of TE supplied by RE by 2030	24%	66.7%	4
Malaysia	31% of TE supplied by RE by 2025 (13GW) & 40% by 2035 (18GW)	16.2% as of 2020	52.3%	4
New Zealand	100% of Total Primary Energy Supply supplied by RE by 2030	87%	87.0%	6
Philippines	35% of TE supplied by RE by 2030	21% as of 2020	60.0%	4
Singapore	3% of TE supplied by Solar Energy by 2030	0.93% as of 2020	31.0%	4
South Korea	21.6% of TE supplied by RE by 2030	7.50%	34.7%	4
Taiwan	27-30% of TE supplied by RE by 2030	6.3% as of 2021	23.3%	2
Thailand	30% of TE supplied by RE by 2037	14.90%	49.7%	4
Vietnam	30-39% of TE supplied by RE by 2030	35.45% as of 2020	100%	6

Overall scoring for a Jurisdiction's progress towards their RE Targets	**Points**
<25% to Target State	2
Between 50-75% to Target State	4
Between 75-100% to Target State	6

Note: All data in this table was from IEA

Figure 20: Comparison of Jurisdictions' progress towards individual RE Targets

Substitute Tier (9 points)		
Jurisdiction	**Total score (out of 9 points)**	**Score**
Australia	7	2
China (Mainland)	7	2
Hong Kong	3	1
India	6	2
Indonesia	8	3
Japan	6	2
Malaysia	6	2
New Zealand	9	3
Philippines	6	2
Singapore	5	2
South Korea	5	2
Taiwan	3	1
Thailand	6	2
Vietnam	9	3
Overall Efforts for Substitute tier		**Score**
Minimal Effort: 3 - 4 Points		1
Moderate Effort: 5 - 7 Points		2
Substantial Effort: 8 - 9 Points		3

Figure 21: Overall Scoring for Substitute Tier

2.3 Tier 3 - Sequester

2.3.1 Introduction - Carbon Capture Utilisation and Storage (CCUS)

There are three types of carbon sequestration – biological (i.e., storage of CO_2 in forests, oceans, soil etc.), geological (i.e., storage of CO2 in underground geological formations through injections) and technological (removal of CO_2 using novel technologies) (UC Davis, 2022). In this report, biological carbon sequestration was not considered because while trees have the capability to absorb CO_2 from the atmosphere, they would become carbon neutral upon reaching maturity, hence offsetting the benefits they originally bring from photosynthesis when the trees release CO_2 back to the atmosphere through processes of decay, respiration and consumption by animals and insects (Tso & Harvey, 2020). As such, this report would focus on the geological and technological carbon sequestration, which emphasises the capturing and storing of carbon emissions using technologies, specifically with the use of CCUS technologies.

CCUS is a collective term which refers to the variety of techniques used in capturing and permanently storing or using the CO_2 gas that was released from burning fossil fuels through the use of technologies (International Energy Forum, 2021). While most of the captured CO_2 comes from large point sources, such as industrial or power plants that burn either fossil fuels or biomass as fuel, CO_2 can also be directly captured from the ambient air with newly developed technologies (also known as direct air capture, or DAC). After capturing the CO_2, if the gas is not used on-site, it would be compressed into a fluid and is either injected into deep geological formations, like depleted oil and gas reservoirs or saline formations which traps the CO_2 for long-term storage, or is transported through the use of pipeline, truck, rail or ship for other uses.

There are a few methods to capturing CO_2 (Ara Ake, 2022):

- Post-combustion: the removal or CO_2 from flue gas after burning the fuel by employing a chemical solvent for instance
- Pre-combustion: the transformation of fuel into a gas mixture of hydrogen and CO_2 before burning it. The leftover hydrogen-rich mixture is then utilised as fuel after removing the CO_2
- Oxy-fuel combustion: the production of CO_2 and steam by burning fuel with mostly pure oxygen, then capturing the emitted CO_2 afterwards
- Bioenergy Carbon Capture and Storage (BECCS): the absorption of CO_2 from the air into the biomass of plants via photosynthesis before burning in power plants
- DAC: the capture and removal of CO_2 directly from the atmosphere through the use of thermo-electric or chemical processes
- Carbon mineralisation: the on-site or off-site capture of CO_2 through the use of minerals that naturally exist whereby carbon cannot be re-released into the air

There are a few uses of captured CO_2 (IEA, 2019):

- Urea manufacturing in producing fertiliser: this process uses approximately 130 Mt CO_2 yearly, making it the largest consumption of CO_2
- Enhanced Oil Recovery (EOR): the CO_2 is used to raise the highest possible amount of on-site extraction of gas and oil (Ralston, 2021). This is done through injecting CO_2 into reservoirs or existing oil fields to drive out hydrocarbons or oil respectively for extraction. This process is the second largest consumption of CO_2, using approximately 80 Mt CO_2 yearly
- Direct use in producing food and carbonated drinks

- Manufacturing synthetic fuels (e.g., methane, methanol), chemicals (e.g., plastics, synthetic rubber) and construction materials (i.e., concrete is produced in a process called CO_2 curing whereby water is replaced with CO_2)

There are a few types of underground geological formations for storing CO_2 (IEA, 2021b):

- Depleted oil and gas reservoirs/fields: similar to how gas and crude oil were trapped under the porous rock formations over millions of years, the injected CO_2 can also be trapped under the porous rock formations. These reservoirs, alongside deep saline formations, have the biggest capacity in storing CO_2
- Deep saline formations/aquifers: common in both offshore and onshore sedimentary basins, the layers of porous and permeable rocks which have been saturated with salty water (brine) can trap the injected CO_2 permanently
- Unmineable coal seams/bed: storing CO_2 in coal that is too challenging to mine or is too deep, enabling the absorption of CO_2 if the coal has sufficient permeability for the gas to pass through (BGS, n.d.)
- Basalt formation: the formation of stable minerals from the reaction of injected CO_2 and chemical components can trap the CO_2, though it is currently in its early stages of developing

The effective storage of CO_2 is only possible due to the four mechanisms that traps the gas in the subsurface, preventing the escape of the gas back into the atmosphere (National Energy Technology Laboratory, n.d.):

- Structural Trapping: a seal is formed when a part of the injected gas migrates to the top of the saline formation and becomes structurally trapped beneath the impermeable cap rock as the injected gas has slightly higher buoyancy that the fluids that are found in the surrounding space
- Residual Trapping: small amounts of CO_2 get trapped in tiny pore spaces that exists in between rock grains as the injected CO_2 migrates to the top
- Solubility Trapping: some CO_2 will dissolve into the brine water that is found within the pore spaces of the rock
- Mineral Trapping: occurs during or after solubility trapping happens, whereby the dissolved CO_2 reacts with the minerals found in the rock to form solid carbonate minerals that will permanently trap and store that portion of the injected gas

CO_2 can be transported via various modes: pipeline, ship, truck and rail. For large-scale transportation of CO_2, pipeline and ship are used, while truck and rail are used for small-scale or short-distance delivery though at a higher price (IEA, 2021b). Although pipeline is the cheapest way of transporting large amounts of CO_2 onshore, there are some limitations in the amount and distance in transporting offshore, but pipeline still remains the most used form of transporting CO_2. Shipping can occasionally be a more affordable alternative as it provides more flexibility in transporting CO_2 to various offshore locations compared to pipeline.

2.3.2 Benefits of CCUS

The adoption of CCUS technologies can play a significant role in the world's transition towards net-zero (IEA, 2020). Firstly, CCUS can reduce the extensive amount of emissions from existing infrastructures. By retrofitting CCUS to extant industrial and power plants, it can prevent the emission of 600 billion tonnes of CO_2 over the next 50 years, equating to around 17 times of current yearly emissions. Moreover, for nations that depend heavily on emissions-intensive industry, retrofits can ensure their continued use and economic success, especially for young fleets of power plants, preventing the costs of early retirement. In addition, retrofitting CCUS to the existing plants is a more cost-effective option than building new plants with alternative technologies (Baylin-Stern & Berghout, 2021).

Secondly, CCUS can effectively decarbonise hard-to-abate industries (i.e., financially or technologically challenging in transiting to net-zero) (Lombard Odier, 2021) since the technology can capture and store the significant amounts of generated emissions permanently. For example, the cement industry generates around 2.4Gt of global emissions, whereby 66.7% of the emissions are from process emissions and not from burning fossil fuels (IEA, 2020). Since there are no alternatives in producing cement, CCUS can effectively capture and store 1.6Gt of emissions (66.7% of 2.4Gt).

Thirdly, CCUS presents an opportunity to produce low-carbon hydrogen (i.e., alternatives to fossil fuels) from coal or natural gas at a low cost, further supporting the decarbonisation of sectors like heavy industry, and transport (IEA, 2020). Moreover, CCUS can also reduce emissions from existing fossil fuel- and natural gas-reliant hydrogen production plants which emit over 800MtCO_2 annually. Additionally, these CCUS retrofitted hydrogen production plants have the benefit of being a low-cost alternative in places that use fossil fuels and have large carbon storage capacities in the future.

Lastly, CCUS can serve to be the technology-based solution to removing carbon from the atmosphere as there are still emissions that cannot be lowered directly or avoided (i.e., hard-to-abate emissions) (IEA, 2020). Aside from using nature-based solutions such as reforestation and afforestation, carbon removal can be accomplished with CCUS technologies like DAC and BECCS, albeit BECCS has its limitations if there are insufficient sustainable biomass.

2.3.3 Constraints of CCUS

While CCUS has its benefits, there are also constraints that jurisdictions have to consider which would deter their adoption of CCUS. Firstly, jurisdictions could face geographical constraints which would limit the types of CCUS projects that they can adopt. Geographical constraints would refer to aspects such as the availability of suitable geographical sites and proximity to carbon storage sites. For instance, Australia has many available underground geological sites for the permanent injection of CO_2 (Lyne, 2021). As a result of such large potential capacities that Australia has to offer, 24 out of the 29 operational, under construction or planned projects are/will be used as dedicated storage for injected CO_2 (refer to Appendix E).

On the other hand, jurisdictions would need to consider the distance between the CO_2 sources and their potential carbon storage sites when deciding to transport the carbon. The cost of transporting carbon would then depend on the mode of transport used, the volume of CO_2 transported, and the conditions for storage. For example, in the United States, the onshore pipeline cost of transporting carbon is priced around USD 2-14/tonne, while the cost of onshore storage has a wider range, though most costs less than USD10/tonne (Baylin-Stern & Berghout, 2021). In this case, jurisdictions might consider building a CCS hub-and-cluster which would allow the reaping of economies of scale and reduce the unit cost of transporting and storing carbon (Zhang, 2020).

Secondly, a jurisdiction might face certain financial constraints in adopting CCUS due to the insufficient funds to support the very large upfront capital and maintenance costs of CCUS projects. This could thus deter developing jurisdictions from venturing into CCUS since CCUS technologies are still relatively expensive. Based on a CCS case study for a retrofitted coal-fired power plant in the Blora Regency in Central Java, Indonesia, done by Mitsubishi Research Institute, the capital cost[1] for CO_2 capture and storage was USD 433.05 million and USD

[1] All costs mentioned for the case used by the Asia CCUS Network Secretariat had been referred from a 2005 study made by the Research Institute of Innovative Technology for the Earth (RITE).

264.36 million respectively, while the annual operating costs were USD 89.63 million and USD 26.52 million respectively (Asia CCUS Network Secretariat, 2022).

Moreover, the extremely large cost would deter the adoption of CCUS compared to other carbon management practices such as renewables like wind. Additionally, all CCUS technologies do not have the same costs. According to IEA, under carbon capture, the costs can vary greatly from USD 15-25/tonne for processes that produces high concentration of CO_2 (e.g., production of ethanol) to USD 60-120/tonne for processes that produce low concentration of CO_2 (e.g., production of cement) (Baylin-Stern & Berghout, 2021). The carbon capture costs can even go up to USD 134-342/tonne for the newly developed technology, DAC.

Thirdly, jurisdictions could face technological constraints as there are concerns and uncertainties with the technological performance of CCUS operations. Despite the existence of large-scale operational CCUS which are currently capturing CO_2, there are CCUS projects that are underperforming and have yet to meet their targets. According to a report by the Institute for Energy Economics and Financial Analysts (IEEFA), out of the 13 CCUS projects that they have reviewed, 10 were underperforming and were not meeting their capture capacity (Robertson & Mousavian, 2022). As such, there are scepticisms of whether the technological performance can justify the large costs of CCUS. In addition, some CCUS technologies, such as the developing BECCS and DAC technologies, do not have the sufficient technological maturity and reliability, which would require more improvements before they can be widely employed.

Moreover, jurisdictions have to consider the energy efficiency of CCUS projects and determine if adoption of the project would cause the energy used to bring about more reductions or emissions.

Lastly, there is the risk of the leakage of CO_2 after it has been pumped underground. However, years of experience with storing CO_2 have shown that hazards of leakage are minimal and can be efficiently handled, but thorough monitoring systems and careful site selection are essential (Malischek & McCulloch, 2021). Another risk is the human-made tremors that could be brought about by the build-up of pressure underground where CO_2 is injected into (i.e., induced seismicity). Micro-seismicity is typically defined as having a magnitude of +2 or lower, while a magnitude of +3 or above would be regarded as significant (Global CCS Institute, 2016). However, there have not been any recorded events where the magnitude is larger than +1 as a result of carbon storage operations. Hence, the risk of induced seismicity as a result of CO_2 injection is low.

2.3.4 Current Situation of CCUS in the Jurisdictions

According to the March 2023 updated CCUS database by IEA (IEA, 2023a), there are a total of 573 operational, under construction, planned, or decommissioned CCUS projects around the world, amounting to a total maximum capacity of 1172.255Mtpa (million tonnes per annum). Out of the 1172.255Mtpa, 95.207Mtpa comes from operating CCUS, which has the potential to account for 0.2587% of the 2022 global energy-related CO_2 emissions[2].

Across the aforementioned 14 jurisdictions, there are a total of 76 CCUS projects, which consists of 9 operational, 8 under construction and 59 planned projects, leading to a total maximum capacity of 117.654Mtpa (refer to Appendix E). However, there are no such projects in Hong Kong, the Philippines and Vietnam (Figure 22).

[2] 2022 global energy-related emissions reached 36.8 billion tonnes (IEA, 2023b).

To assess the progress of CCUS projects across the 14 jurisdictions, two indicators – Status and Total Potential Effectiveness (p.a.) (to be explained below) were used. Points were assigned to the jurisdictions based on their status, whereby '3' points were given to those with operating projects, '2' points were given to those with projects that were under construction, '1' points were given to those with planned projects, and '0' points were given to those that had no CCUS.

Jurisdiction	**Status**	**Status score (up to 3 points)**
Australia	Operating	3
China (Mainland)	Operating	3
Hong Kong	None	0
India	Planned	1
Indonesia	Planned	1
Japan	Operating	3
Malaysia	Under Construction	2
New Zealand	Planned	1
Philippines	None	0
Singapore	Planned	1
South Korea	Planned	1
Taiwan	Planned	1
Thailand	Planned	1
Vietnam	None	0

Figure 22: Status of CCUS projects in the 14 jurisdictions with allocated points

There are three jurisdictions that have operational (i.e., project has been authorised for operations) CCUS projects, namely Australia, China (Mainland), and Japan (Figure 23). To evaluate the potential effectiveness (p.a.) of the jurisdictions'' operating projects, the maximum capacity per annum (p.a.) is measured against how much of their own 2020 CO_2 emissions can be reduced.

Australia only has one project, the Gorgon CCS, which has a maximum capacity of 4Mtpa that can reduce 1.069% of her own 2020 CO_2 emissions (refer to Appendix E). China (Mainland) has six projects which have a combined maximum capacity of 1.98Mtpa that can reduce 0.0196% of her own 2020 CO_2 emissions (refer to Appendix E). Japan has two projects, the Mikawa Power Plant BECCS Fukuoka Prefecture and the Tomakomai CCS demonstration project, but the latter has been suspended since 2019 and is now kept for monitoring purposes. As such, the former has a maximum capacity of 0.18Mtpa which can reduce 0.0182% of her own 2020 CO_2 emissions (refer to Appendix E). Comparing the three jurisdictions' maximum capacity of their operational projects in reducing their own emissions against the global effort of 0.2587% (Figure 23), Australia is outperforming the world, while China and Japan are falling short.

Jurisdiction	Potential Effectiveness of Operating Projects (p.a.)
Australia	1.0689%
China (Mainland)	0.0196%
Japan	0.0182%
World	**0.2587%**

Figure 23: Table of Potential Effectiveness of Operating Projects (p.a.)

There are also three jurisdictions that have CCUS projects that are currently under construction (i.e., Construction is under way after a Final Investment Decision (FID) has been announced) and would start operating no later than 2025. On the other hand, accounting for the majority of CCUS projects, the 11 jurisdictions have a total of 59 planned projects (i.e., project is at conceptual design, feasibility or engineering study (FEED) stage), which have plans to start their operations by 2030 (refer to Appendix E).

Despite the growing momentum of CCUS in the APAC regions, the progress of CCUS projects in the APAC region cannot be compared to that of the west due to the expertise gained over the years prior to starting earlier. As such, due to the steep learning curve involved in CCUS development, the current performance efficiencies of operational CCUS projects would not be evaluated upon. However, the availability and maximum capacity of the projects would then be used as a measurement for the effectiveness of CCUS as a carbon management strategy for the 14 jurisdictions. To evaluate the total potential effectiveness (p.a.), the maximum capacity per annum (p.a.) of all the planned, under construction and operational CCUS projects of the jurisdiction is measured against how much of their own 2020 CO_2 emissions can be reduced.

According to the United Nations Economic Commissions for Europe (UNECE), CCUS projects will be required to reduce 14% of emissions by 2050 to allow the world to align with the Paris Agreement (Center for Climate and Energy Solutions, n.d.-a). Currently based on all announced information[3], only Australia would be able to hit that set benchmark with the combined maximum capacity of all operational, under construction and planned projects (Figure 24). Points were then assigned to the jurisdictions based on whether they have hit the set benchmark, whereby '2' points were given to those that were able to reach the set target, while '1' point was given to those that were unable to reach the set target.

Jurisdiction	Total Potential Effectiveness (p.a.)	Total Potential Effectiveness (p.a.) score (up to 2 points)
Australia	17.71%	2
China (Mainland)	0.24%	1
India	0.03%	1
Indonesia	1.83%	1
Japan	0.83%	1
Malaysia	1.44%	1

[3] There are unannounced capacities for many planned projects (refer to Appendix E).

New Zealand	3.25%	1
Singapore	5.72%	1
South Korea	0.10%	1
Taiwan	0.04%	1
Thailand	0.41%	1
Target		**14%**

Figure 24: Table of Total Potential Effectiveness (p.a.) with allocated points

By considering the status of the CCUS projects of the jurisdictions (Figure 22), along with the total potential effectiveness (p.a.) of the projects (Figure 24), a scoring system out of 5 points has been established. Jurisdictions with '0' points are classified under minimal, '2-4' points are classified under moderate, and '5' are classified under substantial. It should be noted that no jurisdictions would obtain 1 point due to the nature of the scoring system since a minimum of 2 points would be awarded to jurisdictions with planned projects.

With that, the consolidated total points of all 14 jurisdictions in this 'Sequester' tier can be seen in the following Figure 25.

Sequester Tier (5 points)					
Jurisdiction	**Status**	**Status score (up to 3 points)**	**Total Potential Effectiveness (p.a.)**	**Total Potential Effectiveness (p.a.) score (up to 2 points)**	**Total score (out of 5 points)**
Australia	Operating	3	17.71%	2	5
China (Mainland)	Operating	3	0.24%	1	4
Hong Kong	None	0	-	0	0
India	Planned	1	0.03%	1	2
Indonesia	Planned	1	1.83%	1	2
Japan	Operating	3	0.83%	1	4
Malaysia	Under Construction	2	1.44%	1	3
New Zealand	Planned	1	3.25%	1	2
Philippines	None	0	-	0	0
Singapore	Planned	1	5.72%	1	2
South Korea	Planned	1	0.10%	1	2
Taiwan	Planned	1	0.04%	1	2

Thailand	Planned	1	0.41%	1	2
Vietnam	None	0	-	0	0
Overall Efforts Towards Sequester Tier					**Score**
0 [Minimal]					1
2 - 4 [Moderate]					2
5 [Substantial]					3

Figure 25: Final scoring of jurisdiction's efforts in carbon management for the Sequester Tier

2.4 Tier 4 - Compensate

2.4.1 Introduction - Carbon Pricing Methods

Carbon pricing is a strategy that tags a price to emissions, which aims to shift the burden for the damage from GHG emissions to emitters who are responsible for it. It places the decision in the emitters' hands as they decide whether to transform their activities and lower their emissions, or continue emitting and pay for their emissions. Currently, there are a total of 73 carbon pricing initiatives, which are projected to cover 11.66 $GtCO_2e$, representing 23% of global GHG emissions (The World Bank, n.d.).

There are 2 main methods of carbon pricing - carbon tax and carbon markets. A carbon tax is a direct price set on carbon through explicit tax rates on GHG emissions. It is normally quantified with a price per tCO_2e. Businesses and industries that produce carbon emissions through their operations have to pay the taxes accordingly (Kagan, 2022). On the other hand, carbon markets are trading systems where there is a sale and purchase of carbon credits. These markets provide a platform for companies or individuals to compensate for their GHG emissions (United Nations Development Programme, 2022). Carbon markets can be further broken down into voluntary and compliance carbon markets, each with its own mechanism and impacts.

The carbon tax and compliance carbon market methods both put a price on carbon and utilise a market to generate revenue. Both methods require firms to be compliant to the obligations with monitoring, reporting and verification in place (Michigan State University, 2022). However, both differ in their approach towards cost and environmental certainty. Carbon Taxes are cost certain by the way it offers predictability regarding compliance costs and establishes stable prices (Carl & Fedor, 2016). Compliance carbon markets instead are environmentally certain with an environmental goal set beforehand, but through the allowance and cap-and-trade system, the cost to achieve the environmental goal is determined by the market supply and demand forces (BloombergNEF, 2022). The carbon taxation and compliance carbon market approaches both strive to price carbon to reduce emissions while taking on different approaches.

2.4.2 Carbon Tax

A carbon tax is one of the carbon pricing methods whereby the tax is levied on the carbon emissions required to produce goods and services. According to the World Bank, there are currently 36 carbon tax regimes (Ellerbeck, 2022). These regimes would cover 2.76 $GtCO_2e$, representing 5.62% of global GHG emissions.

To formulate the carbon tax mechanism, there are a few design choices that must be considered. First, the method of evaluating the tax rate. There are several ways to determine the tax rate, either by basing it off the net benefits associated with reduced emissions, or to first predetermine the emissions target such that the rate can then be set to achieve the desired target. Second, the scope of the tax. Policymakers would need to consider the broadness of the tax in terms of the industries and substances covered in the tax. Tax can be limited to sectors of the economy that produce the most greenhouse gas emissions and specifically carbon emissions. Third, the stakeholders that the tax is being imposed on. This can be determined by the point in the energy supply chain where taxes could be levied at (Center for Climate and Energy Solutions, n.d.-b). By taxing the upstream, the payers would include those who produce fossil fuels. Similarly, petroleum refineries would be the midstream taxpayers and consumers would be the downstream taxpayers.

Impacts of Carbon Tax

Looking at the direct effect of carbon tax on businesses and individuals, it aims to address climate change by making it more expensive to use carbon-based fuels, thereby encouraging manufacturers and consumers to lower their carbon emissions. On the other hand, the indirect effect of taxation aims to mitigate and remove the negative externalities of carbon emission (Kagan, 2022). It can generate more immediate environmental, societal and health benefits such as reducing deaths resulting from local air pollution within communities that are near factories. Carbon tax can also raise significant revenue for governments which can in turn be used for investment funding for other projects (Parry, 2019).

The use of carbon taxes is currently not at a universal level as there are arguments against the adoption of carbon tax. First, the welfare impacts of carbon tax can hurt poor people more than the richer ones. Carbon taxes would result in consumption baskets to be more expensive, resulting in a welfare loss when prices rise, affecting the poor more. Second, economic disruptions may be magnified as the restructuring of resources takes time. During the transition from fossil fuels to renewable energy, resources can be unemployed and it would not be as efficient. This would result in a supply-demand mismatch in the short run due to the substantial uncertainty in the size of fuel reserves and pace of innovation in the alternative energy sources (Islam, 2022).

Carbon Taxes across Jurisdictions

To analyse the progress of each jurisdiction in carbon tax, we made use of 2 indicators - whether they have implemented tax and their current carbon emissions. The results are as shown in the below Figure 28. Detailed sources of the data can be found in Appendix G.

Carbon Tax (3 points)				
Jurisdiction	**Carbon Tax**	**Carbon Tax Price (US$ / tCO_2e)**	**Carbon Emissions per unit of 2015 GDP (kg/USD)**	**Total (out of 3 points)**
Australia	No		0.3	1
China (Mainland)	No		0.7	0
Hong Kong	No		0.1	1
India	No		0.8	0
Indonesia	Yes	2.1	0.5	2
Japan	Yes	2.16	0.2	2
Malaysia	No		0.6	0
New Zealand	No		0.1	1
Philippines	No		0.3	1
Singapore	Yes	3.77	0.1	3
South Korea	No		0.3	1
Taiwan	No		0.4	1
Thailand	No		0.5	1

Vietnam	No		0.9	0

Overall Effectiveness	**Score**
No Carbon Tax, High Emissions[1] (No Enforcement, High Emissions)	0
No Carbon Tax, Low Emissions[1] (No Enforcement, Low Emissions)	1
Low Carbon Tax[2] (Partial Enforcement)	2
High Carbon Tax[2] (Effective Enforcement)	3

[1]Low emissions are regarded as less than or equal to 0.5kg/USD, high emissions are those with more than 0.5kg/USD

[2]Low carbon tax is defined as a tax price of less than US$3/$tCO_2e$, high carbon tax is defined as a tax price of more than US$3/$tCO_2e$

Figure 26: Scoring framework and results for Carbon Tax

Across the aforementioned 14 jurisdictions, only 3 jurisdictions - Singapore, Indonesia and Japan have carbon taxes in place. For all the other jurisdictions, there have yet to be formalised adoption of carbon taxation policies in place. However, jurisdictions including Malaysia, Thailand and Taiwan have announced their intention to work toward the implementation of carbon tax. It is worth noting that Australia had once implemented carbon tax back in 2012 at a price of AUD 24.15/tCO_2. However, it was repealed in 2014 due to oppositions that claimed that tax was useless in helping the environment and destructive as it damaged jobs and increased burden on families' cost of living (Geline, 2014).

The lack of implementation for carbon tax is attributed to 2 main reasons - welfare impacts and the fear of harming competitiveness. The enforcement of carbon tax is often regressive in its impact, in which the poor would bear a relatively larger burden of taxes compared to the rich. Thus, those jurisdictions without a carbon tax now may not have been able to make progress due to its inability to draft its taxation policies in a way such that it can better protect its vulnerable groups. Another reason is that jurisdictions fear the negative impacts of taxes on its market attractiveness. When taxes are imposed, potential business interests and investments may be lost as these businesses turn to other markets that do not have taxes levied in order to keep their costs of production minimal. This would thus harm the jurisdiction's economy in the long term as it loses its economic attractiveness, resulting in governments to deter from carbon taxation due to the conflict with its political interests (Roumeen, 2022). Gathering the above, these are the reasons as to why certain jurisdictions are making minimal progress in carbon tax, which is especially more prominent amongst developing jurisdictions.

With that, we will now explore the dynamics of the jurisdictions that have implemented a carbon tax.

Indonesia Carbon Tax

The Harmonisation of Tax Regulations (Harmonisasi Peraturan Perpajakan/HPP) Bill was signed in 2021 in which the carbon tax was officially introduced in Indonesia. The price was set at Rp 30/tCO_2 with a prioritisation of tax levied on corporations and at the initial stage, only applicable to the coal-fired power sector. Expansion of the carbon taxation was also scheduled to be carried out in stages from 2025 onwards, after considerations for the readiness of the relevant sectors or players, economic conditions and the overall scale of application.

Support is also given in the form of a carbon 'offset' whereby participants in carbon trading and emissions offsetting can be granted a carbon tax reduction or other incentives to fulfil their carbon tax obligations (Sukardi and She, 2022).

Japan Carbon Tax

The carbon tax in Japan was implemented in 2012 with a tax rate of JPY289/tCO_2e. Tax applies to all fossil fuels including petroleum, oil products, natural gas and coal. However, different carbon emissions content get levied at different rates. To better ease the tax burden, the tax rate will be set to increase gradually over three and a half years. However, the tax rate has remained at the same price since 2016. The carbon tax would account for approximately 5.69 million tons to 23.5 million tons of CO_2 reduction.

Carbon tax exemptions and refund measures are also extended to certain fossil fuel products used in particular energy intensive industries such as home electricity generators. These measures include cost reduction in fuel production and distribution, stabilisation of fuel supply and energy-savings in logistics and transportation sectors (Gokhale, 2021).

Singapore Carbon Tax

The carbon tax in Singapore was first implemented on 1 January 2019, set at a price of S$5/$tCO_2e$ for the first 5 years from 2019 to 2023 as a transitional period for emitters to adjust. The pricing system is a progressive one as the prices would start to increase over the years. Carbon tax would be raised to S$25/$tCO_2e$ in 2024 and 2025, and S$45/$tCO_2e$ in 2026 and 2027, and eventually S$50-80/$tCO_2e$ by 2030. The design of the carbon tax in Singapore include tax levied on facilities that directly emit at least 25,000 tCO_2e of GHG emissions annually, with a coverage of 6 GHGs - carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride. Nitrogen trifluoride emissions would be counted in the tax coverage from 2024 onwards. The carbon tax currently covers 80% of Singapore's total GHG emissions from 50 facilities in the manufacturing, power, waste and water sectors.

To further provide support for the affected businesses and consumers, there are a few other schemes that work in conjunction with the carbon tax. First, the use of international carbon credits can be used to offset up to 5% of taxable emissions. This would help to relieve some strains on companies in the short run that find it challenging to significantly cut down emissions in the near term. However, the limit is capped at 5% as the focus is still on prioritising domestic emissions reduction in the long run. Second, a transition framework is in place to provide support for existing emissions-intensive trade-exposed (EITE) companies that include chemicals, electronics and biomedical manufacturing sectors. Allowances would be awarded based on the facility's performance on internationally-recognised efficiency benchmarks and decarbonisation plans. These EITE companies are identified as companies that face a higher risk of carbon leakage as they have a higher tendency of relocation to other jurisdictions with less stringent climate policies. Hence, to protect the business competitiveness in Singapore, the transition framework aims to alleviate the near-term impact and minimise the risk of carbon leakage. Third, consumers are also given support through subsidies such as vouchers to offset the cost of purchasing more energy efficient and climate friendly appliances. Regulators also closely watch over the conduct of market players to ensure that consumers are not over-charged by retailers who pass on the tax burden to consumers (National Climate Change Secretariat, n.d.).

Challenges

The commonalities of the 3 carbon tax regimes in Singapore, Japan and Indonesia demonstrates the challenge of matching the rate of adoption for taxation with the ideal pricing for carbon tax to have a significant impact on the reduction of emissions. At the current stage, all the regimes are in their transition stage, together with many support schemes to ensure that emitters have the capacity to adjust to the new regulations.

Looking at Figure 29 below, it can be seen that the current carbon tax is insufficient to cover the emissions produced in the jurisdiction. The current emissions covered by carbon tax is at 5.62%. A research by Energy Modeling Forum (EMF) reported 2 different scenarios with different impacts on emissions reductions after 5 and 15 years. The World Bank also estimates that a carbon price of $50 - 100/$tCO_2e$ is required by 2030 to meet the temperature goals of below 2 degree Celsius above pre-industrial levels set in the Paris Agreement. From the current range of $2 - $4 carbon tax, it is evident that the pricing is far from the ideal state. A more aggressive pricing likened to Singapore's carbon tax strategy needs to be enforced across all the other jurisdictions to make a significant impact in the reduction of emissions.

Scenario	Range of Emissions Reductions after 5 Years	Range of Emissions Reductions after 15 Years
$25 per ton, rising 1% per year	16-28%	17-38%
$50 per ton, rising 5% per year	21-35%	26-47%

Figure 27: Scenario analysis of carbon prices

Source: Alexander R. Barron, Allen A. Fawcett, Marc A. Hafstead, James R. McFarland, and Adele C. Morris, "Policy Insights from the EMF 32 Study on U.S. Carbon Tax Scenarios," Climate Change Economics 9:1 (2018)

2.4.3 Carbon Markets

Carbon markets represent the other pricing approach, whereby establishing trading systems to allow organisations and individuals to engage in the buying and selling of carbon credits as a means of compensating their carbon emissions. One tradable carbon credit is equal to one tonne of carbon dioxide or the equivalent amount of a different greenhouse gas reduced, sequestered or avoided (United Nations Development Programme, 2022).

Two primary carbon market structures exist: Voluntary and Compliance Carbon Markets.

2.4.3.1 Voluntary Carbon Markets

The Voluntary Carbon Market (VCM) is a component of the global carbon market that allows entities, usually companies, to take responsibility and assume accountability for mitigating or eliminating GHG emissions (Carbon Credits, n.d.). The 'voluntary' nature of the market is attributed to participation being discretionary rather than being legally or regulatorily enforced by law. Entities participating in a VCM have the option to buy and sell carbon credits (Carbon Offset Guide, n.d.). The VCM and its credits abide by existing standards that outline the criteria for the production and eligibility for offsets.

The VCM consists of a buy-side and supply-side. Sellers in the VCM initiate projects and are issued carbon credits when eligible according to criteria, such as reforestation or developing renewable energy plants (World Economic Forum, 2023). The projects must demonstrate a genuine need and requirement for financing to support their implementation and to distinguish itself from business-as-usual activities. On the buy-side, buyers acquire the credits issued to these projects to offset their own carbon emissions. Companies often opt to engage based on their environmental and corporate social responsibility (CSR) goals and objectives, going beyond their legal mandates (Carbon Credits, n.d.). Through the purchase of carbon credits, companies acquire the entitlement to claim the responsibility for a designated reduction or elimination of GHGs from the environment.

The tradability of these entitlements provides companies with flexibility in achieving their emission reduction objectives.

In contrast to the substantial $851 billion global carbon market, the voluntary market constitutes only a small fraction of $2 billion as of 2021 (Twidale, 2023). Although the monetary size of the VCM appears modest in comparison to the global financial requirements for a shift towards net-zero emissions, it holds a significant importance in the broader efforts to address climate change and promote sustainable development. There is considerable potential as companies are likely to turn towards offsetting residual emissions in the decades to come once all other options for emission reduction are used up (BloombergNEF, 2022).

Domestic and International Markets

The voluntary carbon market operates in both domestic and international spheres, allowing entities to engage in emissions offsetting on a broader scale. Jurisdictions operate and mandate their VCMs according to their own regulatory standards or through widely verified international regulatory frameworks (Dawes et al., 2023). Different factors come into play for jurisdiction specific markets and the way they operate depends on the discretion of the jurisdiction's regulations. Key considerations include project locations and regulatory compliance. In the domestic market, projects are typically located within the jurisdiction of operation, while the international market allows for a more diverse range of project locations (Favasull & Sebastian, 2021). Domestic markets adhere to the regulations and standards decided by the domestic government. For markets open internationally, international regulatory frameworks are often adopted to cater to the need to navigate diverse regulatory landscapes.

Regulatory Frameworks

Verra and the Gold Standard are two prominent organisations that play key roles in the field of carbon markets, certification, and sustainable development (Verra, 2023). These frameworks are most often adopted in international VCMs and are also found in domestic markets.

Verra's Verified Carbon Standard (VCS) is one of the most widely used standards for VCMs, offering a stringent framework for the creation and validation of projects that yield carbon offsets (Verra, 2023). Verra takes charge of formulating, overseeing methodologies that provide project developers with guidelines for measuring, reporting, and verifying their emissions reductions. These methodologies are instrumental in ensuring a standardised and credible approach in quantifying the carbon benefits of projects.

The Gold Standard for the Global Goals (Gold Standard), is a standard specifically tailored for the VCM and adopts a comprehensive approach to project certification (Gold Standard, 2023). The Gold Standard goes beyond assessing the project's direct contribution to emissions reduction, and also evaluates the project's broader impact on achieving Sustainable Development Goals (SDGs). By considering both environmental and socio-economic factors, the Gold Standard aims to ensure that projects not only mitigate climate change, but also contribute positively to SDGs on a global scale.

In domestic markets, regulators and governmental bodies may opt for their own set of regulatory frameworks for the operation of the VCM within the jurisdiction.

Jurisdictions implementing a VCM must establish regulatory frameworks to guarantee the credibility and quality of the market. This is crucial for verifying that the project emission reductions are genuine, quantifiable, and represent an actual environmental gain, beyond what would have happened without the project (Mendelsohn et al., 2021). These guidelines play a pivotal role in promoting consistency across projects, enhancing transparency, and bolstering the overall credibility of the market.

Voluntary Markets Across Jurisdictions

Jurisdictions are evaluated based on the implementation progress of the VCM as well as the extent of participation in the global VCM market. This provides a comprehensive understanding of the functionality and effectiveness of the establishment of the market as well as evaluating the impact of the jurisdiction's participation and contributions. It considers both the tangible impact on emissions reduction and the regulatory infrastructure that supports the integrity and growth of the market (World Economic Forum, 2023).

Australia: Australia's VCM operates domestically and utilises The National Carbon Offset Standard (NCOS) to serve the voluntary market, ensuring the integrity of the offset available to consumers and businesses within Australia (Clean Energy Regulator, 2022). The Carbon Neutral Program offers a certification mechanism grounded in the National Carbon Offset Standard (NCOS) to attain carbon neutral certification. Australian Carbon Credit Units (ACCUs) and other carbon offsets are available for voluntary purchase by Australian entities outside of the compliance market to meet their own emission reduction commitments (Carbon Neutral, n.d.). The Australian VCM functions as an expansion of the compliance market within the jurisdiction.

China (Mainland): China (Mainland) is set to reintroduce its voluntary carbon credits program through the China Certified Emissions Reduction (CCER) scheme by the end of 2023 (Chen, 2023). In the concluding phases of reinstating the market, they are in the process of finalising and refining its legislation, methodologies, and trading platform. The program was previously terminated due to challenges regarding data manipulation fraudulence where 10 million tonnes of CO_2 per year were found to be falsified in emissions data within 2 years of its inception (You, 2023). Due to data integrity issues, the market faced delays in expansion, necessitating a thorough review and subsequent relaunch.

Despite no VCM currently being in operation, China (Mainland) holds the position of the largest supplier of carbon credits in the global VCM, constituting 20.8% of the total voluntary carbon credit issuances globally in the first quarter of 2023 (Yin, 2023).

Hong Kong: Hong Kong operates an international VCM namely Core Climate. Core Climate operates as a marketplace facilitating the trade of international voluntary carbon credits within their exchange (HKEX, 2023). The platform currently provides access to carbon credits originating from over 30 internationally certified projects. Their traded credits undergo verification against the Verified Carbon Standard by Verra. Core Climate has been well established and positions Hong Kong as a notable leader in the VCM.

India: As of present day, the VCM in India remains stable and has not undergone any significant government interventions or modifications recently. The market has demonstrated success, as reflected in trading volumes from 2010 to 2022 with a substantial 278 million credits issued, accounting for 77% of the global supply (Sahil Ali, 2023). As of June 2023, India boasts 860 registered projects and a total of 1451 at various states of consideration within Verra and Gold Standard. This data underscores India's substantial presence and success in the carbon credit market.

Indonesia: Voluntary parties dominate their current carbon market with VCM being the current main platform. The Indonesia Climate Exchange (ICX) was established as a trading platform, with the primary objective to cultivate an ecosystem for the private sector within the VCM, to facilitate transactions and collaboration (Cabinet Secretariat of the Republic of Indonesia, 2023). Indonesia has also launched a National Registry for their own set of VCM standards. However, the registry does not impose restrictions on buyers who wish to adhere to global VCM standards like Verra and Gold Standard. Due to this, ongoing discussion has been taking

place to suggest that projects certified under Verra and Gold Standard should not be listed on the global registry but on Indonesia's dedicated national registry to prevent double counting issues from arising (Yin, 2023). This underscores the evolving dynamics and considerations in the management and recognition of carbon offset projects within the Indonesian carbon market.

Japan: Japan's current emphasis on the VCM over the compliance market is notable. However, the shift has been attributed to the perceived absence of rules and regulations in the compliance market. In 2022, Japanese companies witnessed an increase in the retirement of carbon credits compared to the previous year, marking a deviation from the global trend where carbon credit retirements decreased by 4% in 2022 compared to 2021 (Sebastian, 2023). Despite Japan's active engagement in the retirement of carbon credits, it's worth mentioning that there are relatively few Voluntary Carbon Market (VCM) projects initiated within Japan itself. This highlights an interesting dynamic where the retirement of credits within Japan doesn't necessarily align with a significant number of VCM projects being developed domestically, which may be attributed to Japan's lack of land for forestry and additional requirements for verifiable carbon projects (Sebastian, 2023).

Malaysia: Malaysia has implemented a VCM, however doubts have been raised regarding its effectiveness due to a limited response from buyers and the absence of regulations (E. Stek, 2023). The inaugural auction on Malaysia's recently established VCM, the Bursa Carbon Exchange (BCX), occurred in March 2023, resulting in approximately RM7.7 million worth of carbon credits being sold (Bursa Malaysia, n.d.). The jurisdiction faces challenges, including the lack of a significant domestic pool of carbon buyers and sellers. The initiation of the VCM represents Malaysia's initial step towards other carbon pricing mechanisms, bridging them towards carbon taxation and the implementation of a cap-and-trade scheme.

Singapore: Climate Impact X (CIX) is set to become a Singapore-based global carbon exchange and marketplace with the objective of expanding the voluntary carbon market (Climate Impact X, 2023). The primary focus of CIX will be on catering to large-scale buyers, including multinational corporations and institutional investors. Contracts on this exchange will be established based on predefined terms and quality criteria, providing a framework for the delivery of carbon credits. In contrast to individual project-based credit purchases, these standardised contracts facilitate the aggregation of a significant volume of credits from various projects that collectively meet quality standards.

Thailand: Thailand implemented its initial voluntary carbon credit exchange, FTIX, in September 2022 (Lombard Odier, 2023). FTIX is set to integrate the government's ongoing voluntary emission reduction program, functioning as a trading platform dedicated to carbon credits, renewable energy, and renewable energy certificates. Presently, the platform facilitates domestic trading exclusively in conjunction with the government program, but there are expectations that it will explore international trading in the future.

With that, Figure 28 consolidates the results across the jurisdictions for its carbon management efforts in the Voluntary Carbon Market.

Voluntary Carbon Market (1 point)				
Jurisdiction	**Implementation Status**	**Regulatory Frameworks**	**Significant Export Credit Issuances**	**Total (1 point)**
Australia	Yes	NCOS		1

China (Mainland)	Planned		Yes	1
Hong Kong	Yes	VCS		1
India	Yes	VCS, GS	Yes[1]	1
Indonesia	Yes	Registry, VCS, GS	Yes[1]	1
Japan	Yes	VCS, GS, ACR, CAR		1
Malaysia	Yes	VCS, GS		1
New Zealand	No			0
Philippines	No			0
Singapore	Yes	VCS, GS		1
South Korea	Planned			0
Taiwan	No			0
Thailand	Yes	VCS		1
Vietnam	Planned			0

Overall Effectiveness	**Score**
Implementation Status of Planned or No, and No Significant Export Credit Issuances	0
Voluntary Carbon Market Implemented with Regulatory Frameworks	1
Implementation Status of Planned or No, and Significant Export Credit Issuances	1

VCS: Voluntary Carbon Standards, GS: Gold Standards, ACR: American Carbon Registry, CAR: Climate Action Reserve

[1] Indonesia and India are ceasing the export of carbon credits as part of their efforts to align with their respective domestic climate objectives (BloombergNEF, 2022).

Figure 28: Scoring framework and results for Voluntary Carbon Market

8 out of the 14 jurisdictions currently have a VCM in place be it domestic or international. China (Mainland) has also been credited a point due to the significant figures in export credit issuances globally despite not having a VCM in place. In the first half of 2023, credit issuances were predominantly driven by nature-based solutions (NBS). The top 10 countries hosting NBS projects accounted for 89.77% of the total NBS supply recorded during this period, amounting to 53 million metric tons. China (Mainland) secured the 4th position in the rankings, with an overall issuance of 30 million metric tonnes of CO_2e in NBS credits up to the present date and 4 million metric tonnes of CO_2 in the first half of 2023.

China (Mainland) and South Korea have set to implement its VCM later in 2023. Vietnam's VCM is in the planning stages, with a pilot program scheduled to run from 2025 to 2027, followed by official operation from 2028. Taiwan has adopted a unique approach called 'Voluntary Reduction Trading' through its Taiwan Carbon Solution Exchange (TCSE). Unlike the commonly used cap-and-trade system, Taiwan's carbon exchange is voluntary,

primarily because the jurisdiction has not yet imposed a cap on carbon emissions, functioning differently from the typical compliance and voluntary market. At present, the Philippines and New Zealand have not indicated any plans to initiate a voluntary carbon market.

Limitations and Challenges

Slowed Growth

Over the last five years, the VCM has experienced substantial growth, propelled by increased corporate commitments to emission reduction and the necessity for offsetting emissions in the absence of mandatory regulatory mandates (Denig et al., 2023). However, despite the growth, there has also been a deceleration in VCM progress, which may be attributed to uncertainties regarding market standards, governance, and the mechanisms used for verifying emission reductions.

Ongoing endeavours to standardise and harmonise practices aim to instil confidence and trust in the market. In the global market, different jurisdictions are operating with both their implemented VCMs along with the global VCM and projects within are subjected to regulations of the specific VCM market (Adam, 2023). The effectiveness and credibility of the VCM hinge on achieving alignment and clarity in carbon credit practices. Ambiguous or inconsistent practices can pose challenges for companies striving to make well-informed decisions regarding carbon offsetting.

Double Counting Practices and Carbon Credit Quality

Carbon credits have the capacity for multiple transactions, a phenomenon termed "double-counting." This practice introduces concerns regarding the efficacy of carbon credits in truly accomplishing emissions reductions, as the identical reduction may be asserted by multiple entities (Kaupa, 2022). This poses a problem due to the wide variety of regulatory frameworks available (VCR, GS, ACR, CAR) as well as a jurisdiction's self-proposed regulations such as Australia's NCOS and Indonesia's National Registry. The sheer number of registries and databases may lead to double counting challenges which may inevitably result in fraudulent credits which caused the previous collapse of the VCM from China (Mainland).

2.4.3.2 Compliance Carbon Markets

Compliance carbon markets are created and overseen by mandatory carbon reduction regimes. They are schemes usually called the emission trading scheme (ETS) to be created to set limits on the total amount of GHG emissions that can be emitted. Every emitter captured in the scheme is obliged to take part in the market. These ETSs can also be further categorised into 2 main categories - cap-and-trade schemes and baseline-and-credit schemes. Under the cap-and-trade schemes, a hard cap is set on the total volume of GHG by all emitters. Within this cap, companies buy or receive emissions allowances which they can trade according to their needs. On the other hand, under the baseline-and-credit schemes, emitters must keep their emission below their individually set baselines. If a company emits less than its baseline, it may be able to sell its excess credits to other regulated entities. If a company emits more than its baseline, it must purchase additional carbon credits (CORE Markets, 2022).

There are currently 30 compliance carbon markets operating around the world. These compliance carbon markets have reached a value of more than $850 billion in 2021 and cover close to one fifth of the global GHG emissions (BloombergNEF, 2022).

Impacts

The obligation under the compliance carbon markets pushes emitters to comply with its rules and even seek more productive ways to decarbonise. This is because decarbonisation becomes a cost-saving measure for emitters.

However, risks involved in the compliance carbon markets include carbon credits surplus and leakage risks. The excessive amount of credits available on the market will result in a decrease in the price of carbon credits. This would result in a lower incentive for emitters to keep within their regulated limits as it does not incur much costs for them to purchase more emission credits. Leakage also occurs when emitters transfer their operation to jurisdictions without carbon market regulations to avoid paying for pollution (Climate Seed, 2023).

Compliance Carbon Markets across Jurisdictions

To assess the progress of the jurisdictions in their implementation of the compliance carbon markets, we explored using 2 indicators - number of sectors covered by the carbon market amongst 7 main sectors and the carbon emissions accounted for with the carbon market. We have chosen the 7 main sectors to narrow the grading scope, mainly Forestry, Waste, Domestic Aviation, Transport, Buildings, Industry and Power, as these are the commonly identified top carbon-emitting sectors as seen from the graph below in Figure 31 (Ritchie, et.al, 2020).

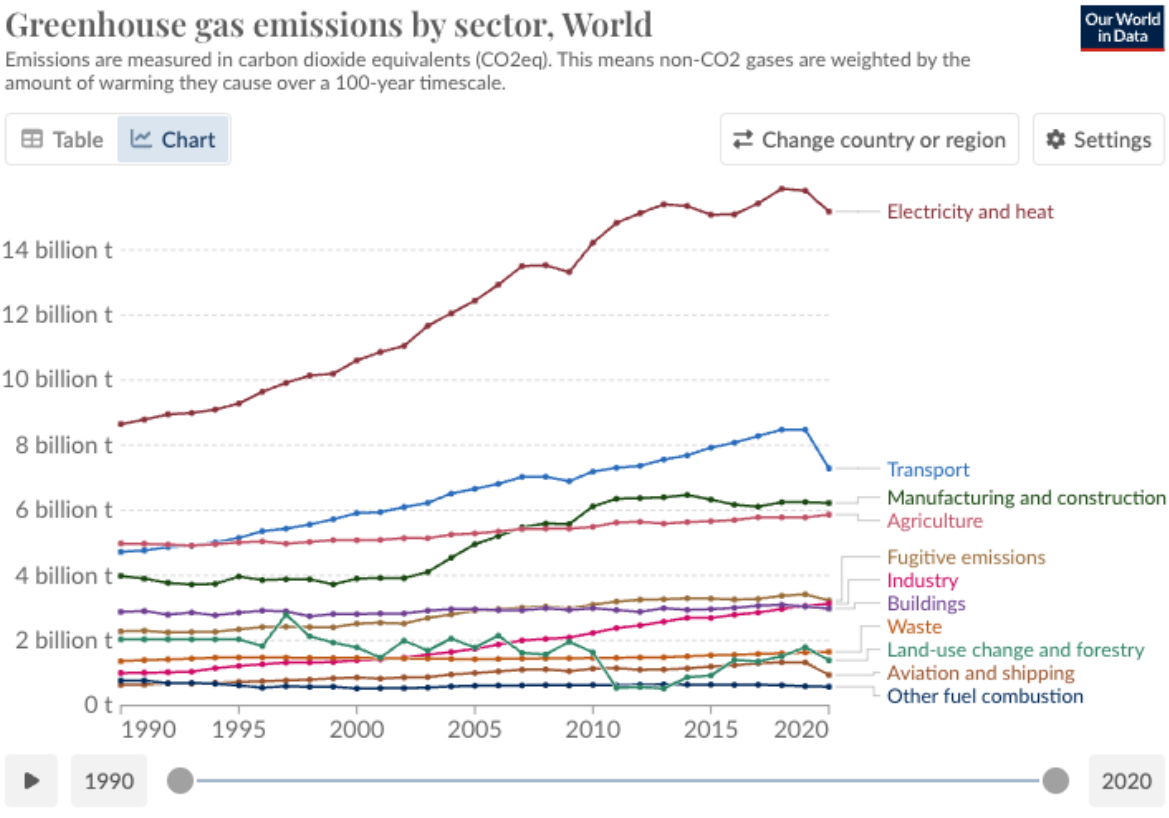

Figure 29: Graph of commonly identified sectors to evaluate sectoral emissions

Source: Climate Watch (2023)
OurWorldInData.org/co2-and-greenhouse-gas-emissions

The results are as follows in Figure 30. A detailed breakdown of the sources for the data can be found in Appendix H.

Compliance Carbon Markets (2 points)

Jurisdiction	Sectors Covered	Number of Sectors	Carbon Emissions Accounted for (%)	Total (out of 2 points)
Australia	Transport, Waste, Industry	3	28	2
China (Mainland)	Power	1	44	2
Hong Kong		0	0	0
India		0	0	0
Indonesia	Power	1	6	1
Japan	Buildings, Industry	2	1.87	1
Malaysia		0	0	0
New Zealand	Forestry, Power, Industry, Buildings, Transport, Domestic Aviation and Waste	7	49	2
Philippines		0	0	0
Singapore		0	0	0
South Korea	Power, Industry, Buildings, Transport, Domestic Aviation and Waste	6	74	2
Taiwan	Transport, Waste, Industry	0	0	0
Thailand	Power	0	0	0
Vietnam		0	0	0

Overall Effectiveness	Overall Score
No Carbon Markets	0
Carbon Markets enforced, Less than 10% of carbon emissions accounted for	1
Carbon Markets enforced, More than 10% of carbon emissions accounted for	2

Figure 30: Scoring framework and results for Compliance Carbon Market

Among the 14 jurisdictions, 6 currently have implemented compliance carbon markets including Australia, China (Mainland), Indonesia, Japan, New Zealand, and South Korea. Other jurisdictions – Hong Kong, Malaysia, Philippines, Singapore and Thailand have yet to have any plans in rolling out the compliance carbon markets.

India on the other hand, has recently drafted its Carbon Credit Trading Scheme (CCTS) proposal to roll out the carbon market. This works in conjunction with its Perform, Achieve and Trade (PAT) Mechanism. The PAT mechanism in India is regulated likened to a carbon compliance market, in which it was designed to reduce the specific energy consumption (SEC) of 478 industrial units in 8 sectors - Aluminium, Cement, Chlor- Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Thermal Power Plant and Textile. Energy saving targets called Designated Consumers (DCs) were given, and industrial units that managed to achieve SEC level lower than their targets could receive energy savings certificates (ESCerts) for the excess savings. However, the difference lies in the scope of trading as CCTS allows buyers of credits from other jurisdictions and permits multiple options of technologies for emission intensity reduction (Kumar, 2023).

Taiwan has also embarked on its carbon exchange, which is jointly invested by the Taiwan Stock Exchange and the National Development Fund. This carbon exchange works with the same mechanism as with other cap and trade systems in which emitters with lower carbon emissions can sell their excess carbon credits to companies with high carbon emissions to achieve their carbon reduction goals. The Taiwan Stock Exchange has planned for the carbon exchange to include a carbon consultancy, education and training, as well as to offer carbon credit trading (Chen, 2023). Trading has yet to be enforced as trading rules are still being drafted and the current focus of the carbon exchange would be on providing consultation, education and training services for businesses.

Vietnam has been indirectly participating in carbon credit trading activities through several schemes and projects such as the European Union Emissions Trading Scheme (EU-ETS) and the Joint Crediting Mechanism (JCM) with Japan. Since the implementation of JCM in 2013, Vietnam has been producing ten million tons of carbon dioxide credits per year for Japan through 28 projects. Vietnam ranks 4th in the number of credits among the participating jurisdictions and this also gives it the opportunity to access Japanese energy-saving and emissions-reducing technologies. Vietnam has planned to formulate its regulations and pilot programs for its carbon credit trading floors in the next 5 years, as it works towards officially operating the carbon market in 2028 (Truong, 2023).

We have observed that common reasons for the absence of a domestic compliance carbon market include the lack of standards for the data collection of carbon emissions amongst businesses. This is especially so for developing jurisdictions such as India in which its economy is rather fragmented. Thus, this causes the centralisation and validation of data to be challenging, which is a huge limitation when setting up carbon markets as accurate emissions data needs to be collected to support the cap and trade mechanism.

With that, we will now delve deeper into the mechanisms adopted by the different jurisdictions that have a compliance carbon market.

Australia - Safeguard Mechanism

The Safeguard Mechanism was established in 2016, which requires Australia's highest greenhouse gas emitting facilities that emit more than 100,000 tCO_2e of covered emissions in a financial year to keep their emissions below a baseline. This applies to around 215 facilities across a broad range of industry sectors, including electricity generation, mining, oil and gas, manufacturing, transport, construction and waste, accounting for about 28% of Australia's emissions. These baselines are adjusted with annual production, however the overall baselines would be tightened by 4.9% each year (Hatfield-Dodds et al., 2023). For facilities that keep within their baseline, they would be entitled to receive Safeguard Mechanism credit units (SMCs). For facilities that exceed their baseline, they are required to buy either SMCs or Australian Carbon Credit Units (ACCUs) to cover the volume of carbon emissions that exceed their baselines. These SMCs can be exchanged between emitters.

China National ETS

The China National ETS was implemented in 2021. It is the world's largest in terms of covered emissions, covering more than 4 billion tCO_2, accounting for 44% of the jurisdiction's carbon emissions. More than 2,000 emitters from the power sector are regulated under the ETS. Currently, only the power generation sector is covered under this ETS. This national ETS builds on the successful experience of the 8 pilot carbon markets in the different regions of China (Mainland) as these pilots continue to operate in parallel with the national ETS. It applies a bottom-up approach whereby the cap is the sum of the total allowance allocation to all covered entities at 4,500 $MtCO_2$. This cap is intensity-based as it varies according to actual production levels. Each emitter will be allocated allowances equal to its verified emissions. For companies that are able to reduce the carbon intensity of their production, they can generate a surplus of allowances to sell. Allowance price is dynamic and changes every day, which currently sits at an average listing price of 41 - 61 yuan per tonne (Roldao, 2022).

The national ETS system is expected to gradually expand its sectoral coverage from 2021 to 2025 across sectors including steel, non-ferrous metals and cement. However, a key challenge faced by the regime was data fraud. The emission data produced by emitters had data issues which resulted in a delay in trading as the government delayed the distribution of allowances by 2 months to double check the historical emissions reports. This would have affected the market's pricing and credibility in penalising the emitters. With that, stricter benchmarks have been in place for the market in the second compliance period in 2022 (Tan, 2022).

Indonesia ETS

Indonesia launched the first phase of its ETS plan back in 2022 which will last for 2 years till 2024, targeting the power generation sector. 99 coal-fired power plants were covered under this first stage as their individual capacity was of at least 100 MW. Prices were estimated to be between $2 to $18 per tonne, reducing carbon emissions by 36 million tonnes (Reuters, 2023). Similar to China (Mainland), it adopts an output-based emission cap by the sum of allocations. 3 benchmarks are also included for power plants with different capacities with 100% free allocation. Emitters that fail to meet their obligations would be subjected to tax. The ETS will be expanded in the second and third phrases to also include oil and gas-fired power plants and other industrial sectors.

Japan - Saitama Target Setting Emissions Trading System, Tokyo Cap-and-Trade Program

Japan has 2 ETS in place across 2 different regions - Tokyo and Saitama. The ETS in Tokyo started its operations earlier back in 2010 while Saitama operated its ETS in 2011. Both ETS covers the commercial buildings and industrial sectors. The Tokyo ETS covers around 20% of the area's emissions, and 1,200 facilities which annually use 1,500 kL or more of energy in terms of crude oil equivalent, which reportedly exceeded targets as emissions were reduced by 27% on average during the second compliance period. The Saitama ETS on the other hand reportedly reduced emissions by 29%, covering about 600 emitters (Asia Society, n.d.). Both systems have plans to increase reduction factors across three compliance periods, increasing the cap to reduce emissions below baseline emissions. Credits are issued to facilities where emissions fall below the baseline. Both systems are linked in which credits can be mutually exchanged between the two jurisdictions. Bottom-up approach is also adopted whereby the cap is aggregated from facility-level baselines, determined based on the type of facility and factors such as expected energy efficiency gains and the extent to which they consume energy supplied by other facilities.

New Zealand Emissions Trading Scheme (NZ ETS)

The NZ ETS was launched in 2008, covering a broad group of sectors, including forestry, stationary energy, industrial processing, liquid fossil fuels, waste, and synthetic GHGs (Asia Society, n.d.). It would cover 49% of

GHG emissions and 359 entities. For each one tonne of emissions emitters emit, they would have to surrender one emissions unit, known as the NZU. The government sets the cap on NZUs supplied to the market and reduces the number of units supplied over time, limiting the quantity that emitters can emit. Emitters under the ETS can buy and sell units. However, the New Zealand government is reviewing the scheme as the current system is not as effective in encouraging emissions reductions as it is cheaper for emitters to purchase emissions units, rather than investing in ways to cut pollution (Craymer, 2023). Furthermore, the NZU price has been on a downward trend, tumbling to a near 2 year low in June 2023 as initial bullishness after the failure of the carbon allowance auction was overtaken by uncertainty around government policy (Gollya, 2023). There are no phrases in the NZ ETS regime.

Korean Emissions Trading System (K-ETS)

The K-ETS was launched in 2015, covering the power, industry, buildings, transport, domestic aviation and waste sectors (Asia Society, n.d.). It covers 74% of South Korea's national GHG emissions and 684 of the jurisdiction's largest emitters across the different sectors. The K-ETS caps GHG emissions from emitters within the scheme and issues a number of emission allowances - Korea Allowance Units (KAU), where each allowance represents 1 ton of carbon dioxide equivalent (tCO_2e) permitted to be emitted. Emitters that emit less than their allocation can sell excess allowances while those who do not have enough allowances have to purchase them. The K-ETS was implemented to be carried out in 3 phrases.

However, a key challenge faced by the system was the constant drop of KAU prices due to an oversupply. The KAU prices dropped by 50% in 2022 as the market lacked buyers due to the Ukraine-Russia war and inflationary pressures (Ghosh, 2022). This points to a need for the government to take policy reform actions to increase market participation and help carbon prices sustain.

Challenges

There are 3 key challenges of a compliance carbon market. First, the issue of market volatility as observed in the ETS of South Korea and New Zealand. Price fluctuations are present due to various uncertainties such as regulatory changes, political decisions and market trends. This would impact the financial planning of the carbon trading systems.

Second, risk of overallocation and scarcity. There is a great emphasis on the need to have the optimal carbon allowances to ensure that the mechanism will work. If carbon allowances are overallocated, there would be a surplus, driving market prices low. If there is a lack of subsidies, there would be higher compliance costs.

Third, administrative burden. Robust regulations need to be in place to ensure accurate emission measurement, reporting and verification of the emitters. This is crucial in ensuring that high carbon emitters are penalised rightfully for its emissions.

2.4.4 Integration of Carbon Taxation and Carbon Markets

The scoring system for the pricing tier was derived based on the integration across all three strategies. Three points were allocated to the carbon taxation strategy, two points were allocated to the compliance market strategy, and one point was allocated to the voluntary market strategy.

A heavier weightage of 3 points was placed on the carbon taxation strategy due to regulatory certainty as emission reduction goals are achieved through a fixed price on carbon. Singapore obtained a full score of 3 due to the complete enforcement across the jurisdiction. Japan and Indonesia also have carbon taxation in place,

however both jurisdictions have tax refunds, exemptions and offsets implemented. These terms undermine the taxation enforcement effectiveness and have been classified under 'partial enforcement'. The remaining jurisdictions have no taxation policies in place and have been classified under low or high emissions. Jurisdictions with no taxation policies and current low emissions have been awarded 1 point, which serves as an assumption and exemption that a carbon taxation policy is not yet in high demand.

The size of the voluntary market is minor in contrast to the current compliance market. In 2021, the voluntary carbon market reached a market value of $2 billion in comparison to the market value of $851 billion for the compliance market. The Compliance Market operates within a regulated, mandatory trading framework, while the VCM functions on a voluntary basis, where trading occurs at the discretion and will of corporations and individuals. Hence, 1 point has been allocated to VCM while 2 points have been awarded to the Compliance Markets.

Out of the 14 jurisdictions, 8 have a VCM in place. A point was awarded if a jurisdiction had a VCM implemented along with regulatory frameworks, or if the jurisdiction has been a big player in the global VCM market as a credit supplier. Australia, Hong Kong, India, Indonesia, Japan, Malaysia, Singapore and Thailand have been awarded 1 point for a VCM in place with regulatory frameworks. China (Mainland) has been awarded a point without a VCM due to its significant contributions. This framework functions as an avenue to credit efforts for setting up a VCM for participation in both the buy and sell side domestically as well as to credit jurisdictions for having a significant impact on the supply side of the market on a global scale.

The point system for the compliance market was derived based on the total carbon emissions accounted for by the compliance market as well as the number of sectors. Australia, China, Indonesia, Japan, South Korea, and Malaysia have compliance markets in place. However, Indonesia and Japan have a significantly lower percentage of carbon emissions, accounting for under 10%, and hence have been awarded a total of 1 out of 2 points.

With considerations of the robustness of the strategies across the entire carbon market as well as the extent in implementation with regulations and effectiveness as criteria, a scoring system out of 6 points has been established. Jurisdictions with '0-1' points are classified under minimal, '2-3' points under moderate, and '4 and above' under substantial. It can be noted that the highest score obtained across all jurisdictions is 4, which can be attributed to the fact that no jurisdiction has effectively enforced and implemented both a carbon taxation strategy as well as a carbon market strategy.

Carbon Taxation and the Compliance Carbon Market are carbon policy instruments. These instruments have unique sets of regulations and play crucial roles in addressing carbon emissions. It can be observed that Indonesia and Japan have made partial strides in implementing carbon taxation, with a limited percentage of carbon emissions accounted for in the compliance market. Conversely, Singapore demonstrates effective enforcement of carbon taxation, while Korea, New Zealand, China, and Australia exhibit a significant percentage of carbon emissions covered in their compliance markets. Notably, the remaining jurisdictions currently lack any established carbon policy instruments.

With that, the consolidated total points and progress of all 14 jurisdictions in this 'Compensate' tier can be seen in the following Figure 31.

Compensate Tier (6 points)				
Jurisdiction	**Carbon Tax (3 Points)**	**Compliance Carbon Markets (2 points)**	**Voluntary Carbon Market (1 point)**	**Total score (out of 6 points)**
Australia	1	2	1	4
China (Mainland)	0	2	1	3
Hong Kong	1	0	1	2
India	0	0	1	1
Indonesia	2	1	1	4
Japan	2	1	1	4
Malaysia	0	0	1	1
New Zealand	1	2	0	3
Philippines	1	0	0	1
Singapore	3	0	1	4
South Korea	1	2	0	3
Taiwan	1	0	0	1
Thailand	1	0	1	2
Vietnam	0	0	0	0

Overall Efforts Towards Compensate Tier	**Score**
Minimal	0 - 1
Moderate	2 - 3
Substantial	4

Figure 31: Final scoring of jurisdiction's efforts in carbon management for the Compensate Tier

2.5 Tier Summary

Looking at Figure 32, we tabulated the total scores for all tiers for each jurisdiction. We have also categorised their progress based on their overall scores.

Across Tiers (12 points)					
Jurisdiction	**Reduce**	**Substitute**	**Sequester**	**Compensate**	**Total score (out of 12 points)**
Australia	2	2	3	3	10
China (Mainland)	3	2	2	2	9
Hong Kong	1	1	1	2	5
India	3	2	2	1	8
Indonesia	2	3	2	3	10
Japan	2	2	2	3	9
Malaysia	1	2	2	1	6
New Zealand	1	3	2	2	8
Philippines	1	2	1	1	5
Singapore	2	2	2	3	9
South Korea	3	2	2	2	9
Taiwan	3	1	2	1	7
Thailand	2	2	2	2	8
Vietnam	2	3	1	1	7

Overall Progress	**Score**
Minimal	5 - 6
Moderate Efforts	7 - 8
Substantial Efforts	9 - 10

Figure 32: Consolidated results for the progress of carbon management across all tiers

Jurisdictions with minimal progress are Hong Kong, Malaysia and Philippines. Jurisdictions with moderate progress are India, New Zealand, Taiwan, Thailand and Vietnam. Jurisdictions with substantial progress are Australia, China (Mainland), Indonesia, Japan, Singapore and South Korea.

2.5.1 Trends Analysis

Upon arranging our findings in order of descending scores, we observe the following results as shown below in Figure 33.

Across Tiers (12 points) [Re-arranged]					
Jurisdiction	**Reduce**	**Substitute**	**Sequester**	**Compensate**	**Total score (out of 12 points)**
Australia	2	2	3	3	**10**
Indonesia	2	3	2	3	**10**
Japan	2	2	2	3	**9**
China (Mainland)	3	2	2	2	**9**
Singapore	2	2	2	3	**9**
South Korea	3	2	2	2	**9**
Thailand	2	2	2	2	**8**
New Zealand	1	3	2	2	**8**
India	3	2	2	1	**8**
Taiwan	3	1	2	1	**7**
Vietnam	2	3	1	1	**7**
Malaysia	1	2	2	1	**6**
Hong Kong	1	1	1	2	**5**
Philippines	1	2	1	1	**5**

Overall Progress	**Score**
Minimal	5 - 6
Moderate Efforts	7 - 8
Substantial Efforts	9 - 10

Figure 33: Re-arranged overall findings

Positive Overall Prospects

Evidencing the column on 'Total score (out of 12 points)', it is observed that the number of jurisdictions within the overall progress categories decreases as it moves from 'Substantial Efforts' to 'Minimal', decreasing from 6 to 5 to 3. This trend provides insights on how the overall prospects of progress appear promising for the APAC region, with more jurisdictions performing well with substantial efforts over minimal efforts.

Evenly Distributed Progression Across Tiers for Upper Ranks

For the first 7 jurisdictions in the ranks (Thailand and above), they are making at least moderate progression across all tiers with no 1-point rating assigned to a singular tier. A holistic approach towards the integration of carbon management practices across all tiers can be inferred, suggesting that these jurisdictions take on a wide variety of strategies with moderate to substantial efficacy.

Majority of Tier Progress Indicators under Moderate Progress

Across all tiers and jurisdictions, out of the 56 boxes in total, 30 of them have been allocated a score of 2 and identified in yellow indicating moderate progress, which accounts for more than 50% of the total. This observation suggests that at the jurisdiction levels for each tier, most of the strategies are still a work in progress with room for improvement. There are 14 boxes identified in red and with a point of 1, slightly outnumbering 12 green boxes with a score of 3, suggesting that substantial sufficient efforts are still lagging behind minimal progress and the lack of effective carbon strategies,

Tier Specific Trends and Insights

Referencing the 'Compensate' column, most jurisdictions are making minimal progress in this tier with a total of jurisdictions scoring 1. The score of 1 can be attributed to the lack of comprehensive carbon pricing mechanisms across all 3 strategies of carbon taxation, compliance or voluntary carbon market, or reliance solely on voluntary carbon markets. This indicates that the widespread adoption of carbon pricing may be limited at the moment.

In comparison to the other 3 tiers, the 'Sequester' tier has the least number of jurisdictions receiving a score of 3. This observation suggests sequestration strategies not being a priority or focus for jurisdictions within the APAC region. Reasons may be attributed to the limitations identified in section 2.3.3, and the benefits of other carbon strategies may outweigh the costs and feasibility challenges for jurisdictions.

2.5.2 Tier Level Recommendations

These recommendations are more general and not jurisdiction specific for a broader overview, while factoring 2 dimensions - Regulators' and Businesses' perspectives. Relating back to our framework, the ideal development of carbon management should be moving towards the 'Reduce' tier as the effects would eventually trickle down. Given that most jurisdictions are currently making minimal to moderate progress in the 'Reduce' tier, it would hence be recommended that these jurisdictions concentrate their efforts in this tier.

Reduce

Relating back to our framework, the ideal development of carbon management should be moving towards the 'Reduce' tier as the effects would eventually trickle down. Given that most jurisdictions are currently making minimal to moderate progress in the 'Reduce' tier, it would hence be recommended that these jurisdictions concentrate their efforts in this tier. The following recommendations are targeted at the different sectors with the 'Reduce' tier.

Buildings

Regulators	Firstly, we propose that various jurisdictions collaborate to establish standardised building codes, along with appliance and equipment standards and labelling. This collaborative effort would facilitate better comparisons between APAC jurisdictions, enabling them to monitor progress and exchange strategies for achieving their carbon management goals. Secondly, regulators across jurisdictions can prioritise the enforcement of legal requirements related to these standards, ensuring widespread adoption.

	Lastly, regulators can also encourage the transition to low-carbon processes by providing subsidies and grants to businesses for them to invest in the relevant technologies to eventually drive their processes towards a more carbon free one.

Industrial

Businesses	We recommend that businesses take a proactive approach to meet efficiency standards and attain certifications like ISO 50001. Additionally, exploring alternatives to traditional fuels and incorporating circular design strategies can promote fuel switching, thereby contributing to carbon-friendly business operations and fostering the transition toward carbon-free processes.

Transport

Regulators	For the Transport sector, we recommend that regulators focus on driving EV growth through financial incentives and infrastructure improvements. We believe that the implementation of relevant policies that support and promote the commercialisation of EVs within respective jurisdictions to be crucial for fostering adoption.

Substitute

For the 'Substitute' tier, it should be noted that the ability for a jurisdiction to progress in this tier depends heavily on climatic and geographical factors. Climatic factors include a jurisdiction's latitude as jurisdictions such as Malaysia which are near the equator experience high solar irradiation allowing them to leverage much heavier on Solar Energy as compared to jurisdictions such as New Zealand or China (Mainland). Geographical factors include a jurisdiction's terrain or access to natural resources. Hong Kong for example, is extremely mountainous and has very limited land space, preventing them from making any meaningful progress in the Substitute tier. As renewables are derived from natural sources, it may be tougher for certain jurisdictions such as Singapore which have no access to natural resources to make significant advancements in this area. Thus, this tier may be of lower emphasis for certain jurisdictions as they compensate for their emissions in other areas. Regardless, regulators and businesses can still collaborate to find work arounds and succeed in boosting the adoption rate of renewables, regardless of the jurisdiction's constraints.

Regulators	To overcome a jurisdiction's constraints, regulators should look into alternative renewables that function independently of the climate or terrain. **Nuclear** and **Hydrogen Energy**, in particular both have the potential to generate high amounts of energy, regardless of the jurisdiction they're situated in. **Nuclear Energy** Nuclear energy is derived from a process called **Nuclear fission** which involves splitting atoms in a reactor to heat water into steam, turn a

	turbine, and generate electricity. Nuclear energy brings many advantages including: 1. 0 Carbon emissions during energy generation 2. Low operating costs 3. Extremely energy efficient (1 nuclear reactor produces the same amount of electricity as 3.125 million solar panels in 1 day) (Office of Nuclear Energy, 2021) Currently only Nuclear fission is used to harness Nuclear Energy. However, it is possible that in the future **Nuclear Fusion**, which is the process of slamming two atoms together to create a heavier atom can be used simultaneously. While Nuclear Fusion has been known to produce exponentially more energy than fission with the same materials, the process is incredibly difficult to achieve and is still unfeasible (Sawrey, 2022). However, with advancements in technology, using Nuclear Fusion to harness energy could be the next big renewable energy source. Nuclear energy has already been showing signs of growth in recent years with nuclear plants supplying 2653 TWh of electricity in 2021, up from 2553 TWh in 2020. European countries tend to rely heavily on nuclear energy with France deriving 70% of its electricity from nuclear energy in 2021 while Ukraine, Slovakia, Belgium, and Hungary get about half of their total energy from nuclear. However, it is worth noting that while **Nuclear Energy is a renewable energy source**, the element most often used in nuclear power plants, Uranium, is non-renewable (Morse, 2023). **Hydrogen Energy** When hydrogen reacts with oxygen, it produces water and releases energy. This energy can be used in fuel cells to produce electricity or can be burned in internal combustion engines. Furthermore, Hydrogen's ability to be stored and transported as a gas or liquid positions it as a promising energy carrier (Birrol, 2019). Hydrogen Energy's advantages include: 1. Low set up costs as existing infrastructure (Gas storage and gas transport) can be repurposed for hydrogen 2. 0 Carbon Emissions during power generation 3. Energy dense 4. Easily transported/stored Regulators can focus on upscaling and making Improvements to the relevant technologies and infrastructures such as the upgrading of power grids to hone these renewables, maximising the renewables capacity and potential. For jurisdictions that are unable to fulfil their renewables blueprint due to the infeasibility of domestic geological formations, they can consider fostering international joint efforts across jurisdictions to establish and support projects that are geologically feasible, and then shipping a portion of the produced renewables back domestically.

Businesses	On the other hand, businesses can consider forming partnerships with other businesses/regulators, to facilitate information exchange. One such example would be the agreement between Gucci and Intesa Sanpaolo announced in July 2021 (Gucci, 2021). The initiative aims to provide these SMEs with easier access to loans on favourable terms. The goal is to enable these businesses to initiate their own industrial transformation in alignment with the principles of the green revolution and ecological transition, as outlined in the PNRR national plan. Another example would be Mitsubushi Heavy Industries (MHI) and Thailand's major power producer, the Electricity Generating Authority of Thailand (EGAT), entering a Memorandum of Understanding in November, 2022 (Mitsubushi, 2022). The agreement aims to facilitate the study and exchange of information concerning clean power generation and hydrogen. MHI is seeking to leverage this partnership by developing gas turbines that rely on cleaner fuels such as hydrogen and ammonia. The existence of these 2 partnerships/agreements prove that businesses on any jurisdiction can leverage on strategic partnerships to improve their progress in the 'Substitute' tier.

Sequester

For the 'Sequester' tier, the relatively new technology, CCUS, still faces several challenges, mainly costs, technical difficulties, safety, and geographical constraints. It is currently still not commercially viable as the current cost of adopting the technology is too high. Also, infrastructure poses a challenge as storage sites have to be remote, while captured CO_2 has to be transported across large distances, thus requiring an intensive network of transportation methods. This increases the complexity of adopting CCUS as the CCUS infrastructure would have to be integrated with existing infrastructure, such as power plants, if undergoing retrofitting. With that, it may not be very possible to embark on the 'Sequester' tier especially for the developing jurisdictions. Hence, efforts should only be channelled to the 'Sequester' tier if the jurisdiction has the capacity to take on intensive rounds of research and development to formulate and adopt the technology well.

Regulators	Regulators can seek international collaborations with jurisdictions that have good progress with their operating CCUS projects (e.g., USA, Norway) to increase the scalability, affordability and feasibility of CCUS techniques through economies of scale. Joint efforts would be much more promising in overcoming the limitations of the current CCUS progress. Regulators can also pump in additional incentives to businesses to further understand the CCUS space through research. This could be in terms of financial aid, or carrying out feasibility studies, which would reduce financial costs for businesses.
Businesses	Businesses with strong financial capabilities who are interested in expanding into the jurisdictions can look into either investing locally or internationally. They can then explore the various methods and uses of CO_2.

Compensate

For the 'Compensate' tier, given that several jurisdictions already have certain forms of carbon pricing in place, it would be easier for jurisdictions that have yet to have a system in place to make use of these successful use cases. Regulators can then mimic these pricing frameworks and regulations to formulate their own carbon markets according to their jurisdiction's demographics.

Recommendations are tailored to the distinct carbon policy instruments of Carbon Taxation and the Compliance Carbon Market. These instruments have unique sets of regulations and play crucial roles in addressing carbon emissions.

Carbon Policy Instruments

Regulators	When formulating its carbon pricing strategies, regulators have to be mindful and thorough about the regulatory enforcements that are required to maintain a robust system and data integrity. Accurate collection of emissions data is also the foundation to an operational carbon market mechanism. This can be achieved through abiding formal international standards that have been there in the guidelines of computing emissions data, which should then be enforced across the reporting systems of every business. **Carbon Taxation** For jurisdictions that currently lack both carbon taxation and a compliance market, considering carbon taxation offers practical advantages over emission trading systems. This is particularly relevant in the context of developing countries. Carbon taxation presents several benefits, including ease of administration, price certainty, the potential to generate revenue, and a broader coverage of emission sources (Parry et al., 2022). Implementing a carbon tax system can provide a straightforward and administratively manageable approach to addressing emissions while offering financial predictability and the opportunity to generate funds for sustainability initiatives. **Compliance Carbon Market** For jurisdictions looking to establish a compliance carbon market, it is advisable to emulate pricing frameworks and regulations from established models and adapt them to suit their jurisdiction's demographics. This approach allows for the formulation of effective carbon markets tailored to local characteristics. However, it's crucial to recognize that this transition may pose challenges for businesses. To facilitate a smooth integration of this policy, regulators have to propose additional transition support measures, such as subsidies to help cushion the potentially drastic impact on businesses, particularly smaller firms, enabling them to overcome increased operational costs resulting from rising carbon prices (NCCS, 2023). Given the regulated emissions cap inherent in Emission Trading Systems (ETS), jurisdictions must prioritise transition support to assist businesses in adhering to the cap and ensuring a successful transition to carbon pricing practices in light of rising costs in carbon prices.

Voluntary Carbon Market

Regulators	**Operates in harmony with the Compliance Carbon Market** In the context of the voluntary carbon market (VCM), it is advisable to create a framework that functions seamlessly alongside the Compliance Carbon Market, promoting a unified and synergistic approach to carbon management. By aligning these two markets, a cohesive platform is established, allowing for the trading of excess credits from the compliance market within the VCM (Mendelsohn et al., 2021). This complementary relationship broadens the scope of carbon transactions, covering not only mandatory compliance requirements but also providing an avenue for the exchange of surplus credits. Such integration enhances the overall efficiency of carbon management efforts and encourages a more comprehensive approach to environmental responsibility. **Standardised regulations to avoid double counting, trading within the jurisdiction and in international markets** These regulations should prevent double counting, both within the jurisdiction and in international markets, ensuring the integrity of emission reductions. Compliance with recognized regulatory standards such as Verra and Gold Standard is essential for trading in the global market, facilitating transparency and credibility. Jurisdictions with their own set of regulations should be mindful of potential challenges, such as internal trading barriers and difficulties for international buyers and sellers due to regulatory gaps and issues like double counting (Khanna et al., 2023). By aligning with global regulatory standards, jurisdictions can open up their VCM to international participants, fostering a more inclusive and interconnected marketplace. **Adoption of a Voluntary Carbon Market within the jurisdiction** Domestic VCMs promote not only the sale of carbon credits but also encourages local businesses to actively participate in emission reduction initiatives. By emphasising the buy-side of the VCM and creating avenues for local businesses to engage, jurisdictions can stimulate broader involvement.
Businesses	**Active participation in the buy side of the VCM** As for businesses, their involvement can be made more actively in the voluntary carbon markets as they should purchase carbon credits in the market. By purchasing these credits, they can fund emission reduction projects that will contribute towards carbon management, further spurring the progress towards global net zero. Moreover, it positions businesses favourably in terms of corporate social responsibility,

	showcasing a commitment to sustainability and environmental stewardship.

Further recommendations

Other than regulators and businesses, we would like to offer another perspective from another group of stakeholders - advocates which can also play a part in spurring the progress of carbon management in each jurisdiction, regardless of the specific tiers. By speaking out about the issue for sustainability and climate action, as well as supporting organisations that are working to make a difference, advocates can help develop the needed standards, as they share the ways in which their own business lines are contributing to the climate movement. This would help to pool knowledge, ideas and best practices, facilitating a sharing of knowledge with others (SKF Group, 2023). This would create a movement for climate change, as more stakeholders realise the importance of making a change for a better world.

Overall, jurisdictions need to make a comprehensive report on their current progress, to compare it against their targets. This would help jurisdictions to evaluate their strengths and weaknesses, eventually identifying opportunities that they can better expand and concentrate their resources on for carbon management. Our compilation serves as a guide for jurisdictions to understand their performance in different tiers relative to other jurisdictions. With this guide, they can also zoom into their weakest tiers which we will be delving into greater extents in Section 4 of our report, to evaluate if there are any possible solutions to improve their progress in those tiers.

3 Comparative Progress Analysis

3.1 Indicators of the Comparative Progress Matrix

3.1.1 Carbon Emissions per GDP

To delve deeper into our analysis, we have also taken note of each jurisdictions' carbon emissions per unit of 2015 GDP. This would facilitate us in understanding their progress with regards to their current emissions more holistically.

The indicator of each jurisdiction's Carbon Emissions per GDP has been selected over Carbon Emissions per GDP per Capita due to several considerations.

Carbon Emissions per GDP reflects on the carbon intensity of the jurisdiction's economy, providing insights on its total emissions relative to its economic output. This provides insights on the absolute impact of the jurisdiction on emissions within the APAC region and globally. Carbon Emissions per GDP per Capita instead provides a measure of carbon intensity on a per-person basis, offering insights into individual impacts. Another consideration would be Carbon Emissions per GDP per Capita not fully capturing the overall carbon intensity of significantly larger and smaller populations which pose as outliers.

Overall, the primary interest of this landscape study is to understand the overall carbon intensity of a jurisdiction's economy and its absolute impact on global emissions rather than the average individual impact, hence the indicator of Carbon Emissions per GDP has been selected.

3.1.2 Emissions Level

With that, similarly we have categorised their emissions based on the Figure 36 as follows. The colours for 'substantial' and 'minimal' have been swapped around, specifically green for minimal emissions and red for substantial emissions as the lower the emissions, the better the overall emissions level the jurisdiction is in.

Emissions		
Jurisdiction	**Carbon Emissions per unit of 2015 GDP (kg/USD)[1]**	**Overall Level**
Australia	0.3	Minimal
China (Mainland)	0.7	Substantial
Hong Kong	0.1	Minimal
India	0.8	Substantial
Indonesia	0.5	Moderate
Japan	0.2	Minimal
Malaysia	0.6	Moderate
New Zealand	0.1	Minimal
Philippines	0.3	Minimal

Singapore	0.1	Minimal
South Korea	0.3	Minimal
Taiwan	0.4	Moderate
Thailand	0.5	Moderate
Vietnam	0.9	Substantial
Overall Level		**Score**
Minimal		0.1 - 0.3
Moderate		0.4 - 0.6
Substantial		0.7 - 0.9

Figure 34: Emissions level across jurisdictions

3.1.3 Progress Level

Utilising our scoring system derived from our structured assessment framework, we have categorised their progress levels based on the Figure 37 below.

Progress						
Jurisdiction	**Reduce**	**Substitute**	**Sequester**	**Compensate**	**Total score (out of 12 points)**	**Progress Level**
Australia	2	2	3	3	10	Substantial
China (Mainland)	3	2	2	2	9	Substantial
Hong Kong	1	1	1	2	5	Minimal
India	3	2	2	1	8	Moderate
Indonesia	2	3	2	3	10	Substantial
Japan	2	2	2	3	9	Substantial
Malaysia	1	2	2	1	6	Minimal
New Zealand	1	3	2	2	8	Moderate
Philippines	1	2	1	1	5	Minimal
Singapore	2	2	2	3	9	Substantial
South Korea	3	2	2	2	9	Substantial
Taiwan	3	1	2	1	7	Moderate
Thailand	2	2	2	2	8	Moderate
Vietnam	2	3	1	1	7	Moderate
Overall Progress						**Score**
Minimal						5 - 6
Moderate Efforts						7 - 8
Substantial Efforts						9 - 10

Figure 35: Progress level across jurisdictions

3.1.4 Comparison of Overall Progress Against Emission Level

Combining their progress and emissions, we arrive at the following results as shown in Figure 38. The level of emissions paints a better idea of the current effectiveness and sufficiency of the carbon management strategies when plotted against the progress.

Overall Progress Against Emission Level		
Jurisdiction	**Progress**	**Emissions**
Australia	Substantial	Minimal
China (Mainland)	Substantial	Substantial
Hong Kong	Minimal	Minimal
India	Moderate	Substantial
Indonesia	Substantial	Moderate
Japan	Substantial	Minimal
Malaysia	Minimal	Moderate
New Zealand	Moderate	Minimal
Philippines	Minimal	Minimal
Singapore	Substantial	Minimal
South Korea	Substantial	Minimal
Taiwan	Moderate	Moderate
Thailand	Moderate	Moderate
Vietnam	Moderate	Substantial

Figure 36: Consolidated results of progress and emissions levels across jurisdictions

3.2 Comparative Progress Matrix

Jurisdictions have been classified and sorted into 9 different clusters according to their progress and emissions level.

This analysis allows for comparisons between jurisdictions for a comprehensive comparison of where they stand amongst others. From this matrix, we can have a further drill down evaluation in 2 dimensions - (i) emissions-based analysis and (ii) cluster based analysis.

3.2.1 Emissions Based Analysis

Gathering from the above results in Figure 38, we can further evaluate the jurisdictions based on their level of emissions as shown in Figure 39 below.

Minimal Progress, Substantial Emissions	**Moderate Progress, Substantial Emissions** India Vietnam	**Substantial Progress, Substantial Emissions** China
Minimal Progress, Moderate Emissions Malaysia	**Moderate Progress, Moderate Emissions** Thailand Taiwan	**Substantial Progress, Moderate Emissions** Indonesia
Minimal Progress, Minimal Emissions Hong Kong Philippines	**Moderate Progress, Minimal Emissions** New Zealand	**Substantial Progress, Minimal Emissions** Australia, Japan, Singapore, South Korea

Figure 37: Comparative Progress Matrix evaluated by emissions based

First, for the minimal emissions row, it is commendable that although the jurisdictions there are the lowest carbon emitters, most jurisdictions have made substantial progress in their carbon management. Second, for the moderate emissions, most jurisdictions are also making at least moderate progress. Last, for the substantial emissions, it is comforting to see that they are making up for their emissions as most jurisdictions are at least making moderate progress as well. We can thus conclude that most jurisdictions have been responsible for their emissions as they strive to better manage their emissions.

3.2.2 Cluster Based Analysis

Lastly, for the extreme top left cluster, we see that there are currently no jurisdictions in the cluster, further reinforcing that generally, moderate progress is observed overall across the 14 jurisdictions of our evaluated scope.

Minimal Progress, Substantial Emissions **(Worst Performing State)**	**Moderate Progress, Substantial Emissions** **(Excess emissions over average progress levels)** India Vietnam	**Substantial Progress, Substantial Emissions** **(Sufficiency in terms of progress against current emissions)** China (Mainland)
Minimal Progress, Moderate Emissions **(Excess emissions over average progress levels)** Malaysia	**Moderate Progress, Moderate Emissions** **(Average performance)** Thailand Taiwan	**Substantial Progress, Moderate Emissions** **(Progress levels exceeding current emissions)** Indonesia
Minimal Progress, Minimal Emissions **(Sufficiency in terms of progress against current emissions)** Hong Kong Philippines	**Moderate Progress, Minimal Emissions** **(Progress levels exceeding current emissions)** New Zealand	**Substantial Progress, Minimal Emissions** **(Ideal state of minimising emissions while maximising strategies)** Australia Japan Singapore South Korea

Figure 38: Comparative Progress Matrix evaluated by cluster based

Zooming into the extreme top right and bottom left clusters in which jurisdictions - China (Mainland), Hong Kong and Philippines are ranked in, we see that overall there is sufficiency in terms of progress against their current emissions. China (Mainland) has the potential to reduce its current emissions, while Hong Kong and the Philippines have the potential to improve their progress.

As for the middle cluster including the jurisdictions - Thailand and Taiwan, they are currently at average performance. It is worth noting that given that Thailand has attained moderate progress across all tiers as seen in Figure 35 from Section 2.5.1, we have set Thailand as our baseline for comparison when doing cross-evaluations between jurisdictions.

For the orange clusters in which jurisdictions - India, Vietnam and Malaysia are ranked in, we see that there is excess emissions over average progress levels. This highlights that these jurisdictions would need to further

drive progress in their carbon management strategies to ensure that they compensate fairly for the emissions that they are emitting.

Referring to Figure 40, we should be expecting all jurisdictions to be in the extreme bottom right of the matrix, as they make substantial progress in their carbon management strategies, to achieve minimal emissions. This illustrates the ideal state of minimising emissions (emission level) while maximising the progress of carbon management strategies (progress level). Currently, 4 of our evaluated jurisdictions, including Australia, Japan, Singapore and South Korea are in the expected grid, signalling that these jurisdictions are on track in their contributions towards the target.
For the light green clusters in which jurisdictions - Indonesia and New Zealand are ranked in, we see that their progress levels exceed their current emissions. This shows that their effectiveness of their carbon management strategies can be further enhanced to further lower their emissions, eventually reaching the ideal state.

The absence of jurisdictions in the top-left cluster is a positive indicator, signifying that no jurisdiction falls under the worst-performing state within the assessment framework. This suggests that all assessed jurisdictions demonstrate a certain level of progress and effectiveness in their carbon management strategies. The clustering outcome reflects a favourable scenario where each jurisdiction exhibits a degree of advancement, avoiding classification in the least effective category.

In the next section, we will then look at how different jurisdictions in the different grids can further improve and transform their efforts in carbon management to reach the ideal state.

4 Jurisdiction Level Analysis

In this section we will have an analysis of each jurisdiction in which we would evaluate 3 key areas - (i) Net Zero Target and Approaches, (ii) Progress Evaluation and (iii) Recommendations.

For the Net Zero Target and Approaches, we have adapted the net zero target status consolidated from the Energy and Climate Intelligence Unit (Energy & Climate Intelligence Unit, n.d.). We have re-adapted their target statuses into 7 main indicators - Achieved (externally validated), Achieved (self-declared), In Law, In Policy Document, Declaration/Pledge, Proposed/In Discussion, and No Target. The following table shows the definitions for 'In Law', 'In Policy Document', 'Proposed/In Discussion' and 'No Target' as the target statuses across the 14 jurisdictions lie within these 4 categories. We then consolidated their main approaches for carbon management through various documents including their NDCs and Long-Term Low Emissions Development Strategy (LT-LEDS) documentations.

Net Zero Target Status	
In Law[4]	The target has legal force, for example is enshrined in legislation or in an administrative order.
In Policy Document[1]	The target is included in a policy or planning document. For example, this could include policy strategy documents published by ministries, as well as NDCs and/or Long-term Strategies (LTSs) that have been submitted to the UNFCCC.
Proposed/In Discussion[4]	The entity's leadership is considering a target or has joined an international initiative (e.g. the Climate Neutrality Coalition or Climate Ambition Alliance) pledging to set a net zero target, but it has not yet taken steps to operationalise this pledge.
No Target	There are currently no official targets registered.

For the 'Progress Evaluation' section, we have consolidated the detailed breakdown of the progress of each tier and each indicator in the tables. The colours in the following table shows the legends for the progress levels.

Colours Legend for Progress Levels	
	Minimal Progress
	Moderate Progress
	Substantial Progress

From the consolidation, we will then include subsections - strengths, weaknesses and further insights that we managed to derive from our analyses.

[4] Definitions are consolidated from the Energy and Climate Intelligence Unit (Energy & Climate Intelligence Unit, n.d.).

Lastly, we then provide recommendations to complement our prior analyses under 'Progress Evaluation'. These recommendations are structured such that it highlights the tier that we are providing recommendations for, which we will then delve deeper into providing in-depth recommendations for 2 main stakeholders - regulators and businesses.

With that, we will be providing a robust and comprehensive evaluation of the carbon management practices within each jurisdiction, as well as providing recommendations that are better tailored to each jurisdiction's demographics.

4.1 India (Moderate Progress, Substantial Emissions)

Net Zero Targets and Approaches

Currently, India has announced a net zero by 2070 target, which its status is 'in policy document'. Their main approaches towards carbon management include a focus on the 'Reduce' and 'Substitute' tiers. For the 'Reduce' approach, they aim to reduce emissions intensity of its GDP by 45% by 2030, compared to its 2005 levels. As for the 'Substitute' approach, they are looking at achieving about 50% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030, with the help of transfer of technology and low-cost international finance including from the Green Climate Fund (GCF) (UNFCCC, 2022).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

We can see that the strength of India's carbon management strategy lies in the 'Reduce' as it is the only tier that they are making substantial progress in. This is attributed to the wide adoption of the ISO 50001 standards which thus places substantial progress in the decarbonising of the industrial sector. Given the competitive business environment in India, businesses would be more inclined to adopt the standards to build their credibility and trust in the market. The presence of a regulatory authority, India Certification Council (OAC) overlooking the promotion of these standards to operating organisations in India also further spears the adoption. India has also been making substantial progress in the transport sector as their EV sales grew 3 times faster than the global average. This is due to the presence of foreign investments and the government's efforts in upscaling the EV infrastructures.

Weaknesses

For weaknesses, despite 'Substitute' being India's main focus for its carbon management approach, they are only making moderate progress in the tier. This is due to the poor financial condition of power distribution companies which limits their potential to further scale up renewables in India, resulting in the delay of several

renewable energy projects for up to 6 to 18 months. The weak transmission grid in India also creates a barrier for the progress in renewables as the renewable energy projects nowadays produce so much power that they have to pause its operations sometimes to ensure that the grid will still operate smoothly (Nuwal & Som, 2021). Thus, due to poor infrastructures and financial circumstances, India is limited in the expansion of its renewables efforts.

Another area that India is currently making minimal progress in is its 'Compensate' tier. One of their main obstacles in implementing a carbon tax is the potential impact on the economy. Given that India is still a developing jurisdiction, the implementation of a carbon tax would increase the cost of production for industries and eventually lead to higher prices for consumers, which may create greater burdens on the economy. Another challenge is also the lack of accurate data on carbon emissions as India's economy is highly fragmented with a large number of small and medium enterprises (SMEs). These SMEs may not have the resources or expertise to accurately measure their emissions, thus designing a carbon tax and even the carbon market would make it challenging for India to implement its pricing strategies effectively and equitably (Qutubuddin, 2023).

Further insights

It is worth noting that despite its overall minimal progress in the 'Compensate' tier, there are still efforts in the participation of the voluntary carbon markets. Furthermore, they recently drafted its Carbon Credit Trading Scheme (CCTS) proposal to roll out the carbon market, highlighting promising prospects that India could make in terms of its progress in the 'Compensate' tier.

Recommendations

We have formulated the following recommendations for India to advance in the 'Substitute' tier given that its main approach for carbon management includes substituting its energy sources. We have also recommended India to embark on the 'Compensate' tier as not only the proposal of their carbon markets have already been drafted which highlights the need to further drive the implementation, the revenue generated through carbon pricing can also be used effectively in energy-efficient projects (Shrivastav, 2022).

Substitute	Regulators	**Active interventions in scaling up of grid and infrastructures** To ensure that India's renewables potential can be maximised, regulators can step in to scale up the grid and infrastructures through active interventions. This could include adoption of new developments such as the battery storage solutions, off-shore wind turbines and technology solutions to integrate an increasing share of renewables into the grid (Nuwal & Som, 2021). This can also be supported with the provision of financial support to power distribution companies in aiding their exploration of technology solutions.

Compensate	Regulators	**Speed up review in setting up its green taxonomy** Regulators should speed up its review in setting up its green taxonomy in India. This can be achieved by putting in place a broad-based carbon pricing system that is in-line with emerging global best practices to introduce carbon taxation in India. Indian regulators can also further explore complementary redistributive policies that can be adapted with carbon tax to help the financially weaker firms to

		move to more eco-friendly modes of production and patterns of consumption. Further reviews that should be adopted also include the need to have a clear definition of 'green' and to identify sustainable green assets and activities in order to limit the potential risk of greenwashing and spur direct investments through better-designed policies (Kayastha, 2023). With that, by focusing its efforts on pushing through its plans of building its carbon pricing system, regulators need to concentrate its resources on this area to a greater extent in order to drive progress in the 'Compensate' tier.
	Businesses	**Implementation of internal carbon pricing** In India, it is notable that several companies are in the process of implementing an internal carbon price, in which they tag a price to their internal carbon emissions to facilitate greener decision making. Adopting an internal price on carbon is a promising place for India to start on its carbon pricing strategies. Working on this, more companies should thus embark on pricing its carbon to contribute to the jurisdiction's progress and goals towards carbon pricing. A way that businesses can price its carbon is through shadow pricing (Gajjar, 2018). This is a strategy in which companies will attach a notional value to carbon emissions to assess the risks that they would be exposed to under anticipated government policies that increase emissions-related costs. By forecasting the possible effects, companies would get an idea of the derived cost of carbon emissions to better understand how tagging a price will affect its business processes. This is usually useful in helping organisations to review its firm's performance against future projections for carbon pricing regulations. Hence, firms can then better formulate its risk management and internal strategic planning strategies to curb and manage its carbon emissions. This will overall help to improve India's performance in managing emissions through carbon pricing (CDP, 2023).

4.2 Vietnam (Moderate Progress, Substantial Emissions)

Net Zero Targets and Approaches

Vietnam has announced a net zero by 2050 target, which its status is 'in policy document'. Their main approaches towards carbon management include a focus on the 'Reduce', 'Substitute' and 'Sequester' tiers. For the 'Reduce' approach, their emphasis on improving energy efficiency would be on increasing the share of energy efficient equipment in use within the industrial, residential and agricultural sectors, as well as the reduction of fuel use from the electrification of agricultural machinery in the post-harvest agricultural production chain. As for the 'Substitute' approach, the Ministry of Industry and Trade's Power Development Plan 8 (PDP8) indicated its aim to switch about 75% of generation capacity to renewables by 2045. Lastly, for

the ‘Sequester’ approach, Vietnam is looking to increase its carbon sequestration by 20% with total emissions and removals reaching at least negative 95 million mtCO_2e (UNFCCC, 2022c).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

We can see that the strength of Vietnam’s carbon management strategy lies in the ‘Substitute’ tier as it is the only tier that they are making substantial progress in as they have already reached its 2030 goal with 35.45% of its energy derived from renewables. This is due to its unique physical potential as they have natural endowments with high potential for wind and solar power (McKinsey & Company, 2023).

Weaknesses

We see that Vietnam is making minimal progress in the ‘Sequester’ and ‘Compensate’ tier. First for the sequester tier, its existing policies are not strong enough and lack the regulations needed to support the application of CCUS. Financial support for the implementation of the CCUS projects is also currently insufficient. The Vietnam Environment Protection Fund is too weak to provide incentives to CCUS projects. Most commercial banks in Vietnam are also not strong enough to provide financing and lending would be severely limited by the risk due to uncertain policy frameworks (Minh, et al., 2017). As for the ‘Compensate’ tier, it has currently made no progress in carbon taxation or carbon markets. However, there have been plans for pilot projects for carbon markets from 2025 to 2027 before its official operations from 2028. As our evaluations do not factor future projections, there still remains room for evaluation as to whether Vietnam would make progress in the ‘Compensate’ tier after its roll out of the carbon markets.

Further insights

It is worth noting that Vietnam has been indirectly participating in the carbon credit trading activities through projects such as the EU-ETS. This is actually one of its strengths in its carbon management approach given that they have been producing 10 million tons of CO_2 credits per year for Japan through 28 projects, enabling them to be at a rank of 4th in the number of credits among participating jurisdictions. Thus, as our evaluations focus on domestic progress and do not factor their compensation efforts across jurisdictions, their efforts in this area have not been captured by our scores.

We can also observe that within each tier, Vietnam’s demonstrated equal progress across all indicators. We could thus infer that their approach is more focus driven and consistent on specific tiers.

Recommendations

Our recommendations are targeted at the 'Reduce' tier which is part of their main approaches. Although their approach also includes the 'Sequester' tier, we would not be providing recommendations in that area due to the weak financial position that Vietnam is in currently which thus shows that it would not be financially viable for Vietnam to venture further into sequestration in the near future. Thus, we would recommend moving towards the 'Compensate' tier first as revenues from carbon pricing can help Vietnam to accumulate its pool of money that can be used to fund other projects.

Reduce	Regulators	**Industrial - Funding support for the deployment of green metals** Given that some Vietnamese provinces are already pioneering green metals such as Dak Nong. They have been considering the implementation of green aluminium manufacturing which incorporates renewable energy (McKinsey & Company, 2022). Regulators can thus further support the industrial sector by providing funding support for deployment of green metals. **Transport - Implementation of High-Speed Rail** 40% of trips within Ho Chi Minh City and Hanoi have to be accounted for by metro or bicycle by 2050 together with increased teleworking to reduce daily commuter cities in these 2 cities by 6%. Rail transport including high speed rail should also replace aviation and bus trips between Vietnam's major cities. Thus, regulators must start drafting its plans to implement the high-speed rail by 2040 to capture 20% of baseline domestic aviation passengers quickly, which will subsequently increase to 30% by 2050 (McKinsey & Company, 2022).
	Businesses	**Industrial - Wider adoption of carbon friendly technologies** As for businesses, they should switch to more carbon friendly technologies in their current processes. For example, steel companies can switch to the use of direct reduced iron and electric arc furnace (DRI-EAF) technology which uses green hydrogen and renewable electricity to produce its steel, maximising the green-steel manufacturing capacity (McKinsey & Company, 2022).

Compensate	Regulators	**Implementation of tax regime** Looking at carbon pricing, regulators can fund the energy transition through the establishment of carbon markets and carbon tax to help Vietnam raise revenues. A national committee on climate change can allocate funding and support to industries and technologies that require help in creating its foundations in Vietnam (McKinsey & Company, 2022). Regulators should consider a tax rate that starts at VND 89,861 (US$3.86) per tCO_2, with a real annual increase of 10% which can overall reduce emissions by about 11.2%, while generating a cumulative revenue of about US$21.9 billion by 2030. The tax can be regulated for fossil fuels, as we partake in an upstream approach, with the tax levied on about 150 coal mining companies, petroleum

		extraction sites, natural gas extraction sites, and import terminals (Thang & Burke, 2021).

4.3 China (Mainland) (Substantial Progress, Substantial Emissions)

Net Zero Targets and Approaches

China (Mainland) has announced its 2060 net zero target, with its status 'in policy document'. Its carbon management approach covers across all 4 tiers. For the 'Reduce' tier, it plans to foster a green, low-carbon and circular economic system, as well as establishing a low GHG emission industrial system. It also encapsulates the formation of a low-carbon comprehensive transportation system. As for the 'Substitute' tier, China (Mainland) would vigorously develop its non-fossil energies as they accelerate the pace of renewable energies development including wind, solar, biomass and marine energies. For sequester, it has issued about 70 CCUS related policies at the national level, including plans, standards, roadmaps and technology catalogues accumulatively. Lastly, for the 'Compensate' tier, it aims to promote the market-based mechanisms as well as actively participating in international carbon market-related cooperation (UNFCCC, 2023).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

China (Mainland) has been faring exceptionally well in the 'Reduce' tier, specifically the buildings and transport sector. In the buildings sector, China (Mainland) has been regulating mandatory building codes back in April 1 2022 for both residential and commercial sectors, which thus mandates the adoption of energy efficient infrastructures, fostering the progress in the reduce tier. Furthermore, as the world leader in the production of EV, they have well positioned themselves in advancing their progress in decarbonising its transport sector. This is due to the provision of government subsidies, tax rebates, procurement contracts and incentives that helped to spur the commercialisation of EV to a great extent.

Weaknesses

Zooming into the 'Compensate' tier, China (Mainland) has minimal progress in carbon tax and voluntary carbon markets. China (Mainland) has yet to implement any carbon taxations due to the concern of the burden of higher energy prices on vulnerable groups. To provide support to the bottom 20% income bracket of the population, about 5% of the carbon tax revenues would be needed through reduced social security contributions and increased welfare and social spending. However, China (Mainland) has been lagging in its efforts to provide transitional support to its vulnerable groups compared to other advanced and middle income

jurisdictions (Perry & Wingender, 2016). Thus, it makes it infeasible for China (Mainland) to implement carbon taxes given that it currently does not have a robust policy and regulations to manage the burden of the lower income groups. As for its voluntary carbon market, it was placed on pause due to data integrity issues from data manipulation fraud. Thus, China (Mainland) has several regulatory shortfalls in managing its carbon pricing regimes, resulting in a moderate progress in the 'Compensate' tier.

Further insights

For the 'Substitute' and 'Sequester' tiers, we observe a similar trend in which they do have substantial policies implemented for these tiers. However, in terms of the policies' effectiveness and progress towards the targets, it is still lacking. This shows that China (Mainland) has to review and revamp its current policies to further its progress in these tiers and maximise progress.

Recommendations

With that, we have the following recommendations for China (Mainland) to advance its progress in the 'Sequester' and 'Compensate' tiers. We chose to target the 'Sequester' tier as given that CCUS is still a developing concept, considering that China (Mainland) has 6 operational CCUS projects such as the China Energy Jinjie Power, this highlights their potential to further its effectiveness as they can build on their current foundations. As for 'Compensate', similarly given that they already have the relevant frameworks in place, as long as they can resolve their regulatory issues, they should be able to make greater progress in the tier.

Sequester	Regulators	**Active deployment of R&D in CCUS** The Chinese government needs to provide more support for decarbonisation technologies for sequester needs. Given that China (Mainland) is already in the lead in manufacturing and deployment of renewables, the government should now channel its efforts in accelerating its support for early-stage technologies - CCUS such that they can be commercialised more efficiently (BloombergNEF, 2023). This can be achieved by incorporating CCUS as an integral part of China's (Mainland) technology portfolio, thus accelerating the forward-looking deployment of technology research and development (R&D) as well as large-scale integration demonstration (Zhang, et.al, n.d.). **Increased funding allocations for businesses in private sectors** China (Mainland) should also start to place private companies on an equal footing with state-owned enterprises. The Chinese government has been prioritising state-owned companies in terms of funds, technology and support as 90% of government new energy contracts were handed to state-owned companies in 2022 as reported by the China Energy News. Given that the private firms have actually become leading suppliers of various low carbon technologies, the potential of the private sector has been overlooked by regulators as they favour state-owned companies more. As the private companies are positioned in the international markets, the intense competition pushes them to continually invest and innovate new solutions (Sheng, 2023). Hence, regulators should actually start to place more focus on

		its private sector by giving them similar incentives such that they can continue to build on their potential and spur greater growth in new technologies including sequestration techniques.
	Businesses	**International cooperation and exchange** Some Chinese companies have been playing a part in piloting CCUS projects in China (Mainland). This includes China (Mainland)'s Sinopec Corp which has recently announced its operations of the jurisdiction's largest CCUS facility in east China (Mainland) as it plans to build 2 more plants of similar scale by 2025 (Reuters, 2022). Hence, it is expected that China (Mainland) can further its progress in sequestration upon the successful implementation of these projects. With governmental support and continued research efforts from these businesses, more sequestration technologies can be undercovered to promote China (Mainland)'s progress in this tier. International cooperation and exchange can also be considered to complete the current domestic efforts.

Compensate	Regulators	**Integration synergies between ETS and tax to raise carbon prices** The role of carbon pricing can be further expanded through a more broadly applied and higher carbon price. From simulation results, it has been reported that by raising carbon prices to US$50 - 75 tCO_2e, China (Mainland) can reduce its emissions by about 15 - 20% (World Bank, 2022). Regulators can thus consider strengthening its current ETS design with a total emissions cap and pre-announced annual emissions cap reductions. In sectors in which ETS implementation is not feasible, regulators should also consider adopting carbon taxation to complement the limitations. This can be achieved by introducing tax in tandem with ETS for the interim such as the allowance of carbon tax refunds for entities required to obtain emissions permits (Parry & Wingender, 2016). **Review of regulatory standards** There is also a pressing need for regulators to review its regulations for the voluntary carbon market, to ensure that data integrity is well-maintained. This can be achieved by creating or adopting international frameworks and standards that serve as a guide in validating emissions.

4.4 Malaysia (Minimal Progress, Moderate Emissions)

Net Zero Targets and Approaches

Malaysia has announced its 2050 net zero target with its status as 'in policy document' as part of the National Energy Policy 2022 - 2040 (Economic Planning Unit, 2022). Its carbon management approach is covered in the Low Carbon Nation Aspiration 2040 which was developed based on existing plans in the energy sector. As such their efforts/targets are mainly focused on the Reduce and Substitute Tiers in the form of 9 distinct targets: Increase the % of urban public transport modal share from 20% to 50%, Increase the % of EV share from <1% to 38%, Change the Alternative fuel standard for heavy transport from B5 to B30, Increase the % of Liquefied Natural Gas (LNG) as alternative fuel for marine transport from 0% to 25%, Increase the % of industrial and commercial energy efficiency savings from <1% to 11%, Increase the % of residential energy efficiency savings from <1% to 10%, Increase the total installed capacity of RE from 7,597MW to 18,431MW, Decrease the % of coal in installed capacity from 31.4% to 18.6%, Increase the % of RE in the Total Primary Energy Supply (TPES) from 7.2% to 17%.

Note that the base year for all targets is 2018 while the target state/year is 2040

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

Malaysia's strengths lie in the 'Substitute' tier, especially its utilisation of Hydro and Solar Energy. In 2020, almost 90% of Malaysia's Total RE supply (16.20% of Total Energy) is derived from Hydro Energy (14.36%). Furthermore, Malaysia has been experiencing rapid growth in its Solar Energy Capacity, due to them capitalising on their geographical location near the equator. Solar Energy accounts for 2,172 MW of the total 3,758 new RE capacity (57.96%) to be installed between 2020 - 2025 in Malaysia

Weaknesses

On the other hand, Malaysia is performing poorly in the 'Reduce' tier, especially in the Industrial and Transport sectors. Zooming into the Industrial sector, Malaysia has an extremely low adoption rate of ISO 50001 certifications with only 40 organisations being certified, which could be due to high initial costs. As for the Transport sector, Malaysia has the lowest EV adoption rate across all 14 jurisdictions, with EV sales in 2022 accounting for just 0.41% of the total vehicle fleet. The main cause behind this phenomenon would be EVs being economically unviable for most people as well as a lack of public charging infrastructure (Aiman, 2023)

Reduce	Regulators	**Invest in a comprehensive charging infrastructure network** Malaysia currently suffers from a severe lack of EV chargers. To put things into perspective, Malaysia has about 900 EV charging stations, (reported by Edgeprop) to support a population of roughly 34M. In comparison, neighbouring Singapore, currently has 3,600 charging stations to support a significantly smaller population of 5.92M

		(Aiman, 2023). This causes Malaysian EV owners to suffer from range anxiety - A fear some EV owners have that their vehicle may not have sufficient energy to drive to the destination or the next EV charger. By increasing the number of EV chargers available for public use, it not only alleviates range anxiety which helps to increase EV sales but also indirectly EVs due to the station visibility. As charging stations proliferate, drivers may become curious, leading them to explore EVs and potentially transition to owning one (Khaw, 2023). **Fund public education campaigns to raise awareness on the advantages of an EV** Public education campaigns could help to highlight the advantages of EVs such as having a lower operating cost compared to traditional internal combustion engine vehicles (ICE), thereby eliminating the misconception that EVs are more expensive than ICE vehicles in the long run, boosting their adoption amongst cost-conscious consumers. **Provide incentives to offset the expensive nature of EVs** Providing incentives could work hand-in-hand with the public education campaigns to dissuade the notion that EVs are expensive. This is something the Malaysian government is already embarking on ever since the 2022 Budget, the government declared complete exemptions for EVs from import, excise, and sales taxes, along with road tax exemptions and income tax reliefs for buying charging facilities. Furthermore, EV users in Malaysia also don't have to pay road tax until 2025 (Bedi, 2023). Continuing to provide new incentives for EV owners is only going to further boost the EV adoption rate in Malaysia. **Introduce policies and regulations to encourage competition in the EV market** The potential for new entrants in Malaysia's EV market is presently limited, and the number of EVs available in the Malaysian market is extremely limited compared to other countries, with Tesla being the only large EV supplier in Malaysia thus only meeting the needs of a small group of consumers who can afford Tesla's luxurious price points. Not even local automakers such as Proton or Perodua offer fully EVs. By implementing supportive policies and regulations, the government could attract more participants, fostering competition and innovation, thus driving down the steep cost of EVs in Malaysia, while improving the quality and subsequently, increasing the EV adoption rate
	Businesses	**Strengthen R&D to roll out technologies that decrease the price of EVs** For example, RydeEV is already offering a battery swapping solution as a much cheaper alternative. Offering a battery swapping solution helps to increase EV adoption rate in 2 distinct ways:

		1. By decoupling the vehicles with its batteries, the price point of EVs drop significantly, as the integrated battery is the most costly component of an EV, therefore boosting EV adoption rates. 2. Concerns about long charging times may deter people from buying electric vehicles (EVs). However, rydeEV's battery swapping solution completely eliminates this issue, allowing users to quickly swap batteries at rydeEV locations instead of waiting for a lengthy 2-3 hours for their EV to charge (Khaw, 2023). **Local automakers should focus on manufacturing entry-level EVs** If local automakers such as Proton and Perodua were to enter the EV market, they would be able to fill the gap left by the luxurious EVs offered by Tesla by locally manufacturing entry-level EVs. This would further decrease the prices of EV, provide the customers with more EV options and spur competition between EV manufacturers, which will undoubtedly increase the quality of EVs in Malaysia in the long run therefore increasing EV adoption rate (Aiman, 2023). **Change in marketing/branding** While sustainability is a key attraction of electric vehicles (EVs), not everyone prioritises environmental concerns. To broaden appeal, messaging about EVs should extend beyond their eco-friendliness. Additionally, affordable options and corresponding branding are crucial for widespread adoption, especially given the luxury price points of many EVs (Khaw, 2023).

4.5 Thailand (Moderate Progress, Moderate Emissions)

Net Zero Targets and Approaches

Thailand has announced its 2065 Net Zero targets with its status being 'In Policy Document'. Thailand's efforts are mainly focused on the 'Reduce' and 'Substitute' tier, with small amounts of effort being put into the 'Sequester' tier. As for Thailand's transport sector under the 'Reduce' tier, they aim to move to 100% EV sales from 2035 onwards. As for the 'Substitute' tier, the share of renewable electricity is targeted to be 68% of total electricity generation in 2040, and 74% in 2050. Lastly for the 'Sequester' tier, Thailand aims to achieve LULUCF sinks of approximately 120 MtCO2e annually by 2037. Ultimately, CCS effectiveness in Thailand is uncertain and not economically viable. Their priority lies in immediate emission reduction ('Reduce' tier) and advancing clean energy technologies ('Substitute' tier) in the medium term.

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		Compensate		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

Thailand excels in the 'Substitute' tier, especially its utilisation of Biomass energy. In fact, Thailand has the highest utilisation of Biomass Energy (9.12%) as a % of their total energy needs as compared to the 14 other jurisdictions. Thailand generated 4.7 GW of power from Biomass Energy in just 2021 alone, dwarfing the 3.0 GW generated from Solar Energy, Thailand's second biggest RE source. THeir Biomass Energy share was even higher than the next 2 highest users of Biomass energy combined (Indonesia at 4.95% and New Zealand at 3.96%). Thailand extensively utilises biomass energy, primarily derived from rice, sugar cane, and cassava, owing to its status as a major producer of these crops. The widespread adoption includes innovative practices such as sugar companies powering their plants by burning waste from sugar cane processing (Muramatsu, 2022). Biomass, being plant-derived, doesn't contribute to greenhouse gas emissions when burned, as plants absorb carbon dioxide during growth. Additionally, biomass proves to be a more reliable industrial energy source compared to weather-dependent options like wind or solar energy. According to Zafar (2022), the common sources of biomass energy in Thailand include: Woody biomass residues from forest plantations, Agricultural residues (rice husk, bagasse, corn cobs, etc.), Wood residues from wood and furniture industries (bark, sawdust, etc.), Biomass for ethanol production (cassava, sugar cane, etc.), Biomass for biodiesel production (palm oil, jatropha oil, etc.), Industrial wastewater from agro-industry, Livestock manure, Municipal solid wastes and sewage.

Weaknesses

Thailand performed poorly in the 'Reduce' and 'Compensate' tiers. Zooming into the 'Reduce' tier, Thailand achieved minimal progress in the Buildings sector with poor appliance and equipment standards where only 4 appliances have MEPS while none of the key appliance groups have MEPS. As for the Transport sector, Thailand has made 0 progress towards its target fuel economy standards. As for the compensate tier, no compliance carbon markets have been enforced in Thailand, causing poor performance in the 'Compensate' tier.

Recommendations

Substitute	Regulators	**Continue to focus on Biomass energy as Thailand's main RE source** Despite Thailand's high Biomass energy utilisation, 40 million tons of waste still remain untapped yearly in Thailand. This represents a huge growth potential for Biomass Energy in Thailand. As a result, 15 biomass power plants are currently under construction to tap on this natural resource. This has also led to an increase in the number of energy crops (low-cost crops grown solely for RE production) such as bamboo, acacia, and napier grass being grown, which will further boost the utilisation of the upcoming biomass power plants.
	Businesses	**Businesses could enter partnerships with power producers to expedite RE adoption rate** In November 2022, Mitsubishi Heavy Industries (MHI) and Thailand's major power producer, the Electricity Generating Authority of Thailand (EGAT), entered into a Memorandum of Understanding. This agreement aims to facilitate the study and exchange of information concerning clean power generation

		and hydrogen. MHI is seeking to leverage this partnership by developing gas turbines that rely on cleaner fuels such as hydrogen and ammonia. As private companies are encouraged to join the power generation sector in Thailand, they could form similar partnerships. These collaborations could foster information exchange among companies and existing power producers, ultimately accelerating the adoption of renewable energy.

4.6 Taiwan (Moderate Progress, Moderate Emissions)

Net Zero Targets and Approaches

The status of Taiwan's 2050 net zero target is 'in policy document' as part of the 'Taiwan's Pathway to Net-Zero Emissions in 2050' document published by NDC in March 2022. Taiwan's efforts are focused entirely on the "Reduce', 'Substitute' and 'Sequester' tiers, with a much heavier emphasis placed on the first two. Zooming into the 'Reduce' tier, Taiwan is aiming to achieve 100% electrification of official vehicles and buses by 2030 and 100% electrification of new sedans and motor scooters sold by 2040. To do so, they are planning to invest NT$168.3 billion in the electrification of vehicles by 2030 (NDC, 2022). As for renewables, Taiwan is planning to invest NT$210.7 billion in renewables. In particular, Offshore wind capacity is targeted at 40 - 55 GW by 2050, while the target for total installed capacity for solar PVs is between 40 - 80 GWs by 2050. Lastly, the total installed capacity for Hydrogen power is targeted at 7,300 MW by 2050. Lastly, while the costs of CO2 capture remain too high to be widely deployed, the CCUs carbon reduction target is roughly 4.6M tons by 2030 (NDC, 2022).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

Taiwan achieved significant progress in the 'Reduce' tier, and in particular, the Industrial Sector. Taiwan has an extremely high adoption rate of ISO 50001 certifications with 456 organisations being certified, ranking as the jurisdiction with the 3rd highest number of ISO 50001 certifications, losing out only to India and China as they are much larger jurisdictions by comparison. The high adoption rates are largely due to various authorities in Taiwan, including the Economic Affairs' Bureau of Energy and Industrial Development Bureau, promoting energy conservation standards. The Taiwan Green Productivity Foundation aims to certify 600 organisations within five

years. Through proactive measures, such as funding, workshops, and publicity, the government encourages businesses to obtain energy management system certification. This initiative has led to widespread adoption, resulting in significant energy savings and cost reductions, with 37.87 million kWh of electricity and 752 kLOE of oil saved.

Weaknesses

However, Taiwan has only achieved minimal progress in the 'Compensate' tier. No compliance carbon markets have been enforced. As for voluntary carbon markets, the Taiwan Carbon Solution Exchange (TCX), was opened in August. However, trading on the exchange has not begun as it awaits more detailed regulations governing carbon fees and carbon exchanges to be announced by the end of the year. While Taiwan has no formal carbon tax implemented, it chose to go with a 'Carbon Fee' instead. Hsiao (2023) distinguishes between carbon "fees" and "taxes" in Taiwan. The Ministry of Environment collects carbon fees, and the funds are allocated for specific purposes. Meanwhile, carbon taxes, collected by the Ministry of Finance, contribute to the general budget of the state. In this scenario, carbon fees are utilised to provide support for those adversely affected by the transition to lower-emission processes (Hsiao, 2023).

Additionally, Taiwan has also achieved minimal progress in the 'Substitute' tier which can be attributed to 2 main reasons. Over-reliance on energy imports: Taiwan currently imports 98% of its energy sources, including 43% from coal and 39% from natural gas (Maguire, 2023). This has made short-term renewable investment extremely unappealing. Furthermore, its over-reliance on energy imports, makes Taiwan extremely vulnerable to energy market risks such as the ongoing Russo-Ukrainian War. High Costs & Low-supply of RE certificates have resulted in a lack of corporately sourced renewable energy in Taiwan. In Taiwan, bundled renewable energy certificates are pricey. Corporate power purchase agreements are also expensive and have stringent conditions: buyers must be significant electricity consumers and commit to contracts lasting 10 to 20 years (Hsu, 2022). This results in bundled certificates being economically unviable for many, and power purchase agreements being restricted to only a few eligible companies.

Recommendations

Substitute	Regulators	**Increase investments in Wind Energy** Despite Taiwan's mountainous terrain and strong winds, wind energy only accounted for 0.86% of Taiwan's TE needs in 2022. This proves that Taiwan is significantly underutilising the Wind energy available to them. Recently, Taiwan has started to leverage this natural resource as supported by the 66 GW of wind power capacity currently under development, ranking in at the fourth highest in Asia and the ninth largest globally. Should Taiwan continue to improve its wind power capacity, its performance in the 'Substitute' tier is sure to improve. **Scale down Renewable Energy Certificates** To address the fact that RE certificates are too costly for most SMEs, the government should decrease the commitment period of the certificates while making them available in smaller batches. As of October 2023, TaiPower initiated a renewable energy bidding platform, offering 10,000 kWh and 50,000 kWh batches from its solar installations for one, three, or five years. Taiwan should expand this initiative, providing a broader range of energy batches with shorter commitments, thereby reducing barriers for SMEs to

		source renewable energy.
	Businesses	**Invest/finance RE projects** Businesses are also able to support Taiwan's shift to Wind power. For example, as of June 2022, banks have signed contracts for approximately NT$348.1 billion in local financing for offshore wind power. Similarly, As of July 2022, insurance companies have authorized investments of about NT$14.8 billion in green energy power plants, with two life insurance companies contributing NT$4.2 billion to offshore wind farms.

4.7 Indonesia (Substantial Progress, Moderate Emissions)

Net Zero Targets and Approaches

Indonesia has not yet communicated an explicit net zero target but is exploring scenarios that could lead to net zero emissions by 2060 or sooner (Climate Action Tracker, 2022). From their nationally determined contributions document, Indonesia has highlighted 'Reduce' and 'Substitute' tier strategies, prioritising the implementation of energy efficiency measures across energy-consuming sectors, encompassing industry, commercial enterprises, transportation, and residential areas (UNFCCC, 2022). These measures involve enhancing the efficiency of devices and energy systems, which includes the adoption of electric vehicles and the establishment of their supporting ecosystems. Indonesia is also focusing on replacing coal with other essential natural minerals as it is crucial as a jurisdiction that is among the world's largest consumers and exporters of coal, given its abundant coal resources.

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

Their 'Substitute' tier demonstrates commendable progress, aligning well with their established goals. This achievement is particularly praiseworthy considering Indonesia's current heavy reliance on coal and fossil fuels (Institute for Essential Services Reform, 2021). Despite being the largest global exporter of coal by weight, Indonesia is actively working towards diversifying its energy sources. Notably, renewable energy presently constitutes 18.84% of the total energy mix, with a target set at 23% for the year 2025. This shift is significant, given the substantial role that coal and fossil fuels play in both Indonesia's exports and domestic energy supply.

Furthermore, Indonesia's voluntary market is thriving, characterised by the implementation of both global standards and its own set of regulations for their own carbon market. This approach facilitates extensive trading activities, both domestically and internationally, showcasing the country's commitment to sustainable practices in emissions reduction and environmental responsibility.

Weaknesses

Indonesia's primary weakness lies in the 'Reduce' tier, where their energy efficiency measures, despite being a key priority, are falling short of expectations. The adoption of ISO 50001 standards is minimal, with the industrial sector having its own standards in place, albeit not conforming to ISO standards. This variance contributes to the lower performance scores in this aspect.

In the industrial sector, adherence to Government Regulation 70/2009 is required for companies with an annual energy consumption exceeding 6,000 tonnes of oil. This regulation mandates the appointment of an energy manager, the development of an energy conservation plan, the conduct of energy audits, and the reporting of energy consumption to the government (IEA, 2021). However, the overall performance in this area is hindered by the limited adoption of ISO 50001 standards. Regarding the transport sector, the adoption of EVs is minimal, and although vehicle labelling is on target, the lack of mandatory fuel efficiency labelling hampers progress. Additionally, in the construction sector, building codes in Indonesia only extend to large commercial buildings, presenting a limitation in addressing energy efficiency in a broader range of structures.

Further insights

Indonesia's overall performance is noteworthy as it spans across all four tiers, indicating substantial progress in their environmental initiatives.

Recommendations

Reduce	Regulators	**Focus on the Industrial Sector for both regulators and businesses with the sector with ISO 50001** Prioritising the industrial sector for both regulatory bodies and businesses, with a specific emphasis on implementing ISO 50001 standards, is imperative for Indonesia's energy efficiency goals. This sector currently exhibits the lowest scores in the "Reduce" tier compared to building and transport, making it a critical focal point for improvement. Notably, statistics from the International Energy Agency (IEA) for the period 2014-2018 underscore the significant potential within the industrial sector. Despite its current lower performance, this sector achieved the highest efficiency gains, boasting an impressive 90% improvement (IEA, 2021). The associated energy savings during this period further illustrate the impact: Industry achieved savings of 358.6PJ, surpassing both the transport (35.1PJ) and building (11.4PJ) sectors. In light of these findings, directing efforts toward enhancing energy efficiency in the industrial sector through the implementation of ISO 50001 standards emerges as a strategic approach. By doing so, Indonesia can capitalise on the substantial gains witnessed in the recent past and pave the way for further advancements in reducing

		energy consumption and promoting sustainability. **Expansion of Building Code Coverage** It is crucial to advocate for the expansion of building code coverage, extending it to encompass a more diverse array of structures beyond large commercial buildings (Global Alliance for Buildings and Construction, 2022). The current building codes are limited in scope, focusing exclusively on large commercial structures and neglecting the residential sector and other building types.

Sequester	Regulators	**Price and technology constraints when implementing CCUS** Indonesia encounters significant challenges in terms of price and technology constraints when implementing its Carbon Capture, Utilisation, and Storage (CCUS) strategy. Despite upcoming projects, such as the 'Muara Enim downstream coal to dimethyl ether DME project,' slated to commence operations in 2024, reports from the Institute for Energy Economics and Financial Analysis (IEEFA) underscore the unprofitability of these initiatives, even with conservative cost assumptions and projected returns (Karyza, 2023). The deployment of CCUS strategies using current technological capabilities and unrealistic price targets poses a considerable risk. Such an approach could lead to a financial "black hole" in the economies involved, where funds are excessively and ineffectively utilised. Given these challenges, there is a critical need for a careful reassessment of the CCUS strategies, ensuring that they align with both technological feasibility and economic viability. Adjusting expectations and fostering a realistic understanding of costs and returns is essential to avoid potential economic setbacks associated with the implementation of CCUS projects.
	Businesses	**Wider sector of businesses to explore CCUS technology** As of October 31, 2023, the Indonesian government has disclosed its intent to finalise a regulation that will result in a significant expansion of CCS projects. This regulatory update marks a departure from the existing framework, which exclusively applies to the oil and gas sector (Reuters, 2023). The forthcoming rules will extend the scope of CCS and CCUS to encompass industries beyond oil and gas, including cement and metal. The decision to allow the storage of greenhouse gases emitted by other countries within Indonesia opens up international business opportunities. This initiative can foster collaboration between nations, creating a market for carbon storage services on a global scale. By positioning itself as a hub for the storage of greenhouse gases, Indonesia stands to benefit economically while contributing to

		worldwide efforts to combat climate change. This approach aligns business interests with environmental responsibility, creating a win-win scenario for both national and global stakeholders.

4.8 Hong Kong (Minimal Progress, Minimal Emissions)

Net Zero Targets and Approaches

Hong Kong has opted for a carbon neutrality target by 2050 instead of setting a net-zero target. In their Climate Action Plan for 2050, they have outlined strategies to achieve this goal, with a focus on reducing electricity consumption in buildings and transitioning fully to electric vehicles (The Government of the Hong Kong Special Administrative Region, 2021). Additionally, there is a commitment to completely cease the use of coal in daily electricity generation. For the 'Reduce' approach, Hong Kong aims to reduce the electricity consumption of commercial buildings by 30% to 40% and that of residential buildings by 20% to 30% from the 2015 level by 2050 and by 2035 or earlier, the plan calls for the cessation of new registrations of fuel-propelled and hybrid private cars, signalling a clear transition toward fully embracing electric vehicles. For the 'Substitute' approach, the government has committed to ceasing the use of coal for daily electricity generation by 2035, retaining it solely for backup support. The plan entails replacing coal with cleaner alternatives such as natural gas and zero-carbon energy sources.

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

Hong Kong has a strong presence in the voluntary carbon market, making it a key focus. The internationally open nature of the VCM allows neighbouring countries, such as China, to participate in supplying carbon credits.

Weaknesses

Hong Kong faces notable weaknesses in the 'Reduce' and 'Substitute' tiers, impacting the achievement of their main goals. While there is progress in transitioning to electric vehicles, challenges persist in fuel standards, vehicle fuel efficiency labelling, and comprehensive strategies for green transport.

Hong Kong faces substantial challenges in its transport sector, particularly in the realms of fuel standards, efficiency labelling, and the broader adoption of sustainable practices. The current lack of clear fuel economy standards, with a recorded value of 12.84 litres per 100 kilometres falling below the target, positions Hong Kong unfavourably compared to 14 other jurisdictions. The absence of mandatory vehicle fuel efficiency labelling

further limits consumer awareness and choice, hindering informed decisions regarding environmentally friendly options. Additionally, insufficient support for electric vehicles from other regulations poses obstacles to overall progress in reducing carbon emissions from the transportation sector.

Within the 'Substitute' tier, Hong Kong grapples with a reliance on cheaper energy alternatives, indicating difficulties in transitioning to more sustainable options (Anbumozhi et al., 2015). Furthermore, feasibility challenges in implementing renewable energy solutions contribute to the jurisdiction's struggle to meet renewable energy goals. The modest target of 3.2% falls significantly below the benchmarks set by other jurisdictions, emphasising the need for more ambitious and effective strategies to promote the adoption of renewable energy sources.

Further insights

Hong Kong currently does not have any CCUS systems in operation or on schedule. The decision not to implement CCUS is attributed to the extremely limited supply of renewable energy and land resources in Hong Kong, indicating that this technology is not considered ready for widespread application at the present stage.

Recommendations

Reduce	Regulators	**Complementary regulations for the adoption of electric vehicles** To enhance the adoption of EVs in the transport sector, Hong Kong should implement complementary regulations alongside its current efforts. It is imperative for regulators to explicitly state targets and strategies for crucial aspects such as fuel economy standards and fuel efficiency labelling.
	Businesses	**Retrofitting existing high-rises over building new green buildings** In Hong Kong's approach to sustainable buildings, there is a notable opportunity to emphasise retrofitting existing high-rises as opposed to constructing new green buildings. This strategy aligns with the goal of making the majority of the current building stock more energy-efficient and capitalises on the expertise of property developers already committed to science-based greenhouse gas emissions targets. Given that property developers make up four of the ten enterprises in Hong Kong that have had their greenhouse gas emissions objectives approved by the Science Based objectives initiative (SBTi) to be aligned with 1.5 degrees Celsius, there exists a substantial foundation for fostering a shift in focus (Yeung, 2022). To encourage this shift, policymakers, industry stakeholders, and environmental advocates should collaborate to create supportive frameworks, financial incentives, and regulatory structures that prioritise retrofitting initiatives.

Substitute	Regulators	**Decommissioning coal-fired power plants while simultaneously increasing investments in renewable energy and energy efficiency initiatives** To address the current over-reliance on fossil fuels and achieve a more sustainable energy future, it is essential for Hong Kong to

		undertake a two-fold approach: decommissioning coal-fired power plants and concurrently increasing investments in renewable energy and energy efficiency initiatives. While coal will be phased out for daily electricity generation, it is prudent to retain it solely for backup support. This approach acknowledges the need for contingency measures to maintain a reliable energy supply during unforeseen circumstances or fluctuations in renewable energy availability. By designating coal for backup support, Hong Kong can strike a balance between the imperative to reduce carbon emissions and the practical necessity of ensuring uninterrupted energy provision. Simultaneously, Hong Kong must proactively diversify its energy portfolio to enhance reliability and resilience. A diversified energy mix is key to mitigating risks associated with dependence on a single energy source. In this regard, incorporating renewable sources such as solar, wind, and hydroelectric power becomes paramount. These renewable options not only contribute to a reduction in greenhouse gas emissions but also offer a sustainable and dependable alternative, fostering energy security and resilience in the face of evolving energy needs and potential challenges.

4.9 Philippines (Minimal Progress, Minimal Emissions)

Net Zero Targets and Approaches

As of now, the Philippines is the only ASEAN jurisdiction that has yet to commit to a net zero target. However, it aims to reduce carbon emissions by 75% from its business-as-usual (BAU) trajectory by 2030. Their primary strategies for carbon management revolves around the 'Reduce' and 'Substitute' tiers. In the 'Reduce' approach, there have been revisions to the Philippines Energy Plan (PEP) (2020-2040) within the energy sector. However, the plan is carbon intensive and relies on high levels of fossil gas imports and generation for the future energy mix (Climate Action Tracker, n.d.). Despite having a moratorium on new coal projects, there is an exemption for an additional capacity of 2.6 GW of coal power.

Also, a significant portion of the initially planned coal projects has been replaced with fossil gas (Farand, 2020). In the pursuit of the 'Substitute' approach, a moratorium on new coal-fired plant proposals was announced in 2020, accompanied by various measures to bolster renewable energy. Under the National Renewable Energy Program (NREP) 2020-2040, the government aims to reach 35% renewable energy in power generation by 2030 and 50% by 2040 (Farand, 2020).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		Compensate		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

For the Philippines, it exhibits relative strength in the 'Substitute' tier compared to the other tiers. It has managed to fulfil 21% of its total energy demands through renewable sources by leveraging on its unique volcanic topography, which accounts for nearly half of this renewable energy contribution. The jurisdiction has made substantial progress by attaining 60% of its 2030 target, aiming to source 35% of its total energy from renewables. Additionally, the Philippines is actively engaged in various renewable energy projects to diversify its portfolio. Significant endeavours include the Luzon Geothermal Project for geothermal expansion, the Rizal Wind Farm for wind energy, and the Kaliwa Dam for hydroelectric energy (Ricardo, n.d.).

Weaknesses

However, its weaknesses are in the other tiers. For the 'Reduce' tier, the adoption of ISO 50001 standards in the industrial sector is low, with only 20 organisations being certified. This results in limited site coverage and partial sector coverage.

For the 'Sequester' tier, there are no CCUS projects planned which could stem from the absence of a proper carbon price, making it difficult for carbon capture initiatives to gain traction. Additionally, the lack of legal and regulatory frameworks from the government regarding the acceptance of CCUS projects and the prevailing perception that carbon sink projects are not welcomed further contribute to this weakness (Climate Adaptation Platform, 2022).

For the 'Compensate' tier, there are no implemented carbon taxes, and there are no compliance or voluntary markets in place at the moment. The Department of Finance deems the implementation of carbon taxes unfeasible, as it could render the jurisdiction uncompetitive in terms of power rates. Their perspective is that developing jurisdictions should not be deprived of affordable electricity (Simeon, 2022).

Further insights

Given its policies, procurement strategies, and economic context, we contend that the Philippines is better positioned for renewables development. Recognising the jurisdiction as an emerging market with limited resources, we propose a strategic focus on energy efficiency development. Allocating more resources to this aspect would enable the Philippines to concentrate efforts where it has a comparative advantage and maximise the impact of its carbon management initiatives. This targeted approach aligns with the jurisdiction's strengths and addresses the challenges associated with resource constraints.

Recommendations

We have formulated the following recommendations for the Philippines to enhance its performance in the 'Reduce' tier, acknowledging it as a primary approach for carbon management despite its current challenges. We believe that for an emerging market like the Philippines, focusing on the Reduce tier will be the most efficient and cost-effective measure for them. Additionally, we recommend that the Philippines ventures into the 'Sequester' and 'Compensate' tiers through collaboration and partnerships, as we believe these areas hold untapped potential with the right regulatory efforts to drive project implementations. This strategic expansion

would not only advance the jurisdiction's objectives in generating cleaner energy but also contribute to fulfilling its NDCs, fostering economic development in the process.

It's important to highlight that there will not be any recommendations provided for the 'Compensate' tier, given the Department of Finance's perspectives on the carbon market.

Reduce	Regulators	**Increase government budget allocation for climate resilience** The Philippines could explore the possibility of increasing government budget allocations, specifically for climate resilience, with a particular emphasis on energy efficiency. With a current budget of PHP 5.268 trillion, approximately 8.8% (PHP 464.6 billion) is allocated to environment-related programs. However, only around 40% (PHP 2.2 billion) of the environment-related budget is designated for the implementation of energy projects in 2023. Scaling up these budgets could significantly accelerate the jurisdiction's efforts in reducing carbon emissions. **Foster international partnerships and collaborations for funds** Moreover, the Philippines government might consider fostering cross-border collaborations and international partnerships to secure additional funds for enhancing energy efficiency. This approach could contribute significantly to achieving its climate ambitions. Notably, between 2018 and 2020, donor governments and multilateral institutions provided $2.4 billion in climate-related development finance. Successfully leveraging these funds could allow the government to establish a robust project pipeline and potentially allocate resources to address other tiers of carbon management as well.
	Businesses	**Integration of ESG into their current banking practices for business in financial sectors** Businesses in the financial sector of the Philippines can enhance their commitment to environmental, social, and governance (ESG) principles by integrating them into their current banking practices. By learning from the practices of banks and financial institutions in other jurisdictions that have been active in the ESG space, businesses can adapt and incorporate similar approaches into their existing processes. Some noteworthy initiatives include the collaboration between The Bangko Sentral ng Pilipinas (BSP) and the International Finance Corporation (IFC), aiming to encourage the local banking sector to intensify efforts in sustainable finance. This collaboration encourages banks to increase financing for projects that are both climate-friendly and socially inclusive. Promoting more initiatives of this nature can foster the exchange of ESG approaches and practices, providing valuable insights into sustainable finance initiatives,

		opportunities, and available resources (International Finance Corporation, 2018).

Sequester	Regulators	**Increase positive sentiments and acceptance for sequestration** A study conducted in 2005 highlighted that the Philippines possesses significant potential for engaging in carbon sequestration projects, citing its tropical forests, fallow areas, and vast expanses of degraded land suitable for sequestration through reforestation and rehabilitation (Climate Adaptation Platform, 2022). However, as previously mentioned regarding sentiments on the Philippines' sequester market, regulators must carefully review existing laws, rules, and regulations related to the oil and gas industry for potential adoption or extension to CCUS projects (Tamang, 2023). Therefore, it is essential for the Inter-Agency Committee on Climate Change (IACCC) to address this matter for progress in sequestration efforts (Climate Adaptation Platform, 2020). By opening its markets to carbon sequestration projects, the Philippines can potentially benefit from reduced emissions resulting from these initiatives. **Participation in cross-border projects** Additionally, regulators can explore cross-border projects, leveraging economies of scale, risk-sharing, shared capital expenditure, and potentially tapping into deeper pockets for financing and risk mitigation. Notable examples of such projects include the Northern Lights project in Norway and the Acorn Project in the UK. We believe that regulators can analyse and consider adopting strategies from successful international ventures, providing valuable insights for the Philippines to enhance the effectiveness and viability of its carbon sequestration initiatives.

Compensate	Regulators	Regulators can enhance their commitment to cross-border partnerships, exemplified by initiatives like the Joint Crediting Mechanism (JCM). The JCM was established through a Memorandum of Cooperation between the Philippines and Japan, facilitating the collaboration of Japanese and Philippine proponents in setting up low-carbon projects in the Philippines. The resulting carbon emission reduction credits are then shared between the project proponents. By emphasising and expanding efforts in such cross-border partnerships, regulators can foster international cooperation and contribute to the broader objectives of sustainable and low-carbon development.

4.10 New Zealand (Moderate Progress, Minimal emissions)

Net Zero Targets and Approaches

Currently, New Zealand has officially declared a net zero target by 2050, which its status is ‘in law’. The jurisdiction's primary strategies for carbon management involve a comprehensive focus on the ‘Reduce’,

'Substitute', and 'Compensate' tiers. In pursuit of the 'Reduce' approach, New Zealand aims to achieve emissions reductions in the energy and industry sectors through five interdependent initiatives: the Equipment Energy Efficiency Programme, Warmer Kiwi Homes, Energy Efficient Products and Services Consultation, Support for Energy Education in Communities Programme, and the State Sector Decarbonisation Fund. For the 'Substitute' Tier, New Zealand has implemented the New Zealand Energy Strategy, outlining plans to revolutionise the energy system by significantly reducing reliance on fossil fuels and increasing dependence on renewable electricity and low-emission fuels. Lastly, in the 'Compensate' Tier, the jurisdiction has instituted The New Zealand Emissions Trading Scheme (NZ ETS), serving as a pivotal mechanism to drive emissions reductions in the Energy and Industry sectors. The NZ ETS utilises a rising carbon price to incentivize the reduction of fossil fuel usage through energy efficiency improvements and fuel switching opportunities (New Zealand Legislation, 2019).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

The strengths of New Zealand's carbon management strategies are prominently evident in its Substitute and Compensate tiers. In the 'Substitute' tier, the jurisdiction stands out as a leader in renewable energy adoption, with 85% of its total energy needs met by renewable sources. New Zealand is on a trajectory to achieve its goal of 100% renewable energy adoption by 2030. In the 'Compensate' tier, the NZ ETS demonstrates a comprehensive approach by encompassing a diverse range of sectors, notably focusing on forestry and waste. This ETS effectively covers 49% of GHG emissions and includes 359 entities in its scope.

Weaknesses

In the 'Reduce' tier, the jurisdiction faces challenges related to the enforcement of standards in building codes, appliance and equipment standards, and ISO certifications. In the context of building codes, the primary reason for the low score is attributed to the absence of publicly available information needed to derive the necessary details for evaluation. Regarding ISO 50001 certifications, New Zealand has only two organisations certified with ISO 50001 standards. This signifies a substantial gap compared to other jurisdictions where the number of certified organisations may reach into the thousands.

Further insights

It is important to highlight concerns related to CCUS in New Zealand. The jurisdiction confronts challenges related to geographical instability and safety concerns. A paper authored by geological and geotechnical experts from New Zealand and the United Kingdom has outlined the risks associated with earthquakes impacting CO_2 storage in New Zealand, and the possibility of carbon capture and storage triggering seismic activity (Mandow,

2023). Given the potential for significant losses and varying perspectives on CCUS technology, it is our assessment that regulators may not actively pursue this strategy at present.

Recommendations

We have developed the following suggestions for New Zealand to enhance its performance in the ‘
‘Reduce’ tier. Despite having an approach that emphasises emissions reductions through interconnected strategies, it is currently not performing as well as other tiers. Therefore, our focus is directed towards improving its standing in this specific tier.

Reduce	Regulators	**Transport - Integration of renewables with electrification goals** Regulators in New Zealand can strategically concentrate on enhancing the transport sector by prioritising electrification goals, given that the current transport systems largely rely on fossil fuels. The jurisdiction has the potential to develop smart grid technology and leverage renewable integration for charging, aligning with its niche in renewables. Real-world research into the potential of vehicle-to-grid technology could be a key avenue to explore (Scott & Allan, 2013). **Industrial - Stricter regulatory enforcements for buildings and industrial sectors** Furthermore, New Zealand's regulatory efforts can be directed towards implementing stricter regulations in the buildings and industrial sectors. There is an opportunity to refine specific details within Building Code regulations, and incentivising the adoption of ISO 50001 standards could be a valuable strategy. They could potentially explore a more comprehensive approach, which includes policies related to lighting and appliances, modifications to building codes, and targeted subsidies for industrial emitters, that can be used to complement its existing emissions pricing mechanisms and contribute to enhancing overall energy efficiency (Kazaglis et al., 2017).
	Businesses	**Increase investments in R&D in low-emissions technologies** Given New Zealand's comparative advantage in low-emissions technologies, businesses are encouraged to explore investment opportunities in research and development (R&D) within this sector. Collaborative efforts in research and experimentation can be pursued, particularly in areas such as agricultural R&D focusing on methane vaccines. The development of such vaccines has the potential to significantly reduce emissions, specifically methane emissions, without necessitating changes to existing farm systems (New Zealand Agricultural Greenhouse Gas Research Centre, n.d.).

4.11 Australia (Substantial Progress, Minimal emissions)

Net Zero Targets and Approaches

Currently, Australia has announced a net zero by 2050 target, which its status is 'in law'. Their approaches towards carbon management encompasses all four tiers. For the 'Reduce' approach, AUD 280 million would be used to further reduce the emissions of industrial facilities with the new Safeguard Crediting Mechanism. For the 'Substitute' approach, as indicated by the Technology Investment Roadmap, AUD 20 billion will be used to fund low-emissions technologies like energy storage, ultra low-cost solar, clean hydrogen, low emissions steel, CCS, and soil carbon (UNFCCCa, 2022). For the 'Sequester' approach, the Long-Term Strategy (LTS) presents future development of low-emissions technology that have yet to prove its scale such as CCUS, together with international offsets and land use reductions (Climate Action Tracker, n.d.-c). For the 'Compensate' approach, LTS stipulates a dependence on carbon offsets and global technology trends to reach targets (Climate Action Tracker, n.d.-a).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

The strengths of Australia's carbon management strategies lie in the 'Sequester' and 'Compensate' tier. For the 'Sequester' tier, Australia is the current leader of the 14 jurisdictions due to its strong financial and geological capacity to handle all the announced planned CCUS projects, making it the only jurisdiction in our report that is able to achieve the UNECE's target of 14%. For the 'Compensate' tier, Australia is actively participating in both the compliance (Australia Safeguard Mechanism) and voluntary carbon market (National Carbon Offset Standard), due to the strong regulations and support from the authorities and interests from buyers of the carbon offsets (Carbon Market Institute, 2021).

Weaknesses

The weaknesses of Australia's carbon management strategies lie in the 'Reduce' and 'Substitute' tier. For the 'Reduce' tier, Australia has very poor adoption rates of the ISO 50001 certifications across the few sites and sectors covered. Due to a lack of effective policy to reduce GHG emissions in the industrial sector, Australia's industrial sector was ranked as one of the world's worst in energy efficiency in 2018 (Climate Analytics, 2018).

There is also a lack of set target fuel economy standards which suggests no limits to vehicle fuel consumption or CO_2 emissions for new vehicles. Additionally, due to the sparse amount of public charging facilities available in the jurisdiction, whereby the number of EVs per public charging point of Australia is thrice that of the world, this has greatly deterred the adoption of EVs amongst Australians (Jackson, 2023). According to the EY Mobility Consumer Index 2023 global survey (Webster, 2023), the strongest concern of respondents in choosing EVs was the lack of charging, supporting the slow uptake of EVs by Australian consumers, as shown by the sale of EVs

representing only 0.5% of vehicle fleets in 2022 (refer to Figure 17 in Section 2.1.4.3). The two other important reasons being the lack of driving range of EVs and upfront purchase costs.

As such, this made Australia fare poorly in the industrial and transport sectors, thus ranking as one of the lowest in the 'Reduce' tier. For the 'Substitute' tier, Australia is only at 32.9% of its progress towards the target which was set to be achieved in 2030.

Further insights

It is worth noting that while Australia is not performing as well in the 'Reduce' and 'Substitute' tier, the approaches taken seek to improve those tiers, which could potentially foster better performance upon the full usage of the funds. On top of the approaches, the government has rolled out the National Electric Vehicle Strategy to improve the situation of slow EVs uptake by introducing the following initiatives:

- Driving The Nation Fund: to support the building of an EV charging network whereby there are charging points at every 150 km on major highways.
- Electric Car Discount: to reduce the upfront costs of purchasing EVs;
- Green Vehicle Guide: to aid consumers in comparing and choosing lower emissions vehicles.

Additionally, despite wind energy providing 34.7% of all RE in Australia (the second highest among all RE sources in Australia), there is very high potential for expansion in the wind energy sector.

Recommendations

Our recommendations are targeted at all aspects mentioned under their weaknesses, which are not targeted by their approaches.

Reduce	Regulators	**Industrial - Launch energy management system (EnMS) and encourage uptake of ISO 50001 with incentives** The government started launching an energy management system (EnMS) that assesses and provides improvements for the way that organisations are using energy (Department of Climate Change, Energy, the Environment and Water, n.d.). This policy thus ensures that objectives of energy management and expected timeline for achieving set goals are well communicated to corporations. Thereafter, this allows continuous improvement efforts to align with the goal to improve energy management of Australia's industrial sector. In addition to the EmMS, regulators can look into providing some incentives to encourage businesses to attain the ISO 50001 certifications since obtaining the certificates come with great costs that deter corporations from adopting them. **Transport - Continue and fasten implementation of National Electric Vehicle Strategy, EV charging points and fuel efficiency standards** While the introduction of the National Electric Vehicle Strategy is a good initiative to raise the adoption of EVs, the government should look into rolling out public charging points at a faster pace (IEA, 2021a). The government may even look into pushing for access schemes in major cities whereby there are a few zones which only low- and zero-emission vehicles may access, which proved to be

		successful in cities like Oslo. Furthermore, the government should push forth their formulation and implementation of fuel efficiency standards so as to stimulate growth in the market for low-emission vehicles and EVs.
	Businesses	**Industrial - Work towards obtaining more ISO 50001 certificates** Businesses in the industry sector stand to gain from adopting ISO 50001 as the certification not only offers them the chance to become more resilient against energy availability and costs, but it also helps businesses comply with regulations and integrate sustainability best practices (British Standards Institution, n.d.). Hence, corporations in Australia should work towards obtaining more ISO 50001 certifications after measures have been taken to improve their energy efficiencies, for instance, switching to using less carbon-intensive alternatives like natural gas and hydrogen instead of coal. **Transport - Boost the manufacture and imports of vehicles that are within the set targets (upon implementation)** The introduction of fuel efficiency standards would also boost the manufacture and imports of vehicles that are within the set targets. This would then push businesses to look for ways to operate within the newly-set regulations. In the case of a vehicle manufacturing firm, it would seek to produce cars that would emit fewer emissions such that it is within the target, while firms that sell vehicles would look into searching for vehicle manufacturers that can produce such vehicles.

Substitute	Regulators	**Introduce funding and/or revenue support for expansion into wind energy** Despite the vast potential of offshore wind resources in Australia, the high investment risk and costs in developing the offshore wind infrastructure is limiting the confidence of investors, which is reducing the opportunity for Australia to reap the benefits of the strong offshore wind. As such, the government can play a part in reducing the costs by introducing financial funding and/or revenue support such as Feed-in Tariffs (FiTs) or Power Purchase Agreements (PPAs). This would incentivise potential developers to engage in wind energy projects and provide energy to the grid. **Streamline permitting procedures** In addition, regulators should seek to eradicate any uncertainty that may arise upon the enactment of a regulatory framework. For example, with the new Offshore Electricity Infrastructure Regulatory Framework put in place, there are still uncertainties with how the framework will apply in practice as there are unknowns in how additional approvals for projects will interact with the framework (Norton Rose Fulbright, 2023). Furthermore, the regulators should look into streamlining their permitting procedures to boost the development of wind projects (IEA, 2023e).
	Businesses	**Expand into wind energy market** Corporations with expertise on building infrastructure that capture

		wind to generate electricity would tap into the potential of Australia's offshore wind should they aim to reap the monetary gains of the strong winds in Southern Australia. As such, despite the large development costs, a number of developers of offshore wind projects have entered the offshore wind market of Australia. Currently, these developers have introduced many projects that are in early planning stages of development, though they have yet to obtain the licenses required to carry out feasibility and development activities. Hence, these firms should work with the regulators to work out the licensing requirements as early as possible to start the development so that Australia can look to reach their goal to supply 82% of all TE with RE by 2030.

4.12 Japan (Substantial Progress, Minimal emissions)

Net Zero Targets and Approaches

Currently, Japan has announced a net zero by 2050 target, which its status is 'in law'. Their approaches towards carbon management encompasses all four tiers. For the 'Reduce' approach, Japan is seeking to revise building standards such that from 2025, all newly built buildings and houses will have to comply with the upgraded energy efficiency standards. Moreover, financial aids will be provided for house renovations so as to improve energy efficiency and encourage use of RE in buildings (Climate Action Tracker, n.d.-b). For the 'Substitute' approach, the Green Growth Strategy seeks to target renewables efforts like offshore wind power, next-generation solar cells, and hydrogen (METI, 2021). For the 'Sequester' approach, the authorities seek to store 120 - 240 million tonnes of CO_2 annually in 2050, while setting up legislative frameworks to allow the launch of full-scale CCUS operations from 2030 (Obayashi & Stonestreet, 2023). For the 'Compensate' approach, the Joint Crediting Mechanism (JCM) seeks to use public-private partnerships to contribute to international emission reductions and removals at a level of around 100 $MtCO_2$ by fiscal year 2030 (GEC, 2023).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

The strengths of Japan's carbon management strategies lie in the 'Compensate' tier, whereby Japan is one of the few jurisdictions who have shown efforts in implementing Carbon Tax, and is placing greater emphasis on the use of their Voluntary Carbon Market over their Compliance Carbon Markets.

Weaknesses

The weaknesses of Japan's carbon management strategies lie in the 'Reduce', 'Substitute' and 'Sequester' tier. For the 'Reduce' tier, Japan has very poor adoption rates of the ISO 50001 certifications across the few sites and sectors covered, leading to Japan ranking as one of the lowest in the 'Reduce' tier. For the 'Substitute' tier, Japan is at 67% of its progress towards the target which was set to be achieved in 2030. For the 'Sequester' tier, Japan only has one operational CCUS project (Mikawa Power Plant BECCS Fukuoka Prefecture) that has potential to reduce 0.0182% of its own emissions. Moreover, the total potential effectiveness of all current planned and operational projects are not large enough to ensure Japan can reach the 14% target of UNECE.

Further insights

Japan is another jurisdiction with high potential for offshore wind energy, and geothermal energy. However, despite the potential of raising % of TE generated by geothermal energy from 0.3% to 10%, geothermal energy was not expanded on due to the opposition brought about by their powerful hot spring owners, who believed that the development of geothermal projects would lead to a demise of the Japanese culture of onsens or hot springs (Tabuchi, 2023).

On the other hand, though wind energy is currently providing for only 0.05% of all RE, and 0.98% of TE in Japan, offshore wind farms have the potential to generate more than eight times of Japan's current yearly demand for electricity (Nature Publishing Group, n.d.), amounting to over 8,000 TWh of energy per year, according to IEA.

Japan also has the potential to achieve the UNECE's target of 14% by 2050 if Japan is able to store at least 131 Mtpa by 2050, under the assumption that their emissions remain similar. If emissions were to be reduced to around 857 $MtCO_2$, the goal to store at least 120 Mtpa by 2050 would ensure Japan is able achieve the 14% target.

Recommendations

Our recommendations would focus on improving the 'Reduce' and 'Substitute' tier, specifically looking into increasing the adoption of ISO 50001 certifications by boosting energy efficiency and lower carbon intensity of the industrial sector's energy consumption, and to boost expansion into the high potential wind energy market.

While we acknowledge that Japan is seeking to raise their capacity to ensure large storages of CO_2 by 2050, and definitely has the potential to reach the UNECE's target if successful, we would still like to offer recommendations for the 'Sequester' tier, which can also be applied to other jurisdictions looking to expansion of their CCUS efforts.

Reduce	Regulators	**Enforce stricter regulations** The Japanese government can employ a variety of policy tools, such as stricter regulations and subsidies to increase the energy efficiency of the industry sector. The stricter regulations can specify the legal requirements and encourage corporations to operate and produce more efficiently. For instance, the MEPS can be enforced in the industry to push for the use of energy-efficient equipment for important industrial equipment like heating and cooling systems (IEA, 2021a).

		Provide subsidies to lower cost of switching and increase adoption of energy efficient measures Subsidies can also be introduced to lower the cost of switching or using energy efficient measures. For example, energy and electricity taxes can be lowered for the firms that adopt energy efficient measures, or fundings could be provided to develop technologies that make use of renewables and waste heat for process heat.
	Businesses	**Adoption of fuel switching** Cement manufacturers in the industry sector can raise energy efficiency and lower carbon intensity through fuel switching, which is adopting the use of lower carbon-intensive alternatives like hydrogen and natural gas instead of coal and making scrap collection more effective by increasing the use of scrap metals during the process of electrification. Iron and steel manufacturers can look into using excess heat produced from kilns to generate power and adopting more efficient grinding technologies. In addition, manufacturers of the industrial sector can seek to retrofit current plants with less-carbon intensive and more energy-efficient technologies.

Substitute	Regulators	**Engage with local experts for further R&D opportunities** Japan might face significant challenges in building the offshore wind facilities due to the various conditions as a result of its geographical location, such as earthquakes, complex mountainous terrains, typhoon winds and deep coastal water. Thus, to amass offshore wind farm projects, the government should look into engaging with local experts to look into ways to produce wind power technologies, like wind turbines, that can be adapted to suit the aforementioned Japanese conditions, as the usual wind turbines work best on flat terrains. **Education to create specialised workforce** Moreover, more efforts can be placed in educating people to create a specialised workforce that can focus on developing the wind power market. For instance, having the specialist knowledge about the design of the wind turbines would be one essential component in making wind power development a success in Japan. In addition, the government needs to put in place policies that will foster collaboration and investment from foreign companies.
	Businesses	**Partnerships with experts and attainment of Power Purchase Agreements (PPAs)**

		Similar to Australia, corporations that wish to capitalise on the potential of wind power generation to generate monetary profits would look to Japan as a new and rising powerhouse in the offshore wind business. With the government's aims of pushing offshore wind capacity to 30-45GW by 2040, this would make Japan rank third across the world for having large offshore power infrastructure. With that aim in mind, this has brought about several partnerships with European companies that have strong expertise in renewables. Moreover, these businesses can look into obtaining PPAs with regulators to ensure that their investments would yield positive returns and provide a higher certainty to their decision to invest. In addition, corporations like oil and gas companies are currently looking to shift to offshore wind due to how similar offshore oil and gas projects are with offshore wind projects since they are both marine construction projects (Energy Monitor Staff, 2022). Furthermore, with the synergy that exists, along with the companies' expertise in servicing offshore oil rigs, the vast potential of wind power could set off the opportunity for corporations to invest into wind power (Gerdes, 2019).

Sequester	Regulators	**Lower costs of CCUS project development through feasibility studies** The Japanese government can seek to raise the number of CCUS projects by looking into lowering the high costs of developing CCUS technologies in Japan since costs tend to be a factor in determining whether a project would be carried out. Other than reducing the financial constraints for corporations to carry out CCUS projects, the government could potentially start more feasibility studies to look into areas that would be suitable for the building of dedicated storages, which are what the current operational and planned CCUS projects are doing (refer to Appendix F). By doing so, this could incentivise investments from firms to build the storages since they would not need to spend on doing extensive feasibility studies. This would also instil confidence in the firms since safety would be one of the biggest concerns due to the geographical location of Japan. **Prevention of building of coal-fired power plants** Additionally, the authorities should prevent corporations from building more coal-fired power plants when they are seeking to decarbonise their power sector, a hard-to-abate industry, as mentioned in their statement at the 2022 G7 summit since more coal-fired power plants would undermine the efforts of upcoming CCUS projects (Japan Beyond Coal, 2022).
	Businesses	**Transporting carbon**

		Corporations that have the interest in building up CCUS in Japan can look into the feasibility of transporting carbon to expand on the uses of carbon post capture in the jurisdiction. For instance, four Japanese heavyweights have announced a collaboration in January 2023 to carry out feasibility studies on developing a large-scale and wide-area CCUS value chain project, whereby CO_2 from hard-to-abate industries can be captured and transported via shipping (Mandra, 2023).

4.13 Singapore (Substantial Progress, Minimal emissions)

Net Zero Targets and Approaches

Currently, Singapore has set a net zero target by 2050, which its status is 'in policy document'. The jurisdiction employs a comprehensive approach across all four tiers of carbon management. In the Reduce tier, Singapore is actively adopting low-carbon practices, aiming to phase out internal combustion engine vehicles and transition toward a low-carbon built environment by making 80% of buildings, by gross floor area (GFA), green by 2030. For the Substitute approach, there is a focus on investing in research and development (R&D) and test-bedding to optimize space utilization, including deploying floating solar farms to upscale solar power. In the Sequester approach, Singapore monitors technological and market developments and plans to scale up the deployment to sequester CO_2 in suitable sub-surface geological formations. Lastly, in the Compensate approach, the jurisdiction has been progressively increasing the carbon tax (Government of the Republic of Singapore, 2022).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

Singapore's carbon management strategy demonstrates strength in the Compensate tier, where substantial progress is being made. The effective enforcement of high carbon taxes is a key contributor to this strength. Singapore's carbon tax covers 80% of total greenhouse gas (GHG) emissions from 50 facilities spanning various sectors, from manufacturing to water. The jurisdiction has also implemented a progressive pricing system, set to increase over time, encouraging businesses and consumers to actively reduce carbon emissions. To support affected entities, Singapore has complementary schemes, including the use of international carbon credits, a transition framework, and subsidies for the purchase of energy-efficient and climate-friendly appliances.

Additionally, Singapore has introduced a voluntary carbon market called Climate Impact X (CIX). This digital platform, based in Singapore, aims to promote global carbon exchange and create a marketplace. CIX primarily serves large-scale buyers, including multinational corporations and institutional investors. By leveraging its status as a financial, legal, and commodities hub, Singapore aims to position itself as a central hub for carbon-related services and nature-based solutions through the Climate Impact X platform (Climate Impact X, n.d.).

Weaknesses

As the remaining tiers of Singapore have relatively similar progress towards its carbon management strategy, we will delve into the specific subsection within the tiers.

In the Reduce tier, Singapore grapples with a low adoption of ISO 50001 certifications, potentially due to its smaller jurisdiction and market size compared to other jurisdictions. This results in a relatively lower number of organizations in Singapore and, consequently, translates to fewer ISO 50001 certifications. In the Substitute tier, Singapore has one of the lowest renewables targets compared to other jurisdictions. However, this is mainly due to its geographical constraints. Singapore faces challenges because of its compact geography and high population density. Additionally, the relatively narrow tidal range and land scarcity limit the potential for tidal power generation, making solar energy the primary source of renewables (National Climate Change Secretariat, n.d.). For the Sequester tier, similar constraints hinder domestic deployment in Singapore. The lack of known geological formations suitable for the permanent storage of carbon dioxide underground poses challenges in implementing carbon sequestration initiatives.

Recommendations

We have formulated the following recommendations for Singapore to advance in the Reduce, Substitute, and Sequester tiers given that its main approaches for carbon management includes all of the above. We believe that Singapore has been actively working on these tiers and our recommendations would provide specific details on what it could potentially look into to further its progress. We did not mention the Compensate tier as Singapore is faring well compared to the other jurisdictions.

Reduce	Regulators	**Transport - Incentives to spur EVs adoption rates** The Singapore government can encourage the adoption of EVs by introducing incentives such as road tax rebates and COE discounts. Additionally, the development of EV infrastructure can be accelerated by utilising funds, such as the planned S$30 billion in green bonds (Bharadwaj, 2023). Singapore can also explore strategies to position EVs as a more attractive option than traditional vehicles, emphasizing their numerous benefits.
	Businesses	**Industrial - Leverage on initiatives in Singapore** Addressing Singapore's unique challenges, the implementation of alternative energy solutions becomes complex due to the limited land area and high population density. Consequently, Singaporean businesses can explore opportunities in investing in low-carbon technologies like CCUS, solar and energy storage systems, and low-carbon hydrogen.

		Furthermore, businesses in Singapore can undergo transformation by taking advantage of initiatives such as the Resource Efficiency Grant for Emissions and the Energy Efficiency Grant. These grants aim to assist businesses in investing in more resource-efficient equipment, ensuring competitiveness in a low-carbon future (Tan, 2030).

Substitute	Regulators	**Exploring alternative energy options through R&D** Singapore, being a small and resource-constrained jurisdiction, relies on importing all its energy needs, resulting in limited renewable energy options. Despite these constraints, the government has committed to deploying at least 2GW-peak of solar energy by 2030. To overcome these limitations, Singapore has focused its efforts on research and test-bedding to develop innovative integrations of solar energy systems into the urban environment. Additionally, the government is exploring the importation of up to 100MW of hydropower from Laos to support a clean energy project, including setting up a hydrogen facility for electricity generation through a fuel cell (International Trade Administration, 2023). If Singapore continues to follow through with its plans and drive innovations in exploring alternative energy options within its constraints, it can further advance its efforts in renewables.
	Businesses	**Promote deployment of renewables through investments** Businesses can proactively contribute by investing in relevant projects to promote the deployment of renewables in Singapore. For instance, EDP Renewables (EDPR) has announced plans to invest up to $10 billion by 2030 to establish a clean energy hub in Singapore, aiming to accelerate the use of renewables (EDB Singapore, n.d.). With such investments in various initiatives, Singapore can work towards achieving its renewables targets, effectively navigating the natural geographic constraints it currently faces.

Sequester	Regulators	**Continue working towards its planned efforts and potential jurisdictions with suitable geological formations** Similar to the recommendations proposed in the Substitute tier, Singapore can progress in its planned endeavours to enhance the potential of carbon sequestration. Previous research conducted by NUS has demonstrated the feasibility of storing CO_2 below the ocean floor, indicating the potential for further advancements in this storage technology (NUS news, 2022). Pilot projects have already been initiated to enhance the ocean's capacity to absorb CO_2. Consequently, the government should explore funding opportunities to scale up this technology, enabling significant advancements in its carbon sequestration techniques (Stanway, 2023).

		Promote foreign investments to spur investments in CCS capabilities Regulators in Singapore can also attempt to attract foreign investments to drive its CCS capabilities. An example of this is the industrial gas company Linde, which has increased its investments in CCS and is now looking to expand its CCS operations in Singapore. Their forthcoming investment plan includes developing CCS capabilities at the expanded S$1.9 billion gasification facility on Jurong Island (Lim, 2023). This highlights the potential of utilizing foreign direct investments to stimulate the implementation of CCS capabilities in Singapore.

4.14 South Korea (Substantial Progress, Minimal emissions)

Net Zero Targets and Approaches

South Korea has opted for a carbon neutrality target by 2050 instead of setting a net-zero target, which its status is 'in law'. Their approaches towards carbon management encompasses all four tiers. For the 'Reduce' approach, South Korea is increasingly promoting zero-energy building solutions for newly built buildings and encouraging green re-modelling projects for existing buildings (UNFCCC, 2021). The jurisdiction is also focusing on driving the transition to low-carbon in their emission-intensive industrial sectors by introducing electric furnaces in production processes, and use of bionaphtha for use as feedstock. Additionally, improvements are made to their public transport services to reduce the trips made by cars, while raising targets for the deployment of zero-emission vehicles like EVs and hydrogen-powered cars. For the 'Substitute' approach, the authorities are looking to raise use of renewables, and would be supporting the research and development to improve the efficiencies of all major RE facilities and improve power grids. For the 'Sequester' approach, the authorities are looking to secure one billion tonnes of CO_2 storage capacity in the abandoned oil and gas fields, as well as collaborate with global partners to develop cheaper and more effective technologies to capture emissions from various industries (REALISE CCUS, 2023). For the 'Compensate' approach, the authorities are looking to roll out effective reduction measures, improve allocation methods, enhance market functions and linkages, and increase collaboration with global carbon markets (UNFCCC, 2021).

Progress Evaluation

Reduce			**Substitute**	
Buildings	Industrial	Transport	Current State	Progress towards Target

Sequester		**Compensate**		
Status	Total Potential Effectiveness (p.a.)	Carbon Tax	Compliance Carbon Markets	Voluntary Carbon Markets

Strengths

The strengths of South Korea's carbon management strategies lie in the 'Reduce' tier due to their strong enforcement of building energy codes (Building Design Criteria for Energy Saving) and Appliance and Equipment Standards and Labelling Programmes for appliances and equipment. The jurisdiction also has strong enforcements of fuel standards, and labelling regulations, as well as substantial adoption of EVs, hence making South Korea the leader of the 'Reduce' tier amongst the 14 jurisdictions.

Weaknesses

The weaknesses of South Korea's carbon management strategies lie in the 'Substitute', 'Sequester' and 'Compensate' tiers. For the 'Substitute' tier, South Korea is only at 34.7% of its progress towards the target which was set to be achieved in 2030. For the 'Sequester' tier, the jurisdiction only has planned CCUS projects which has minimal total potential effectiveness in reducing their own emissions, amounting to only 0.10% which is severely far from UNECE's target of 14%, leading to South Korea ranking one of the lowest for the 'Sequester' tier. For the 'Compensate' tier, there is a lack of Carbon Tax and Voluntary Carbon Market.

Further insights

Along with the target of RE to supply 21.6% of TE by 2030, the South Korean government led by newly elected President Yoon Suk-yeol is looking to also focus on nuclear energy and is advocating for nuclear to dominate their energy mix, increasing the targets from 24% to 32.4% by 2030 and 34.6% by 2036 (Enerdata, 2023). Despite the additional focus on nuclear energy, and though the jurisdiction is currently lacking in the 'Substitute' tier, the Solar City Seoul Project and the Anma Offshore Wind Project (refer to Section 2.2.2) could serve to push South Korea's progress to reach the 21.6% target to be achievable by 2030.

Additionally, as South Korea is ranked bottom 3 out of the 11 jurisdictions with planned CCUS projects, the jurisdiction is seeking to improve on their CCUS progress. Though the authorities had initially planned to secure 1 billion tonnes of CO_2 storage capacity as aforementioned in their 'Sequester' approach, the government has recently announced that it would invest up to USD1.2 billion to assess the resources for CO_2 storage and to develop CCUS technologies (REALISE CCUS, 2023). Moreover, the government has also verbalised their intention in 2021 to commercialise 14 CCUS technologies by 2030 and to retrofit their 150MW power plants with CCUS technologies applied on small thermal power plants in hopes to apply it to larger power plants used in hard-to-abate industries (Trendafilova, 2021). As a result, South Korea could potentially reach the 14% target, though it is currently unable to do so.

It is also interesting to note that despite having an operating Compliance Carbon Market, Korea Allowance Units (KAU) prices constantly drop due to an oversupply of KAU, resulting in the system being an inefficient one.

Recommendations

There are plans that have been announced to better improve the 'Substitute' and 'Sequester' tiers, despite the lack of explicit quantitative data to back the progress. As such, only recommendations were made for the 'Compensate' tier, specifically to improve the Compliance Carbon Market, which is the K-ETS, to prevent the system from being inefficient.

Compensate	Regulators	**Redevelopment of the market stabilisation instruments used in the K-ETS** Regulators should redevelop the market stabilisation instruments used in the K-ETS such that it bears the ability for total supply of emission allowances to fluctuate based on the price of emission

		permits that are traded in the market. In the case where the price goes beyond a set threshold, the planned quantity of emission permit reserves can be introduced into the market. On the other hand, auctions for the permits may be cancelled, or regulators can purchase the allowances from the market to keep as reserves.
	Businesses	**Improve sustainability efforts by switching to using more environmentally friendly infrastructure and tools** Despite the inefficiencies of the K-ETS system, corporations should still seek to improve on their own sustainability efforts by switching to using more environmentally friendly infrastructure and tools to lower their own emissions. This also helps the corporation to rely less on using the allocated KAU or having the need to purchase more KAU to offset their emissions. Moreover, by doing so, this can reduce their exposure to risk of raised permit prices should the regulators adopt the aforementioned recommendation, and any excess allowances can then be traded in the market for cash.

5 Conclusion

In response to the urgent global call to address the escalating climate crisis, this report serves as a comprehensive exploration of carbon management strategies across 14 jurisdictions in the APAC region.

5.1 Carbon Hierarchical Model

In the initial phase of our assessment, we employed a carbon hierarchical model to categorise diverse carbon management strategies into four distinct tiers. The overarching goal of the carbon hierarchical model framework was to encompass a comprehensive range of common strategies applicable across the diverse landscape of the APAC region. The carbon hierarchical model served as a guiding principle, elucidating the dynamic flow of carbon throughout its life cycle – from reduction (in the 'Reduce' and 'Substitute' stages) to removal (in the 'Sequester' and 'Compensate' stages).

5.2 Structured Assessment Framework

The Structured Assessment Framework offers a panoramic view across the 14 jurisdictions under examination, allocating three points per tier. This evenly spreaded distribution of 3 points per tier aims to account for the varied contextual circumstances within each jurisdiction, ensuring that the assessment does not prioritise any single strategy. The approach is designed to be equitable, acknowledging the diversity of challenges and opportunities present in the APAC region. By adopting this balanced methodology, we aim to provide a nuanced and inclusive evaluation of carbon management strategies that considers the unique characteristics of each jurisdiction.

For analysis within jurisdiction, the effectiveness of carbon management strategies can be evaluated based on both their breadth and quality through the broadness of strategies utilised and the quality of strategies based on scoring respectively. Analysis across all 14 jurisdictions is conducted based on total score comparisons across jurisdictions. While acknowledging that jurisdictions may have varying priorities and circumstances, the scoring system aims to capture a snapshot of the general progress in terms of both quantity and quality of carbon management strategies. It serves as a visual aid, allowing stakeholders to quickly assess the landscape and identify regions of strength and areas for improvement.

A jurisdiction with a broad approach utilises a variety of strategies across different tiers of the carbon management hierarchy. This could involve a combination of tiers, showcasing a comprehensive and well-rounded approach to carbon management. A broad set of strategies allows a jurisdiction to address carbon emissions at various stages of the carbon life cycle, making its approach more resilient and adaptable to changing circumstances. Quality is assessed through a scoring mechanism that considers the efficiency, sustainability, and actual impact of each strategy which have been conducted through thorough research on specific indicators and statistical figures to assess the effectiveness of the carbon strategies. The final score, derived from the cumulative points across all tiers, serves as a quantitative representation based on the qualitative research on the jurisdictions' overall progress in carbon management strategies. While understanding that different jurisdictions have unique priorities, this scoring system provides a comprehensive at-a-glance overview, facilitating a comparative assessment of the APAC region's efforts in combating carbon emissions.

A holistic approach for future recommendations is also then performed on a tier level. Through recognizing challenges and opportunities at the tier level, these suggestions are strategically pushed towards more effective carbon management practices that are more general and not specific to any jurisdiction. These recommendations offer a broad overview, considering two dimensions and perspectives – Regulators and Businesses. The goal is to deliver overarching guidance for a strategic advancement towards more effective carbon management practices, ultimately benefiting all jurisdictions within our analysis.

5.3 Comparative Progress Analysis

The research employed a method of obtaining nine distinctive emission clusters, leveraging the Structural Assessment Framework to observe trends in effectiveness and sufficiency. This Comparative Progress Analysis linked the progress determined from the framework to the level of emissions per jurisdiction, providing a nuanced understanding of the current state of carbon management strategies.

The comparative analysis revealed varying degrees of progress across jurisdictions. Notably, Hong Kong, Malaysia, and the Philippines exhibit minimal progress, whereas India, Taiwan, Thailand, and Vietnam demonstrate moderate advancements. Australia, China (Mainland), Indonesia, Japan, New Zealand, Singapore, and South Korea stand out with substantial progress in their carbon management initiatives. The Comparative Progress Analysis benchmarks the progress of each jurisdiction against a standardised framework. This allows for a systematic and uniform assessment, making it easier to compare the effectiveness and sufficiency of carbon management strategies.

The results highlight distinctive emission clusters, showcasing varying degrees of advancement. A visual matrix serves to illustrate each jurisdiction's progress in terms of emissions and strategies, allocating them into distinct emission clusters. From the matrix, it enables comprehensive comparisons between jurisdictions, providing valuable insights into their relative standings and performances in the realm of carbon management.

5.4 Jurisdiction Level Analysis

Building upon the comprehensive comparative progress analysis and the meticulous structured assessment framework, the report emphasises the transformative potential within each jurisdiction and explores avenues for improvement.

The scoring system, while recognizing the diverse priorities and circumstances of different jurisdictions, seeks to provide a snapshot of general progress in both the quantity and quality of carbon management strategies. This approach allows for a comparative assessment across regions. However, jurisdiction-level analysis takes a more context-based approach, emphasising the unique economic, social, and environmental landscapes of each jurisdiction. The goal is to pinpoint specific areas of improvement within their capabilities and goals. This dual perspective ensures a comprehensive evaluation that considers both the overarching trends and the specific contextual factors influencing carbon management efforts in each jurisdiction.

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Appendix

Appendix A - Identified sectors for scoring evaluations of section 2.1.3

This data is applied for the 'number of sectors covered' indicator for the evaluation of ISO 50001 standards in the industrial sector as shown in Figure 11 of Section 2.1.3.

Source:
ISO. (n.d.). *CASCO - Committee on conformity assessment.* ISO. https://www.iso.org/committee/54998.html?t=KomURwikWDLiuB1P1c7SjLMLEAgXOA7emZHKGWyn8f3KQUTU3m287NxnpA3DIuxm&view=documents#section-isodocuments-top

Industrial Sectors Covered			
Agriculture, Fishing and Forestry	Nuclear fuel	Aerospace	Transport, storage and communication
Mining and quarrying	Chemicals, chemical products & fibres	Other transport equipment	Financial intermediation, real estate, renting
Food products, beverage and tobacco	Pharmaceuticals	Manufacturing not elsewhere classified	Information technology
Textiles and textile products	Rubber and plastic products	Recycling	Engineering services
Leather and leather products	Non-metallic mineral products	Electricity supply	Other Services
Manufacture of wood and wood products	Concrete, cement, lime, plaster etc.	Gas supply	Public administration
Pulp, paper and paper products	Basic metal & fabricated metal products	Water supply	Education
Publishing companies	Machinery and equipment	Construction	Health and social work
Printing companies	Electrical and optical equipment	Wholesale & retail trade, repairs of motor vehicles, motorcycles & personal & household goods	Other social services
Manufacture of coke & refined petroleum products	Shipbuilding	Hotels and restaurants	

	Sectors									
Jurisdictions	Agriculture, Fishing and Forestry	Mining and quarrying	Food product, beverage and tobacco	Textiles and textile products	Leather and leather products	Manufacture of wood and wood products	Pulp, paper and paper products	Publishing Companies	Printing companies	Manufacture of coke & refined petroleum products
Australia										
China (Mainland)				1						
Hong Kong			1							
India	1	1	1	1			1		1	1
Indonesia		1	1	1			1			1
Japan										
Malaysia			1			1				
New Zealand										
Philippines		1	1				1			
Singapore			1	1						
South Korea			1							
Taiwan		1	1	1			1			1
Thailand			1	1		1				
Vietnam	1		1	1			1			

	Sectors									
Jurisdictions	Nuclear fuel	Chemicals, chemical products & fibres	Pharmaceuticals	Rubber and plastic products	Non-metallic mineral products	Concrete, cement, lime, plaster etc.	Basic metal & fabricated metal products	Machinery and equipment	Electrical and optical equipment	Shipbuilding
Australia		1								
China (Mainland)		1				1	1	1	1	
Hong Kong						1				
India		1	1	1	1	1	1	1	1	1
Indonesia		1	1	1		1	1		1	
Japan		1					1		1	
Malaysia		1		1		1	1	1	1	
New Zealand			1							
Philippines							1		1	
Singapore		1	1				1		1	1
South Korea		1	1	1	1		1	1	1	1
Taiwan		1	1	1	1	1	1	1	1	
Thailand		1	1	1	1		1	1	1	
Vietnam		1		1	1	1	1		1	1

	Sectors									
Jurisdictions	Aerospace	Other transport equipment	Manufacturing not elsewhere classified	Recycling	Electricity supply	Gas supply	Water supply	Construction	Wholesale & retail trade, repairs of motor vehicles, motorcycles & personal & household goods	Hotels and restaurants
Australia									1	
China (Mainland)			1							
Hong Kong								1	1	1
India		1	1		1				1	
Indonesia		1			1	1			1	
Japan				1				1	1	
Malaysia							1			
New Zealand										
Philippines					1		1	1		
Singapore	1		1	1		1				
South Korea		1						1		
Taiwan	1	1	1	1	1		1		1	1
Thailand		1	1		1		1		1	
Vietnam			1	1	1					

	Sectors									
Jurisdictions	Transport, storage and communication	Financial intermediation, real estate, renting	Information technology	Engineering services	Other Services	Public administration	Education	Health and social work	Other social services	**Total**
Australia	1			1	1					5
China (Mainland)						1				8
Hong Kong	1	1	1	1	1					10
India	1		1	1	1		1			25
Indonesia	1									16
Japan	1			1						8
Malaysia		1			1	1		1	1	14
New Zealand							1			2
Philippines	1		1							10
Singapore	1	1			1	1				15
South Korea				1						12
Taiwan	1	1	1	1	1	1	1	1	1	30
Thailand	1	1	1		1	1				20
Vietnam	1	1	1		1					18

Appendix B - Sources used to tabulate relevant values for Section 2.1.4.1

The following table shows the relevant references and sources used to arrive at the respective values for the scoring framework of the fuel standards indicator in Section 2.1.4.1.

Fuel Standards (4 points)				
Jurisdiction	**Current Fuel Economy Standards, 2015 (Lge/100km)**	**Target Fuel Economy Standards (Lge/100km)**	**Progress**	**Score (up to 4)**
Australia	[5]8.5	0	0.00% [Minimal progress]	1
China (Mainland)	[2]8	[7]4	50.00% [Below target]	2
Hong Kong	[9]12.84	0	0.00% [Minimal progress]	1
India	[1]5.8	[10]4.87	83.97% [Above Target]	4
Indonesia	[1]7.3	[11]5	68.49% [On Target]	3
Japan	[1]6.2	[12]3.94	63.55% [On Target]	3
Malaysia	[1]6.6	0	0.00% [Minimal progress]	1
New Zealand	[6]9.132	[3]6.25	68.44% [On Target]	3
Philippines	[1]7.7	0	0.00% [Minimal progress]	1
Singapore	[1]7.2	[14]3.94	54.72% [On Target]	3
South Korea	[1]6.3	[13]3.56	56.51% [On Target]	3
Taiwan	[4]6.55	[15]3.76	57.40% [On Target]	3
Thailand	[1]7.5	0	0.00% [Minimal progress]	1
Vietnam	[8]11.1	[13]7.9	71.17% [On Target]	3

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Calculations: 145g CO_2/km = 6.25 Lge/100km

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Calculations: 15.28km/L = 6.55 Lge/100km

Appendix C - Sources used to tabulate relevant values for Section 2.1.4.2

The following table shows the relevant references and sources used to arrive at the respective values for the scoring framework of the vehicle labelling indicator in Section 2.1.4.2.

Vehicle Labelling (2 points)				
Jurisdiction	**Mandatory Vehicle Labelling**	**CO_2 displayed**	**State**	**Score (up to 2)**
Australia[1]	Yes	Yes	Effective Enforcement	2
China (Mainland)[1]	Yes	No	Partial Enforcement	1
Hong Kong[1]	No	No	No Enforcement	0
India[2]	Yes	No	Partial Enforcement	1
Indonesia[3]	Yes	No	Partial Enforcement	1
Japan[1]	Yes	No	Partial Enforcement	1
Malaysia[4]	No	No	No Enforcement	0
New Zealand[1]	Yes	No	Partial Enforcement	1
Philippines	Yes	Yes	Effective Enforcement	2
Singapore[1]	Yes	Yes	Effective Enforcement	2
South Korea[1]	Yes	Yes	Effective Enforcement	2
Taiwan[1]	Yes	No	Partial Enforcement	1
Thailand[1]	Yes	Yes	Effective Enforcement	2
Vietnam[1]	Yes	No	Partial Enforcement	1

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Appendix D - Sources used to tabulate relevant values for Section 2.1.4.3

The following table shows the relevant references and sources used to arrive at the respective values for the scoring framework of the electric vehicle sales indicator in Section 2.1.4.3.

Electric Vehicle Sales (2 points)			
Jurisdiction	**EV sales of vehicle fleet in 2022 (%)**	**State**	**Score (up to 2)**
Australia[13]	0.5	Minimal Adoption	0.5
China (Mainland)[3]	22	Widespread Adoption	2
Hong Kong[2]	7.2	Substantial Adoption	1.5
India[1]	5.59	Substantial Adoption	1.5
Indonesia[5]	1	Minimal Adoption	0.5
Japan[14]	2.1	Minimal Adoption	0.5
Malaysia[12]	0.41	Minimal Adoption	0.5
New Zealand[11]	1	Minimal Adoption	0.5
Philippines[10]	2.72	Moderate Adoption	1
Singapore[9]	1.3	Minimal Adoption	0.5
South Korea[4]	6.2	Substantial Adoption	1.5
Taiwan[8]	3.4	Moderate Adoption	1
Thailand[7]	3	Moderate Adoption	1
Vietnam[6]	1	Minimal Adoption	0.5

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Calculations: (1013/37259)*100 = 2.72

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Calculations: (2631/641773)*100 = 0.41

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Operational Projects - Project has been authorised for operations									
						Announced Capacity (Mtpa)			
Jurisdiction	**Project**	**Fate of Carbon**	**Announced Year**	**FID Year**	**Operational Year**	**Low**	**High**	**Max. Capacity**	**% reduction p.a.**
Australia	Gorgon CCS	Dedicated storage	2009	2019	2019	3.3	4	4	1.0689%
China (Mainland)	Changling Gas plant /Jilin Oil Field CO2-EOR Full-scale (Jilin)	EOR	2006	2018	2018	0.43		0.43	0.0043%
	China Energy Jinjie Power	EOR	2018	2021	2021	0.15		0.15	0.0015%
	Jiling Petrochemical CCUS (Nanjing refinery)	EOR	2021	2023	2023	0.1		0.1	0.0010%
	Karamay Xinjiang Dunhua methanol plant	EOR		2015	2015	0.1		0.1	0.0010%
	Sinopec Nanjing Chemical Industries CCUS Cooperation Project	EOR	2015	2021	2021	0.2		0.2	0.0020%
	Sinopec Qilu Petrochemical Shengli	EOR	2012	2022	2022	0.7	1	1	0.0099%
Japan	Mikawa Power Plant BECCS Fukuoka Prefecture	Unknown/ unspecified	2016	2020	2020	0.18		0.18	0.0182%
	Tomakomai CCS demonstration project	Dedicated storage	2008	2016	2016	0.1			

Appendix E - CCUS Database (updated March 2023)

Under Construction Projects - Construction is under way after a Final Investment Decision (FID) has been announced								
						Announced Capacity (Mtpa)		
Jurisdiction	**Project**	**Fate of Carbon**	**Announced Year**	**FID Year**	**Operational Year**	**Low**	**High**	**Max. Capacity**
Australia	CTSCo Project	Dedicated storage	2010	2023	2023	0.11		0.11
	Mineral carbonation international Carbon Plant demonstrator	Use	2021	2023	2023	0.3		0.3
	Moomba Carbon Capture and Storage	Dedicated storage	2019	2024	2024	1.7		1.7
China (Mainland)	China Energy Taizhou power	Mixed	2021	2023	2023	0.5		0.5
	CNOOC Enping offshore CCS	Unknown /unspecified	2021	2023	2023	0.3		0.3
	Guanghui Energy CCUS integration project Phase 1	EOR	2022			0.1		0.1
	Huaneng Zhengning coal power plant	Use	2021	2023	2023	1.5		1.5
Malaysia	Petronas Kasawari gas field CCS project (Kasawari Phase 2 project)	Dedicated storage	2020	2025	2025	3.3		3.3

Taken from [1]IEA 2023 Database:

Planned Projects - Project is at conceptual design, feasibility or engineering study (FEED) stage								
						Announced Capacity (Mtpa)		
Jurisdiction	**Project**	**Fate of Carbon**	**Announced Year**	**FID Year**	**Operational Year**	**Low**	**High**	**Max. Capacity**
	Adbri Calix new Lime plant Kwinana	Dedicated storage	2021					
	Barossa and Darwin liquefied natural gas (DLNG) CCUS	Dedicated storage	2021	2025	2025	2.3	2	2.3
	Bayu-Undan field storage hub Timor-Leste phase 1	Dedicated storage	2021	2027	2027	2.3	2	2.3
	Bayu-Undan field storage hub Timor-Leste phase 2	Dedicated storage	2021				10	10
	Bonaparte CCS Assessment G7-AP	Dedicated storage	2022	2026	2026		2	2
	Boral Southern Highlands cement and lime facilities	Use	2022			0.1		0.1
	Bridgeport Energy Moonie CCUS Project	EOR	2018	2023	2023	0.12		0.12
	CarbonNet	Dedicated storage	2010	2030	2030	1	5	5
	Cstore 1	Dedicated storage	2021			1.5	7	7
	Geovault Carnarvon Basin CCS assessment	Dedicated storage	2022					
	H2Perth Woodside	Unknown /unspecified	2021					
	Hydrogen Energy Supply Chain (HESC) Project Full scale (CarbonNET)	Dedicated storage	2018	2030	2030	1.8	4	4
	J-Power Sumitomo joint feasibility clean hydrogen Latrobe Valley (VI)	Dedicated storage	2023					
Australia	Longford gas plant	Dedicated storage	2022	2025	2025	2	2	2

	MEPAU Mid West CCUS hub	Dedicated storage	2021	2028	2028			
	Mid West Clean Energy Project	Dedicated storage	2021	2025	2025			
	Multi-user Burrup CCUS hub and network (Karratha CCS Project)	Dedicated storage	2022					
	Santos Bonaparte Basin storage	Dedicated storage	2022					
	Santos Carnavon Basin storage (Reindeer CCS)	Dedicated storage	2022	2028	2028	2.4	2	2.4
	Santos Moomba storage Hub	Dedicated storage	2019				20	20
	Santos Port Botany, New South Wales	Use	2021			0.15		0.15
	South East Australia carbon capture and storage (SEA CCS) hub	Dedicated storage	2022	2025	2025		2	2
	South West Blue Hydrogen	Dedicated storage	2021					
	South West Hub Project	Dedicated storage	2010			0.8		0.8
	Woodside Browse CCS Assessment	Dedicated storage	2022					
China (Mainland)	CNPC China Northwest (Xinjiang) hub phase 1	EOR	2019	2025	2025	1.5	1	1.5
	CNPC China Northwest (Xinjiang) hub phase 2	EOR	2019	2030	2030	1.5	1	1.5
	CNPC China Northwest (Xinjiang) hub refinery hydrogen	EOR	2019	2025	2025	1.5	1	1.5
	CRP Haifeng Project	Unknown /unspecified	2013	2030	2030	1	1	1
	Daya Bay CCS Hub	Dedicated storage	2022			10	10	10
	GreenGen Tianjin Huaneng IGCC Project	Unknown /unspecified	2011	2030	2030	2	2	2

	Phase III							
	Jiangsu Sailboat Green Methanol plant Shengong petrochemical	Use	2021			0.15		0.15
	Nanhai petrochemical plant-Capture for Daya bay CCS	Dedicated storage	2022					
	Sinopec Shengli Power Plant CCS	EOR	2011	2030	2030	1	2	2
	Yangchang integrated CCUS Yulin Coal Chemical	EOR	2015	2023	2023	0.3		0.3
India	Dalstur Energy Coal India coal hydrogen	Unknown /unspecified	2022					
	Indian Oil Corporation Koyali refinery	EOR and use	2021	2025	2025	0.7		0.7
Indonesia	Arun CCS (Arun LNG)	Dedicated storage	2022	2028	2028			
	Balikpapan Refinery	Unknown /unspecified	2022					
	Gundih gas field EGR	EOR	2020	2026	2026	0.3		0.3
	Inpex Abadi LNG	Unknown /unspecified	2018	2030	2030	2.41	2	2.41
	Jambaran Tiung Biru gas processing Sukowati oil field EOR	EOR	2020	2028	2028	0.9	2	2
	Marubeni Pertamina pulp mill BECCS project	Dedicated storage	2022					
	Muara Enim Downstream Coal to Dimethyl Ether (DME) Project	EOR	2021	2024	2024			
	PT Panca Amara Utama (PAU) Banggai ammonia plant, Luwuk Central Sulawesi	Unknown /unspecified	2021	2028	2028			
	Repsol Sakakemang Block carbon capture	Dedicated storage	2021	2027	2027	1.5	2	2

	Tangguh LNG Vorwata LNG	EOR	2021	2027	2027	2.5	3	3
Japan	Eneos J-Power coal power capture	Dedicated storage	2022			3		3
	Large-Scale and Wide-Area Carbon Capture and Storage	Dedicated storage	2023	2030	2030	2		2
	Niigata East Port CCUS Hub & Cluster	Dedicated storage	2022	2030	2030	1.5		1.5
	Tomakomai CCUS hub & cluster	Dedicated storage	2023	2030	2030	1.5		1.5
Malaysia	BIGST gas field Cluster Heads of Agreement	Dedicated storage	2022					
	H2biscus	Unknown /unspecified	2022					
New Zealand	Project Pouakai Hydrogen Production with CCS	Unknown /unspecified	2018	2024	2024		1	1
Singapore	Chevron Mitsui CO2 shipping SGP-AUS	Unknown /unspecified	2022			2.5	2	2.5
South Korea	Boryeong LNG Terminal blue hydrogen	Dedicated storage	2022	2025	2025	0.15		0.15
	Donghae CCS Project	Dedicated storage	2022	2026	2026	0.4		0.4
Taiwan	Taiwan Cement Hoping/Heping plant	Use	2019	2030	2030	0.1		0.1
Thailand	Arthit offshore gas field CCS	Dedicated storage	2022	2026	2026	0.7	1	1
							Total Capacity	117.654

- Listed CCUS projects have announced capacity of more than 0.1Mtpa
- Japan's Tomakomai CCS demonstration project (operational) has been suspended since 2019 and is kept for monitoring purposes, hence the operational capacity of the project is not taken into account for the calculation of % reduction p.a. and the total capacity.
- Planned CCUS projects without announced capacities do not have attached values.

[1]IEA. (2023, March). *CCUS projects database - data product*. https://www.iea.org/data-and-statistics/data-product/ccus-projects-database

Appendix F - CCUS Projects: Fate of Carbon

Jurisdictions	Dedicated Storage	EOR	EOR & use	Mixed	Unknown/ unspecified	Use	Grand Total
Australia	24	1			1	3	29
China (Mainland)	2	12		1	3	2	20
Hong Kong							
India			1		1		2
Indonesia	3	4			3		10
Japan	5				1		6
Malaysia	2				1		3
New Zealand					1		1
Philippines							
Singapore					1		1
South Korea	2						2
Taiwan						1	
Thailand	1						1
Vietnam							
Grand Total	39	17	1	1	12	6	76

Taken from [1]IEA 2023 Database:

- Dedicated storage: CO_2 is injected deep underground and stored permanently in a dedicated storage site
- EOR: CO_2 is used for enhanced oil recovery
- Use: CO_2 is used in a product with significant climate benefits. Internal use (e.g. CO_2 capture and use in urea production) is excluded
- Unknown/unspecified: Fate of carbon has not been communicated

[1]IEA. (2023, March). *CCUS projects database - data product*. https://www.iea.org/data-and-statistics/data-product/ccus-projects-database

Appendix G - Carbon Tax

Carbon Tax (3 points)				
Jurisdiction	**Carbon Tax**	**Carbon Tax Price (US$ / tCO_2e)**	**Carbon Emissions per unit of 2015 GDP (kg/USD)[1]**	**Total (out of 3 points)**
Australia	No		0.3	1
China (Mainland)	No		0.7	0
Hong Kong	No		0.1	1
India	No		0.8	0
Indonesia[2]	Yes	2.1	0.5	2
Japan[3]	Yes	2.16	0.2	2
Malaysia	No		0.6	0
New Zealand	No		0.1	1
Philippines	No		0.3	1
Singapore[4]	Yes	3.77	0.1	3
South Korea	No		0.3	1
Taiwan	No		0.4	1
Thailand	No		0.5	1
Vietnam	No		0.9	0

[1]IEA. (n.d.). Countries & Regions - IEA. https://www.iea.org/countries

[2]Christi, P. (2022, June 14). *Does Indonesia's Carbon Tax Have the Power to Trigger a Sustainable Market Shift?.* SEADS. https://seads.adb.org/solutions/does-indonesias-carbon-tax-have-power-trigger-sustainable-market-shift

[3]International Carbon Action Partnership. (2023, February 22). *Japan's Cabinet approves policy roadmap including plans for national ETS.* International Carbon Action Partnership. https://icapcarbonaction.com/en/news/japans-cabinet-approves-policy-roadmap-including-plans-national-ets

[4]Eberhard, K., & Cavert, J. (2023, March 9). *Singapore's manufacturing-friendly carbon tax.* Niskanen Center. https://www.niskanencenter.org/singapores-manufacturing-friendly-carbon-tax/

Appendix H - Compliance Carbon Markets

Compliance Carbon Markets (2 points)				
Jurisdiction	**Sectors Covered**	**Number of Sectors**	**Carbon Emissions Accounted for (%)**	**Total (out of 2 points)**
Australia	[2]Transport, Waste, Industry	3	[1]28	2
China (Mainland)	[3]Power	1	[3]44	2
Hong Kong		0	0	0
India		0	0	0
Indonesia	[4]Power	1	[5]6	1
Japan	[6]Buildings, Industry	2	[6]1.87	1
Malaysia		0	0	0
New Zealand	[8]Forestry, Power, Industry, Buildings, Transport, Domestic Aviation and Waste	7	[8]49	2
Philippines		0	0	0
Singapore		0	0	0
South Korea	[7]Power, Industry, Buildings, Transport, Domestic Aviation and Waste	6	[7]74	2
Taiwan	[2]Transport, Waste, Industry	0	0	0
Thailand	[3]Power	0	0	0
Vietnam		0	0	0

[1]L, J. (2022, August 11). *Australia to Merge Compliance and Voluntary Carbon Markets?* CarbonCredits.com. https://carboncredits.com/australia-climate-change-authority-carbon-markets/

[2]Department of Climate Change, Energy, the Environment and Water. (2023, May 1). *Safeguard Mechanism Reforms.* DCCEEW. https://www.dcceew.gov.au/sites/default/files/documents/safeguard-mechanism-reforms-factsheet-2023.pdf

[3]International Carbon Action Partnership. (2023, March 27). *China National ETS.* International Carbon Action Partnership. https://icapcarbonaction.com/en/ets/china-national-ets

[4]International Carbon Action Partnership. (n.d.). *Indonesia.* International Carbon Action Partnership. https://icapcarbonaction.com/en/ets/indonesia

[5]IEA. (n.d.). *Executive summary – An Energy Sector Roadmap to Net Zero Emissions in Indonesia – Analysis - IEA.* International Energy Agency. https://www.iea.org/reports/an-energy-sector-roadmap-to-net-zero-emissions-in-indonesia/executive-summary
Munthe, B. C., & Davies, E. (2023, February 22). *Indonesia launches carbon trading mechanism for coal power plants.* Reuters. https://www.reuters.com/business/energy/indonesia-launches-carbon-trading-mechanism-coal-power-plants-2023-02-22/

Calculations: (36mil / 600mil) * 100 = 6%

[6]Environmental Defense Fund. (n.d.). *TOKYO: AN EMISSIONS TRADING CASE STUDY.* Environmental Defense Fund. https://www.edf.org/sites/default/files/tokyo-case-study-may2015.pdf

International Carbon Action Partnership. (n.d.). J*apan - Saitama Target Setting Emissions Trading System.* International Carbon Action Partnership. https://icapcarbonaction.com/en/ets/japan-saitama-target-setting-emissions-trading-system

IEA. (n.d.). *Japan - Countries & Regions - IEA.* International Energy Agency. https://www.iea.org/countries/japan (998.1)

Calculations: Tokyo - 0.2 * (26+20.9+12) = 11.78
Saitama - 6.9
Total emissions accounted for = 11.78 + 6.9 = 18.68
Total emissions accounted for (%) = (18.68 / 998.1) * 100 = 1.87%

[7]International Carbon Action Partnership. (n.d.). *Korea Emissions Trading Scheme.* International Carbon Action Partnership. https://icapcarbonaction.com/en/ets/korea-emissions-trading-scheme
[8.]International Carbon Action Partnership. (n.d.). New Zealand Emissions Trading Scheme. International Carbon Action Partnership. https://icapcarbonaction.com/en/ets/new-zealand-emissions-trading-scheme