KEMENTERIAN SUMBER ASLI DAN KELESTARIAN ALAM

Malaysia's Nationally Determined Contribution Roadmap and Action Plan (NDC RAP)

A

Executive summary

Introduction

The climate crisis has put the world at an inflection point. Studies by the World Meteorological Organisation have confirmed that the decade between 2011-2019 have been the warmest on record – and that temperatures in each successive decade have been steadily increasing since the 1980s. The world is seeing higher incidences of extreme weather events and crises such as droughts, heatwaves, coastal flooding, and food shortages. Some of these impacts could be seen in Malaysia over time as Malaysia's climate vulnerability rises in tandem.

In publishing the Nationally Determined Contributions Roadmap and Action Plan (NDC RAP), Malaysia reaffirms its commitments to achieving its NDC target of 45% reduction of greenhouse gas intensity by 2030 (compared to 2005 levels). This document harmonise the policies and strategies the Government has already implemented and announced, and present a consolidated view of five sectors' decarbonisation trajectory (Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use, and Waste).

Finally, the Ministry of Natural Resources and Environmental Sustainability wishes to express its gratitude to all stakeholders who have participated in the project and shared their invaluable guidance throughout. These include other ministries, industry associations, private sector players, academia, and non-governmental organisations.

National circumstances

Malaysia's key geographical, demographic, socio-economic, and natural capital starting points can be summarised as follows:

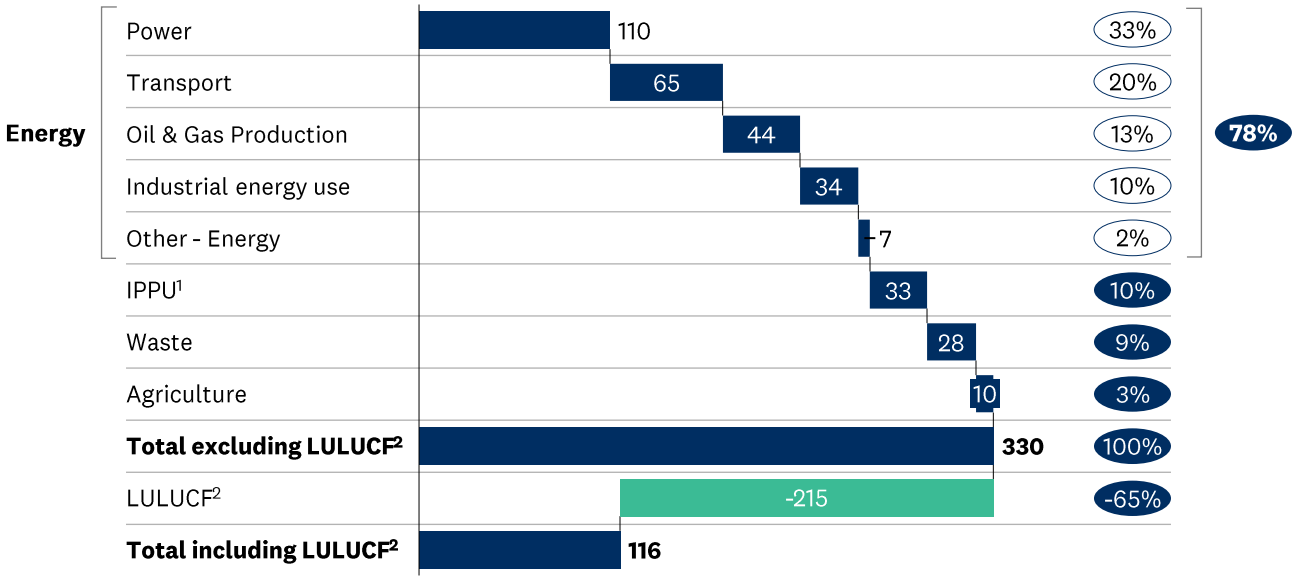
- **Geography and climate:** Malaysia comprises thirteen states and three Federal Territories, divided into three regions of Peninsular Malaysia, Sabah and Sarawak. It has an equatorial climate with a uniform daily variation of temperatures throughout the year – and two monsoon periods;
- **Socioeconomic details:** The total population of Malaysia in 2022 was 32.7 million – and may trend towards an 'ageing society' over time as a result of declining birth rate and increase in life expectancy;
- **Economy:** Malaysia recorded a nominal Gross Domestic Product (GDP) of RM1,791 billion and a Gross National Income per capita of RM52,968 in 2022. Economic composition is largely concentrated in the service (59%) and manufacturing (24%) sectors. However, in 2019, manufactured goods formed the backbone of the export economy at 84.5% with electrical and electronic products accounting for 37.5% of the total export share. Other major primary industry exports include palm oil-based agriculture products (4.4%), liquified natural gas (4.3%) and crude petroleum (2.6%);
- **Natural resources**: Malaysia has consistently maintained more than 50% of its landmass as forest following its voluntary pledge at the Earth Summit in 1992. In 2020, 18.05 million ha, or 54.6% of the total land area of Malaysia was under forest cover. Terrestrial biodiversity is concentrated within tropical rainforests that extend from coastal plains to mountainous areas and wetlands, such as lakes and rivers. Marine biodiversity is primarily located among islands and coastal ecosystems, especially in mangrove/tidal mudflats, coral reefs, and seagrass meadows. Malaysia receives about 973 billion cubic metres per year (BCM/year) of water from rainfall annually according to the National Water Resources Study (2000-2050); and
- **Institutional and legal frameworks**: Malaysia is a constitutional monarchy that employs a Parliamentary system and is a federated state. The Government of Malaysia is led by a Prime Minister. The Ministry of Natural Resources and Environmental Sustainability is the focal ministry for climate change, whereas energy is overseen by the Ministry of Economy and the Ministry of Energy Transition and Water Transformation. Multiple sectoral and cross-sectoral entities participate in climate change decision making today in Malaysia. The cabinet remains the highest policy decision-making body in Malaysia, climate decisions and policies are also further discussed at the *Majlis Tindakan Perubahan Iklim Negara (MTPIN)*, which comprises of cabinet members related to climate change as well as chief ministers

In the Fourth Biennial Update Report published by Malaysia in 2019 (BUR4), Malaysia recorded 330 million tonnes of CO_2 equivalent ($MtCO_2e$) of emissions excluding Land Use, Land-Use Change and Forestry (LULUCF) removals, and 116 $MtCO_2e$ of total emissions net LULUCF removals in 2019. Approximately 80% of emissions are from the energy subsectors (comprising Power, Transport, Oil and Gas Production, Industrial Energy Use, and Other Energy emissions). Net emissions have grown at a compounded annual growth rate (CAGR) of approximately 6% over the past 15 years – a trend reflective of the nation's growing population and economy.

Recognising the inherent complexity of decarbonisation strategies, five decarbonisation objectives have been formulated. Balancing trade-offs against these five objectives contextualised to Malaysia's starting point will be key in the consideration of decarboniastion strategies across all sectors. These five objectives, further detailed in Exhibit 2, are:

- **Self-sufficiency** – how could decarbonisation impact security of supply?;
- **Affordability** – how could decarbonisation impact equitable pricing for all *rakyat*?;
- **Economic developmen**t – what kind of macroeconomic impact could be created as a result of investments in decarbonisation?;

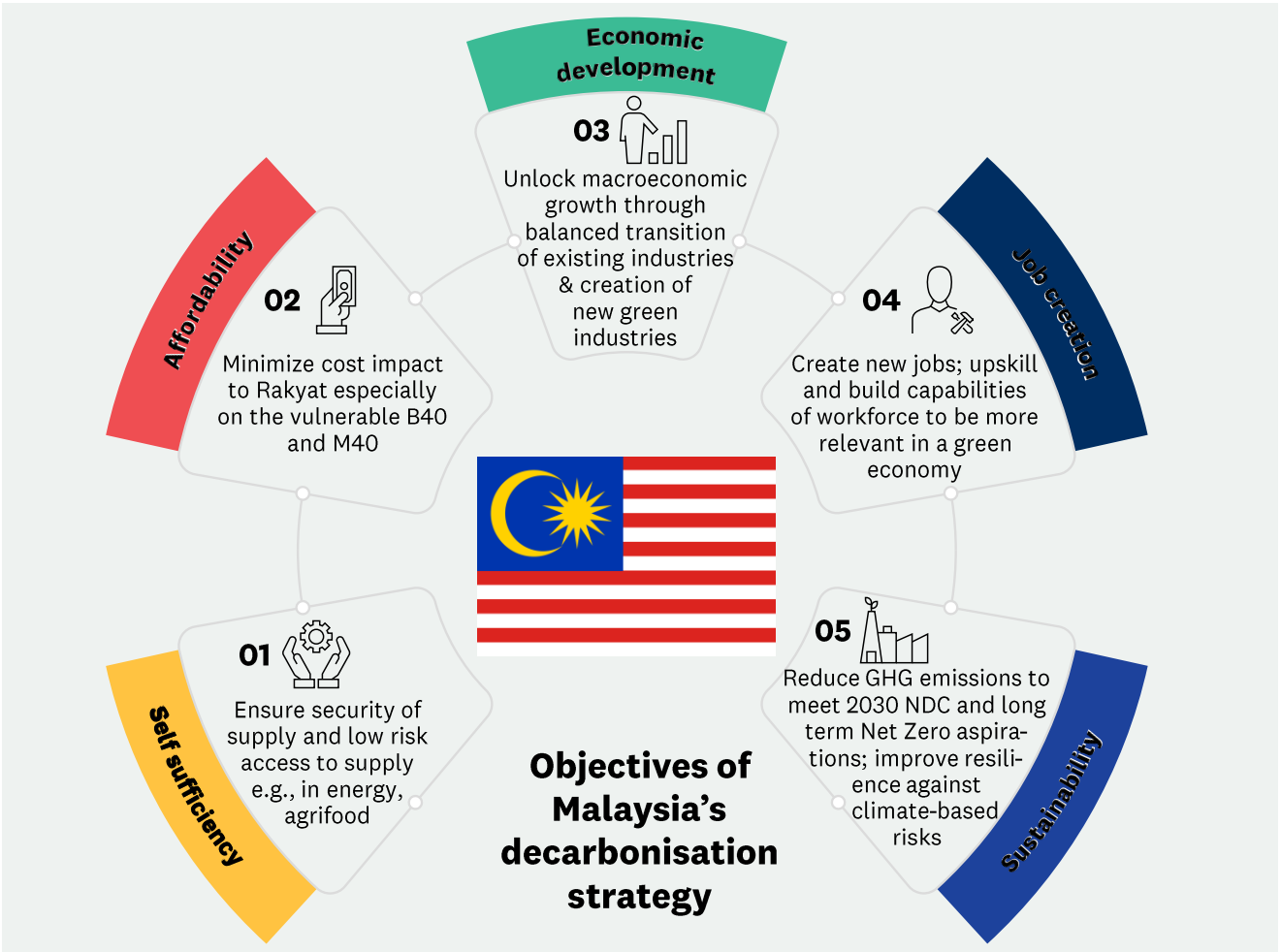
Exhibit 1
Malaysia's greenhouse gas (GHG) emissions, $MtCO_2e$ (2019)



1 Industrial Processes and Product Use
2 Land use, land-use change, and forestry

SOURCE: Malaysia Fourth Biennial Update Report (BUR4)

Exhibit 2
Objectives



- **Job creation** – what is the job creation potential of these investments, and what capability-based enablers may be required?; and
- **Sustainability** – what is the impact on a wide range of sustainability considerations?

Country targets and aspirations

Malaysia reaffirms its commitments to achieving its NDC target of 45% reduction of greenhouse gas intensity by 2030 (compared to 2005 levels). To this end, the Ministry of Natural Resources and Environmental Sustainability (NRES) embarked on the NDC RAP to chart Malaysia's pathways towards meeting its 2030 decarbonisation commitments.

In the spirit of mobilising a whole-of-nation approach to decarbonisation in alignment with the Malaysia MADANI values, this project sought to synthesise and bring together initiatives Malaysia has already developed to drive forward this vision. These include the Mid Term Review of the 12th Malaysia Plan (RMK-12), National Energy Policy (NEP), Sabah Energy Roadmap (SE-RAMP), National Energy Transition Roadmap (NETR), Low Carbon Mobility Blueprint (LCMB), National Biofuel Policy, National Agrofood Policy (NAP), the New Industrial Master Plan (NIMP 2030), Hydrogen Economy and Technology Roadmap (HETR), and more.

Additionally, Malaysia seeks to achieve decarbonisation in alignment with the Sustainable Development Goals (SDGs). The strategies laid out in this document contribute to goals that include (but are not limited to);

- SDG 1: No Poverty;
- SDG 6: Clean Water and Sanitation;
- SDG 7: Affordable and Clean Energy;
- SDG 8: Decent Work and Economic Growth;
- SDG 9: Industry, Innovation, and Infrastructure;
- SDG 10: Reduced Inequalities;
- SDG 11: Sustainable Cities and Communities; and
- SDG 12: Responsible Consumption and Production.

Methodology and approach for development of NDC RAP

The development of Malaysia's NDC RAP was led by and undertaken by the NRES' Climate Change division *Bahagian Perubahan Iklim (*BPI), the focal point for Malaysia's emission inventory computations that are submitted to the United Nations Framework Convention on Climate Change (UNFCCC). This effort was supported by a steering and technical committee comprised of members from different Ministries and agencies comprised of;

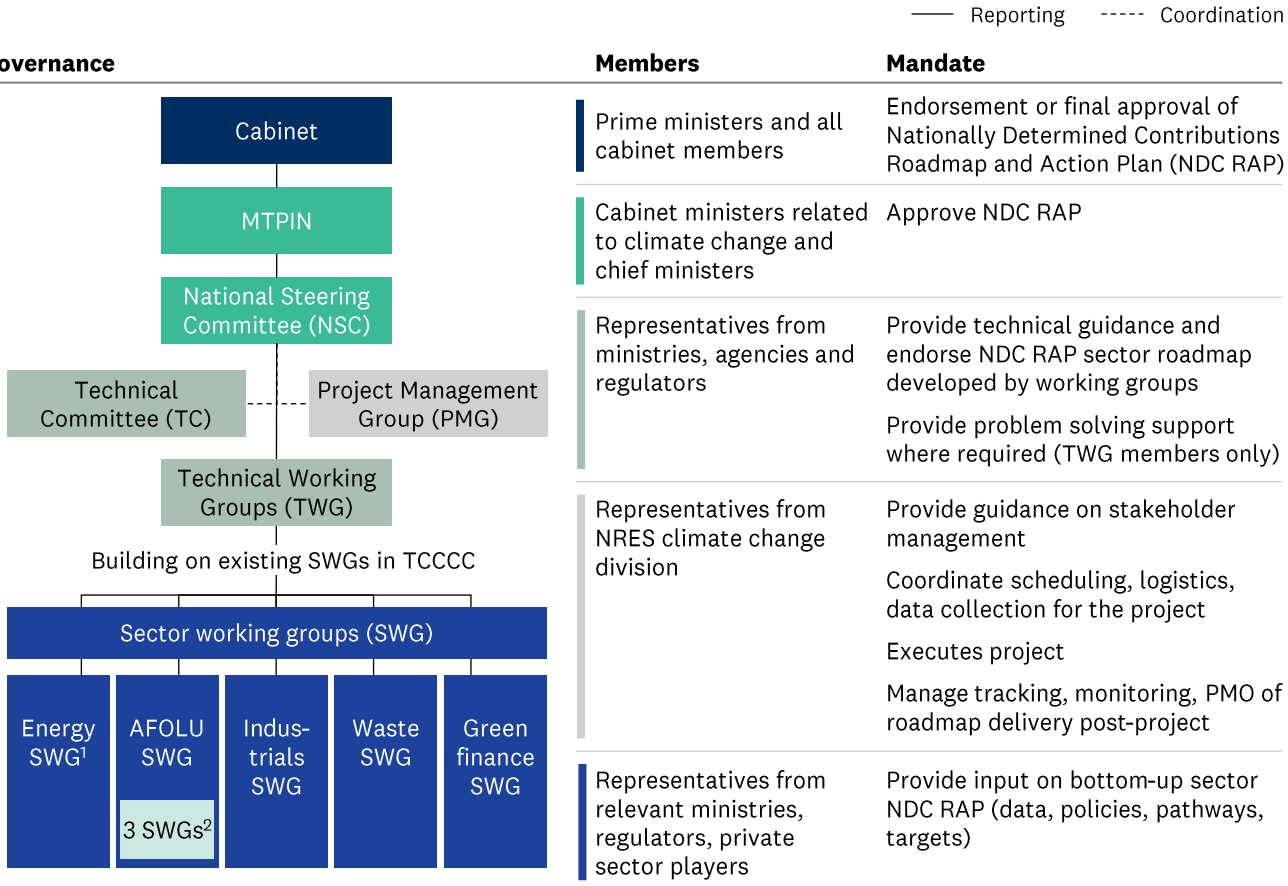
- Ministry of Finance (MOF);
- Ministry of Economy (MOE);
- Ministry of Foreign Affairs (MOFA);
- Ministry of Energy Transition and Water Transformation (PETRA);
- Ministry of Agriculture and Food Security (MAFS);
- Ministry of Investment, Trade and Industry (MITI);
- Ministry of Science, Technology and Innovation (MOSTI);
- Ministry of Plantation and Commodities (KPK);
- Ministry of Housing and Local Government (KPKT);
- Ministry of Transport (MOT);
- Ministry of Human Resources (KESUMA);
- Central Bank of Malaysia (BNM);
- Department of Statistics Malaysia (DOSM); and
- Economic Planning Units (UPEN) of Sabah and Sarawak.

The project first began with data collection that included a stocktake of existing policies and stakeholder engagements. To support the analysis and refinement process, Sector Working Groups (SWGs) were convened, and one-on-one sessions with targeted key stakeholders (e.g., policymakers and policy owners, data custodians, industry associations, non-governmental organisations) were held. These engagements continued for the entire duration of this project to ensure feasibility and accuracy of assumptions and analyses being conducted across each sector – and resulted in over 100 stakeholder engagements being held over the course of this project.

The inputs were continuously refined through these ongoing stakeholder engagements, interviews with local and global experts, and triangulation with internal and external databases or published documentation (e.g., the Malaysia Energy Transition Outlook or "METO"). Stakeholders spanned representatives from the public and private sector, as well as non-governmental organisations.

The sectoral experts and relevant stakeholders were then involved in refinement of sectoral analysis and pathways. Following this, the consolidated findings were presented to the technical committee for their feedback. An illustration of the governance structure as described here is found in Exhibit 3.

Exhibit 3
Governance structure for the project



1 Includes representatives from state governments in the energy sector
2 3 SWGs: Peninsular Malaysia, Sabah, Sarawak

Data collected from all sources (including the stocktake) were then incorporated into three modelled scenarios, based on scenarios defined by the UNFCCC in Decision 18/CMA.1[1]. These scenarios are further illustrated in Exhibit 4, and are the Without measures (WOM) scenario, With existing measures (WEM) scenario, and With additional measures (WAM) scenario. These are defined as follows, and illustrated in Exhibit 4:

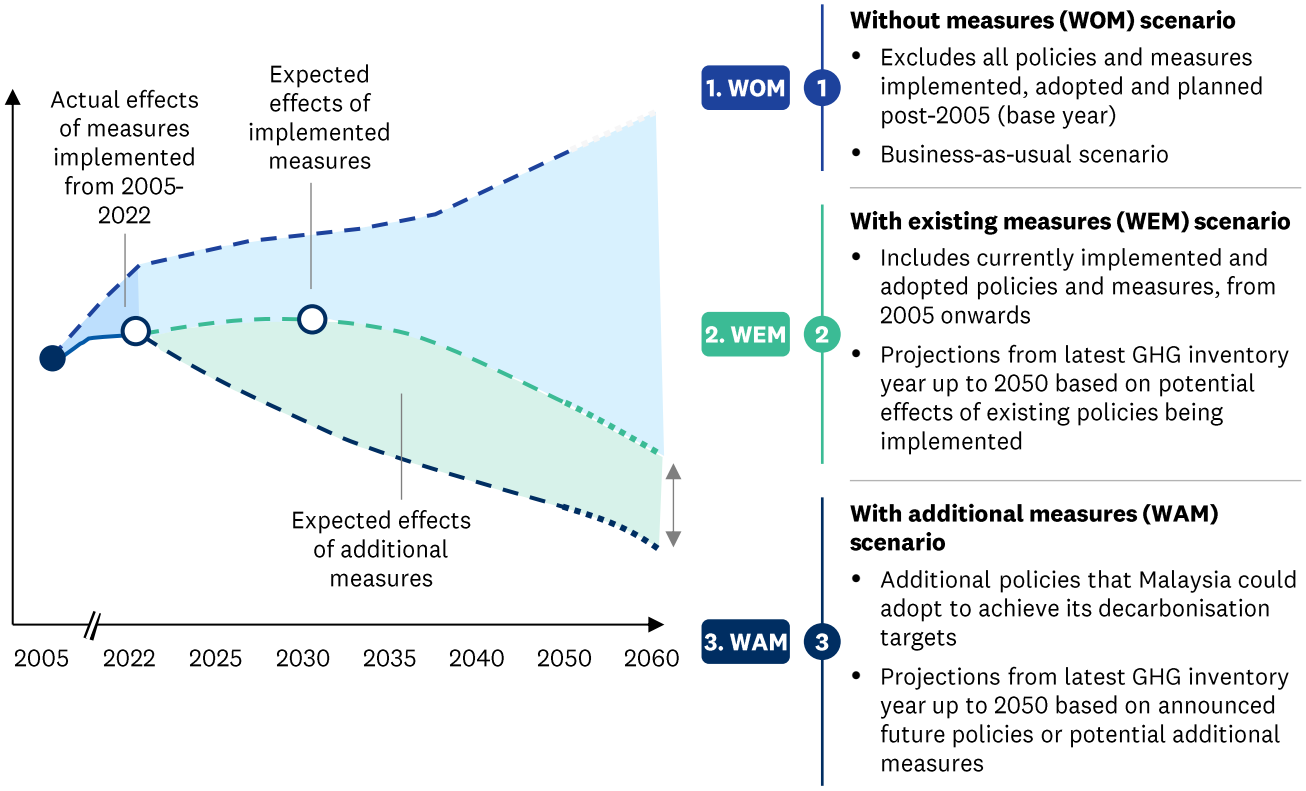
- **Without measures scenario (WOM):** this scenario excludes all policies and measures implemented, adopted, and planned post 2005. This is a hypothetical scenario that illustrates how sectoral emissions could have evolved in the absence of decarbonisation initiatives and if Malaysia had not ratified the UNFCCC with a commitment to reduce carbon intensity (against GDP) of 45% in 2030 compared to 2005 levels;
- **With existing measures scenario (WEM):** this scenario includes all currently implemented and adopted policies and measures from 2005 onwards up to December 2022, the defined cut off point. This scenario illustrates the impact of decarbonisation measures announced up to December 2022, and includes measures Malaysia has undertaken in fulfilling the UNFCCC commitment; and
- **With additional measures scenario (WAM):** this scenario includes all policies and measures announced from January 2023 onward, up to the document's conclusion period. This scenario illustrates the potential impact of policies and measures that are planned and announced but have not been implemented yet – and incorporates recent forthcoming or published sectoral plans shared by stakeholders (e.g., forthcoming plans for decarbonisation by private sector players).

[1] Decision 18/CMA.1 defines these scenarios: "a 'with measures' scenario encompasses implemented and adopted policies and measures. If provided, a 'with additional measures' scenario encompasses implemented, adopted and planned policies and measures. If provided, a 'without measures' projection excludes all policies and measures implemented, adopted and planned after the year chosen as the starting points for the projection

Exhibit 4
Illustrative Pathway Scenarios

Greenhouse gas (GHG) emissions intensity, tCO_2e/GDP

ILLUSTRATIVE



SOURCE: United Nations Framework Convention on Climate Change (UNFCCC)

Malaysia's potential economy-wide decarbonisation pathways

Without measures (WOM) scenario

Without any policies and mitigating measures implemented past 2005, Malaysia's net emissions could have reached 357 $MtCO_2e$ by 2030. This is significantly higher than the estimated level of emissions in Malaysia in a WEM scenario of 148 $MtCO_2e$, further detailed in the following subchapter. A comparison of WOM against projected country-wide WEM and WAM is shown in Exhibit 5.

Significantly higher emissions in a WOM scenario are the theoretical result of key mitigating measures introduced from 2005 onwards not occurring. These include:

- No renewables being introduced in the Power subsector;
- No electrification of mobility and sustainable fuels adopted by the Transport subsector;
- No energy efficiency savings achieved in the Energy sector as a whole;
- No treatment of generated waste in the Waste sector; and;
- No restoration initiatives or reduction in annual deforestation over time.

With existing measures (WEM) scenario

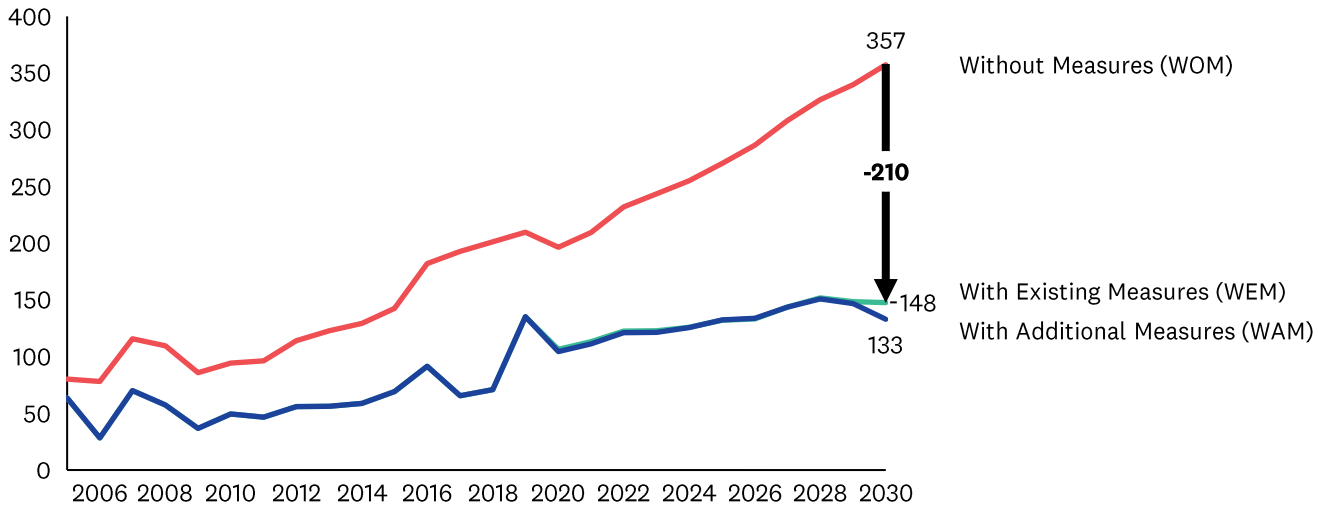
Under the WEM scenario, Malaysia's emissions are projected to increase by 28% in 2030 compared to 2019 to 148 $MtCO_2e$. Lower emissions relative to the WOM scenario are largely driven by energy sector decarbonisation measures, such as initiatives implemented under the power sector's 2022 Peninsular Malaysia Generation Development Plan published by the *Jawatankuasa Perancangan dan Pelaksanaan Pembekalan Elektrik dan Tarif (JPPPET)*, and emissions reduction targets in the oil and gas sector (e.g., planned plant-up of renewable capacity and methane reduction targets). Based on preliminary analyses, Malaysia could potentially achieve its NDC target under the WEM scenario.

Increases in emissions are projected be driven by the Industrial Processes and Product Use (IPPU) sector. Given that manufacturing will remain an important driver of the Malaysian economy, both energy and process emissions could grow due to announced capacity plant-ups and increased production levels. Waste sector emissions could also grow given increases in population and urbanisation growth.

Agriculture, forestry, and other land use (AFOLU) could remain a significant net sink under measures announced. A summary of Malaysia's potential emissions profile and sectoral evolutions over time is illustrated in Exhibit 6.

Exhibit 5
Malaysia's emissions

Malaysia's net emissions[1] including Land Use, Land-Use Change and Forestry (LULUCF), $MtCO_2e$

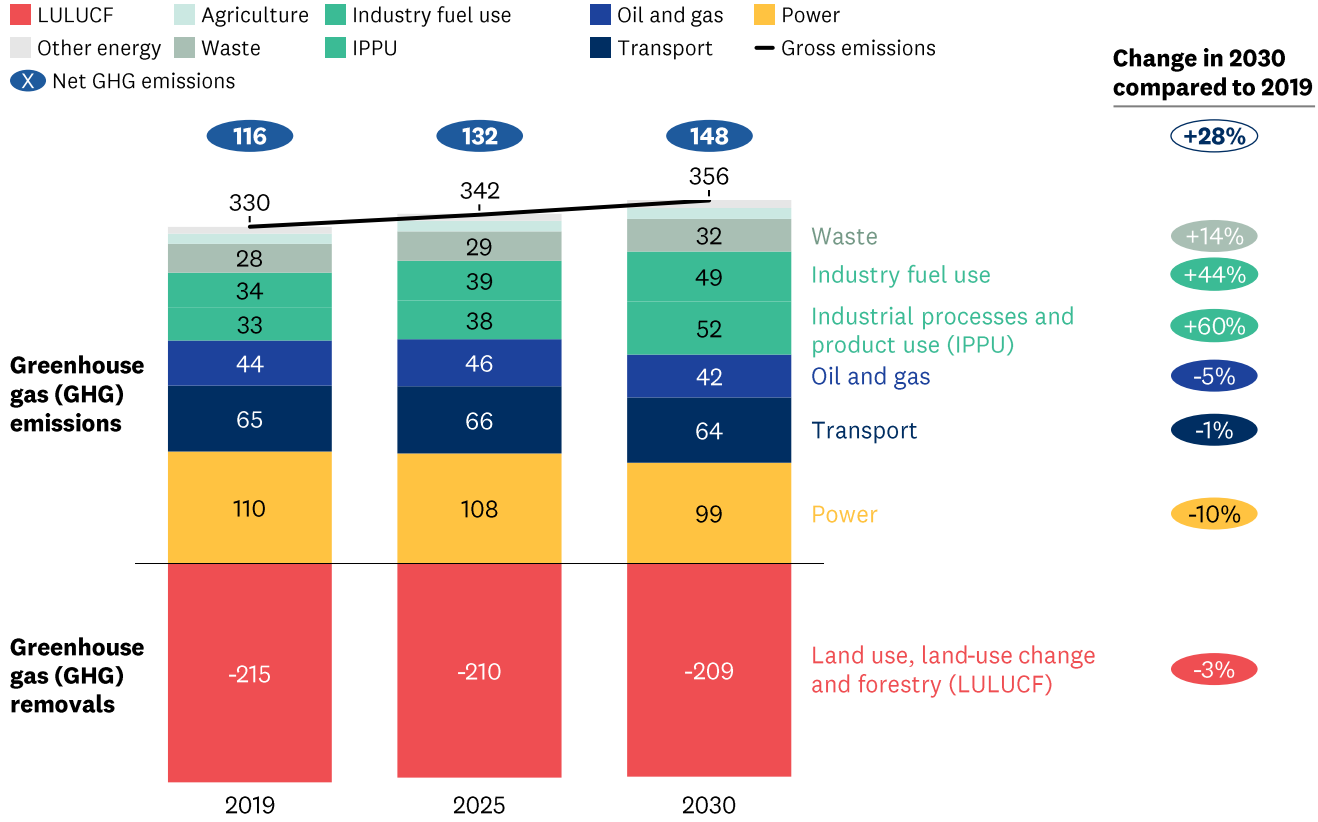


1 Pre-2020 data in the scenarios reflect actual historical emission figures

Source: Malaysia reports to United Nations Framework Convention on Climate Change (UNFCCC) (e.g., BURs, NCs), press search

Exhibit 6
With existing measures scenario

Malaysia greenhouse gas (GHG) emissions – With existing measures (WEM), $MtCO_2e$



SOURCE: SWG input across all sectors, publications and announcements by ministries and private sector players, industry association data, Ministry of Economy

With additional measures (WAM) scenario

Under the WAM scenario, Malaysia's emissions are projected to grow by 17 $MtCO_2e$ (15% compared to 2019) to 133 $MtCO_2e$ in 2030. This is shown in Exhibit 7. These reductions are largely driven by:

- Higher ambitions and targets set in energy sector, notably the power sector's higher renewable capacity mix of 55% and energy efficiency gains;
- Increased decarbonisation in the IPPU sector, including a shift to low carbon alternatives in manufacturing; and
- Retention of AFOLU as a vital sink, with additional gains projected based on lower projected deforestation and improved forest management.

It should be noted that Waste emissions could remain relatively flat due to a projected increase in treatment via waste to energy plants. These could generate similar emissions per tonne of waste as landfilling[2].

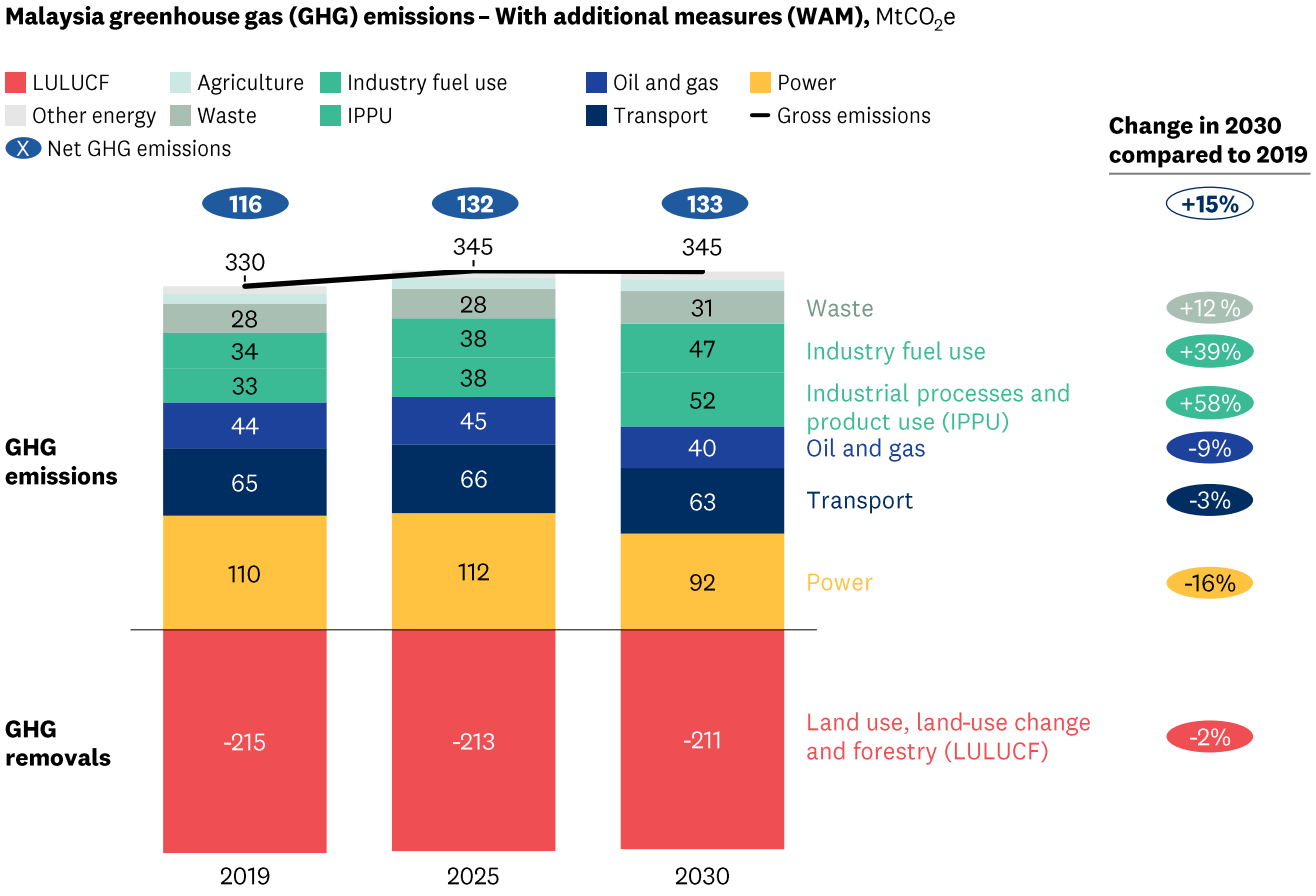
Malaysia's decarbonisation strategies

Malaysia's decarbonisation strategies can be broken into 15 distinct sector-specific initiatives, as shown in Exhibit 8. These illustrate the driving forces that could influence how decarbonisation across each of the six sectors of focus (power, transport, oil and gas, industries, AFOLU, and waste) could evolve over time.

In addition, three cross cutting strategies were identified: energy efficiency, hydrogen, and carbon capture, use, and storage. These are complemented by six enablers required to support both the sectoral and cross-sectoral strategy: monitoring, reporting, and verification (MRV) and governance, carbon pricing, green financing, SME and MSME empowerment, awareness and behavioural change, talent and capabilities development.

[2] Emissions from Waste to Energy technologies are dependent on the type of technology used. Emissions from landfilling are dependent on various factors (including waste composition) pertaining to the waste being landfilled.

Exhibit 7
With additional measures scenario



SOURCE: SWG input across all sectors, publications and announcements by ministries and private sector players, industry association data, Ministry of Economy

Exhibit 8
Overview of Malaysia's decarbonisation strategy

Malaysia's balanced and just transition to a Net Zero future

Targets and aspirations	**Achieve** -45% greenhouse gas (GHG) intensity reduction against GDP compared to 2005 levels by 2030	**Aspire to reach** Net Zero by 2050
Objectives	Self sufficiency; Affordability; Economic development; Job creation; Sustainability	
15 sectoral strategies	**Power** Renewables and storage at scale New green fuels and clean tech Interconnected grid of the future	**Transport** Electrified mobility Sustainable fuels Public transport
	Oil & gas CCUS at scale Green electrification Methane reduction	**Industries** Low carbon materials and fuel alternatives
	Agriculture, forestry, land use Protection and restoration at scale Sustainable agriculture	**Waste** Separation at source Recycling at scale Waste-to-wealth
3 cross cutting strategies	Energy efficiency	
	Hydrogen	
	Carbon capture, utilisation and storage (CCUS)	
6 key enablers	MRV and governance	Carbon pricing
	Green financing	
	SME and MSME empowerment	Awareness & behavioral change
	Talent & capabilities development	

These sectoral, cross sectoral decarbonisation strategies, and enablers are anchored on Malaysia's commitments to achieving its NDC target of 45% reduction of greenhouse gas intensity by 2030 (compared to 2005 levels).

These strategies and enablers also consider the impact of decarbonisation against the five decarbonisation objectives: self sufficiency, affordability, economic development, job creation, and sustainability.

Risks and uncertainties

There are four critical risks to Malaysia's achievement of its NDC target. Taken together, should these implementation risks be unmanaged and left to materialise, Malaysia could face higher risk of missing its targets.

Firstly, there is a risk of missing sectoral decarbonisation-related goals. Each sector has set relevant decarbonisation goals that contribute directly to the nation's overall decarbonisation journey – these include renewable energy penetration targets (such as large scale solar plant ups) in the power sector, forest cover retention in AFOLU, and 15 – 20% xEV penetration in the transport sector. These targets are critical in enabling effective mitigation of emissions, but may be missed as a result of several factors such as a lack of financing, capability or stakeholder misalignment, insufficient relevant infrastructure, limited, or slower-than-expected technological viability, or sufficient governance structures to oversee mitigation efforts.

Secondly, lower than expected GDP growth, particularly in low emitting sectors, could impact Malaysia's NDC achievements in 2030. This is a result of Malaysia setting an emissions intensity reduction target against GDP. Slower than expected nominal GDP growth or fluctuations in expected inflation could place the intensity target at risk.

Thirdly, Internationally Transferred Mitigation Outcomes (ITMOs) resulting from the sale of carbon credits could also impact Malaysia's achievement of its NDC targets. As Malaysia is endowed with an abundance of natural assets that contribute to a sizeable sink, there could be a potential for Malaysia to participate in the international sale of carbon credits. Lack of coordination and alignment on the quantum of carbon credits that can be generated and sold on the international market could result in a significant growth in net emissions.

Lastly, an overall growth in emissions due to demand and supply factors can impact the pathways significantly. For example, higher population growth could drive increased power consumption and vehicle ownership, which may lead to increased emissions if energy sources remain as per the WEM scenario. In addition, increased manufacturing activity to cater for unexpected increases in demand and new infrastructure projects could also lead to higher emissions – with emissions in these sectors also currently being hard to abate with available technologies.

Additionally, uncertainties in long-term projections and data availabilities should also be accounted for. These include changes in assumptions (e.g., emission factors adopted as standards by the international scientific community), or advances that allow for more granular data tracking and monitoring, reporting, and verification activities. It is therefore important that this report is treated as a living document, and that these projection targets are constantly monitored and revised where necessary – mitigating the impact of both risks and uncertainties while enabling Malaysia to achieve its decarbonisation commitments.

Conclusion

Malaysia's success in ensuring the achievement of our decarbonisation targets and aspirations hinge on three core imperatives.

Firstly, the ability to balance trade-offs against the five decarbonization outcomes to ensure the maximization of benefits for the *rakyat*, industry, and country – while ensuring the minimisation of unintended consequences. This includes taking advantage of emergent opportunities for green business building in new sectors and clusters (e.g., electric vehicles, CCUS), as well as embracing and encouraging innovation. At the same time, this also includes mitigating risks such as ensuring that industry is encouraged and supported in adopting their own respective decarbonisation strategies, and protecting the vulnerable segments of society in Malaysia.

Secondly, the ability to ensure implementation excellence across all decarbonisation strategies. The achievement of sectoral targets are crucial to ensure that each sector is able to play its part in Malaysia's decarbonisation journey. No sector can achieve Net Zero alone – Malaysia can only achieve its targets and aspirations if concerted effort is undertaken by all stakeholders in every sector, in collaboration with each other.

Thirdly, the ability to galvanise stakeholders towards this anchor purpose. Mobilisation of all stakeholders in a whole-of-Government and indeed a whole-of-country approach will be key – and this will only grow in importance as decarbonisation strategies become more complex and interconnected with other sectors' efforts. Additionally, galvanising support from international actors in technological knowledge sharing and funding will also be crucial in supporting sectors' efforts to adopt the latest and most feasible technological advancements in their decarbonisation strategies.

Given innovations that are moving at pace, the NDC RAP is intended to be published as a living document that will continue to serve as a guide to orient Malaysia's decarbonisation strategy. The publication of this documents represents Malaysia's commitment to safeguard the planet, Malaysia's biodiversity, and the future for generations to come – while ensuring that current vulnerable generations remain protected, and are able to contribute to Malaysia's sustainable development in the years to come. Cooperation from every segment of society will be required to enable Malaysia to prepare and face the greatest challenge of this generation as a united *Rakyat* – and the Government looks forward to work with all stakeholders in achieving a balanced and just transition for Malaysia together.

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01

Introduction

Background

Responding to the climate crisis is one of the greatest challenges of this generation. Studies by the World Meteorological Organisation have confirmed that the decade between 2011 and 2019 has been the warmest on record – and that temperatures in each successive decade have been steadily increasing since the 1980s. Rising global temperatures have the potential to cause significant disruption. As global temperatures have seen an increase by 1.1 degrees Celsius between 1920 and 2020, the incidences of extreme weather events and crises such as droughts, heatwaves, coastal flooding, and food shortages have been on the rise.

In the face of increasing global temperatures, Malaysia's climate vulnerability could rise in tandem. While extreme weather events such as floods already occur domestically, Malaysia could see higher incidences of flooding. Conversely, Malaysia could also be more prone to dry spells – jeopardising the health and livelihoods of the *rakyat*. Additionally, sea levels surrounding Peninsular could rise up to 0.1m through 2030, and 0.2m through 2050[1].

Given the threat to the lives and livelihoods that climate change poses, it is crucial that Malaysia formulates strategies to contribute to the global impetus to drive down emissions. Malaysia is committed to playing a part in achieving the targets set forth in the Paris Agreement – to limit temperature increases in 2100 to no more than 1.5 degrees Celsius above pre-industrial levels. Additionally, it is also important that Malaysia develops adaptation strategies to effectively mitigate the forthcoming impacts of climate change to ensure continued resilience over time. Finally, Malaysia is committed to pursuing decarbonisation in a balanced and just way. This ensures that Malaysia's pathway to decarbonisation does not unfairly detriment the *rakyat*, particularly the vulnerable who could be disproportionately impacted by climate change.

About this document

The Nationally Determined Contributions Roadmap and Action Plan (NDC RAP) lays out strategies between 2024 and 2030 to document how Malaysia could meet its NDC targets, as well as lay the foundation for the years ahead. This NDC RAP starts with a consideration of Malaysia's national starting point, context, targets and aspirations. Then, the methodology of the study is discussed in detail – followed by a discussion of the potential economy-wide decarbonisation pathways. This is then followed by a sector-by-sector discussion on the strategies each sector could pursue in its journey to decarbonisation. Each subchapter discusses one of five key sectors' (Energy, Industrial Processes and Product Use, Agriculture, Forestry and Other Land Use, and Waste) sectoral starting point, sector specific decarbonisation pathways, sectoral strategies and enablers that could support these pathways, and resulting Key Performance Indicators (KPIs) to be monitored. Following this, the cross-sectoral strategies and enablers are then discussed in detail, followed by a discussion on key risks and uncertainties, how Malaysia will be pursuing adaptation strategies, and finally concluding remarks.

Existing policy documents form the basis of the NDC RAP's strategies. These include recently published roadmaps and publications such as the National Energy Transition Roadmap, the Hydrogen Economy and Technology Roadmap, and the National Biomass Action Plan. Collaboration and stakeholder engagement has formed the heart this study – ensuring that these documents truly reflect a whole-of-nation approach to decarbonisation in the spirit of the MADANI Government's approach to sustainable development and prosperity for all.

Acknowledgements

The Ministry of Natural Resources and Environmental Sustainability wishes to express its gratitude to all stakeholders who have participated in the project and shared their invaluable guidance throughout. These include other ministries, industry associations, private sector players, academia, and non-governmental organisations. Further details on the stakeholders engaged as a part of this project can be found in chapter 4.

[1] Malaysia's Third National Communication and Second Biennial Update Report to the UNFCCC, 2018

02

Country profile

National greenhouse gas (GHG) emissions profile and trend over time

Challenges and limitations

National circumstances

Country profile

Geography

Malaysia is situated in the Southeast Asia region, with a total land area of 330,241 km^2 – including 8,840 km of coastline and over 879 islands. It consists of thirteen states and three Federal Territories.

Eleven of the states and two of the Federal Territories (Kuala Lumpur and Putrajaya) are in Peninsular Malaysia. The states of Sabah and Sarawak are located on the Borneo Island and are separated from Peninsular Malaysia by the South China Sea. The Federal Territory of Labuan is located off the coast of western Sabah. The topography of Malaysia ranges from coastal plains to mountainous terrains. A map of Malaysia is shown in Exhibit 2-1.

Climate

Malaysia has an equatorial climate with a uniform daily variation of temperatures throughout the year. The daily mean temperature lies between 26 ºC and 28 ºC. In the past 50 years, there has been a positive trend in temperature increase. Malaysia's climate can be characterised by two monsoons which are separated by two shorter inter-monsoon periods. The boreal winter monsoon usually occurs from November to March, while the boreal summer monsoon occurs between May to September. During inter-monsoonal periods, occurrence of heavy rain and thunderstorms in the late afternoons and evenings are common.

Population

The total population of Malaysia in 2022 was 32.7 million, growing an average of 1.2% per annum from 2010 to 2022. The nation is rapidly urbanising, with an increase in rate of urbanisation from 51% in 1990 to 78% in 2022 and a rise in population density from 86 person per km^2 in 2010 to 99 people per km^2 in 2022.

As of 2022, 69.6% of the population are of working age (15 to 64), 23% aged 14 and below, and 7.4% are aged 65 and above. A shift in population structure towards an 'ageing society' could occur. This is due to a declining birth rate and increase in life expectancy, with an estimated 15% of the population aged 60 years and over by 2030 (5.8 million).

Economy

Malaysia has a growing economy, with a nominal Gross Domestic Product (GDP) of RM1,791 billion in 2022. Nominal GDP has grown at a rate of 6.7% per annum from 2010 to 2022. This has also translated into a rise in Gross National Income per capita at current prices, increasing from RM27,819 in 2010 to RM52,968 in 2022.

The nation has undergone rapid industrialisation over the past decade and is presently transitioning to a service-based economy, with high value-add manufacturing. As of 2022, the composition of the economy is 59% service, 24% manufacturing, 6% agriculture, 6% mining and quarrying, and 4% construction. In 2019, manufactured goods formed the backbone of the export economy at 84.5% with electrical and electronic products accounting for 37.5% of the total export share. Primary industries goods made up 14.8% of export consisting mainly of palm oil and palm oil-based agriculture products (4.4%), liquified natural gas (4.3%), and crude petroleum (2.6%).

Natural Resources

Malaysia's forests are comprised of complex ecosystems and are home to a wide range of species. Malaysia has consistently maintained more than 50% of its landmass as forest following its voluntary pledge at the Earth Summit in 1992.

In 2020, 18.05 million ha, or 54.6% of the total land area of Malaysia was under forest cover. The remaining land area comprised of agricultural and commodity crops, settlements, wetlands, and grasslands. Malaysia's terrestrial biodiversity

Exhibit 2-1
Map of Malaysia

Source: From Malaysia Fourth Biennial Update Report (BUR4)

is concentrated within tropical rainforests that extend from coastal plains to mountainous areas and wetlands, such as lakes and rivers. Marine biodiversity is primarily located among islands and coastal ecosystems, especially in mangrove/tidal mudflats, coral reefs, and seagrass meadows.

Malaysia relies on rainfall as its main water source that feeds its 2,986 river basins. The country receives about 973 billion cubic metre per year (BCM/year) of water from rainfall annually according to the National Water Resources Study (2000-2050). Rainfall is unevenly distributed with some states receiving more rain than others. Areas with smaller water catchments are likely to be more susceptible to water stress in the future. The National Water Resources Policy launched in 2012 under the 10th Malaysia Plan outlined clear directions and strategies for water resources management, including collaborative governance to ensure water security and sustainability.

Institutional and legal frameworks

Malaysia is a constitutional monarchy that employs a parliamentary system and is a federated state. The Government of Malaysia is led by a Prime Minister. It has three branches of government – the Executive, the Legislature, and the Judiciary. Its legislative power is divided between its federal and state legislatures. The federal legislature and the executive arm of the government have the responsibility for developing and implementing policies and drafting national laws to enable the country to fulfil its international obligations in addressing climate change.

The Ministry of Natural Resources and Environmental Sustainability is the focal ministry for climate change. Additionally, energy is overseen by the Ministry of Economy and the Ministry of Energy Transition and Water Transformation. Each respective state has jurisdiction over the management of natural resources, especially land, forest, and water.

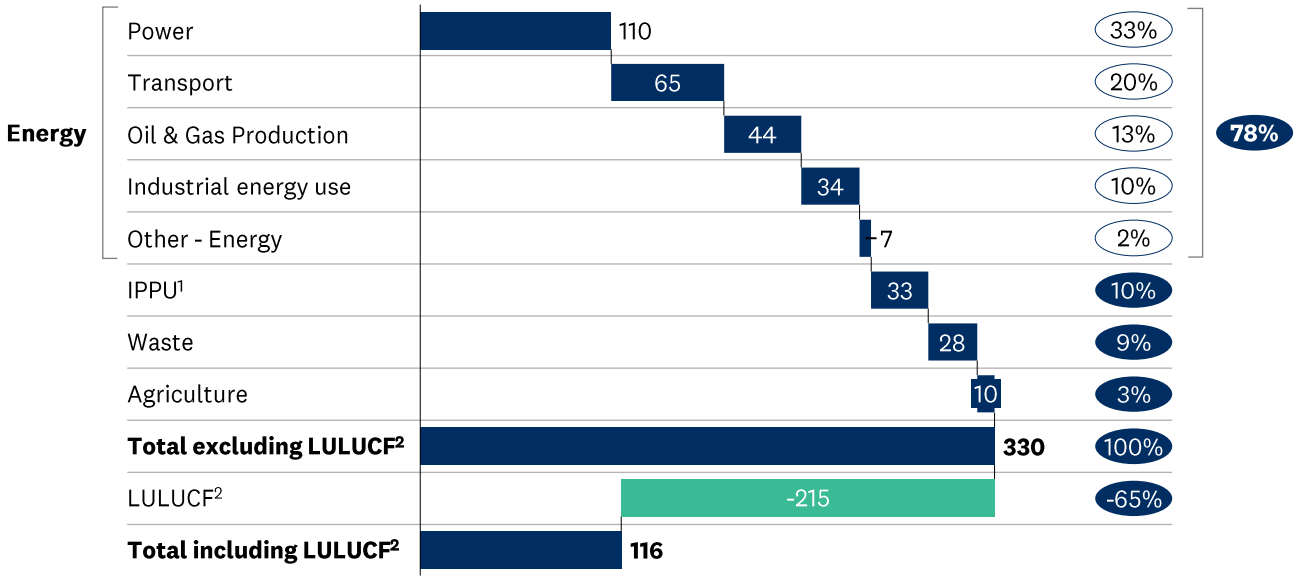
Multiple sectoral and cross-sectoral entities participate in climate change decision making today in Malaysia. While Cabinet remains the highest policy decision-making body in Malaysia, climate decisions and policies are also further discussed at the *Majlis Tindakan Perubahan Iklim Negara (MTPIN)*, which comprises cabinet ministers related to climate change and chief ministers. Further details on sectoral and cross-sectoral climate policymaking is discussed in subchapter 7.9.

National greenhouse gas (GHG) emissions profile and trend over time

In the Fourth Biennial Update Report published by Malaysia in 2022 (BUR4), Malaysia recorded 330 $MtCO_2e$ of emissions excluding Land Use, Land-Use Change and Forestry (LULUCF) removals, and 116 $MtCO_2e$ of total emissions net LULUCF removals in 2019. 80% of emissions are from the energy subsectors (comprising Power, Transport, Oil and Gas Production, Industrial Energy Use, and Other Energy emissions).

Exhibit 2-2 shows a breakdown of Malaysia's emissions in 2019 as reported in the BUR4. It should be noted that Malaysia's greenhouse gas inventory has been conducted based on guidelines issued by the Intergovernmental Panel

Exhibit 2-2
Malaysia's greenhouse gas (GHG) emissions, $MtCO_2e$ (2019)



1 Industrial Processes and Product Use
2 Land use, land-use change, and forestry

SOURCE: Malaysia Fourth Biennial Update Report (BUR4)

on Climate Change (IPCC) in 2006. Among other details, this includes how emissions are broken down by sector, and provides guidance on activity data used to estimate and measure emissions.

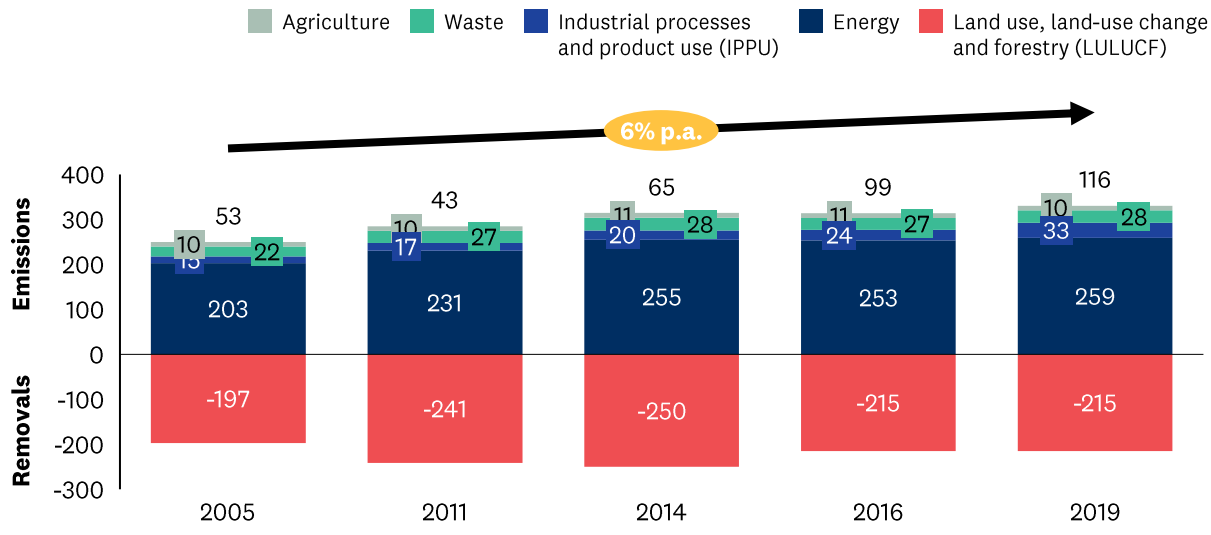
Malaysia's net emissions have grown at a compounded annual growth rate (CAGR) of 6% over the past 15 years, from 53 $MtCO_2e$ (2005) to 116 $MtCO_2e$ (2019). This upward tend is reflective of the nation's growing population and economy. This is illustrated in Exhibit 2-3, which also shows emissions growth within each sector.

Challenges and limitations

Decarbonisation is not a zero-sum game. However, it will be essential to balance trade-offs against five key objectives that are contextualised to Malaysia's unique starting point. . Exhibit 2-4 presents these five objectives, which anchor the sectoral strategies throughout this report. They are:

- **Self-sufficiency – how could decarbonisation impact security of supply?** This includes security of energy supply, as transitioning to domestically generated renewable energy (RE) could reduce Malaysia's reliance on imported energy, and lower exposure to fluctuating commodity markets. Peninsular Malaysia, which forms the majority of electricity demand in Malaysia, currently relies on imported fuel for 60-70% of its power supply. Malaysia also strives for improvements in agrifood sufficiency, and has set self-sufficiency ratio targets for key agricultural products such as rice (80% by 2030) and beef (50% by 2030);
- **Affordability – how could this impact equitable pricing for all *rakyat*?** Malaysia's decarbonisation strategy should ensure that adverse impacts on vulnerable B40 and M40 households are minimised. For example, within the power sector, renewable energy costs are currently lower than that of conventional fuels such as coal and gas, making it a cost-viable decarbonisation lever. In the future, Malaysia could also consider new emerging technologies such as Carbon Capture for Use or Storage (CCUS). However, given its nascency, costs of capture in hard-to-abate industries that could see its rapid adoption (such as power and manufacturing) remain high relative to applications that are more economically viable (e.g., gas processing and petrochemicals manufacturing);
- **Economic development – what kind of macroeconomic impact could be created?** Catalytic investments in green technology could unlock new green industries – an aspiration the Government has shared in recent roadmaps such as the New Industrial Masterplan 2030. While investments in decarbonisation levers such as energy transition have been estimated by recent studies (e.g., the Malaysian Energy Transition Outlook) to be up to RM 1.9 trillion, the multiplier impact could in turn be of significant scale;
- **Job creation – what is the job creation potential, and what capability-based enablers may be required?** While the aforementioned catalytic investments in green technologies could also result in job creation opportunities within these new green industries (estimated in the Low Carbon Nation Aspiration 2040 to be over 200,000), it is important to also consider upskilling and capability building as a critical enabler

Exhibit 2-3
Historical net[1] greenhouse gas (GHG) emissions, $MtCO_2e$



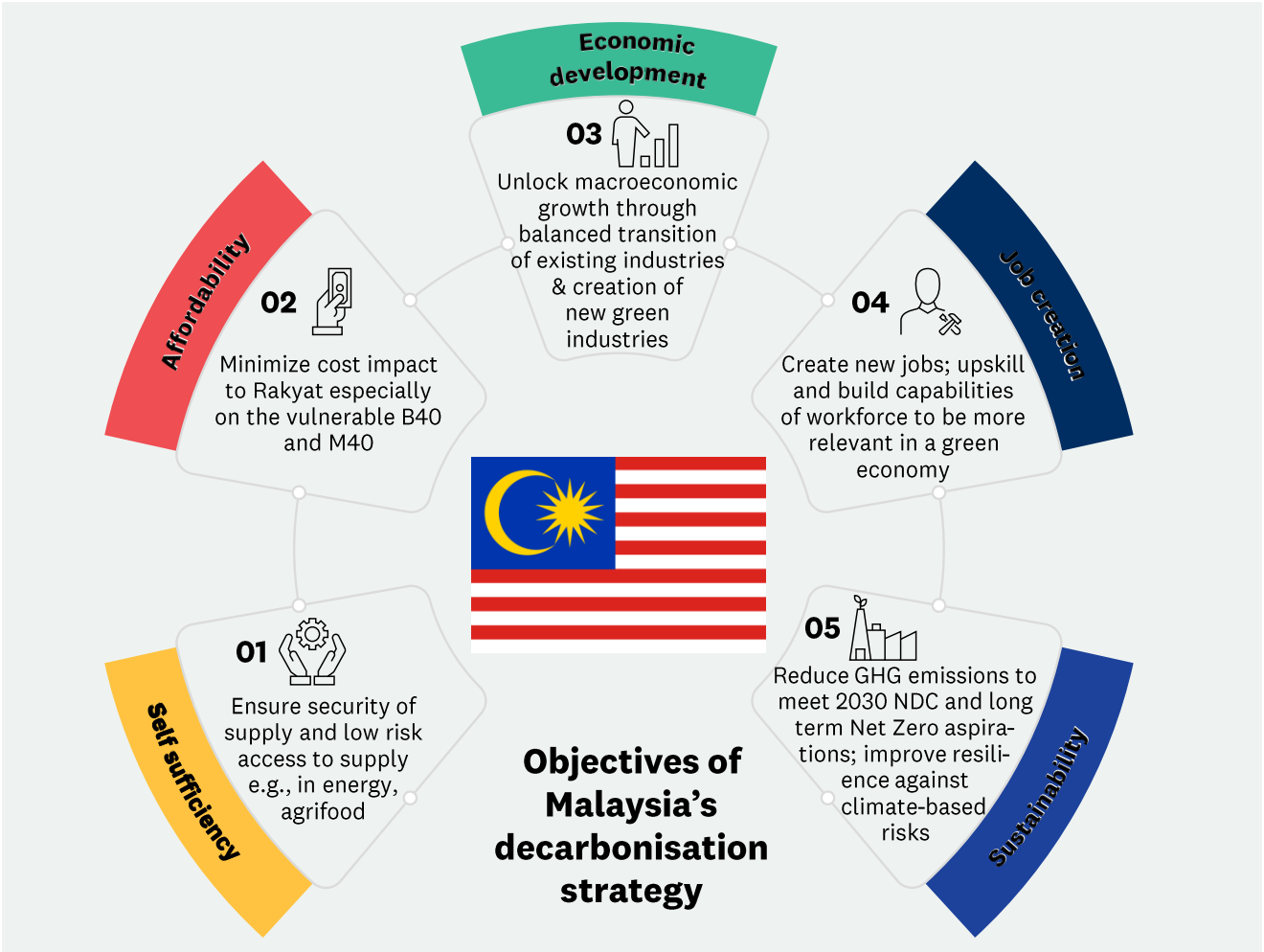
1 Net of Land Use, Land-Use Change and Forestry (LULUCF) removals

Source: Malaysia Fourth Biennial Update Report (BUR4)

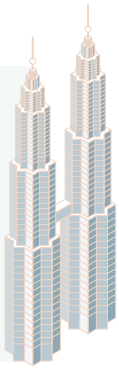
across all sectors. Additionally, studies have also shown that investments in RE technologies could create over 2.5 times more jobs than similar investments in fossil fuel industries; and

- **Sustainability – what is the impact on a wide range of sustainability considerations?** While this includes emissions reductions, it also includes how Malaysia could improve its resilience against climate-based risks such as extreme weather events (e.g., droughts, floods), and ensure local industries' compliance with changes in global regulatory environments as a trade consideration (e.g., the Carbon Border Adjustment Mechanism or CBAM). These would also enable Malaysia to also to achieve several of the United Nations' Sustainable Development Goals (SDGs) (e.g., creation of sustainable communities and cities).

Exhibit 2-4
Recap Objectives



Malaysia has committed to -45% GHG intensity against GDP compared to 2005 level in 2030 and aspires for Net Zero by 2050



03

Country targets and aspirations

In May 2023, the Ministry of Natural Resources and Environmental Sustainability embarked on the National Roadmap Action Plan (NDC RAP) to chart Malaysia's pathways towards meeting its 2030 decarbonisation commitments. This builds on the numerous policies and initiatives Malaysia has already developed to drive forward this vision. These include the Mid Term Review of the 12th Malaysia Plan (RMK-12), National Energy Policy (NEP), Sabah Energy Roadmap (SE-RAMP), National Energy Transition Roadmap (NETR), Low Carbon Mobility Blueprint (LCMB), National Biofuel Policy, National Agrofood Policy (NAP), the New Industrial Master Plan (NIMP 2030), Hydrogen Economy and Technology Roadmap (HETR), and more.

As part of the global effort to address the imminent impact of climate change, Malaysia has committed to a 45% greenhouse gas (GHG) intensity reduction by 2030 versus its 2005 levels and is aspiring to achieve Net Zero emissions by 2050 at the earliest. To achieve this, the Government looks to mobilise a whole-of-nation effort and achieve decarbonisation through a united front. Malaysia envisions a stronger and greener ecosystem, built on the foundations of new green technology and alternative fuels, energy efficiency improvements, innovative green financing, digital innovation, small and medium enterprise (SME) and micro, small, and medium enterprise (MSME) empowerment, and talent and capabilities advancements. The decarbonisation strategy of Malaysia also aligns to the underlying values of Malaysia MADANI.

Additionally, the path to achieving Malaysia's climate targets are aligned with the SDGs. Firstly, transitioning towards a low carbon nation could enhance Malaysia's food and energy self-sufficiency, as well as bolster energy sovereignty. Malaysia's plans to scale renewable energy and enhance agro-food productivity contributes towards SDG 2: Zero Hunger and SDG 7: Affordable and Clean Energy. Additionally, Malaysia is committed to ensuring an equitable decarbonisation journey and endeavours to develop solutions that are fair and equitable for the B40 and M40 groups. This is done in accordance with SDG 1: No Poverty and SDG 10: Reduced Inequalities – and in alignment with the MADANI values of sustainability, care and compassion, and prosperity.

Additionally, sustainability and economic development go hand in hand. The energy transition could unlock new green industries and economies for Malaysia to lead in, while also driving forward SDG 8: Decent Work and Economic Growth, SDG 9: Industry, Innovation, and Infrastructure, and SDG 17: Partnerships for Goals. Emerging opportunities include those in green mobility, CCUS, and the hydrogen economy – new sectors Malaysia aspires to drive, in alignment with the MADANI value of innovation. Driving these new industries forward also creates potential for new green jobs, with 207,000 estimated jobs to be created based on Malaysia's Low Carbon Nation Aspiration initiatives alone. As a comparison, renewable technologies have the potential to create 75 direct and indirect jobs per USD 10 million versus 27 jobs from fossil-fuel based technology. Bearing in mind that the transition could lead to job losses in certain industries and a potentially negative economic impact on small businesses and communities in affected localities, safeguards will need to be implemented to ensure a just transition, such re-skilling and/or upskilling support for employees in affected industries, or cash transfers to low-income households to limit the impact from higher energy prices.

Lastly, the low-carbon transition can shield Malaysia from climate-based risks, while safeguarding its rich biodiversity. The collective, cross-cutting sector initiatives to pursue renewable energy and low carbon technologies, reduce deforestation, tackle waste generation, and develop nature-based solutions are aligned with several SDG goals. Beyond those mentioned above, Malaysia's climate target and NDC roadmap initiatives directly align with SDG 6: Clean Water and Sanitation, SDG 11: Sustainable Cities and Communities, SDG 12: Responsible Consumption and Production, SDG 13: Climate Action, SDG 14: Life Below Water, and SDG 15: Life on Land.

04

Project governance and institutional arrangement

Stakeholder engagement

Stocktake of national policies integrated into the report

Scenario development methodology

Methodology and approach for development of NDC RAP

The project's approach heavily involved data collection that included (but was not limited to) a stocktake of existing policies and stakeholder engagements. This was further supplemented with data from proprietary databases and industry publications where available.

Stakeholder engagements were conducted through convening of Sector Working Groups (SWGs) and sessions with targeted key stakeholders (e.g., policymakers and policy owners, data custodians, industry associations, non-governmental organisations). This allowed continuous refinement of the data, improvement of the analyses, and sharpening of assumptions in the development of sectoral pathways.

Stakeholders were engaged during the data collection and analysis process as well as to finalise and endorse their respective sectors' assumptions. This enabled the approach of this project to be as collaborative and transparent as possible, as well as ensured the incorporation the latest data available in this report.

Project governance and institutional arrangement

The development of Malaysia's NDC RAP was led by and undertaken by the NRES' Climate Change division *Bahagian Perubahan Iklim* (BPI), the focal point for Malaysia's emission inventory computations that are submitted to the United Nations Framework Convention on Climate Change (UNFCCC). This effort was supported by a steering and technical committee comprised of members from different Ministries and agencies comprised of (but not limited to);

- Ministry of Finance (MOF)
- Ministry of Economy (MOE);
- Ministry of Foreign Affairs (MOFA);
- Ministry of Energy Transition and Water Transformation (PETRA);
- Ministry of Agriculture and Food Security (MAFS);
- Ministry of Investment, Trade and Industry (MITI);
- Ministry of Science, Technology and Innovation (MOSTI);
- Ministry of Plantation and Commodities (KPK);
- Ministry of Housing and Local Government (KPKT);
- Ministry of Transport (MOT);
- Ministry of Human Resources (KESUMA);
- Central Bank of Malaysia (BNM);
- Department of Statistics Malaysia (DOSM); and
- Economic Planning Units (UPEN) of Sabah and Sarawak.

It should be noted that TWG members have also been involved in preparation of previous reports (e.g., BURs and National Communications), however, the convening of SWGs was conducted for the specific purpose of this project and included significant participation from private sector and industry stakeholders. The consolidated findings were then presented to the technical committee for their feedback. An illustration of the governance structure as described above is found in Exhibit 4-1.

Stakeholder engagement

Data collected was refined through ongoing stakeholder engagements, expert interviews with local and global experts, and triangulation with internal and external databases or published documentation (e.g., the Malaysia Energy Transition Outlook or "METO" recently published by NRECC in partnership with the International Renewable Energy Agency). Across the project, over 100 stakeholder engagements were conducted in forums and one-on-one engagements across all the sectors. Stakeholders spanned representatives from the public and private sector, as well as non-governmental organisations. Stakeholders were continuously engaged throughout the project – from data collection, to the refinement of assumptions, as well as the finalisation of the pathways.

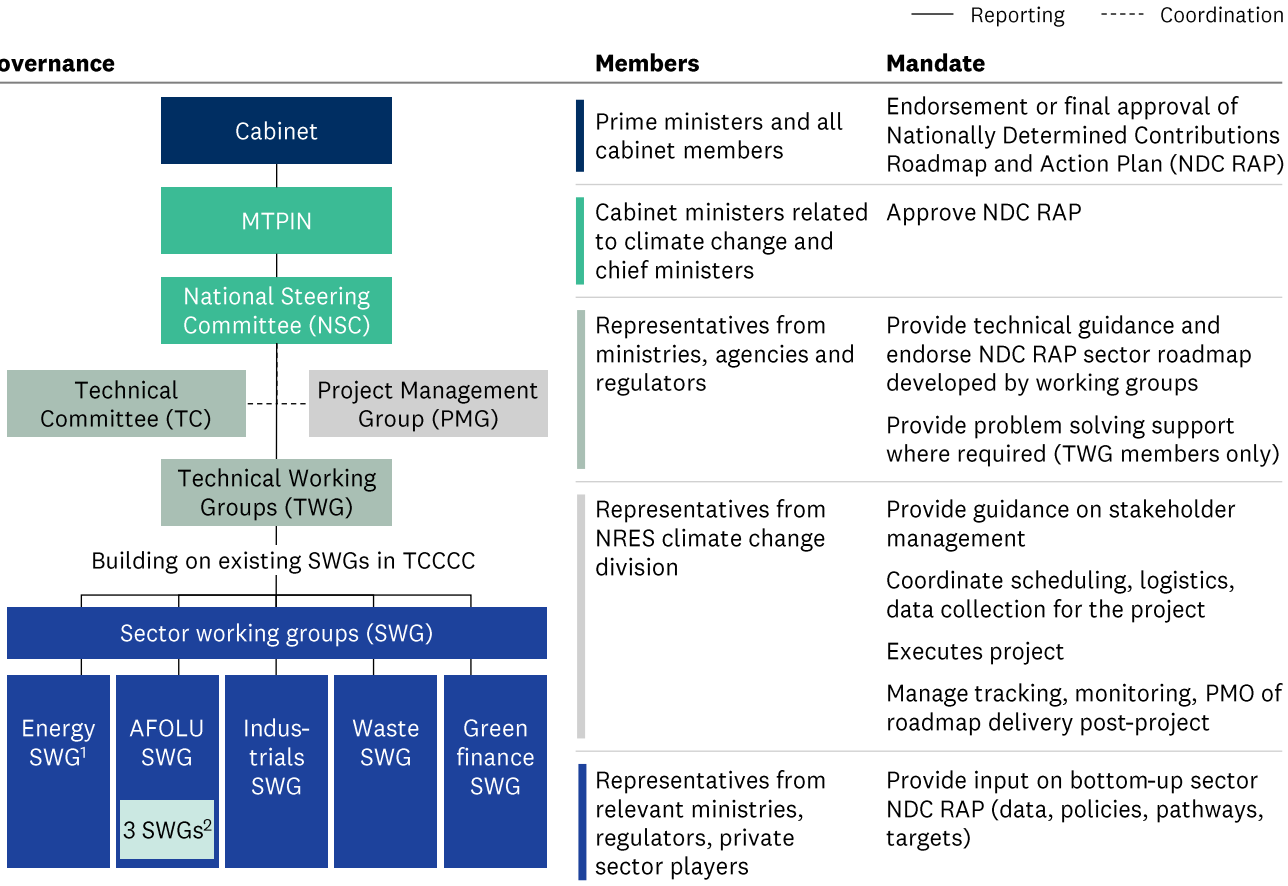
Stocktake of national policies integrated into the report

The purpose of the stocktake was to ensure a holistic view of mitigating policies and measures across the sectors. These formed a crucial input into scenario modelling as well as stakeholder engagements, as the project team sought to further refine the quantification of each of these policies and measures. The stocktake comprised of announcements or documents published between 2005 and end 2023. These included national policies, ministry roadmaps, official announcements (by ministries, agencies, regulators, and private players), and company publications (e.g., annual reports, sustainability reports). Where relevant, documents published by international organisations such as METO were also included. Further details on consulted documents are in the Appendix of this document. Mitigating measures were initially classified into one of three categories:

- **Implemented:** policies or measures that have been put in place with concrete steps taken towards implementation (e.g., alignment on KPIs to be reported, budget successfully approved). These also include targets that have been announced and achieved as at 2023;
- **Forthcoming:** policies or measures that have been announced, and are in the process of being implemented (e.g., cabinet paper or enactment currently being tabled, taskforce being set up to oversee implementation); and
- **Announced:** announcements, which have not been actioned upon yet.

These existing policies and mitigating measures were then presented to SWG members for further clarification, and to enable them to add to these. SWG members also helped

Exhibit 4-1
Governance structure for the project



1 Includes representatives from state governments in the energy sector
2 3 SWGs: Peninsular Malaysia, Sabah, Sarawak

refine the initial classification further. Once all input was incorporated, these policies, mitigating measures, and targets were used as the basis of scenario modelling.

Scenario development methodology

Following the stocktake and stakeholder engagements, three scenarios were modelled based on scenarios defined by the UNFCCC in Decision 18/CMA.1[1]. These scenarios are further illustrated in Exhibit 4-2, and are the Without Measures (WOM) scenario, With Existing Measures (WEM) scenario, and With Additional Measures (WAM) scenario. Data collected over the process of the policy stocktake were used as the basis of assumptions to be included in each scenario, based on the criteria and cut off dates defined in each scenario:

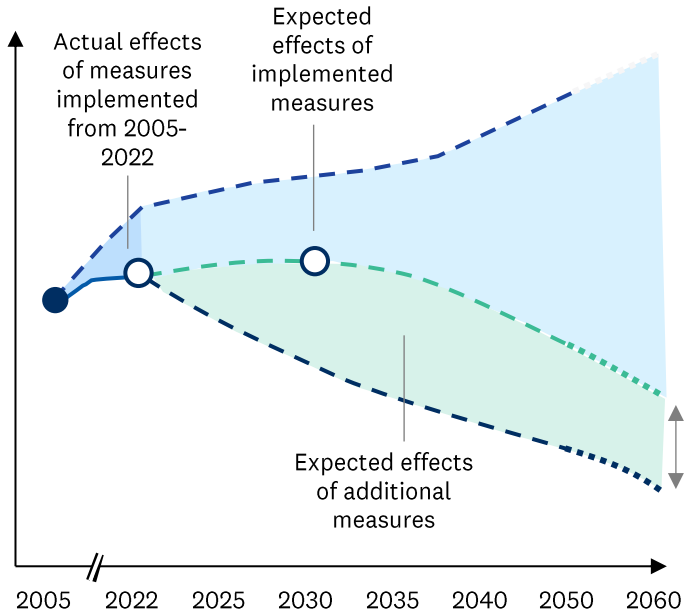
- **Without measures scenario (WOM):** this scenario excludes all policies and measures implemented, adopted, and planned post 2005. This is a hypothetical scenario that illustrates how sectoral emissions could have evolved in the absence of decarbonisation initiatives;
- **With existing measures scenario (WEM):** this scenario includes all currently implemented and adopted policies and measures from 2005 onwards up to December 2022, the defined cut off point. This scenario illustrates the impact of decarbonisation measures announced up to December 2022, and the potential emissions profile resulting from potential effects of these measures; and
- **With additional measures scenario (WAM):** this scenario includes all policies and measures announced from January 2023 onward, up to January 2024, the time of writing of this report. This scenario illustrates the potential impact of policies and measures that are planned and announced but have not been implemented yet – and incorporates recent forthcoming or published sectoral plans shared by stakeholders (e.g., forthcoming plans for decarbonisation by private sector players).

[1] Decision 18/CMA.1 defines these scenarios: "a 'with measures' scenario encompasses implemented and adopted policies and measures. If provided, a 'with additional measures' scenario encompasses implemented, adopted and planned policies and measures. If provided, a 'without measures' projection excludes all policies and measures implemented, adopted and planned after the year chosen as the starting points for the projection"

Exhibit 4-2
Illustrative Pathway Scenarios

Greenhouse gas (GHG) emissions intensity, tCO_2e/GDP

ILLUSTRATIVE



1. WOM 1

Without measures (WOM) scenario

- Excludes all policies and measures implemented, adopted and planned post-2005 (base year)
- Business-as-usual scenario

2. WEM 2

With existing measures (WEM) scenario

- Includes currently implemented and adopted policies and measures, from 2005 onwards
- Projections from latest GHG inventory year up to 2050 based on potential effects of existing policies being implemented

3. WAM 3

With additional measures (WAM) scenario

- Additional policies that Malaysia could adopt to achieve its decarbonisation targets
- Projections from latest GHG inventory year up to 2050 based on announced future policies or potential additional measures

SOURCE: United Nations Framework Convention on Climate Change (UNFCCC)

05

Without Measures (WOM) Scenario

With existing measures (WEM) Scenario

With additional measures (WAM) Scenario

Malaysia's decarbonisation strategies

Malaysia's potential economy-wide decarbonisation pathways

Without Measures (WOM) Scenario

Without any policies and mitigating measures implemented past 2005, Malaysia's net emissions could have reached 357 $MtCO_2e$ by 2030. This is significantly higher than the estimated level of emissions in Malaysia in a WEM scenario of 148 $MtCO_2e$, further detailed in the following subchapter. A comparison of WOM against projected country-wide WEM and WAM is shown in Exhibit 5-1.

Significantly higher emissions in a WOM scenario are the theoretical result of key mitigating measures introduced from 2005 onwards not occurring. These include:

- No renewables being introduced in the Power subsector;
- No electrification of mobility and sustainable fuels adopted by the Transport subsector;
- No energy efficiency savings achieved in the Energy sector as a whole;
- No treatment of generated waste in the Waste sector; and
- No restoration initiatives or reduction in annual deforestation over time.

With Existing Measures (WEM) Scenario

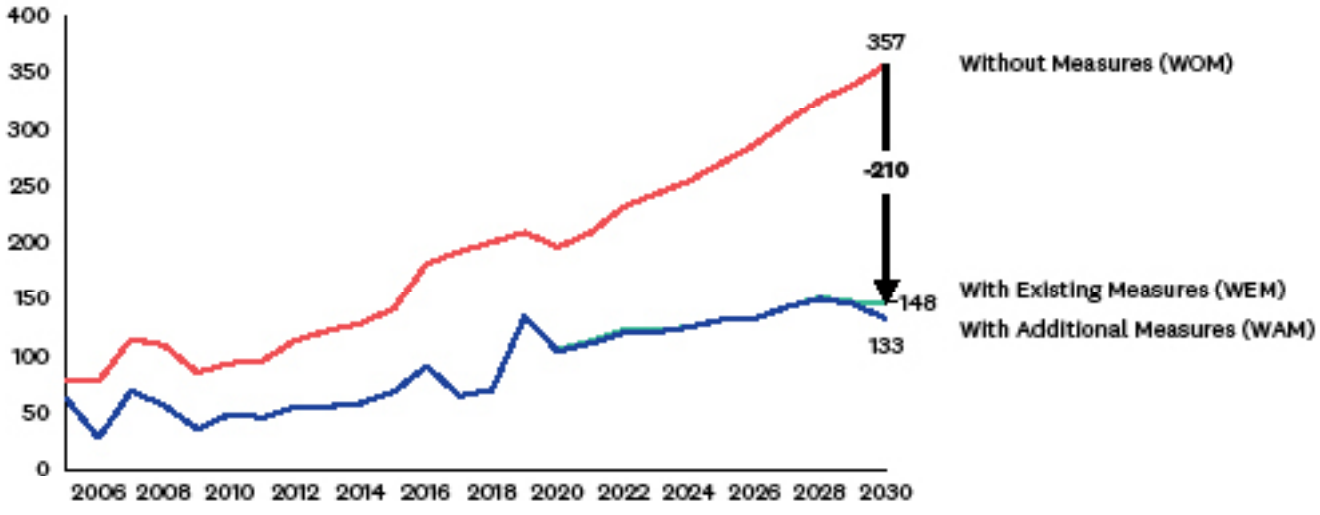
Under the WEM scenario, Malaysia's emissions are projected to increase by 28% in 2030 to 148 $MtCO_2e$. Reductions relative to the WOM scenario are largely driven by energy sector decarbonisation measures, such as initiatives implemented under the power sector's 2022 Peninsular Malaysia Generation Development Plan published by the *Jawatankuasa Perancangan dan Pelaksanaan Pembekalan Elektrik dan Tarif (JPPPET)*, and emissions reduction targets in the oil and gas sector (e.g., planned plant-up of renewable capacity and methane reduction targets). Based on preliminary analyses, Malaysia could potentially achieve its NDC target under the WEM scenario.

Increases in emissions are projected be driven by the Industrial Processes and Product Use (IPPU) sector. Given that manufacturing will remain an important driver of the Malaysian economy, both energy and process emissions could grow due to announced capacity plant-ups and increased production levels. Waste sector emissions could also grow given increases in population and urbanisation growth.

Agriculture, forestry, and other land use (AFOLU) could remain a significant net sink under measures announced. A summary of Malaysia's potential emissions profile and sectoral evolutions over time is illustrated in Exhibit 5-2.

Exhibit 5-1
Malaysia's emissions in a Without Measures scenario

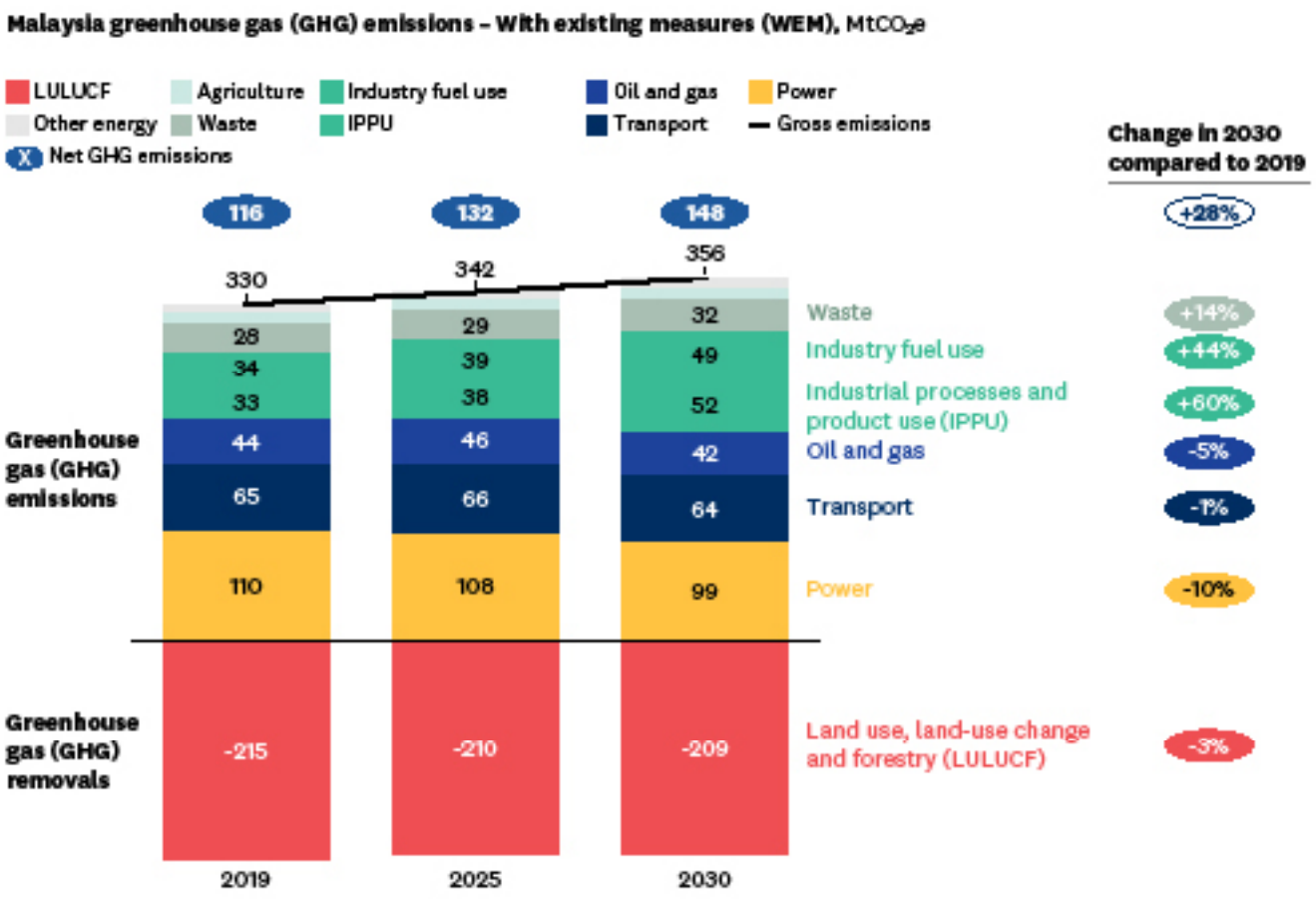
Malaysia's net emissions[1] including Land Use, Land-Use Change and Forestry (LULUCF), $MtCO_2e$



1 Pre-2020 data in the scenarios reflect actual historical emission figures

Source: Malaysia reports to United Nations Framework Convention on Climate Change (UNFCCC) (e.g., BURs, NCs), press search

Exhibit 5-2
With existing measures scenario



SOURCE: SWG input across all sectors, publications and announcements by ministries and private sector players, industry association data, Ministry of Economy

With Additional Measures (WAM) Scenario

Under the WAM scenario, Malaysia's emissions are projected to grow by 17 $MtCO_2e$ compared to 2019 by 2030 to 133 $MtCO_2e$. This is shown in Exhibit 5-3. These reductions are largely driven by:

- **Higher ambitions and targets set in energy sector**, notably the power sector's higher renewable capacity mix of 45%[1] of installed capacity by 2030 and energy efficiency gains;
- **Increased decarbonisation in the IPPU sector**, including a shift to low carbon alternatives in manufacturing; and
- **Retention of AFOLU as a vital sink**, with additional gains projected based on lower projected deforestation and improved forest management.

It should be noted that the increase in Waste emissions is more gradual due to a projected increase in treatment via Waste to Energy plants. These could generate similar emissions per tonne of waste as landfilling[2].

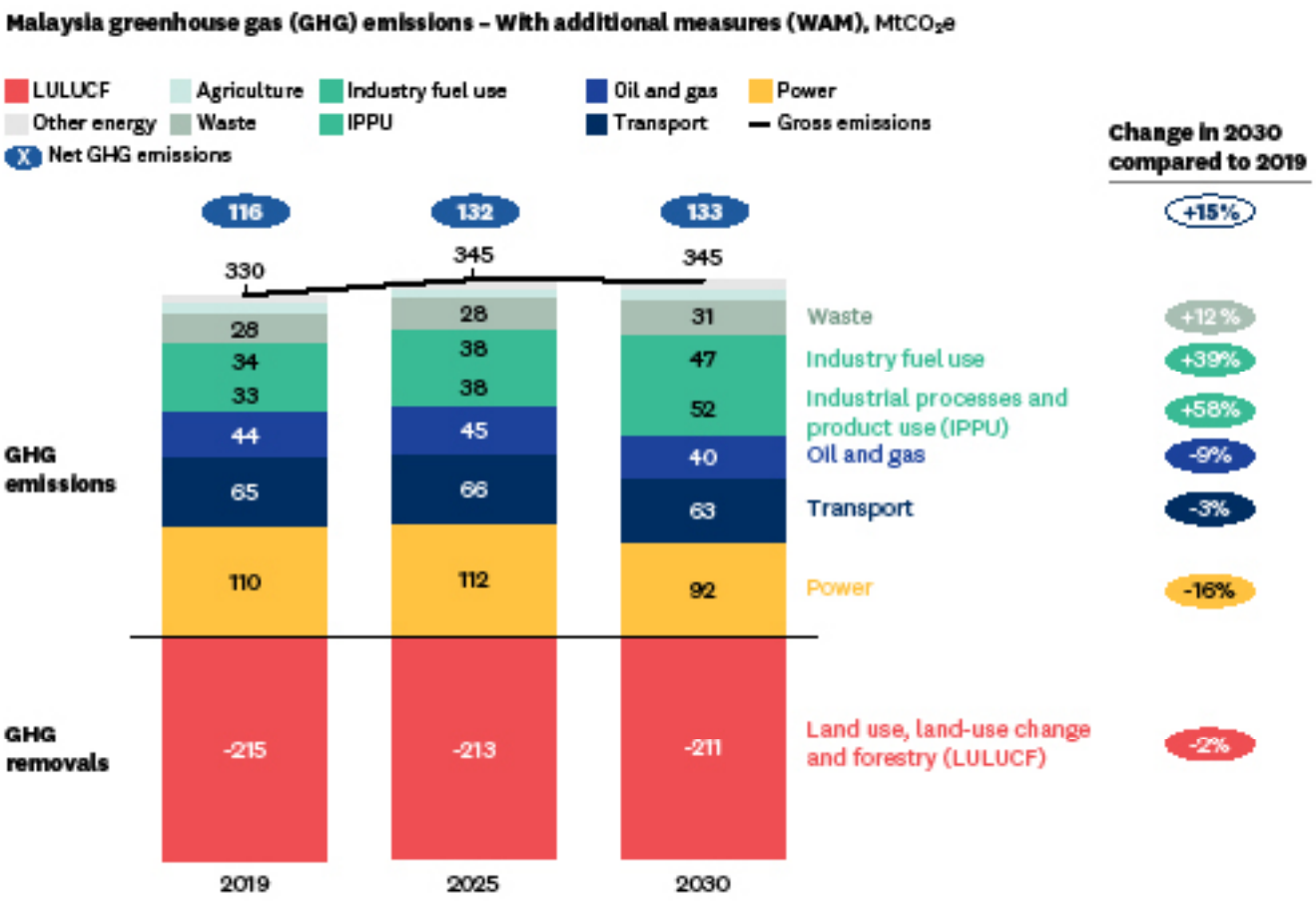
Further details on sectoral decarbonisation across scenarios are discussed in the following chapter.

Malaysia's decarbonisation strategies

Malaysia's decarbonisation strategies can be broken into 15 distinct sector-specific initiatives, as shown in Exhibit 5-4. These illustrate the driving forces that could influence how decarbonisation across each of the six sectors of focus (power, transport, oil and gas, industries, agriculture, forestry and land use, and waste) could evolve over time.

1 Excluding RE connected at distribution level, that accounts for approximately 10% of total capacity (WAM)
2 Emissions from Waste to Energy technologies are dependent on the type of technology used. Emissions from landfilling are dependent on various factors (including waste composition) pertaining to the waste being landfilled.

Exhibit 5-3
With additional measures scenario



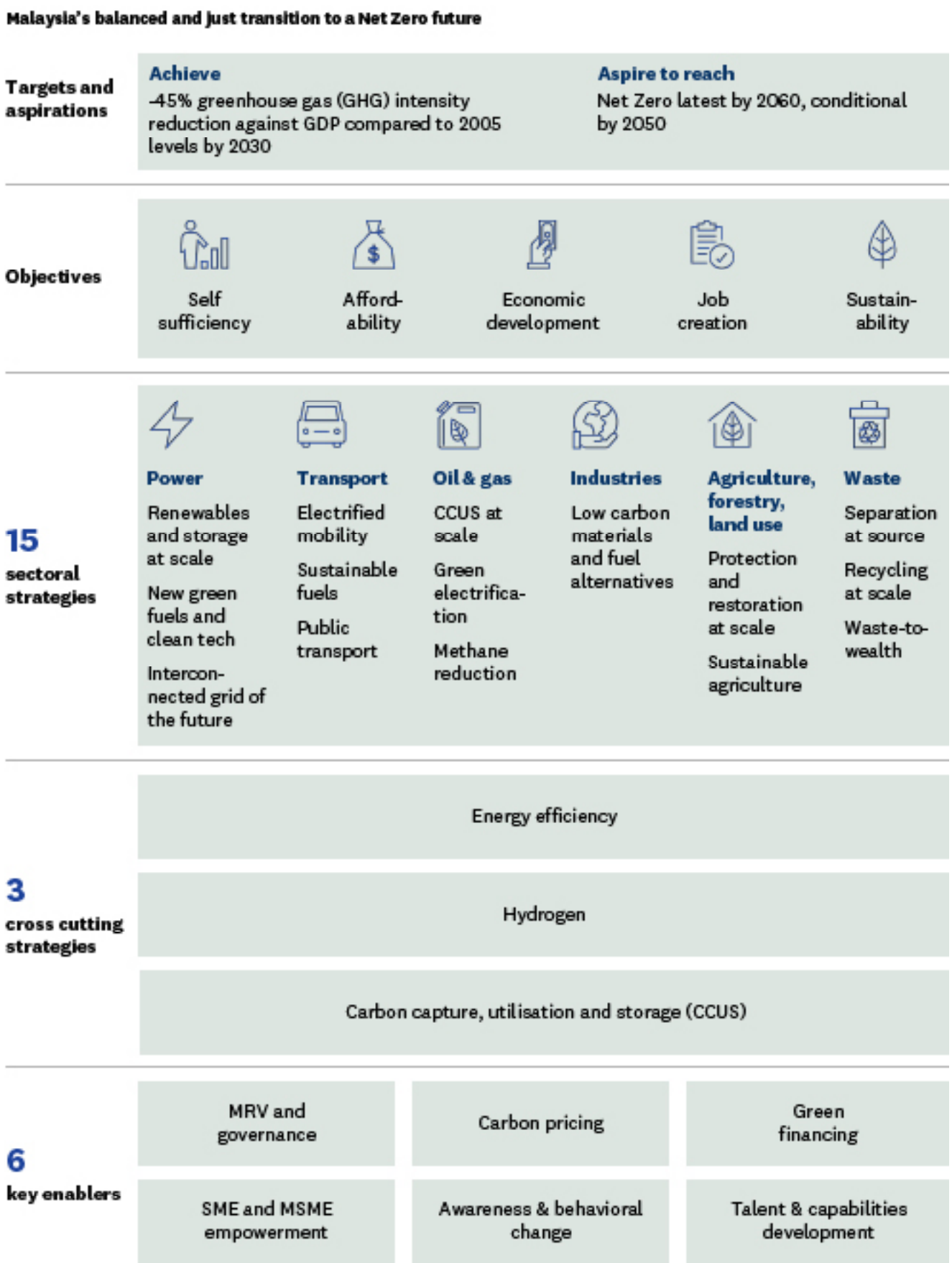
SOURCE: SWG input across all sectors, publications and announcements by ministries and private sector players, industry association data, Ministry of Economy

In addition, three cross cutting strategies were identified: energy efficiency, hydrogen, and CCUS. These are complemented by six enablers required to support both the sectoral and cross-sectoral strategy: monitoring, reporting, and verification and governance, carbon pricing, green financing, SME and MSME empowerment, awareness and behavioural change, talent and capabilities development.

These sectoral, cross sectoral decarbonisation strategies, and enablers are anchored on Malaysia's target to achieve 45% GHG intensity reductions against GDP compared to 2005 levels by 2030. These strategies and enablers also consider the impact of decarbonisation against the five decarbonisation objectives: self-sufficiency, affordability, economic development, job creation, and sustainability.

The following two chapters discuss these strategies and enablers in further detail.

Exhibit 5-4
Overview of Malaysia's decarbonisation strategy




H_2
H_2
CO_2
CO_2

06

Power

Transport

Oil and Gas

Industry Fuel Use

Industrial Processes and Product Use (IPPU)

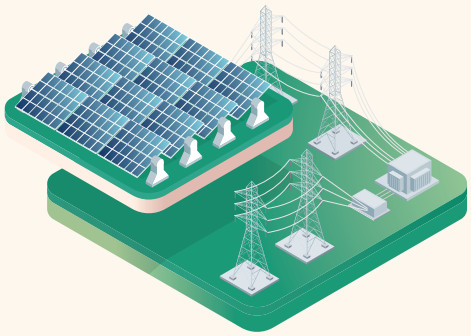
Agriculture

Forestry and Other Land Use

Waste

Sector pathways

Power



Sectoral starting point

The power sector contributed 33% (110 $MtCO_2e$) to Malaysia's emissions in 2019. These emissions are primarily driven by the use of conventional fuels (i.e., gas, coal, and diesel) in electricity generation. The required generation is driven by demand growth from increased economic activities and behavioural changes. However energy efficiency (EE) and distributed generation (DG) improvements partially mitigate the growth in emissions, as illustrated in Exhibit 6-1. The Peninsular Malaysia, Sabah, and Sarawak power sectors are each uniquely distinct. In a nutshell:

- **Peninsular Malaysia** forms the majority of power sector emissions due to its significant reliance on conventional fuels and higher generation requirements (demand) compared to the other two regions. Since 2010, electricity intensity has decreased by 20% due to EE and DG initiatives, such as the National Energy Efficiency Action Plan (NEEAP) and the Net-Energy Metering (NEM) programme;

- **Sarawak** primarily depends on hydroelectric energy, with hydro comprising 75% of its generation mix. Hydroelectric generation continues to grow due to significant state focus on development of hydropower with programmes such as the Sarawak Corridor of Renewable Energy (SCORE). Electricity intensity has surged fourfold since 2010, largely attributed to the growth of bulk power industrial customers from the SCORE initiative. These customers represented 65% of total electricity sales in 2019; and

- **Sabah's** low electricity generation levels (comprising 4% of total Malaysia electricity generation) have resulted in relatively low absolute emissions, despite its reliance on gas. The state also has the highest proportion of diesel in its supply mix. Consequently, Sabah's grid emission factor is higher than Sarawak's, but its overall power sector emissions remain the lowest amongst the three regions due to lesser electricity demand. However, Sabah currently faces hurdles in securing its energy supply with the lowest reserve margins among all regions – and is currently seeking to improve its security of supply as part of the Sabah Energy Roadmap and Master Plan (SE-RAMP).

Exhibit 6-1
Power sector starting point

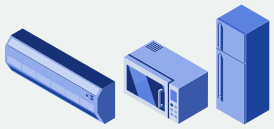
Power sector accounts for 33% of Malaysia's total emissions, making it the largest emitting sector

Demand

+ Electrification

Final energy consumption growth (2019 compared to 2010)

Residential and Commercial	15%
Industry	46%



− Energy efficiency improvements

NEEAP targets 8% reduction in energy demand compared to baseline by 2025

− Distributed generation

Programmes under NEM 3.0[1]:

NOVA	800 MW
Rakyat	150 MW
GoMEN	100 MW

Supply

Fuel type	Power sector greenhouse gas (GHG) emissions[2], $MtCO_2e$ 2019	Generation mix[3], TWh 2019	Installed capacity, GW 2019	Key insights
Coal	75	76 (44%)	13 (37%)	• Conventional power plants operate mainly under long-term PPAs[4] • Conventional fuels make up 80% of generation mix and installed capacity; coal has higher generation and emissions proportion driven by higher dispatch • Coal and gas account for 99% power sector emissions
Natural gas	31	66 (38%)	14 (41%)	
Diesel	2	1 (1%)	0.5 (2%)	• Diesel generation constitutes 1% generation and emissions in the overall system, with slightly higher proportion in Sabah
Hydro	0	26 (16%)	6 (17%)	• 20% of installed capacity in Malaysia is Renewable Energy • High levels of hydro penetration in Sarawak (3.5 GW, or 55% of total hydro capacity in Malaysia) • Increases in solar installed capacity have been driven by the Large Scale Solar programmes in Peninsular and Sabah
Solar	0	1 (1%)	1 (3%)	
TOTAL	**110**	**100%**	**100%**	

1 Programs under Net Energy Metering (NEM) 3.0 include Net Offset Virtual Aggregation (NOVA), NEM Rakyat and for GoMEn (Government Ministries and Entities)
2 Estimated based on energy inputs in National Energy Balance and Sarawak Energy Annual Report, may not sum up to exact 110 $MtCO_2e$;
3 Generation mix for Solar and Others estimated based on National Energy Balance figures
4 Power Purchase Agreements

SOURCE: National Energy Balance 2019, Malaysia Malaysia Fourth Biennial Update Report (BUR4), World Bank data, Sarawak Annual Report 2019, Malaysia Grid Emission Factor Report 2017-2019

Pathways across each scenario

Without measures (WOM), emissions could decrease by 57% in 2030 compared to 2019 levels. With existing measures (WEM), emissions could decrease by 10% compared to 2019 levels in 2030 (to 99 $MtCO_2e$). With additional measures (WAM), emissions could reduce by 16% compared to 2019 by 2030 (to 92 $MtCO_2e$). The power sector's decarbonisation pathways under the WOM, WEM and WAM scenarios are further illustrated in Exhibit 6-2.

The exhibit also shows the four key mitigating levers that underpin these scenarios and shape the power sector's emissions trajectory and how they could evolve over time. These are:

- **Renewables and storage at scale:** Share of renewable energy (RE) in grid-connected generation mix, uptake of RE-based DG (e.g., rooftop solar), and adoption of battery energy storage system (BESS); and long-duration energy storage (LDES);
- **New green fuels and clean technologies:** Deployment of clean technologies in generation supply (e.g., bioenergy);
- **Grid modernisation:** Investments in transmission and distribution grids and interconnection capacity (both domestic and international); and
- **Energy efficiency:** A cross-sectoral lever, this refers to the extent of residential, industrial, and commercial EE saving targets.

Additionally, the decarbonisation pathway of the power sector is highly interconnected with other sectors. Electricity demand from the transport and industrial sectors could greatly impact the total generation requirement and impact power sector emissions. On the supply side, decisions regarding installed capacity and generation mix are closely tied to the availability and price of fuels (e.g., coal, natural gas, hydrogen, biofuels).

Key sectoral strategies

Targets

At the national level, Malaysia has invested considerable effort into its energy transition, most recently through the National Energy Policy (NEP) and National Energy Transition Roadmap (NETR). These policies outline multiple energy transition levers and initiatives, many of which directly drive decarbonisation in the power sector. Forthcoming policies that could further drive decarbonisation efforts include the National Energy Efficiency Action Plan 2.0 (NEEAP 2.0), which builds on the efforts of the first NEEAP.

At the regional level, Malaysia has also set out plans promoting a greener approach to grid-connected generation and the overarching power sector. The 2022 Peninsular Malaysia Generation Development Plan and the subsequent 2023 Peninsular Malaysia Generation Development Plan forecasts a substantial rise in RE share for the Peninsular Malaysia power sector. The generation development plans for Sabah and Sarawak, developed by Single Buyer Sabah (SB Sabah) with the Energy Commission of Sabah (ECoS), and Sarawak Energy Berhad (SEB) with the Ministry of Energy and Environmental Sustainability (MEESTy) are set to further increase the level of RE penetration in both regions as well.

The following are the main mitigating measures accounted for in each scenario – which are also indicated in Exhibit 6-3.

"With existing measures" mitigation strategies (based on policies prior to 2022):

- **Renewables and storage at scale:** by 2030, achieve 35% RE capacity share (excluding DG), 6 GW grid-connected solar capacity, 0.5 GW RE-based DG capacity, and 5 GW storage capacity; and
- **Energy efficiency (cross sectoral):** 8% EE savings across residential, industrial, and commercial in 2025

"With additional measures" raise or add to the levers in WEM (based on policies post-2022):

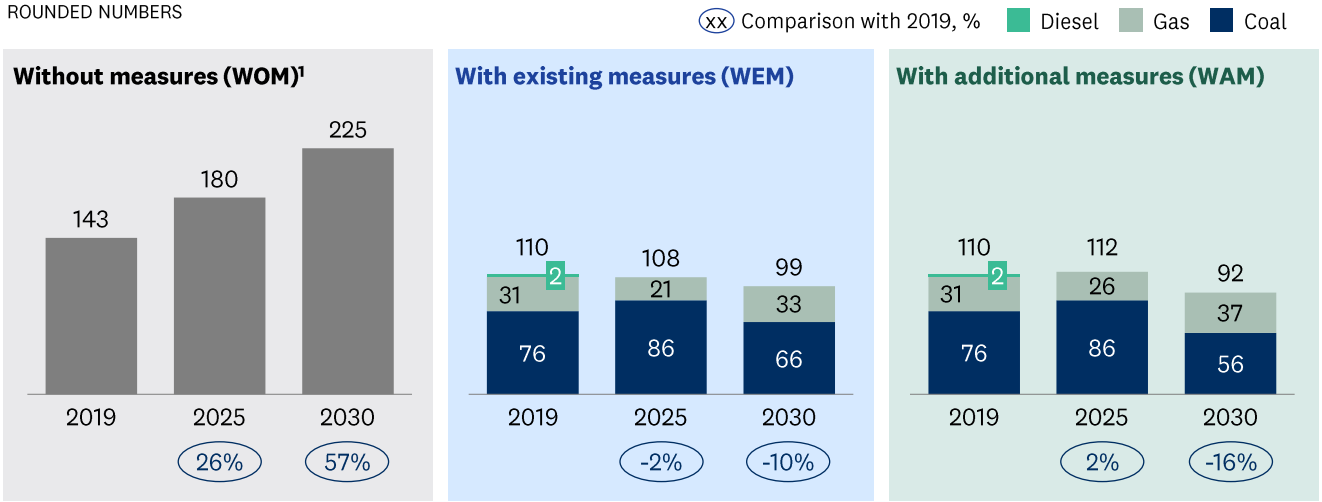
- **Renewables and storage at scale:** by 2030, achieve 45% RE capacity share (excluding DG), 25 GW grid connected solar capacity, 17 GW RE based DG capacity, and 12 GW storage capacity;
- **New green fuels and clean technologies:** by 2030, achieve 0.7 GW bioenergy capacity;
- **Interconnected grid of the future:** by 2030, achieve 2 GW interconnection capacity; and
- **Energy efficiency (cross sectoral):** 10% savings across residential, industrial, and commercial in 2030.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- **Self sufficiency** could improve over time given the increased reliance on domestic interconnections and solar energy in WAM, and reduced reliance on imported coal (though some portions of interconnection based electricity will be imported from abroad);
- **Affordability** could improve over time given that renewables have reached parity with conventional fuels – and increased insulation of Malaysian electricity tariffs from fluctuations in international commodity markets. However this is also dependent on the relative prices of interconnection-based electricity and LDES compared to coal and gas;
- **Economic development** could improve as Malaysia seeks to grow solar panel manufacturing value chains domestically – and higher solar penetration underpins the WAM scenario;
- **Job creation** could improve as a side effect of catalytic investments in solar panel manufacturing mentioned above; and
- **Sustainability** could improve as RE penetration grows over time in WAM.

Exhibit 6-2
Power sector pathways and mitigation levers by scenario

Power sector greenhouse gas (GHG) emissions pathways, $MtCO_2e$
ROUNDED NUMBERS



Lever		Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Renewables and storage at scale	Renewables capacity share	**20%** installed capacity share	**0%** installed capacity share	**35%** installed capacity share	**45%** installed capacity share
	Grid-connected solar[2]	**1 GW**	**N/A**	**6 GW**	**25 GW**
	RE distributed generation capacity	**0.5 GW**	**N/A**	**0.5 GW**	**17 GW**
	Energy storage capacity	**0 GW**	**N/A**	**5 GW**	**12 GW**
New green fuels and clean tech	Bioenergy capacity	**0.3 GW**	**N/A**	**0 GW**	**0.7 GW**
Interconnected grid of the future	Interconnection	**0 GW**	**N/A**	**0.5 GW**	**2 GW**
Cross sectoral Energy efficiency	Industrial & commercial energy efficiency (EE)	**2%** savings	**N/A**	**8%** savings in 2025, remains flat after	**10%** savings
	Residential energy efficiency (EE)				**10%** savings
	Electricity demand growth		**1.5 – 2%**	**1.5 – 2%**	**2 – 2.5%**
	Electric vehicles (EV) sales penetration	**<1%** total vehicle sales	**N/A**	**15%** total vehicle sales	**20%** total vehicle sales

1 Based on sector emission intensity in 2005 and projected using real GDP growth rates (historical and forecast)
2 Excluding RE connected at distribution level, that accounts for approximately 10% of total capacity (WAM)

SOURCE: National Energy Balance, National Energy Policy, NEEAP, MyRER, METO, JPPPET, Sabah Electricity Supply Industry Outlook 2019, Sarawak Energy Berhad Annual Report, expert interviews, stakeholder engagements

Exhibit 6-3
Overview of power sector decarbonisation strategies

Power: Key levers to ensure decarbonization in the power sector include endorsing efforts to scale RE capacity, pilot new green fuels, and enabling grid access
NON-EXHAUSTIVE

	1. Renewables and storage at scale	2. New green fuels and clean technologies	3. Interconnected grid of the future	4. Energy efficiency (cross-sectoral)
	% share of RE installed capacity[1]	*Bioenergy capacity, GW*	*Investments in transmission and distribution grids*	*% share of EE target*
From (today)	**20%**	**0.3**	**-**	**<5%**
2030	**45%**	**0.7**	**-**	**10%**
Potential enablers	• **Enhance current Large Scale Solar mechanisms** to accelerate uptake of utility-scale solar (e.g., one bid per company, at a maximum capacity of 50-100 MW per project) • **Enhance Corporate Green Power Programme** ("CGPP") mechanism to allow selling of excess power to grid and address project size limitation • **Establish structural mechanisms to support** the research, development, and **adoption of Long Duration Energy Storage** (e.g., 8 to 10 hours)	• **Pilot other new green fuels (e.g., bioenergy)** to assess domestic techno economic viability • **For viable technology, address challenges of supply security** to ensure adequate supply of feedstock	• Scale up **SMART Distribution Network** (e.g., smart meter, distributed energy resource software) to promote and support higher Distributed Generation capacity • Invest in grid enhancements (e.g., advanced grid management.) to **manage grid stability** • **Develop Third-party access ("TPA") framework**	• Enhance or extend **existing EE initiatives and their respective targets** (e.g. via National Energy Efficiency Action Plan 2.0 or Energy Efficiency and Conservation Act), including new initiatives targeted at **energy intensive users**

Initiatives and path forward

Renewables and storage at scale

Malaysia has announced a target of 70% RE installed capacity share by 2050, with solar photovoltaics (solar PV) expected to encompass a significant share of the capacity. The roadmap to achieve this national target is detailed in the 2023 Peninsular Malaysia Generation Development Plan, and respective generation development plans in Sabah and Sarawak. Additionally, NETR has outlined several RE initiatives within its Renewable Energy lever.

Analysis of Malaysia's favourable irradiation and unused suitable land (accounting for land use constraints such as protected areas) by the Sustainable Energy Development Authority (SEDA) suggests that Malaysia could have up to 210 GW of ground mounted solar potential – with more capacity available on rooftops and bodies of water for floating solar installations. Given the potential increase in solar penetration in Malaysia, this could inevitably create a need for short and long duration battery storage for applications that span balancing of intra-day variability to being a key ancillary services provider that supports voltage and

frequency regulation. The combination of solar and storage can also help convert energy produced by non-dispatchable technologies (e.g., solar) into dispatchable energy through storage under the management of system operators.

To facilitate the increase of solar PV and battery storage capacity in grid-connected system, further initiatives could be considered, including:

- Conducting a study of the Grid penetration limit to enable and facilitate accelerated solar deployment;
- Enhancing current LSS mechanisms and criteria for solar and LSS projects to accelerate uptake of utility-scale solar (current regulations indicate one bid per company, at a maximum capacity of 50-100 MW per project); and
- Establishing regulations and structural mechanisms to support the research, development, and adoption of storage and LDES (e.g., 8 to 10 hours), which helps address intermittency issues at high variable renewable energy (VRE) penetration.

Meanwhile, adoption of RE-based DG could be improved by:

- Developing and scaling up innovative consumer financing schemes for DG adoption;
- Expanding the virtual aggregation model for rooftop solar; and
- Redesigning the tariff to address potential cost shifting.

Renewables at scale has also been adopted by Sabah as a key strategy designed to protect its energy security and improve access to electricity among its rural communities. Specifically, Sabah under the SE-RAMP is targeting 100% rural electrification through leveraging affordable indigenous RE sources. It also targets diversification of its generation mix for improved energy security – largely through increasing renewables contribution in its generation mix.

New green fuels and clean technologies

While solar energy and storage remain the most viable RE sources at present, Malaysia is committed to exploring and scaling other clean technologies. These include exploring the techno economic viability of other green fuels such as bioenergy and waste to energy.

New green fuels also form an important component of recent policies such as NETR and SE-RAMP, where green fuels is also seen as an enabler to enable Sabah to diversify its generation mix to improve its security supply and meet its Herfindahl-Hirschman Index (HHI) targets.

Initiatives that could enable Malaysia to explore and scale new green fuels include:

- Piloting other new green fuels to assess domestic techno economic viability; and
- For viable technology, addressing challenges of supply security to ensure an adequate supply of feedstock.

Interconnected grid of the future

Higher penetration of variable renewable energy (VRE) necessitates enhanced grid readiness and access to enable continued grid stability and reliability. Moreover, interconnections could also be explored as a viable form of firm RE capacity in enabling Malaysia's RE target. These include exploring domestic interconnections (such as those from Sarawak to Peninsular and Sarawak to Sabah) as well as international interconnections – including those under development as part of the ASEAN Power Grid initiative.

Investing in the interconnected grid of the future could require initiatives that include:

- Developing a plan for accelerated investments in transmission and distribution grids, including scaling up the Smart Distribution Network (e.g., smart meter, distributed energy resource enabling software) to promote and support higher DG capacity;
- Developing a third-party access (TPA) framework for sourcing of RE;
- Developing a plan for new international interconnections, and bilateral or multilateral agreements to enable this;
- Developing a regulatory framework on domestic interconnections; and
- Setting up an RE exchange hub to enable cross-border RE trading.

Cross sectoral initiatives: energy efficiency

Besides increasing the share of RE, decarbonisation drivers to address the demand-side and use of conventional fuels are crucial for Malaysia's decarbonisation journey. EE is one of the primary measures that significantly counteract demand.

The NEEAP has outlined a plan to drive savings of 10-11% compared to baseline in 2025. Recent publications including NETR and the recently passed Energy Efficiency Conservation Act (EECA) seek to further raise these targets to 20% EE savings for Residential, and 23% EE savings for Industrial and Commercial.

Initiatives that could help Malaysia achieve these EE savings target include:

- Improving EE awareness;
- Improving existing Minimum Energy Performance Standards (MEPS) and 5-star rating bands;
- Enforcing mandatory audits for large commercial and industrial buildings;
- Establishing green building codes for energy-intensive residential and commercial buildings;
- Establishing an Energy Service Company platform; and
- Launching a major EE retrofit initiative amongst government buildings.

Cross-sectoral enablers

Green financing

The power sector will require significant investments to enable its decarbonisation due to the capital-intensive nature of the industry. Meeting these financial needs calls for collaboration between the public and private sectors to mobilise and attract both public and private capital towards energy transition projects. Furthermore, catalytic investments (e.g., blended finance) are essential to enable projects that are economically and technically unviable today (such as hydrogen and gas CCUS – if these become techno-economically viable in the long term). The Malaysian government has taken steps towards facilitating these investments – most recently through the setup of the RM 2 billion National Energy Transition Facility.

Summary of power strategy and initiatives

Strategy 1: Renewables and storage at scale

1.1 Accelerate solar and storage deployment

★ Conduct study of grid penetration limit

- Enhance current LSS mechanism and programme criteria for solar / LSS projects to enable higher limits post Grid penetration limit study

★ Implement regulations on and provide clarity on planned BESS business models to enable further research, development, and scaling of deployment

★ Implement regulatory sandbox to enable research, development, and experimentation with LDES

1.2 Improve Renewables and Distributed Generation adoption

- Develop and scale innovative consumer financing schemes to encourage takeup
- Expand virtual aggregation model for rooftop solar
- Redesign tariff in Peninsular Malaysia to address potential cost shifting given expected increases in penetration

Strategy 2: New green fuels and clean technologies

- Pilot other new green fuels (e.g., bioenergy) to assess domestic techno economic viability
- For viable technology, address challenges of supply security

Strategy 3: Interconnected grid of the future

3.1 Scale up grid investment

- Develop plan for accelerated investments in transmission and distribution grids, including scaling up the Smart Distribution Network to promote and support higher DG capacity and manage grid stability
- Develop a TPA framework for sourcing of RE
- Improve grid stability and access to electricity in Sabah (particularly in rural Sabah) - through RE installations, mini grids and installation of transmission lines

3.2 Enable domestic and international interconnections

- Develop plan for investment in and expansion of existing international interconnections (e.g., Thailand)
- Set up RE exchange hub to enable cross-border RE trading
- Develop regulatory framework for domestic interconnections, and bilateral agreements to enable this

★ New initiative ★ Dependent on inflection point being met

Cross sectoral strategies[1]

Energy efficiency

CS1.1 Raise EE savings targets among domestic, industrial, and commercial consumers

- Improve existing MEPS and 5-star ratings bands
- Enforce mandatory audits for large commercial and industrial buildings
- Establish green building codes for energy intensive residential and commercial buildings
- Strengthen incentive schemes to encourage industrial players to pilot or adopt EE initiatives
- Establish an Energy Service Company platform
- Launching a major EE retrofit initiative amongst government buildings
- Promote cogeneration in industries and commercial buildings through the removal of barriers
- Incorporate EE in new building designs and constructions
- Engage industry players to understand challenges in adopting EE and RE
- Strengthen incentive schemes to encourage industrial players to pilot or adopt EE initiatives
- Develop and implement the Sabah Energy Efficiency Action Plan

Transport

Sectoral starting point

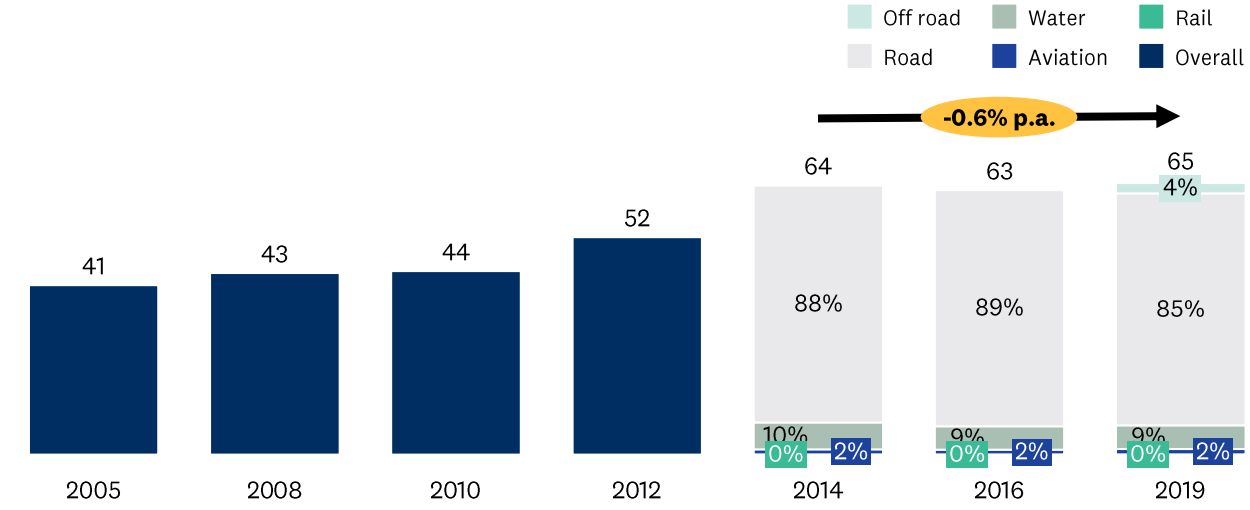
The transport sector drives 20% of the nation's total emissions (65 $MtCO_2e$), with fuel use from road transport generating the largest share of transport emissions (85%; or 55 $MtCO_2e$). Domestic waterborne navigation, domestic aviation, rail, and other off-road vehicles'[1] fuel consumption contributes to the remaining share. Transport emissions, excluding off-road, have declined 1% per annum between 2014 – 2019, a result of gradually increasing adoption of electrified vehicles (xEV)[2] and higher biodiesel blending (from B7 in 2014 to B10 in 2019). This is summarised in Exhibit 6-4, which showcases the transport sector's starting point.

Malaysia has ramped up several measures to support the decarbonisation of the transport sector. This has most recently notably included providing financial incentives for xEV consumers and manufacturers, establishing a B30 mandate by 2030, and developing infrastructure to support the 50% urban public transport modal share target by 2040. Transport sector decarbonisation has been the focus of recent publications and announcements including the NIMP 2030 and Budget 2024 announcements, which included announcements of incentives to increase xEV ownership.

[1] Defined as vehicles and mobile machinery used within the agriculture, forestry, industry (incl. construction and maintenance), residential, and sectors such as airport ground support equipment, agricultural tractors, chain saws, forklifts, snowmobiles. This category was introduced in BUR4.
[2] xEV includes hybrids, BEVs and PHEVs for passenger cars and electrified motorcycles.

Exhibit 6-4
Transport sector starting point

Greenhouse gas (GHG) missions by vehicle category[1], $MtCO_2e$



CAGR (2014 – 2019), %		Key drivers of growth
Road	-0.4%	**↑ Increase in biofuel and EEV usage** • **0.7** $MtCO_2$ reduction in emissions from mitigation actions, from 1.4 $MtCO_2e$ (2014) to 2.1 $MtCO_2e$ (2019) emissions mitigated • Emission reduction largely driven by increase in **EV adoption** and **biodiesel mandate** (B7 in 2014 to B10 in 2019) • **4%** growth in vehicle stock from 2015 – 2019
Aviation	+2%	**↑ Rise in domestic trips** • **1.7%** p.a. growth in total domestic flights
Water	-2%	**↓ Decrease in ships calling to port** • **-1.3%** in total number of ships calling to port
Rail	-9%	**↓ Decrease in freight tonnes-km** • **-8% p.a.** decrease in freight tonnes-km, from 1,045 (2014) to 905 (2019)
Off road	N/A	Off-road and machinery category introduced in Malaysia Fourth Biennial Update Report (BUR4) (2019)

1. As tCO_2e was not provided by vehicle category, emissions were estimated based on activity data from BUR 1, 2, and 3, multiplied by the corresponding emission factors and conversion factors

SOURCE: MY BUR reports

Pathways across each scenario

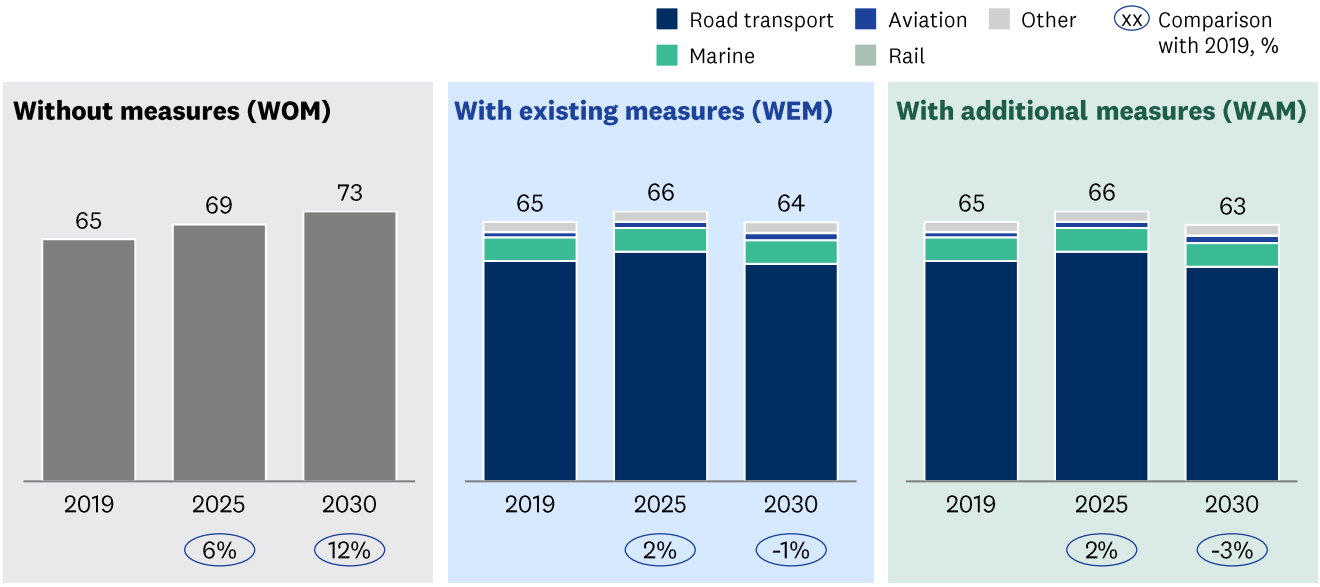
Without measures (WOM), emissions could increase by 12% in 2030 compared to 2019 levels. With existing measures (WEM), emissions could decrease by 1% compared to 2019 in 2030 (remaining largely flat at 64 $MtCO_2e$). With additional measures (WAM), emissions in 2030 would reduce marginally by 3% compared to 2019 levels. The transport sector's decarbonisation pathways under the WOM, WEM and WAM scenarios are further illustrated in Exhibit 6-5.

The exhibit also shows the three key mitigating levers that underpin these scenarios and shape the transport sector's emissions trajectory and how they could evolve over time. These are:

- **Electrified mobility:** Extent of xEV sales penetration in Malaysia;
- **Green fuels:** Share of sustainable fuel adoption (e.g., biodiesel, LNG, hydrogen) across different vehicle types; and
- **Public transport:** Extent of public transport use in urban transport modal share.

Exhibit 6-5
Transport mitigation levers by scenario

Transport sector emissions pathways, $MtCO_2e$
ROUNDED NUMBERS



20-25% improvement in fuel efficiency (litres/km) between 2019 to 2050

Lever		Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Elect. Mobility	**EV sales penetration**	**<1%** % total vehicle sales	**<1%** % total vehicle sales	**15%** % total vehicle sales[1] 5% total parc	**20%** % total vehicle sales[1] 6% total parc[1]
Sustainable fuel	**Biodiesel blending**	**B20** Road transport[2]	**B20** Road transport[2]	**B30** Blending mandate	**B30** Blending mandate
	LNG Marine fuel	**0%** LNG fuel use	**0%** LNG fuel use	**15%** LNG fuel use	**15%** LNG fuel use
Public Transport	**Public transport modal share**	**20%** % modal share	**20%** % modal share	**40%** % modal share	**40%** % modal share

1 Includes passenger cars, motorcycles, and 'other' road transport vehicles (e.g., government vehicles); Gov vehicles assume 50% penetration by 2030
2 B10 program rolled out in 2019, with B20 program implementation starting in 2020

SOURCE: Ministry of Plantation, Industries, and Commodities; Ministry of Investment, Trade, and Industry; Malaysia Green Technology Corporation; Ministry of Natural Resources, Environment, and Climate Change, Ministry of Economy

Similar to the power sector, the transport sector's decarbonisation pathways are also highly interrelated with other sectors. This includes the penetration of renewables in the power sector, oil and gas fuel prices, and the availability of sustainable fuels. As such, a whole-of-nation approach is critical for the transport sector's and Malaysia's decarbonisation journey.

Key sectoral strategies

Targets

Malaysia has introduced several targets and initiatives to chart the path forward for the transport sector, with electrified mobility identified as the biggest unlock. Recent announcements and supporting incentives have been designed to support this. The following mitigation efforts drive decarbonisation across each scenario:

"With existing measures" mitigation strategy (based on policies prior to 2022):

- **Electrified mobility:** Target of appoximately 15% xEV sales penetration by 2030 (MITI) and 38% by 2040 (NEP), as well as achieve 10,000 xEV chargers by 2025 (LCMB);
- **Sustainable fuels:** Increase in biodiesel blending from B10 to B30 (KPK) to primarily reduce emissions from diesel-based commercial vehicles, as well as target 25% LNG adoption in domestic maritime fuel use; and
- **Public transport:** Pursue 50% urban modal share by 2040 (NEP).

"With additional measures" raise or add to the levers in WEM (based on policies post-2022):

- **Electrified mobility:** Target 20% xEV sales penetration by 2030.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- **Economic development** could improve as Malaysia aspires to grow its sustainable fuels industry, local xEV manufacturing ecosystem and launch a locally manufactured xEV in alignment with its ambitions to grow xEV penetration;
- **Job creation** could improve as a side effect of catalytic investments in xEV and sustainable fuels manufacturing mentioned above; and
- **Sustainability** could improve as xEV penetration and sustainable fuels adoption grows over time in WAM. However, as indicated in the previous subchapter, the transport sector's decarbonisation pathway is interlinked with that of the power sector's. It is important to ensure that increased xEV penetration is accompanied by increased RE penetration in the power sector, otherwise the sustainability objective could be impacted[1].

It should be noted that the decarbonisation objective of affordability is, in the case of the transport sector, an enabler (i.e., of increased penetration). More information on this is found in the Box on Total Cost of Ownership.

[1] Increasing xEV penetration increases demand for power in the power sector. If grid decarbonisation does not occur in tandem with increased xEV penetration, a country can risk shifting emissions from one sector to the other (i.e., shifting away from internal combustion engines towards xEVs in the transport sector will result in the sector becoming greener, but it impacts increased demand on a grid dependent on conventional fuels such as coal and gas).

Exhibit 6-6
Overview of transport sector decarbonisation strategies

To accelerate Malaysia's Net Zero target, its EV sales and charging infrastructure ambitions could be raised

NON-EXHAUSTIVE

	1 | Electrified mobility		2 | Sustainable fuels		3 | Public transport
	Drive EV adoption	**Scale EV chargers**	**Leverage biodiesel to transition**	**Introduce FCEV HDVs[1]**	**Unlock first-and-last mile**
	% EV sales penetration by 2050	*# target public EV chargers by 2030*	*Blending mandate by 2030*	*% FCEV HDV sales penetration by 2050*	*% public transport modal share by 2030*
From (today)	**<1%**	**4000[2]**	**B20 for road[3]**	**0%**	**20%**
2030	**20%**	**10000 – 20000**	**B30 mandate**	**0%**	**40%**
Potential enablers	• Foster local component manufacturing and assembly • Establish targeted subsidies • Introduce trade-in-programs for ICE to EV	• Introduce EV charging grant or set subsidies • Provide corporate tax incentives • Leverage geospatial analytics to strategically locate EVCI • Establish EVCI building requirements	• Invest in upgrading of biorefineries • Explore HVO as long-term play for road transport fuel • Incentivize airplane and marine fleet modernization to improve efficiency • Optimize airport and port operations to enable fuel efficiency	• Develop ecosystem of hydrogen players • Scale FCEV re-fuelling stations • Provide subsidies or tax incentives for FCEV HDVs	• Increase formal bus stops with updates on bus timings • Transit-oriented development • Integrated smart ticketing across all stations and public transport types • Congestion charges • Car-free days

1 FCEV: Fuel-cell vehicles ; HDVs (Heavy Duty Vehicles)
2 Target announced by MGTC; Current number is 1k as of Aug 2023
3 B10 program rolled out in 2019, with B20 program implementation starting in 2020

SOURCE: Government websites, Malaysia NDC sector working groups discussion

Initiatives and path forward

Electrified mobility

Malaysia has one of the highest vehicles per capita in Southeast Asia, however xEV adoption stands at less than 5% (as of 2023) – indicating untapped potential for additional mitigation. Key to driving xEV sales lie in introducing enablers that tackle the cost competitiveness of xEVs versus Internal Combustible Engine (ICE) vehicles, as well as tackling xEV charging range anxiety.

Malaysia has pursued several policies to lower xEV total cost of ownership (TCO) and accelerate time to parity with ICE vehicles. These range from reducing import duties, sales, and road taxes for xEV purchases, to tax exemptions for xEV manufacturers. The NIMP 2030 and National Automotive Policy have also outlined targets and strategies to realise xEV adoption in Malaysia.

To further turbo-charge xEV adoption, there are additional opportunities for consideration. These include:

- Providing targeted financial incentives for xEV consumers (e.g., subsidies);
- Offering financial incentives for xEV charging point operators (e.g., tax incentives, grants);
- Addressing regulatory challenges for xEV charger implementation (e.g., right-to-charge law, setting xEV

charging targets or requirements in buildings);

- Introducing low-cost xEV models and increase product awareness;
- Fostering local xEV value chain through the provision of manufacturing incentives to develop Malaysia's high-value manufacturing industry and create a local supply of xEVs; and
- Introducing targeted fuel subsidies to increase the savings proposition of xEVs versus ICE.

Box 1
Total Cost of Ownership (TCO)

Total cost of ownership is an estimate of all the direct and indirect costs attributed to the purchase of a product or service. In this context, TCO is used to determine the full ringgit cost of owning an ICE or xEV vehicle across a set time span. This includes the upfront cost of purchasing the vehicle and the associated taxes, the operating cost (e.g., fuel or electricity consumption, insurance, maintenance) over the set timespan, and less the expected re-sale value of the car.

When an ICE and xEV proxy is at 'parity,' it refers to the point at which the cost of a xEV is equivalent to a comparable ICE vehicle alternative. TCO is directly linked to xEV penetration, as a lower TCO results in increased likelihood of purchase by consumers.

Box 2
Range anxiety

Range anxiety largely refers to the driver's fear that their Battery EV's (BEV) energy storage may be insufficient to cover an intended distance, resulting in being stranded due to a lack of charging infrastructure. Range anxiety is the principal reason that charging infrastructure availability is often cited as a key enabler of xEV adoption – and why consumers are hesitant to adopt xEVs.

Sustainable fuels

As part of Malaysia's decarbonisation journey, biodiesel is looked to as an important transitionary fuel. Malaysia has a high biofuel blending rate versus its Southeast Asia peers, with B20 partially rolled out (as of 2023) and a target to introduce B30 by 2030. In addition, plans by the private sector to pursue hydrotreated vegetable oil (HVO) plants in Malaysia indicates a promising start to the roll-out of higher blending rates for road transport and the use of sustainable aviation fuels (SAF) for the aviation industry.

To unlock the potential of biofuels, investment in the upgrade of biorefineries and HVO plants may be required to support growing demand. This, however, would be contingent on price and economic viability, and prioritisation of palm oil production for exports, food, or fuel.

In the long term, Malaysia seeks to explore the development of green fuel alternatives. This includes taking critical steps to outline roadmaps for future fuels (e.g., HETR, National Nuclear Technology Policy) and setting a 5% target of hydrogen use in heavy duty vehicles by 2050 (NETR). Malaysia is committed to continue investigating opportunities for zero-emission green fuel alternatives.

To increase the adoption of sustainable fuels, initiatives would need to both enable increased domestic demand for green fuels as well as catalyse domestic supply in tandem. These include:

- Implementation of green fuel mandates (e.g., B30 biodiesel blending mandates, sustainable aviation fuel blending mandates);
- Encouragement of investments in biofuel production facilities and research;
- Exploration of alternative fuels for marine transport; and
- Improvement of fuel efficiency through the introduction of relevant regulations (e.g., fuel economy for cars, air traffic management regulation for aircraft).

Public transport

Malaysia has made significant investments to increase the availability of affordable public transport. These include the construction of new infrastructure, such as the Mass Rapid Transit (MRT) Line 3, East Coast Rail Line (ECRL), and Light Rail Transit (LRT) line extensions, to expand public transport capacity and connectivity. In addition, financial incentives have been deployed to boost demand and support operators, including Unlimited Travel Passes and the Interim Stage Bus Support Fund.

However, unlocking first-and-last-mile challenges will be crucial in increasing public transport adoption, such as investing in transit-oriented development, feeder bus services, and walkable pathways. An example of how other countries have tackled first and last mile challenges can be found in Exhibit 6-7.

Initiatives to improve public transport ridership would require the resolution of key passenger demands and needs. These include:

- Piloting and scaling first and last mile connectivity solutions or alternative transport solutions and improving the integration of planning with public transport;
- Facilitating collaboration between public transport authorities and telecoms service providers to leverage real time data on spatial distribution of passengers; and
- Expansion of rail based infrastructure.

Exhibit 6-7
Example of first-and-last mile enablers

Car restrictions

London: Congestion charge fee of £15 during 7am to 6pm on weekdays, and 12 to 6pm on weekends

Jakarta: Weekly car-free days on main city avenues from 6am to 11am

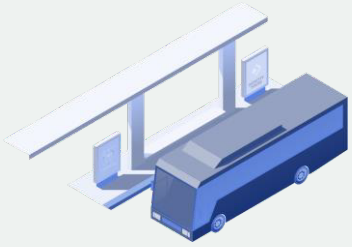
Walkable pathways

Singapore: Network of interconnected green spaces to provide shaded pathways

Feeder buses

Bogota: Dedicated bus lanes on trunk routes

Barcelona: Regular bus stops, with 350m max. distance between transit



Shared mobility and micromobility

St. Petersburg (USA): Uber riders offered half price to reach public transport

Smart ticketing

Brisbane: Integrated smart ticketing system linked to digital wallets, with access to rail, bus, and ferry

Singapore: Testing contactless fare payment systems e.g., RFID system

Transit-oriented development

Kowloon: TOD is financially sustainable through value capture from real estate (i.e., taxes, property sales)

Source: Government websites, press search

Cross sectoral initiatives: hydrogen

Enabling the transport sector's adoption of fuel cell electric vehicles (FCEV) and hydrogen-run heavy-duty vehicles (HDVs) could require significant investment and partnerships, both domestically and internationally. Infrastructure for FCEV re-fuelling could be a critical component to adoption, from the development of hydrogen hubs for the manufacturing of low-carbon hydrogen, to the transportation and logistics of moving the fuel.

Initiatives that could support hydrogen use in the transport sector could include:

- Establishment and adoption of low carbon hydrogen standards and regulations;
- Introduction of initiatives to increase hydrogen sales penetration in HDV fleet when techno economically feasible (e.g., exploring introduction of future fuel powertrains, introduction of mobile hydrogen refuelling stations); and
- Development and establishment of integrated low carbon and hydrogen industrial clusters and hubs at production and end use sectors to galvanise growth of the entire ecosystem.

Chapter 7.2 provides further details on enabling hydrogen in Malaysia.

Sectoral enablers

Green financing

Fostering xEV adoption requires multi-stakeholder collaboration, with financial institutions and automotive industry players playing an essential part in influencing higher xEV penetration. Green financing could be a critical enabler to address 1) the cost competitiveness of xEVs compared to ICE, 2) the ability of automotive manufacturers to accelerate xEV production, and 3) the capabilities of charging point operators to scale and sustain the infrastructure.

There are currently several xEV financing schemes in the Malaysian market to incentivise consumer purchasing, such as the provision of preferential interest rates to express lanes for loan approvals. While this has been beneficial in supporting xEV sales, additional financial support could be channelled towards the scaling of xEV charging infrastructure.

Providing sufficient chargers could be pivotal to the adoption of xEVs by tackling range anxiety from potential consumers. However, charging point operators today are inhibited by limited return-on-investment due to low xEV adoption and the high cost of grid infrastructure upgrades in more remote locations to support the expected surge in electricity demand. Offering innovative financing solutions, such as concessional loans, leasing-models, green bonds, and more, could help encourage first-mover investment in building up charging infrastructure.

Talent and capabilities development

Talent is a crucial part in creating a thriving automotive ecosystem. Developing a xEV industry-specific training programmes could cultivate talent for high-value local automotive manufacturing and the growth of significant automotive hubs, such as the High-Tech Automotive Valley. Doing so would not only create new green jobs, but also increase Malaysia's attractiveness as an investment opportunity for international investors and industry players.

Additionally, fostering a rich innovation ecosystem for research and development could aid in the development of green fuels. This could include regulatory sandboxes and innovation grants dedicated to the exploration and piloting of green fuel solutions in Malaysia.

SME and MSME empowerment

The NIMP 2030 has identified the growth of a thriving local xEV ecosystem as a priority. Specifically, the Masterplan targets a launch of a locally manufactured xEV as one of its core Mission Based Projects. Launch of a locally manufactured xEV could significantly lower TCO compared to imported EVs – and thus increase penetration.

As a part of this, MITI seeks to engage private sector companies to facilitate the creation of a local xEV ecosystem with end-to-end capabilities in xEV manufacturing. This includes enabling the participation of SMEs and MSMEs within the value chain through upskilling.

Given the importance of SMEs and MSMEs as the backbone of the Malaysian economy, SMEs and MSMEs could emerge as both a key enabler of Malaysia's xEV manufacturing and penetration aspirations. Additionally, enabling their participation in high value add manufacturing subsectors can result in macroeconomic benefits that includes helping support the growth of local champions in green future-proof sectors.

Summary of transport strategy and initiatives

Strategy 4: Electrified mobility

4.1 Increase xEV sales penetration

- Introduce targeted incentives aimed at enabling reduced EV TCO (e.g., manufacturing incentives)
- Grow local EV manufacturing ecosystem to enable lower cost of EVs over time (vs. ICE), ensuring participation of SMEs
- Adopt EVs as part of Government fleet

4.2 Increase deployment of xEV chargers

- Introduce targeted incentives aimed at supporting accelerated rollout (e.g., tax relief on charging infrastructure for consumers, tax exemption for manufacturers of EV charging infrastructure)
- Address regulatory challenges for xEV charger implementation (e.g., right-to-charge law, setting xEV charging targets or requirements in buildings)

Strategy 5: Sustainable fuels

5.1 Increase domestic demand for green fuels

- Implement B30 biodiesel blending mandate
- Optimise fuel mix to increase uptake of low sulphur fuel in marine transport
- Implement minimum fuel economy standard on automotive OEMs and vehicle labelling

5.2 Catalyse domestic supply of green fuels

- Invest and upgrade biorefineries to enable rollout of B30 mandate to achieve targets
- Promote investments in biofuel production facilities (e.g., HVO, SAF, marine fuels) and research
- Explore alternative fuels for marine transport, including development of biofuels for marine bunkering and adoption for on-board energy use
- Invest in pilot biofuels projects, study potential viable fuels (including hydrogen), and track developments of air-based mobility tech (as part of CORSIA)
- Institutionalise green port, green airport, and green logistics

5.3 Improve fuel efficiency

- Improve air traffic management and control systems - enhancing efficiency of aircraft movements to minimise aircraft fuel consumption and emissions
- Introduce regulations to improve vehicle fuel economy and efficiency to reduce fuel consumption
- Implement Euro 6 regulation requirements for petrol / diesel engines by 2030
- Introduce an end-of-life vehicle management policy by 2025

[1] Only select initiatives listed. Full list of initiatives for the entire cross sectoral strategy can be found in the relevant subchapter

★ New initiative ★ Dependent on inflection point being met

Strategy 6: Increase public transport ridership

6.1 Increase public transport ridership through resolving key passenger demands and needs

- Pilot and scale first and last mile connectivity solutions / alternative public transport solutions (e.g., Selangor's Demand Reponsive Transit system launched in select zones), improving integration of planning with public transport (e.g., transit oriented developments)
- Undertake study to identify transport model share as well as passenger trends and behaviour to better understand travel demand and needs
- Facilitate collaboration between public transport autority and telecoms service providers to leverage real-time data on spatial distribution of passengers (including using big data analytics to determine factors influencing passenger needs and transport demand)
- Establish a green transport committee to coordinate and harmonise the various rules and regulations in the transport subsector
- Formulate a Green Transport Index
- Expand rail based infrastructure (e.g., MRT 3, LRT Kelana Jaya extension)
- Continue to incentivise public transport ridership with campaigns (e.g., unlimited monthly travel passes)

Cross sectoral strategies[1]

Hydrogen

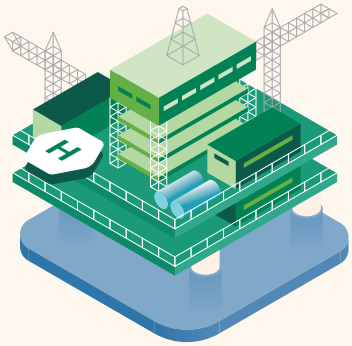
CS2.1 Establish clear policies, frameworks, and governance

- Establish and adopt low carbon hydrogen, standards, and regulations

CS2.2 Set up enabling infrastructure to ensure security of supply

- Develop localised hydrogen infrastructure for production, including green electrolyser manufacturing capabilities
- Reduce levelised cost of hydrogen for low-carbon hydrogen (e.g., through funding and subsidies, increasing commercial viability of RE feedstock)
- Establish regulatory sandbox to test out and develop new fuel low-emission fuel sources (i.e., hydrogen)

Oil and Gas



Sectoral starting point

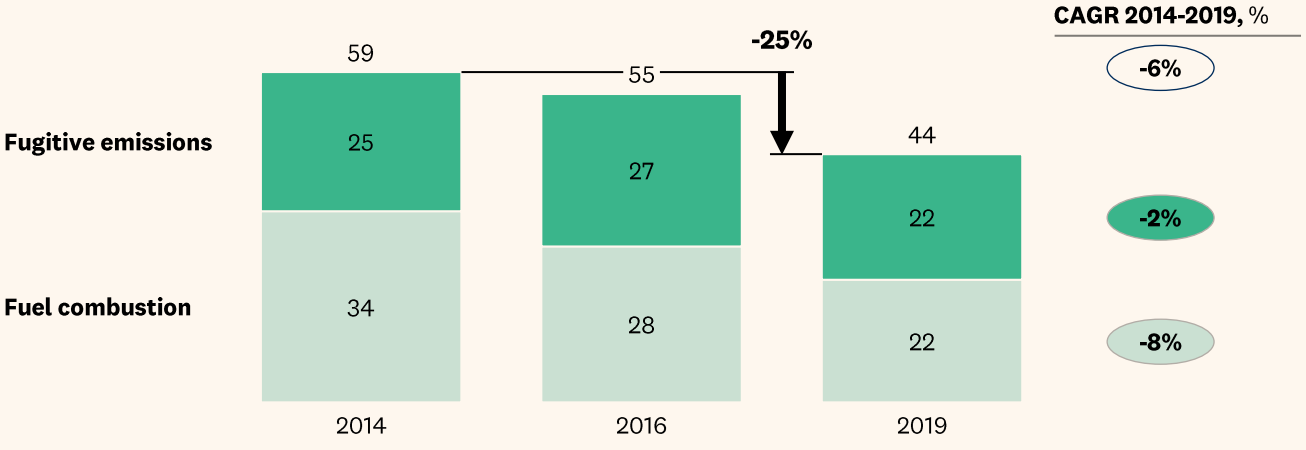
The oil and gas sector in 2019 contributed approximately 15% of Malaysia's total emissions. Sectoral emissions are equally split between fuel combustion and fugitive emissions. Compared to 2014, oil and gas emissions have reduced by 20% led by efforts to reduce venting and flaring and improving energy efficiency (illustrated in Exhibit 6-8).

While emissions have reduced over time, Malaysia's sectoral GHG intensity remains 15-40% higher when benchmarked against peers in Thailand and Indonesia. This is a result of higher upstream intensity and petrochemicals production intensity.

Decarbonising Malaysia's oil and gas sector in alignment with a balanced and just transition can be pursued in consideration of national energy security, economic development, and job creation goals. As an energy producing nation, the oil and gas sector significantly contributes to Malaysia's energy security and economic development. The oil and gas industry was responsible for >70% of Total Primary Energy Supply (TPES), 12% of GDP, and 6% of total jobs in Malaysia in 2018.

Exhibit 6-8
Oil and gas sector starting point

Oil and gas greenhouse gas (GHG) emissions 2014-19, $MtCO_2e$



Source: Malaysia Fourth Biennial Update Report (BUR4)

Pathways across each scenario

With existing measures, emissions could decrease by 5% compared to 2019 by 2030 (to 42 $MtCO_2e$). With additional measures, emissions could decrease by 9% compared to 2019 by 2030 (to 40 $MtCO_2e$).The oil and gas sector's decarbonisation pathways under the WEM and WAM scenario are further illustrated in Exhibit 6-9.

The exhibit also shows the four key mitigating levers which shape the oil and gas sector's emissions trajectory. These are:

- **CCUS at scale:** Capture and storage of CO_2 emitted during oil and gas production into depleted oil and gas fields;
- **Green electrification:** Electrification of compressors and Combined Head and Power (CHP) units to avoid combustion of fuels for energy generation, provided grid decarbonisation occurs to reduce the overall grid intensity;
- **Methane reduction through venting and flaring reduction:** Reduced incidence of methane and CO_2 venting, and eliminating routine flaring;
- **Energy efficiency:** A cross sectoral lever, this refers to the extent to which operational improvements can result in efficiency gains throughout the oil and gas value chain (including electricity use, captured in the power sector emissions).

The decarbonisation strategy of green electrification is interconnected with power sector decarbonisation, in that increased RE penetration is a key enabler of plant electrification. Developments in the oil and gas sector itself also impact decarbonisation initiatives in the power sector and transport sector.

Key sectoral strategies

Targets

Malaysia has introduced several targets and initiatives to chart the path forward for the oil and gas sector, with commitments primarily made towards reducing flaring and venting. The following mitigation efforts drive decarbonisation across each scenario:

"With existing measures" mitigation strategy (based on policies prior to 2022):

- **Flaring and venting reduction:** Malaysia is a signatory to the Global Methane Pledge, committing to reduce methane emissions by 30% by 2030.

"With additional measures" mitigation strategy

- **Additional emission reduction initiatives:** Driven by industry players' decarbonisation targets. For example, by 2030, PETRONAS targets a 25% reduction in overall GHG emissions and a 50% reduction in methane emissions from its natural gas value chain from a reference year of 2019 – with a view towards targeting Net Zero carbon emissions by 2050.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- **Economic development** could improve as Malaysia seeks to leverage depleted oil fields as opportunities for carbon storage in a WAM scenario;
- **Job creation** could improve as a side effect of the growth of a domestic CCUS industry; and
- **Sustainability** could improve, principally driven by increased carbon sequestration in WAM.

Initiatives and path forward

Carbon capture and storage (CCUS) at scale

While CCUS is a cross-sectoral decarbonisation lever, it is a particularly important lever for the oil and gas sector. In Malaysia, CCUS catalyst projects plan to capture CO_2 from gas production at high-CO_2 Kasawari and Lang Lebah gas fields – both of which have been recently designated as NETR flagship projects to showcase and test the potential of CCUS techno economic viability in Malaysia.

Both projects are to be implemented with the collaboration of the Sarawak government and will be Malaysia's first CCUS pilot projects. These projects are also an opportunity to begin development and potential scaling of infrastructure to support Malaysia's aspirations to become a CCUS hub. Initiatives specific to the oil and gas sector within the CCUS strategy could include:

- Conducting of pilots to test operational feasibility of CCUS projects;
- Development and scaling of infrastructure to support Malaysia's aspirations to become a CCUS hub; and
- Establishing a coordination unit to drive planning, implementation, and monitoring of CCUS projects.

Extension of CCUS viability beyond the oil and gas sector for domestic and international storage could potentially be possible, however would require further regulatory, technological, and financial support. These are further discussed in chapter 7.3, as a cross sectoral strategy.

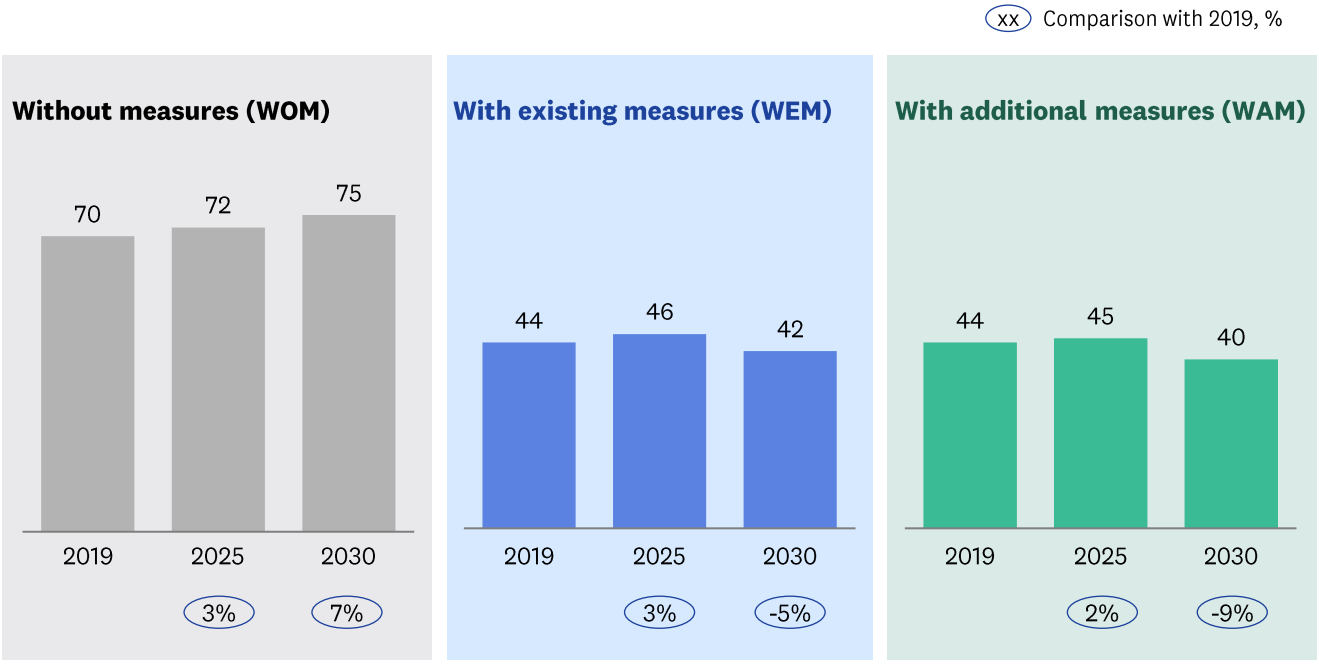
Green electrification

Oil and gas facilities today burn natural gas onsite for heating and power generation purposes, generating fuel combustion emissions. Electrification of these processes can eliminate the need for the combustion of natural gas and reduce emissions.

However, an unintended consequence of pursuing electrification without considering RE penetration could transfer the emissions towards the power sector should energy be generated from non-renewable sources. Malaysia's current energy mix comprises significant proportions of conventional fuels, making current grid intensity higher than the burning of natural gas. Grid

Exhibit 6-9
Oil and gas sector emissions scenarios

Oil and gas sector greenhouse gas (GHG) emissions pathways, $MtCO_2e$



Lever	Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Carbon Capture, Utilisation and Storage at Scale Total storage capacity	0	0	**3.3 MTPA** (5% total emissions)	**4 MTPA** (5% total emissions)
Flaring and venting % methane reduction vs 2019	0	0	**30%**	**30%**
Cross sectoral: energy efficiencies % efficiency gains	0	0	– No announced targets	**1%**

SOURCE: Company sustainability reports, Malaysia NDC sector working groups discussion

Exhibit 6-10
Overview of oil and gas sector decarbonisation strategies

O&G: Increased CCUS storage capacity, reduction of fuel usage and gains in efficiency are core levers that will accelerate O&G decarbonization
NON-EXHAUSTIVE

	Carbon Capture, Utilisation and Storage (CCUS)	Plant electrification	Flaring and venting	Energy efficiency
	CCUS, *total storage capacity*	*% reduced fuel usage*	*% emissions reduction vs 2019*	*% efficiency gains*
From (today)	-	-	**0%** 2019 is used as a baseline to calculate emissions reduction	-
2030	**3.3 $MtCO_2e$** (6% of O&G emissions)[1]	- Fuel reductions are realized in post 2035 onwards (i.e., 2.7% reduction in 2040)	- Roughly constant as benefits will be realized 2033 onwards due to mitigating actions deployed	**3-5%**
Potential enablers	**Develop CCUS regulations** on: • Operator post-closure liability regime • Stewardship Fund contribution requirements **Improve CCUS economic viability** by: • Establishing CCUS clusters • Introducing carbon prices	**Enhance CPPA regulations** by: • Expanding quotas (total and limits per supplier) • Increasing pricing mechanism transparency **Pursue grid decarbonisation** via: • Increasing RE share in grid installed capacity	**Enhance zero-flaring and venting regulations** • Enforcing zero-flaring targets across key players in Malaysia	

Cross- cutting enablers

Futureproof engineering talent by:
- Identify emerging interdisciplinary skills (i.e., CO_2 systems thinker)
- Develop talent through formal and practical methods

Support green investment via:
- Green financing mechanisms (i.e., subsidies, incentives, guarantees)
- Carbon pricing

1. CCUS storage capacity available in 2030 as a proportion of total O&G emissions forecasted in 2030

SOURCE: Government websites, Malaysia NDC sector working groups discussion

decarbonisation is therefore needed to realise the abatement potential of green electrification and as a result, initiatives under this decarbonisation lever are subsumed under the power sector subchapter.

Additionally, challenges remain in implementing plant electrification in Malaysia. Costs to electrify Malaysia's offshore oil and gas production assets remain high when considering installation costs of subsea cables.

Methane reduction from reduced flaring and venting

Flaring and venting emissions arise from the unintended release of gases or other volatile organic compounds (VOCs) into the atmosphere. These emissions can arise throughout the oil and gas value chain and amounted to 22.5 $MtCO_2e$ of emissions in 2019 (50% of total oil and gas emissions).

Flaring and venting reduction initiatives have achieved 11.5 $MtCO_2e$ of emissions abatement between 2017-19 alone. Greater environmental awareness and the economic

incentive to monetise captured vapour drive efforts to reduce flaring and venting.

Reduced flaring and venting is the result of player specific operational excellence initiatives. These ongoing initiatives can include:

- Installation of pipelines to direct captured gases towards processing plants;
- Upgrading gas compressor capacities or installing backup compressors;
- Installation of vapour recovery units (VRUs) to capture excess methane gases; and
- Implementation of regular leak detection and repair (LDAR) processes.

Cross sectoral initiatives: energy efficiency

Similar to methane reduction initiatives, energy efficiency improvements and gains are the result of operational excellence initiatives driven by players. Additionally, energy efficiency across certain processes, such as powering of compressors, could also be improved through electrification.

Examples of EE initiatives being undertaken by players include:

- Gas turbine optimisations in downstream operations; and
- Development of roadmaps and strategies to optimise energy consumption and realise energy efficiencies and savings throughout operational processes.

Sectoral enablers

Green financing

CCUS and oil and gas plant electrification remain economically unviable today. Significant catalytic investments could be required given nascency of technology today, necessitating the need to incentivise research and development in these fields.

Additionally, operating CCUS facilities are costly. Carbon pricing could play a role in equalising the costs of operation by providing a financial incentive for carbon sequestration. A study on the development of a carbon tax mechanism is currently being undertaken by MOF.

Incentives could also be critical to stimulate demand – particularly within hard to abate industries. These could include tax allowances (similar to that introduced in Budget 2024, which provided for tax allowances on investments in CCUS capex) and appointment and support of a sectoral ‘champion’ looking to pursue decarbonisation.

Talent reskilling and upskilling

Malaysia’s green ambitions in developing renewable energy, CCUS, and hydrogen industries are underpinned by a skilled and professional workforce. The oil and gas sector in 2023 employed ~0.5 million people in Malaysia (6% of the total workforce), of which 80% are considered skilled professionals (e.g., engineers). Futureproofing this talent could be a leading priority for the sector to support Malaysia’s energy transition.

Malaysia is considering ways to upskill and reskill existing talent. This is currently being done through identifying emerging interdisciplinary skills and building these capabilities in current and future talent and putting in place formal training programmes (e.g., within Technical and Vocational Training, or TVET courses) to be completed through practical and experiential in-person learning.

Several examples of these formal and experiential training programs exist today. These include the Skills in Oil and Gas (SOGA) and Bridging Gaps programmes, administered by the Johor Petroleum Development Corporation with funding support from the MOE.

Summary of oil and gas strategy and initiatives

★ New initiative ★ Dependent on inflection point being met

Strategy 7: CCUS at scale

7.1 Test operational feasibility of CCUS capture, transport, and storage

- Conduct pilots to test operational feasibility (e.g., Kasawari)

7.2 Scale enabling infrastructure for capture, storage, and transport

- Develop and scale infrastructure to support Malaysia's aspirations to become a CCUS hub

Strategy 8: Green electrification

8.1 Increase procurement of green electricity in oil and gas operations

- Continue to expand CGPP quotas to allow players to source higher levels of RE in their operations

Strategy 9: Methane reduction

9.1 Reduce methane from flaring and venting emissions

- Target reduction in methane emissions via operational excellence and ongoing initiatives (e.g., installation of pipelines to direct captured gases towards processing plants, other operational improvements specific to players)

Cross sectoral strategies[1]

Energy Efficiency

CS1.2 Raise EE savings among oil and gas players through operational excellence

- Target EE savings via operational excellence (e.g., optimization of operations, roadmap design and implementation)

Carbon capture and storage

CS3.1 Establish clear policies, frameworks, and governance

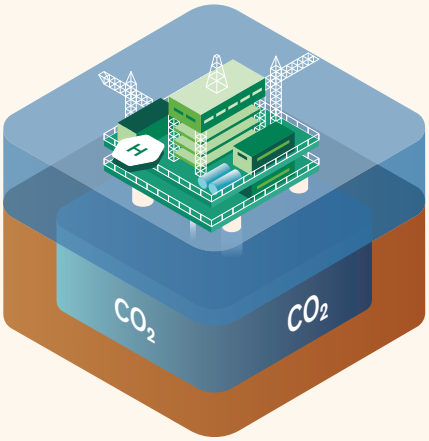
- Develop a CCUS regulatory framework, defining operator liability and transboundary CCUS provisions, as well as capture and storage regulations, to provide clarity to users and operators at both national and state levels

CS3.2 Set up enabling infrastructure for capture, storage, and transport

★ Strengthen current carbon management regulation and introduce a carbon tax to encourage use of CCUS

[1] Only select initiatives listed. Full list of initiatives for the entire cross sectoral strategy can be found in the relevant subchapter

Industry Fuel Use



Sectoral starting point

Manufacturing industries and construction rely on fossil fuels for thermal energy generation. Out of 0.5 PJ energy required in 2019, 14% was from solid fuels, 23% from liquid fuels, and 63% from natural gas. This contributed to 34 $MtCO_2e$ or 10% of Malaysia's emissions, out of which iron and steel contributed to 9.5 $MtCO_2e$ (28% of fuel emissions), non-metallic mineral industries including cement contributed to 8 $MtCO_2e$ (24% of fuel emissions), and food processing, beverage and tobacco contributed to 6 $MtCO_2e$ (19% of fuel emissions). The breakdown of industry fuel emissions is shown in Exhibit 6-11 below.

Industry fuel emissions have remained relatively stable from 35 $MtCO_2e$ in the base year 2005 to 34 $MtCO_2e$ in 2019, suggesting a shift to more advanced, less fuel-reliant industries (e.g., electrical and electronics) and the improvement in energy efficiencies across industries over time.

Exhibit 6-11 also shows how each industrial sector has evolved over time and their source of emissions. Over the 2014-2019 time period, emissions in transport equipment, chemicals, and iron and steel industries have grown fastest largely as a result of increased fuel demand, or movement towards higher proportion of higher-emitting fuels.

Exhibit 6-11
Breakdown of Industry Fuel Emissions in 2019

Industrial fuel greenhouse gas (GHG) emissions, $MtCO_2e$		**industry fuel emissions,** %	**2014-2019 CAGR,** %	**Remarks**
Iron and steel	9	28%	11%	**Grew the fastest since 2014**, due to the operations of new plants
Non-metallic minerals[1]	8	24%	1%	**Emissions growth has been stagnant** as no new clinker plants were built in recent years
F&B, Tobacco	6	19%	9%	Emissions are primarily generated via **heating boilers** for thermal energy
Chemical	4	10%	11%	Driven by **increased energy requirements** from growth in the chemical industry
Transport equipment	3	8%	18%	Growth in emissions due to **increased energy requirements** & higher proportion of **liquid fuel** used in 2019 (compared to natural gas)
Others	3	11%	9%	Driven by other **growing sub-sectors** such as **non-ferrous metals** (e.g., aluminium), and **pulp, paper and print, photovoltaics**
Total	**34**	**100%**	**8%**	

1. Mainly from cement production, the rest are from other non-metallic minerals (e.g., lime and glass production)

SOURCE: Malaysia Malaysia Fourth Biennial Update Report (BUR4), IPCC, MISIF, SEAISI, MITI, MSA, press search

Pathways across each scenario

With existing measures, emissions could increase by 44% in 2030 compared to 2019 (to 49 $MtCO_2e$). With additional measures, emissions similarly could increase by 39% in 2030 compared to 2019 (to 47 $MtCO_2e$). The IPPU sector's fuel emissions evolution pathways under the WEM and WAM scenario are further illustrated in Exhibit 6-12.

These scenarios are underpinned by three key mitigating levers that could shape industry fuel use in the future:

- **Low carbon alternatives:** The use of low-carbon alternative fuels, such as biomass and waste in the short term, and green or blue hydrogen in the longer term;
- **Energy efficiency:** A cross sectoral lever than enables reduction in fuels required per unit of production – impacting both fuel and electricity use. Reductions in electricity use are accounted for in the power sector; and
- **Hydrogen:** A cross-sectoral lever, that supports industries that are able to transition to hydrogen as part of their fuel switching strategy. Hydrogen can be used as both an alternative fuel source and a reductant that replaces natural gas in some industries – and will be discussed within the context of both in the proceeding subchapter, given the higher indicated potential as a decarbonisation lever for process emissions (compared to fuel emissions).

It should be noted that each IPPU subsector adopts each of these levers differently, based on their own sectoral nuances.

Key sectoral strategies

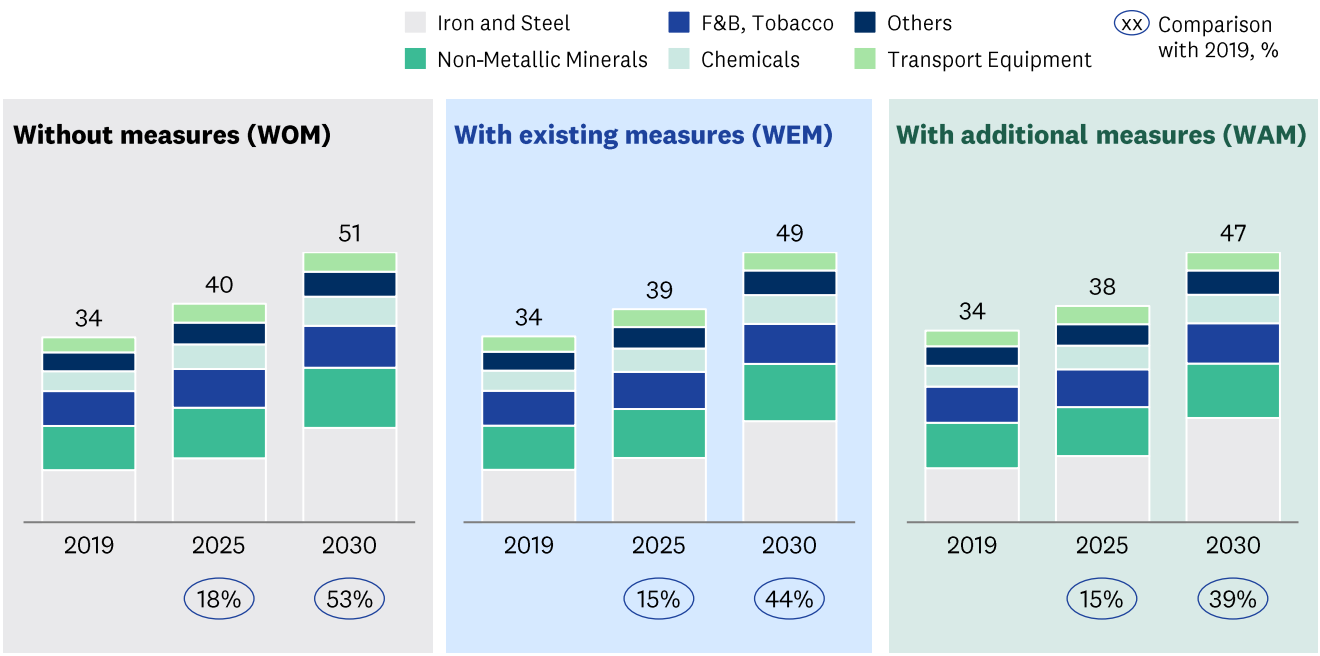
Targets

Private sector players' targets and technical assessments of their individual assets were used to formulate assumptions for WEM and WAM, shared with the project team at sector forums as part of the SWG discussions.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

Exhibit 6-12
Industry Fuel Emission Scenarios

Industrial fuel greenhouse gas (GHG) emissions pathways, $MtCO_2e$



Sub-sector	Lever	Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Steel	**Scrap usage,** % crude steel production	46% crude steel production	34% crude steel production	34% crude steel production	34% crude steel production
	Energy efficiency, % gains vs 2019	0% (Baseline)	0%	1-2%	1-2%
Cement	**Clinker substitution** (Clinker-to-cement ratio, %)	88%	88%	86%	82%
	Alt. fuels, % fossil fuel replacement	5%	5%	20%	40%

SOURCE: NEB, NEP, NETR, NIMP, MITI and MIDA, industry players and associations (e.g., MISIF, MSA, C&CA, FMM AMGM)

- **Economic development** could improve as new capacity is expected to be continued to be planted up in Malaysia in both WEM and WAM scenarios – additional investments in green retrofits (e.g., EE capex) could improve this further;
- **Job creation** could improve as a side effect of increased capacity plant-ups; and
- **Sustainability** could improve in WAM as players adopt initiatives as part of their EE and low carbon alternatives strategy.

Low carbon alternative fuels

Fossil fuel is the main source of thermal energy for industries today. For example, the cement sector uses coal and secondary aluminium sector uses LNG in their production.

On top of reducing the thermal energy intensity of industries, adoption of alternative low-carbon fuels such as biomass and waste could further reduce industry fuel emissions. This will require support from adjacent supply chains, such as ensuring the availability of biomass, hydrogen, refuse-derived fuel supply for various industries.

Fuel switching is the focus of several recent Government policy documents, including the NIMP 2030 and HETR – which both look to provide support for players looking to decarbonise, and appoint industry decarbonisation 'champions'. HETR further targets a demonstration project from the petrochemical industry by 2027.

Initiatives that could enable the adoption of low carbon alternative fuels include:

- Providing support to players looking to explore fuel substitution or alternative fuels such as capability building and technical support, incentives (given the potential need for retrofits in some instances), and facilitating access to feedstock; and
- Revising regulations to accelerate investment approvals for players looking to plant up capacity for producing low carbon alternatives.

Cross sectoral initiatives: Energy efficiency

Fuel is a large source of emissions and production costs for many hard-to-abate industrial sectors. Therefore, there has been considerable effort and technical progress in reducing the thermal energy required per unit of output as to reduce production costs.

Potential energy efficiency improvement measures are industry and company-dependent, but general strategies include reducing waste heat loss and improving waste heat recycling, automated fuel consumption monitoring and optimisation systems. Depending on a plant's starting point and technological advancements, improvements can range between 5% efficiency gains per unit output for industries that are already utilising best available technologies, and more than 20% efficiency gains per unit output for plants with older infrastructure.

Energy efficiency improvements among industrial customers has further been the focus of recent measures introduced by the Government, including the recent EECA and NETR publication. Initiatives to drive EE adoption among industrial players include:

- Enforcing mandatory audits for large commercial and industrial buildings;
- Strengthening incentive schemes to encourage industrial players to pilot or adopt EE initiatives; and
- Engaging players to understand their respective challenges they face in adopting EE and RE initiatives.

Cross sectoral initiatives: carbon capture and storage (CCUS)

As part of the NIMP 2030, MITI is working closely with the oil and gas sector to explore opportunities for local industry players to capture and store carbon in Kasawari and Lang Lebah gas fields. Many subsectors within the IPPU sector are hard-to-abate, and significant decarbonisation potential could be unlocked through CCUS technology.

Selected plants in hard-to-abate sectors such as iron and steel industry could start implementing CCUS in the medium to long term should further regulatory, technological, and financial support be provided. However, CCUS technology remains at infancy at present – and at pilot stages globally. Though it could enable the IPPU sector to accelerate its decarbonisation trajectory and further contribute to Malaysia's Net Zero aspirations, this is only possible should the inflection point of techno economic viability of carbon capture in iron and steel plants materialise in Malaysia.

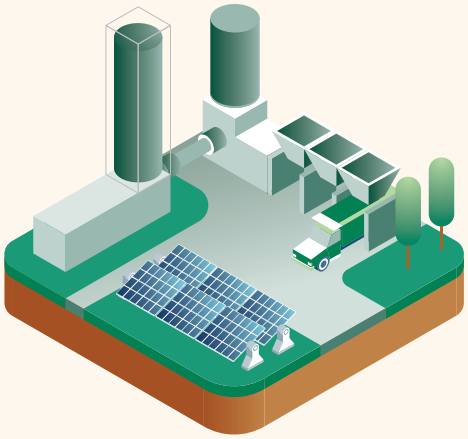
Carbon capture can also present an additionally opportunity for circularity for some industrial players, with industries such as cement globally piloting CCUS applications (e.g., injection of captured carbon into concrete). More information on CCUS, can be found in chapter 7.3.

Sectoral enablers

Industry emissions comprise of process and fuel emissions. Given that the decarbonisation of both emission types are interlinked, cross-sectoral enablers are further discussed in the next subchapter.

Summary of power sector strategy and initiatives

IPPU strategies will be discussed as a whole in the next subchapter – given the similarity and interlinkages between both process and fuel emissions.



Industrial Processes and Product Use (IPPU)

Sectoral starting point

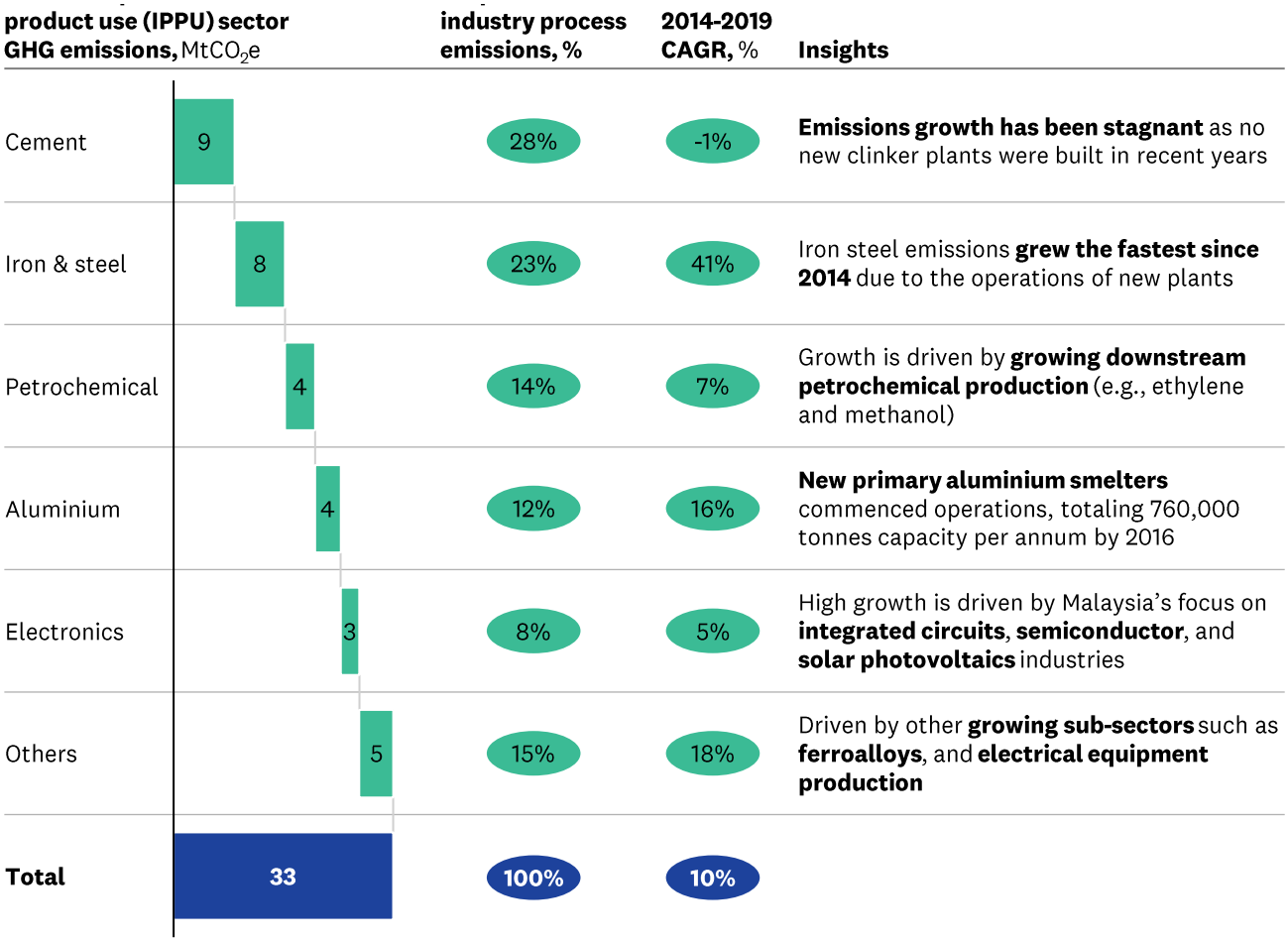
Aside from fuel use, manufacturing processes within the industrials sector also release process emissions. Process emissions result from industrial processes that chemically or physically transform materials, producing emissions in tandem.

Industrial process emissions accounted for 10% (33 $MtCO_2e$) of Malaysia's emissions in 2019. The main industries and sub-sectors contributing to this are:

- **Metals** (13 $MtCO_2e$, 40% of industrial process emissions), mainly from iron and steel production (7.5 $MtCO_2e$, 23% of IPPU emissions);
- **Minerals** (10 $MtCO_2e$, 30% of industrial process emissions), mainly from cement production (9 $MtCO_2e$, 28% of IPPU emissions);
- **Chemicals** (6 $MtCO_2e$; 18% of industrial process emissions), mainly from petrochemical and carbon black production (4.5 $MtCO_2e$, 14% of IPPU emissions); and
- **Electronics** (3 $MtCO_2e$; 8% of industrial process emissions

The breakdown of industry fuel emissions is shown in Exhibit 6-13 below. Industry process emissions emissions have doubled from 15 $MtCO_2e$ in the base year 2005 to 33 $MtCO_2e$ in 2019, growing by a CAGR of 6%. This was driven by the increase in emissions from the metal industry (21% CAGR), due to new capacity plant-ups. The mineral industry, while historically contributing to the highest emissions prior to 2019, grew at a CAGR of 2% from 2005 to 2019.

Exhibit 6-13
Breakdown of industry process emissions in 2019



1. Mainly from cement production, the rest are from other non-metallic minerals (e.g., lime and glass production)

SOURCE: Malaysia Malaysia Fourth Biennial Update Report (BUR4), IPCC, MISIF, SEAISI, MITI, MSA, press search

Pathways across each scenario

With existing measures, emissions could increase by 59% in 2030 compared to 2019 (to 52 $MtCO_2e$). With additional measures, emissions could similarly increase by 57% in 2030 compared to 2019 (to 51 $MtCO_2e$). The IPPU sector's emissions evolution over time is illustrated in Exhibit 6-14.

The switch to low carbon alternatives is the key underlying sectoral strategy that could enable each IPPU subsector to reduce their rate of emissions growth. Each subsector applies this strategy differently – and each major emitting subsector will be discussed in turn in the next subchapter.

Additionally, as shared in the previous subchapter, hydrogen is also a key cross sectoral lever that can reduce both fuel emissions and process emissions in some sectors. This is especially applicable in subsectors that are able to use hydrogen as a reductant to replace natural gas.

Key sectoral strategies

Targets

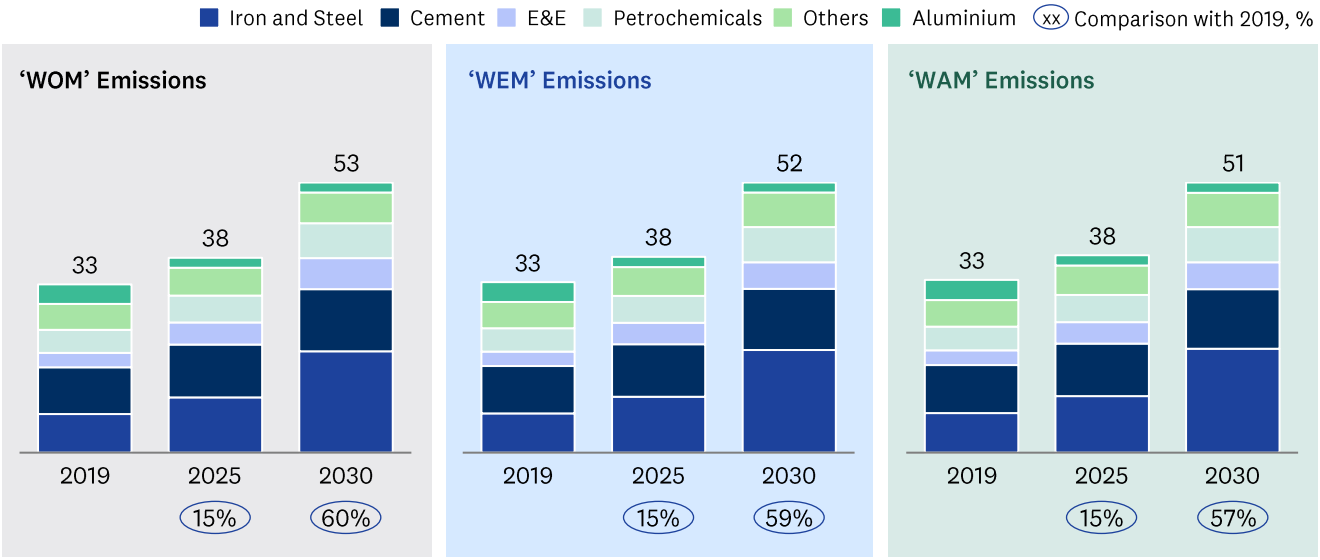
Private sector players' targets and technical assessments of their individual assets were used to formulate assumptions for WEM and WAM, shared with the project team at sector forums as part of the SWG discussions.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- Self sufficiency could improve as many low carbon alternative strategies call for circularity-based strategies (e.g., scrap) or reduction of materials used (e.g., clinker reduction) compared to import of raw materials.
- Economic development could improve as new capacity is expected to be continued to be planted up in Malaysia in both WEM and WAM scenarios – additional investments in green retrofits (e.g., EE capex) could improve this further.

Exhibit 6-14
Industrial Emission Scenarios

Industrial process and product use (IPPU) greenhouse gas (GHG) emissions pathways, $MtCO_2e$



Sub-sector	Levers	Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Steel	Energy efficiency, % gains vs 2019	0% (Baseline)	0%	1-2%	1-2%
Cement	Clinker to cement ratio, %	88%	88%	86%	82%
Aluminium	Operational excellence, % efficiency gain compared to WOM	-	0% (Baseline)	1%	1%

Source: NEB, NEP, NETR, HETR, NIMP, UN Comtrade, MITI and MIDA, industry players and associations (e.g., MISIF, MSA, C&CA, FMM AMGM, MSIA, MPIA)

- Job creation could improve as a side effect of increased capacity plant-ups; and
- Sustainability could improve in WAM as players adopt initiatives as part of their low carbon alternatives strategy.

Iron and Steel

Iron and steel are produced via a few key technological routes: blast furnace-basic oxygen furnace (BF-BOF), Electric Arc Furnace (EAF), or Induction Furnace (IF). BF-BOF plants mainly use iron ore for iron and steel production, whereas EAF and IF plants in Malaysia mainly use scrap as a feedstock.

Malaysia has 2 BF-BOF plants, 1 BF-EAF plant, and about 10 EAF and IF mini-mills today. In addition, up to 13.5 million tonnes per annum of new BF-BOF capacity are being built, leading to a total of 30 million tonnes crude steel production capacity per annum by 2030. While a small amount of Direct Reduced Iron (DRI) is also produced in Malaysia, most are exported in the form of Hot Briquetted Iron (HBI) and not consumed locally. The industry targets to achieve 18 million tonnes production (15 million tonnes local consumption, 4 million tonnes imports, and 7 million tonnes exports) by 2030.

The key levers for existing players to reduce the iron and steel industry's carbon emissions involves circular economy and CCUS (largely applicable for fuel emissions, discussed in the previous chapter). Circular economy entails improving scrap metal availability, including generation, to boost scrap-EAF production and reduce primary iron ore required in production. More information on CCUS is found in subchapter 7.3.

Exhibit 6-15
Overview of industrial sector decarbonisation strategies

Industrials: Key decarbonization levers include boosting energy efficiency, enabling clinker substitution and ensuring adoption to alternative fuel sources
NON-EXHAUSTIVE

	Steel	Cement			Others
Strategies	**Energy efficiency**	**Clinker substitution**	**Alternative fuels**	**Energy efficiency**	**Alternative fuels & EE**
	% savings compared to 2019	*Cement to clinker ratio*	*% fossil fuel replacement*	*% savings compared to 2019*	*% fossil fuel replacement; % savings*
From (today)	**-**	**88%**	**5%**	**-**	**-**
2030	**2 – 5%**	**80%**	**15%**	**2 – 5%**	**2 – 10%**
Potential enablers	**Green financing** • Carbon pricing • Concessional / blended financing • Governmental grants	**Demand / supply regulations** e.g., • Mandates for use of green materials • Guardrails on exports of steel scrap • Incentives / FDI attraction for 'greenfield' green plants	**R&D on new tech** • Regulatory sandboxes for new tech to test out commercial and technological viability e.g., H_2-DRI-EAF steel		**Talent & capabilities** • Reskilling / upskilling of workforce on new green technologies, energy efficient practices (e.g., leveraging TVET to develop skills required)

Cement

Malaysia has 10 integrated cement plants that produce clinker today. Additionally, 2-3 plants are being planned, leading to a total of 45 million tonnes cement production capacity per annum by 2030. Most of the cement produced in Malaysia is consumed domestically, with imports only accounting for 5% of local cement consumption and exports accounting for 10% of local cement production. Domestic demand for cement is projected to grow at a CAGR of 2.3% from 2023 to reach 40 million tonnes by 2050, driven by the construction industry.

Clinker production contributes to all direct GHG emissions in cement production, as GHGs are emitted during (i) the calcination of limestone into lime and carbon dioxide (process emissions), and (ii) fuels, predominantly coal, are burned to generate heat for the calcination process (fuel emissions; which are accounted for under the Energy sector).

A key lever to decarbonise the cement industry is clinker substitution. Reducing the clinker-to-cement ratio through the adoption of supplementary cement materials (SCMs) is a key initiative to reduce both process and fuel emissions from the cement industry. Examples of commonly used SCMs include by-products of other industries, such as fly ash from coal power plants and ground granulated blast-furnace slag from iron blast furnaces. Malaysia's clinker ratio could reduce from 88% in 2019 to 86% by 2030 in the WEM scenario, and to 82% by 2030 in WAM.

Aluminium

IPPU emissions from the aluminium industry are exclusively from primary aluminium smelting. Conversely, recycling production relies largely on fossil fuels such as liquefied natural gas and to a smaller extent, diesel. Existing aluminium players in Malaysia have two primary aluminium smelters today, and currently have no known plans to add primary smelting capacity in future.

Existing smelters produce a total of 1.8 tCO_2e per tonne of aluminium (i.e., 1.6 tCO_2 and 0.2 tCO_2e perfluorocarbons (PFCs)). Few decarbonisation levers are technologically feasible today. However, industry players will continue focusing on operational excellence to further reduce process emissions, leading to lower levels of GHG emissions. To further decarbonise the sector, players may need to explore more nascent technologies – such as inert anodes, CCUS, and carbochlorination.

Cross sectoral initiatives: hydrogen

In the HETR, industry use has been identified as a key end-user of low carbon and green hydrogen. The HETR aspires to replace up to 20% of natural gas use in non-energy industries – with applications to focus on fertilisers, chemicals, and methanol production.

To enable industry adoption of hydrogen, MITI and Malaysian Investment Development Authority (MIDA) are identifying appropriate financial initiatives to overcome cost and investment barriers, as well as foster collaboration between academia and the industry.

Initiatives that could drive the adoption of hydrogen in the IPPU sector include:

- Establishing and adopting low carbon hydrogen, standards, and regulations
- Reducing the levelized cost of hydrogen for low carbon hydrogen
- Reducing the barriers to hydrogen adoption among sectors expected to adopt its use (e.g., through incentives and subsidies); and
- Developing and establishing integrated low carbon and hydrogen industrial cluster and hubs at production and end use sectors.

Sectoral enablers

Measurement, Reporting, and Verification (MRV)

Bursa Malaysia is implementing enhanced sustainability reporting requirements for its Main Market-listed companies in phases, starting from the financial year ending on or after 31st December 2023. However, MRV could be extended to unlisted companies in hard-to-abate industries, as they still represent a significant proportion of production today. Without a whole-of-industry effort, it may be challenging for Malaysia to achieve its decarbonisation targets.

Similarly, GHG emissions potential may be considered by relevant ministries when approving new investments and manufacturing licenses. For example, prospective plants could be asked to meet pre-determined GHG emissions thresholds or use best-available low-carbon technologies ahead of investing and setting up new facilities in Malaysia.

As the IPPU sector's decarbonisation is highly reliant on individual companies' efforts, this also means that private sector players will need to have an understanding of how their businesses and sectors can achieve decarbonisation objectives, as well as meet forthcoming reporting requirements. Upskilling and support programmes such as those to be developed under MITI's recently launched i-ESG framework can enable companies to effectively chart their own decarbonisation strategies.

Carbon pricing

Carbon pricing – whether in the form of an emissions trading system or carbon tax – places a fee on emitting industries, especially hard-to-abate sectors. This therefore provides an impetus for industries to employ more decarbonisation levers to reduce emissions and remain cost competitive.

A number of countries are already beginning to introduce their own domestic carbon pricing mechanisms – with international mechanisms such as CBAM also beginning to emerge over time (applying to emission intensive goods such as aluminium, cement, hydrogen, and iron and steel products).

While Malaysia has not implemented any carbon pricing mechanism today, MOF is studying the feasibility and potential impact of introducing carbon policies in Malaysia. Should CCUS be deployed in the future, carbon pricing will also be a key enabler in accelerating its adoption.

Green financing

Green technology tax incentives, such as the ongoing Green Investment Tax Allowance and Green Income Tax Exemption programme were previously introduced in 2013 to encourage companies to invest in more green technology, including renewable energy.

The continuation of such supporting mechanisms to enable the green economy could be continued and expanded to encourage even more green technology adoption – particularly as investments in green technologies can involve capex-intensive retrofits. Incentives could also be provided to companies looking to pursue or pilot decarbonisation strategies such as low carbon alternatives or alternative fuel use.

Under the NIMP 2030 (among various other publications and policies), the Government is currently exploring the introduction of incentives and policies to encourage private players to adopt decarbonisation.

Small medium enterprise (SME) and micro and small medium enterprise (MSME) empowerment

SMEs and MSMEs not only form the backbone of the economy but are also core to the manufacturing sector. SMEs and MSMEs could face an impetus to decarbonise as many either participate in supply chains of companies with stringent decarbonisation targets (and expect their vendors and suppliers to be equally ambitious), or who may face regulatory headwinds if they do not (e.g., from CBAM).

The recently launched i-ESG framework provides specific, targeted support to MSMEs – including awareness and support in understanding reporting requirements and strategy formulation. This will form a crucial foundational step in enabling SMEs and MSMEs to chart their own deacarbonisation pathways over time.

Additionally, recently launched initiatives should provide specific support to SMEs and MSMEs, especially as (given their large number) they can play key roles in the development of green manufacturing ecosystems and new green clusters over time planned by the Government.

Summary of Industrial Processes and Product Use strategy and initiatives

★ New initiative ★ Dependent on inflection point being met

Strategy 10: Low Carbon Materials

10.1 Encourage and provide support to playerslooking to pilot and scale fuel substitution or alternative fuels

- Provide support to players looking to explore fuel substitution or alternative fuels (e.g., capability building and technical support, incentives, facilitate access to feedstock such as biomass and waste)

10.2 Encourage and provide support to players looking to pilot and scale low carbon alternatives

- Provide support to players looking to explore low carbon alternatives (e.g., increasing scrap availability in the ecosystem by decreasing leakages, ensuring regulations are flexible to the introduction of low clinker cement)

★ Revise regulations to accelerate investment approvals for players looking to plant up capacity for producing low carbon alternatives

- Develop guidelines for industry players and targets for Malaysia to achieve circularity economy targets
- Develop programmes to support the transition of industry players towards circular economy models

10.3 Drive local demand for low carbon alternatives

- Expand government green procurement to the construction sector to more specifically include low carbon alternatives (e.g., low clinker and green cement, green steel, green aluminium etc) under the GGP Works Initiative

Cross sectoral strategies[1]

Energy efficiency

CS1.1 Raise EE savings targets among domestic, industrial, and commercial consumers

- Enforce mandatory audits for large commercial and industrial buildings
- Strengthen incentive schemes to encourage industrial players to pilot or adopt EE initiatives
- Promote cogeneration in industries and commercial buildings through the removal of barriers
- Engage industry players to understand challenges in adopting EE and RE
- Strengthen incentive schemes to encourage industrial players to pilot or adopt EE initiatives

Hydrogen

CS2.1 Establish clear policies, frameworks, and governance

- Establish and adopt low carbon hydrogen, standards, and regulations

CS2.2 Set up enabling infrastructure to ensure security of supply

- Develop localised hydrogen infrastructure for production, including green electrolyser manufacturing capabilities
- Reduce levelised cost of hydrogen for low-carbon hydrogen (e.g., through funding and subsidies, increasing commercial viability of RE feedstock)

CS2.3 Explore and stimulate demand from key sectors

★ Reduce barriers to hydrogen adoption among sectors expected to adopt use (e.g., through subsidies)

★ Develop and establish integrated low carbon and hydrogen industrial cluster and hubs at production and end-use sectors **Carbon capture and storage**

CS3.1 Establish clear policies, frameworks, and governance

- Develop a CCUS regulatory framework, defining operator liability and transboundary CCUS provisions, as well as capture and storage regulations, to provide clarity to users and operators at both national and state levels

[1] Only select initiatives listed. Full list of initiatives for the entire cross sectoral strategy can be found in the relevant subchapter

Agriculture

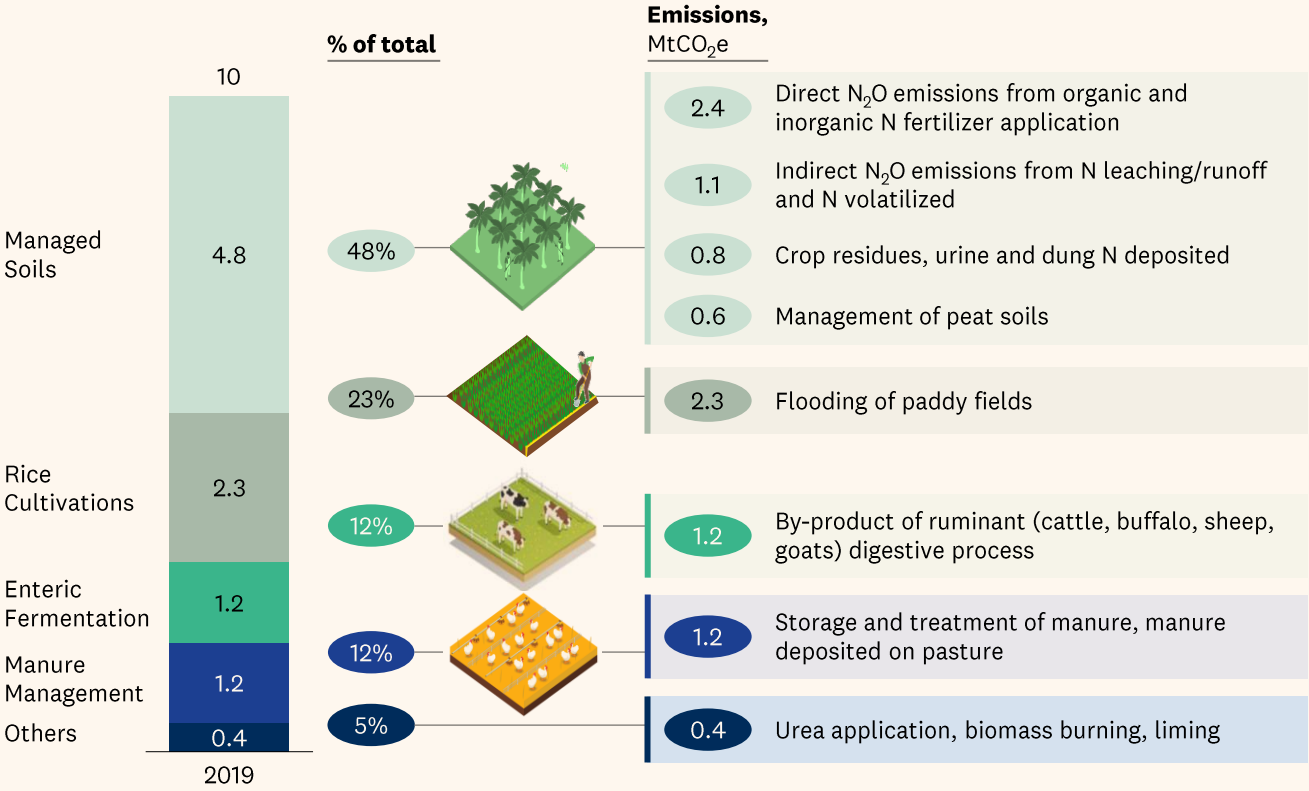
Sectoral starting point

70% of Agriculture emissions are driven by nitrous oxide (N_2O) and methane (CH_4) emissions resulting from fertiliser use on managed soils and rice cultivation – with further detail shown in the exhibit below. Oil palm has the largest share of cropland at 70%, with cropland in Peninsular Malaysia being twice the size of that in Sabah and Sarawak.

Agriculture emissions have reduced slightly by 0.2% per annum between 2005-2019, driven by smaller ruminant populations (e.g., cattle, buffalo) resulting in lower CH_4 emissions from enteric fermentation, and a reduction in N_2O emissions from managed soils (cropland) attributed to the wider adoption of sustainable agriculture practices around fertilizer application. However, methane emissions from rice cultivation has grown due to an increase in the share of irrigated paddy fields (with higher CH_4 emission factors) despite total planted area for paddy remaining largely unchanged from 2005-2019.

Exhibit 6-16
Agriculture sector's starting point

Agriculture greenhouse gas (GHG) emissions, $MtCO_2e$, 2019



SOURCE: Malaysia Fourth Biennial Update Report (BUR4), IPCC 2006 Guidelines

Pathways across each scenario

With existing measures, emissions could increase by 12% compared to 2019 in 2030 (to 10.6 $MtCO_2e$). With additional measures, emissions could increase at a higher rate of 18% compared to 2019 in 2030 (to 11.1 $MtCO_2e$). The agriculture sector's decarbonisation pathways under the WEM and WAM scenario are further illustrated in Exhibit 6-17.

The exhibit also shows the four levers within the sustainable agriculture strategy which influence the agriculture sector's emissions trajectory:

- **Self Sufficiency Ratio (SSR):** This is the ratio of local production to local consumption needs, and a measure of food security for the country. However, achieving higher production volumes typically leads to higher emissions when it involves larger cropland areas or larger livestock populations;
- **Cropland areas:** One of the two drivers of crop production volumes together with crop yields. Larger planted areas could yield higher production volumes but also larger emissions from land use change and land use practices;
- **Crop yields:** The production volume of crops per unit of harvested area, which is a key lever to increase crop production without expanding cropland area; and
- **Sustainable farming:** Measures which help to reduce the degree of GHG emission intensity per unit of cropland area or per unit of livestock.
- **Crop yields:** Increase Crude Palm Oil (CPO) yields to 4.0MT/ha (KPK) and rice yields to 4.7MT/ha (KPKM) by 2030 to achieve targeted CPO export values and SSR targets for rice; and,
- **Sustainable farming:** Reduce N_2O per hectare and reduce CH_4 per head of livestock by increasing the take-up rate of Roundtable on Sustainable Palm Oil (RSPO) and Malaysian Sustainable Palm Oil (MSPO) accreditation for oil palm, and the myOrganic and myGAP certifications for agriculture produce.

Key sectoral strategies

Targets and initiatives

The Twelfth Malaysia Plan aspires to transform the agriculture sector into a modern, dynamic, and competitive sector, given its crucial role in ensuring national food security, economic growth engine and source of employment. The following targets and initiatives help achieve these objective while driving decarbonisation across each scenario:

"With existing measures" mitigation strategy (based on policies prior to 2022):

- **Self Sufficiency Ratio:** Achieve SSR of 70% for rice and 35% for beef by 2030 (Ministry of Agriculture and Food Security, "KPKM) by focusing on increasing yields (rice production per unit of land area) and productivity (volume of beef production per head of livestock);
- **Cropland area:** Oil palm plantation harvested area limited to 6.5 million ha nationally with a ban on new oil palm plantings on peatland (Ministry of Plantation and Commodities, "KPK); low likelihood of increase in planted areas for rice (KPKM);
- **Crop yields:** Increase Crude Palm Oil (CPO) yields to 4.0MT/ha (KPK) and rice yields to 4.7MT/ha (KPKM) by 2030 to achieve targeted CPO export values and SSR targets for rice; and,
- **Sustainable farming:** Reduce N_2O per hectare and reduce CH_4 per head of livestock by increasing the take-up rate of Roundtable on Sustainable Palm Oil (RSPO) and Malaysian Sustainable Palm Oil (MSPO) accreditation for oil palm, and the myOrganic and myGAP certifications for agriculture produce.

"With additional measures" raise or add to the levers in WEM (based on policies post-2022):

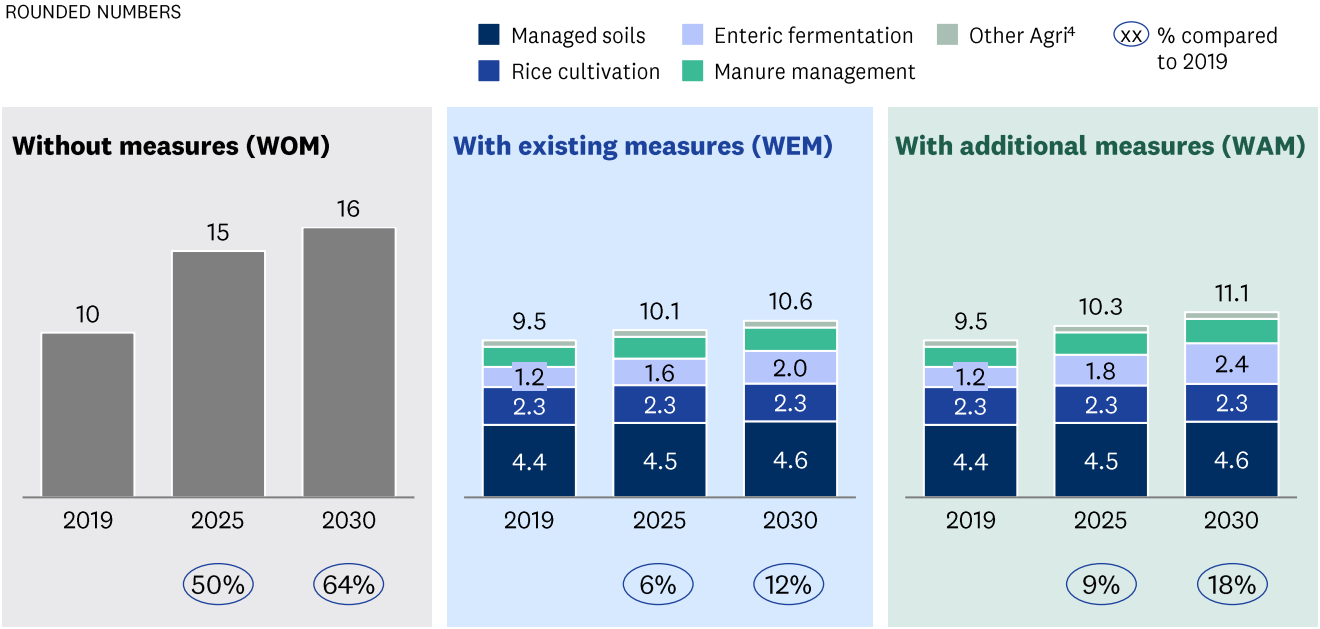
- **Self Sufficiency Ratio:** Achieve SSR of 80% for rice and 50% for beef by 2030 (KPKM);
- **Crop yields:** Increase rice yields to 5.4 metric tonnes per hectare (KPKM) by 2030; and,
- **Sustainable farming:** Reduce N_2O per hectare by increasing the share of organic fertilizer use by 1% p.a., and reduce CH_4 per hectare by expanding water management practices for irrigated paddy areas by 10,000 hectare per year from 2030 onwards.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- **Self sufficiency** would improve over time as initiatives would be implemented to increase the share of local production of key food crops (e.g., rice, beef, poultry meat and eggs) using a combination of better yields and increasing productivity. However, this could result in higher GHG emissions (particularly CH_4 and N_2O) from larger ruminant populations and higher fertilizer application rates to increase yields;
- **Affordability** could improve over time as a larger share of food crops will be produced locally;
- **Economic development** could improve with efforts to increase local production capabilities of key food crops to achieve the self-sufficiency targets;
- **Job creation** could improve as local production capacity would need to increase. However, the nature of jobs may change with the focus on increasing volume by increasing yields compared to increasing planted area or livestock population;

Exhibit 6-17
Agriculture sector's emission pathways

Agriculture emissions pathway – WEM and WAM, $MtCO_2e$
ROUNDED NUMBERS



Lever		Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Sustainable agriculture	**Self Sufficiency Ratio**	**63%** Rice **22%** Beef	**63%** Rice **22%** Beef	**70%** Rice **35%** Beef	**80%** Rice[1] **50%** Beef[1]
	Crop yields	**3.3** CPO MT/ha **2.3** Rice MT/ha	**3.3** CPO MT/ha **2.3** Rice MT/ha	**4.0** CPO MT/ha[2] **3.1** Rice MT/ha[3]	**4.0** CPO MT/ha[2] **3.6** Rice MT/ha[3]
	Sustainable Farming	Minimal impact	Minimal impact	MyOrganic, myGAP, MSPO, RSPO	• MyOrganic, myGAP, MSPO, RSPO • Increased share of organic fertilizer use • Increase in water management practices for rice cultivation

1 National Agrofood Policy 2030 targets;
2 National Agricommodity Policy 2030;
3 KPKM - rice yield required to achieve SSR targets in 2050 at no increase in planted area;

SOURCE: Policy documents, expert interviews, SWG input

Exhibit 6-18
Overview of agriculture sector decarbonisation strategies

Agriculture: Malaysia could enable sustainable agriculture for AFOLU sector's Net Zero journey

	Sustainable agriculture		
	Self sufficiency	**Increase crop yields**	**Sustainable farming**
	Self sufficiency ratio, SSR%	Yields for CPO and Rice, MT/ha	% reduction in CH_4 and N_2O emission intensity
From (today)	**22-63**[1]	**3.3; 2.3**	**0**
2030	**50-80**[1]	**4.0; 3.6**	**2-3%**
Enablers	• **Restructure subsidies or incentives** to increase local productivity e.g. output-based • **Extend technical and financial support for smallholders,** including extension services	• **Extend technical and financial support for smallholders,** including extension services • **Incentivise OP replanting** for small- and medium-sized players • **Increase private sector involvement** in R&D, e.g., high yielding rice seeds	• Develop a **carbon pricing ecosystem to foster Agriculture NBS** projects e.g., rice, cattle, including **domestic standards** for carbon projects • **Clarity on Article 6** (corresponding adjustments) • **Introduce incentives or subsidies** for pilot projects

1. National Agrofood Policy SSR targets for beef (22 to 50%) and rice (63 to 80%) by 2030

SOURCE: Government websites, press search

- **Sustainability** may be adversely impacted (net basis) as higher CH_4 and N_2O emissions offset the gains from sustainable farming practices.

Initiatives and path forward

Increasing oil palm yields

Malaysia is the second largest producer of oil palm globally, producing 20 million metric tonnes of CPO in 2019 or more than a quarter of global production volumes. The oil palm industry is also the largest within the agriculture sector, accounting for 80% of sector exports. As such, oil palm plantations account for more than 70% of cropland area in the country, at 5.9 million ha of harvested area in 2019.

Historically, CPO production volumes have grown on the back of plantation landbank expansions as strong CPO commodity prices have encouraged the switching from rubber and other crops to oil palm. However, this trend may be unlikely to continue due to land scarcity, with policies in place to limit expansion of oil palm planted areas (e.g., KPK policy to cap oil palm planted areas at 6.5 million ha and a ban on new planting on peatlands) and the limited availability of idle non-forest land for conversion to oil palm plantations.

To maintain a growth trajectory in CPO production volumes, KPK has set a target to increase CPO yields from 3.3 metric tonnes per hectare in 2019 to 4.0 metric tonnes per hectare in 2030. These could be achieved by enablers and initiatives such as:

- **For smallholders,** increasing access to high quality and high yielding seeds, facilitating knowledge transfer of agronomic best practices, putting in place programmes that secure fresh fruit bunch offtake, and extending MSPO certification to 100%;
- **For mid cap estates,** expanding sustainable planting practices and supply chain integrity, and putting in place targeted financial support or capability building programmes;
- **For large-cap estates,** supporting mechanisation programmes to reduce labour dependency and enable planting and scaling up precision agricultural solutions; and
- **On a national basis,** considering incentives to increase replanting rates using high yielding seeds.

Achieving 80% SSR for rice by increasing production per hectare

Malaysia produced 1.5 million tonnes of rice in 2019 which met 63% of local consumption demand, with the remaining needs imported from Thailand and Vietnam. Paddy and rice in Malaysia are produced entirely by 200,000 smallholder farmers, with 75% of production from ten granary areas (80% in northern Peninsular Malaysia). Total harvested area is 670,000 ha, of which 40% have access to controlled irrigation and have double-cropping cycles.

Historical growth in rice production volumes has been driven by yield improvements on the back of development of high-yielding rice varieties by the Malaysian Agriculture Research and Development Institute (MARDI), better agronomic practices (e.g., Rice Check Padi checklist of best practices for farmers to achieve 8-10 tonnes of paddy per hectare yields), and subsidy programmes for inputs (i.e., seeds, fertilisers, pesticides) worth RM1-2 billion per year.

Based on existing measures and current policy targets, rice yields could increase to 4.74 metric tonnes per hectare by 2050 to achieve SSR of 70% from 2030 onwards through 2050. Initiatives and measures to increase production per unit of harvested areas include:

- Continuing research and development of high-yielding, pest and draught resistant varieties by public institutions with potential partnership with private players;
- Expanding to five planting seasons every two years, with funding to improve infrastructure; and
- Providing greater extension services in terms of irrigation, planting, and technical advice, for example through the Large-Scale Smart Paddy Field (Smart SBB) programme.

Reducing GHG intensity with sustainable farming

In addition to increasing yields, emissions per ton of crop production could also be reduced by reducing the emissions intensity per area of harvested area through sustainable farming practices. Programmes, such as the Malaysia Good Agricultural Practices scheme (MyGAP) and Malaysia Organic (myOrganic) certification program, recognises good agricultural practices and organic farming nationwide for crops, aquaculture, and livestock.

The Department of Agriculture (DOA) is also embarking on measures for sustainable farming including water saving and management initiatives for irrigation use (e.g., tube/deep wells as alternative sources, rainwater harvesting, drip irrigation or mist blowing), Alternate Wetting and Drying (AWD) to replace continuous flooding which could both reduce water use and CH_4 released from anaerobic digestion, and use of rainfall data to optimise land use.

Sectoral enablers

Unlocking several sectoral enablers would be crucial to supporting the decarbonisation efforts of the agricultural sector. These range from SME and MSME empowerment, green financing for agricultural innovation, to the creation of a carbon pricing system for nature-based solutions.

SME and MSME empowerment

As small-holder farmers are a fundamental part of Malaysia's agricultural landscape, assisting their endeavours to improve their farming practices would be a high priority for the sector's success. This would have a dual impact – both towards greater economic growth and decarbonisation. Initiatives could comprise of additional financial and technical support for rice farmers and oil palm producers to increase production yields and extend sustainable farming practices. It may also entail refining subsidy programmes to incentive higher productivity, such as output-based subsidies or targeted subsidies to increase yields for mid-tier oil palm companies that do not quality for smallholder support.

Box 5
Large-Scale Smart Paddy Field (Smart SBB) to help drive self-sufficiency for rice

The Smart SBB programme was introduced by the government in February 2021 to develop paddy cultivation, with a target of 150,000 hectares per season to produce an average paddy yield of seven metric tonnes per hectare by introducing high yielding rice varieties and leveraging on precision agriculture to achieve ideal planting conditions.

As at Feb 2023, 27 organisations consisting of government-linked companies (GLCs), paddy farmer cooperatives and private companies are working in collaboration to cultivate paddy over 11,000 hectares of land nationwide with the involvement of about 5,000 project participants.

Green financing

Innovation in farming practices could expedite the agricultural sector's progress towards decarbonisation. The private sector's participation in seed research and development, particularly in the creation of high yielding and drought and disease-resistant seedlings, could be a key unlock in improving the quality and yields of Malaysia's agriculture. This could contribute to improve self-sufficiency, exports, and reduced demand pressures on land area, which can instead be retained as forest cover.

Carbon pricing

The path to decarbonisation for the sector also presents an opportunity to establish a carbon pricing system that could foster agriculture nature-based solution projects. This could enable sustainable farming initiatives that would have otherwise been un-economical, such as feed optimisation for cattle to reduce CH_4 emissions from enteric fermentation, and CH_4 capture facilities for manure management.

Summary of agriculture strategy and initiatives

★ New initiative

Strategy 11: Sustainable agriculture

11.1 Increase self sufficiency of key crops to achieve target SSR ratios and reduce need for additional cropland through increased crop yields

★ Increase share of subsidy programmes for rice that are output-based versus input-based to grow rice yields

★ Increase share of subsidy programmes for beef that are output based versus input based to grow beef yield

- Increase capacity and reduce cost of animal feed production e.g. local planted area for corn, PKE as substitute ingredient
- Increase replanting rates for oil palm, particularly among smallholders (independent and organised) and small/mid-sized companies who may require financial support
- Programs to support smallholders in increasing FFB yields including increasing access to high quality and high yielding seeds, facilitating knowledge transfer of agronomic best practices, programmes to secure fresh fruit bunch offtake, and extending MSPO certification to 100%;
- Programs to support mid-sized estates to increase CPO yields including expanding sustainable planting practices and supply chain integrity, and putting in place targeted financial support or capability building programmes
- Programs to support large-cap estates to increase CPO yields, including mechanisation programmes to reduce labour dependency and enable planting and scaling up precision agricultural solutions
- Increase share of paddy harvested areas with access to irrigation or water management systems
- Increase paddy cropping cycles in irrigated areas to 5 times every 2 years (vs twice a year)
- Providing greater extension services in terms of irrigation, planting, and technical advice, for example through the Large-Scale Smart Paddy Field (Smart SBB) programme.
- Increase and encourage R&D by public and private sectors in seed development

11.2 Expand penetration of sustainable farming practices

- Expand number of areas assessed and certified under sustainable management schemes (e.g. MSPO, RSPO)
- Increase use of organic fertiliser
- Expand sustainable water management practices across irrigated areas, including rainwater harvesting, drip irrigation or mist blowing, and Alternate Wetting and Drying (AWD) to replace continuous flooding

★ Explore the use of feed mix optimization or feed additives for cattle to reduce CH_4 emissions

Forestry and Other Land Use

Sectoral starting point

As of 2020, 54.6% of Malaysia's land area is under forest cover at 18.05 million hectares, with 8.3 million ha (25%) as cropland and 2.5 million ha (8%) as settlement land, with the remaining 4 million ha as wetland and grassland areas.

70% of Malaysia's forests comprise inland forests, 14% peatlands, 13 plantation forests and 3% mangrove forests. The state of Sarawak has the largest forest cover of 7.7 million ha (42%), followed by Sabah at 4.7 million ha (26%), and the remaining 5.7 million ha located in the Peninsular Malaysia region (32%).

While Malaysia recorded Land Use, Land Use Change and Forestry (LULUCF) emissions of 110 $MtCO_2e$ in 2019 largely resulting from the conversion of land to settlements, draining of organic soils, and wood harvesting, it should be noted that the subsector is a net sink of 215 $MtCO_2e$ due to the larger removals of 325 $MtCO_2e$ from growth of biomass (trees and crops).

Historically, removals have been growing at 1% per annum between 2005-2019 due to a 6% per annum reduction in timber harvested - the Annual Allowable Cut has reduced by 0.5% per annum since 2006, Protected Areas have grown by 4% per annum since 2005, wider Sustainable Forest Management (SFM) practices, and measures to increase forest areas.

Pathways across each scenario

With existing measures, the LULUCF sink (removals) could increase by 6% compared to 2019 in 2030 from 197 (to 209 $MtCO_2e$). With additional measures, removals could increase at a higher rate of 7% compared to 2019 in 2030 (to 211 $MtCO_2e$). The 2019 LULUCF baseline and projections up to 2030 have been calculated by assuming that CO_2 removals from cropland remaining cropland are zero pending guidance from IPCC on latest treatment of cropland emissions/ removals. The LULUCF sector's decarbonisation pathways under the WEM and WAM scenario are further illustrated in Exhibit 6-19.

The exhibit also shows the three levers within the protection and restoration at scale strategy which influence the LULUCF sector's emissions trajectory:

- **Deforestation rates:** Deforestation is defined as the conversion of forest land to other uses, including the conversion of state land forest into settlement or cropland areas;
- **Sustainable forest management:** A form of forest management practices that involve forest harvesting operations executed through a careful balancing of yield with growth. It involves timber production outputs being maintained at a rate that is directly proportional to forest growth; and
- **Conservation and enhancement of carbon stock:** Includes all activities that result in conservation or increases on carbon stock per area of forest land which includes restoration of degraded land, rehabilitation, or enrichment activities.

Key sectoral strategies

Targets and initiatives

The Malaysia Policy on Forestry recognises forests as a strategic national heritage and is committed to securing sufficient forest areas for their ecosystem services, biodiversity conservation, environmental protection, and sustainable utilisation of resources towards the socioeconomic development and well-being of present and future generations. The following targets and initiatives help achieve these objectives while driving decarbonisation across each scenario:

"With existing measures" mitigation strategy (based on policies prior to 2022):

- **Minimum forest cover:** The Malaysia Policy on Forestry has committed to maintain a minimum forest cover of 50% of land area in Malaysia;
- **Reduce deforestation (conversion of forestland to other uses):** Target Target to reduce conversion of forest land from an average levels of 70,000 ha per year historically to 55,000 ha per year on average from 2019-2050;
- **Sustainable forest management:** Adhere to the cutting limits of $85m^3$ per ha to reduce the logging pressure on natural forests; and
- **Conserve and enhance carbon stock:** By 2050, at least 20% of terrestrial areas and inland waters are conserved through a representative system of protected areas and other effective area-based conservation measures.

"With additional measures" raise or add to the levers in WEM (based on policies post-2022):

- **Reduce deforestation (conversion of forestland to other uses):** Target to further reduce conversion of forest land to 50,000 ha per year on average from 2019-2050
- **Sustainable forest management:** Further reduce logging pressure on natural forests by reducing the cutting limit to $75m^3$ per ha; and
- **Conserve and enhance carbon stock:** Accelerating the 20% protected area target in the WEM scenario to 2025.

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- **Self sufficiency** could be adversely affected as it would be more difficult to increase local crop production through expansion of cropland area, and a likely increase in import share of logs for the local timber industry to reduce pressure on natural forests;
- **Affordability** could be adversely affected as costs for urban development could also increase due to competing demands for forest area (especially degazetted stateland forests);
- **Economic development** could benefit if a holistic planning approach is taken a national level such that national economic development needs are not compromised to achieve targets for forest cover;
- **Job creation** could increase due to additional roles required in sustainable forest management and efforts to restore or rehabilitate degraded forest areas;
- **Sustainability** could benefit as reducing deforestation has the multiple benefits including maintaining GHG removals, protecting biodiversity levels, and retaining socioeconomic benefits for indigenous communities.

Initiatives and path forward

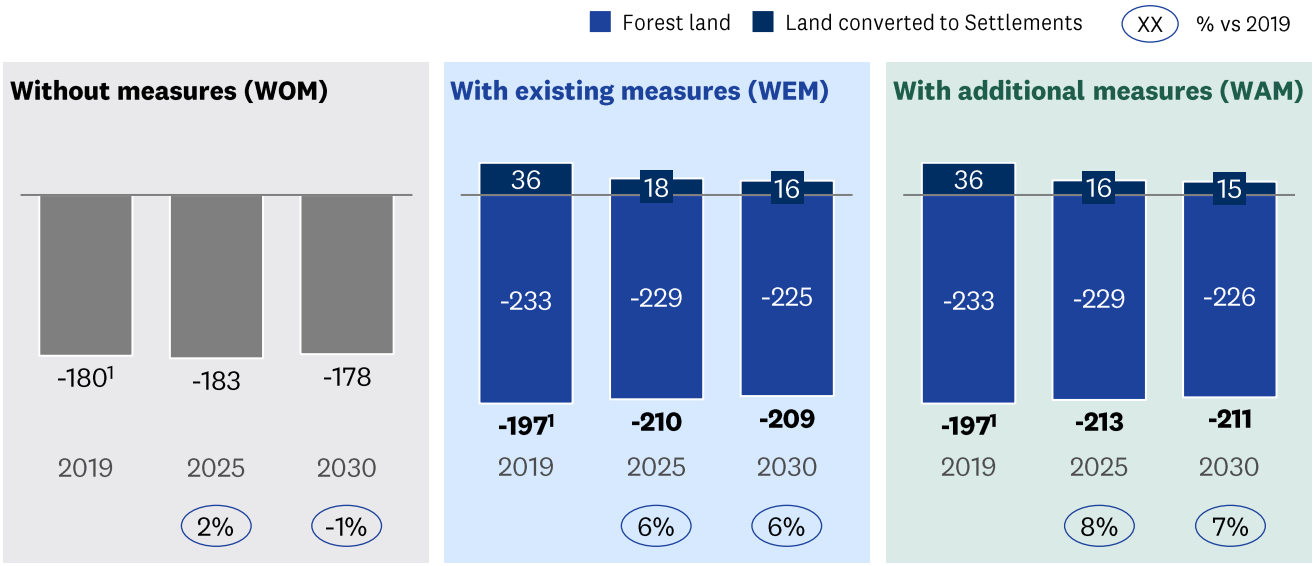
Reduce conversion of forest land to other uses

There are many competing uses of forest land in Malaysia – with main uses including urban build-up, cropland, renewable energy, and mining.

Urban build-up is the largest driver of settlement land use change given projected increases in population growth and urbanisation rates. These plans are captured within the

Exhibit 6-19
LULUCF Emission pathways

Forestry and other land use emissions pathway – WEM and WAM, $MtCO_2e$[1]



Lever		Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Protect and restore at scale	Reduce deforestation[2] rate	**70** '000 ha/yr of forest land converted[3]	**70** '000 ha/yr of forest land converted[3]	**55** '000 ha/yr	**50** '000 ha/yr
	Min forest cover	**55%**	**48%**	**50%**	**51%**
	Sustainable Forest Management	**100** cutting limit, m^3/ha	**85** cutting limit, m^3/ha	**85** m^3/ha[4]	**75** m^3/ha[4]
	Conserve and enhance carbon stock	**10** % of protected area in Malaysia	**10** % of protected area in Malaysia	**20** % of protected area in Malaysia by **2050**	**20** % of protected area in Malaysia by **2030**[5]
		1 '000 ha of degraded peatland rehabilitated	**1** '000 ha of degraded peatland rehabilitated	**10** '000 ha of degraded peatland rehabilitated by **2030**	**10** '000 ha of degraded peatland rehabilitated by **2025**[5]

1 Removals from cropland remaining cropland are zerorised pending guidance from IPCC on latest treatment of cropland emissions/removals
2 Defined as the conversion of forest land to non-forest land, including the conversion of stateland forests into other uses e.g., settlement or cropland
3 Historical average rate of forest conversion per NC3
4 Malaysia Policy on Forestry
5 National Policy on Biological Diversity

SOURCE: Policy documents, expert interviews, SWG input

Exhibit 6-20
Overview of Land Use, Land-Use Change and Forestry (LULUCF) decarbonisation strategies

LULUCF: Malaysia could protect and restore forest land at scale

	Protect and restore at scale		
	Reduce deforestation	**Sustainable forest management**	**Conserve and enhance C stock**
	Annual deforestation, '000 ha/yr	Cutting limit for AC, m^3/ha	Total protected area[2], % and degraded peatland rehabilitated, '000 ha
From (today)	**70[1]**	**100**	**10; 1**
2030	**50-55**	**75-85**	**20[2]; 10[3]**
Enablers	• Develop **centralized land use optimization capabilities** • **More robust governance** of state land forests, e.g. national policy for competing land use • **Greater enforcement** activities	• **Increase productivity of plantation forests** e.g., incentives for replanting • **Ramp-up incentives or regulatory action to increase adoption** of sustainability standards • **Diversification** of timber raw material supply	• **Greater project funding with more diverse sources** e.g., tapping into international funds • Establish a **carbon pricing ecosystem** in Malaysia, including **domestic standards** for carbon projects • **Clarity on Article 6** (corresponding adjustments) • **Strengthen co-benefits** of carbon projects e.g., biodiversity, social benefits

1. WOM assumption based on historical average rate of forest conversion per NC3
2. Increase in protected terrestrial areas and inland waters in Malaysia from 10 to 20% by 2030 (WAM) or by 2050 (WEM)
3. Target to rehabilitate 10,000ha of degraded peatland by 2025 (WAM) or 2030 (WEM)

SOURCE: Government websites, press search

Fourth National Physical Plan for Peninsular Malaysia and Labuan, and the State Structure Plans for Sabah and Sarawak.

The demand for additional cropland could also increase over time due to population growth and the desire to achieve self-sufficiency targets in the National Agrofood Policy (NAP2.0) for key crops and livestock (e.g., rice and beef), or to grow the economic value of exports from key commodity crops (e.g., oil palm, rubber) as aspired in the National Agricommodity Policy (DAKN2030).

There would also be increasing demand for land to be utilised in the production of renewable energy – whether for solar photovoltaic cells, or hydroelectric dams. This could enable Malaysia to achieve the target of 70% Renewable Energy (RE) share of installed capacity by 2050 as aspired to in the (NETR).

The National Mineral Industry Transformation Plan Framework has also set goals to increase the production of selected minerals, e.g., non-radioactive rare earth elements (NR-REE). This could result in a significant increase in the land area required for mining exploration and production.

Reducing the rate of conversion of forest land to other uses would require enablers and initiatives. These include:

- **Policies which ban conversion of forest land into cropland** such as those set by KPK in its DAKN2030 policy;
- **Availability of sufficient idle land** that is sufficiently fertile and with good access to transport infrastructure, that could be used for additional cropland instead of converting stateland forests;
- **Regulations that make it difficult to convert permanent reserve forests for other uses,** for example requirements to conduct detailed Environmental Impact Assessments before mining licenses are issued, and requirements to engage in a public inquiry for any conversion of permanent reserve forest land and to replace any converted permanent reserve forest land.
- **Urbanisation policies which preserve and conserve ecological assets,** such as those in the the Fourth

National Physical Plan that sets six key criteria that need to be met before an area is considered suitable for development, among which is the avoidance of environmentally sensitive areas (*Kawasan Sensitif Alam Sekitar*, "KSAS) and the exploration of vertical developments to maximise utilization of existing settlement areas while improving economic feasibility of public transport and achieving modal share targets.

Expand sustainable forest management practices

Sustainable Forest Management (SFM) as defined by the International Tropical Timber Organization (ITTO) is the process of managing permanent forest land to achieve one or more specified objectives of management with regards to the continued production of forest products and forest-based services without undue undesirable effects on the physical and social environment.

The Malaysia Policy on Forestry and state forest policies emphasize that Permanent Reserved Forests (PRF) will be managed in accordance with the principles of Sustainable Forest Management (SFM) for the maximization of social, economic and environmental benefits. One of the strategies to achieve SFM is to utilise PRFs based on the inherent capability of the forest (its optimal use), and to achieve comprehensive forest land use through forest regeneration and rehabilitation. Malaysia implements a selective harvesting system, which is a technique to provide openings in forest cover to ensure the natural regeneration of seedlings with the intention to sustainably manage forest production within PRF zones (with felling cycles between 25 to 30 years).

Every five years as part of Malaysia's Five Year Plan, the National Land Council sets an Annual Allowable Cut (AAC) to balance the volume of timber production with the capacity of production forest areas within PRFs. Forest harvesting within PRF is carried out in reference to the AAC for the determined area, and pre-felling inventory will determine the total amount of harvest, which cannot exceed 85m^3/ha. This cutting limit is targeted to be reduced to 75m^3/ha in the WAM scenario.

In addition to this, the Malaysian Timber Industry Board (MTIB) and Malaysian Timber Certification Council (MTCC) has set a target to increase the percentage of certified forest areas from 29% in 2020 to 50% by 2030, including increasing the number of certified Forest Management Units (FMU) from 30 (2020) to 50 and the number of Chain of Custody (CoC) holders from 381 (2020) to 750 by 2030.

Expanding SFM, lower AAC areas and lower cutting limits could reduce the pressure on natural forests – this could also result in lower log production from natural forests. As such, KPK and the Malaysian Timber Industry Board (MTIB) have measures in place including:

- **Increasing the production of logs from plantation forests,** with an ongoing phase two of the Forest Plantation Development Program (PPLH 2.0) currently in progress, which targets to plant up to 144,000ha of plantation forest by 2025;
- **Expand alternative sources of raw materials** for example oil palm trunks, kenaf, and biomass;
- **Increase downstream value-added processing of timber** to offset lower upstream supply volumes, for example through increasing the share of Downstream vs Upstream timber product exports from 66:34 (2020) to 70:30 (2030); and,

Likewise, Sabah and Sarawak also have initiatives to increase log production from plantation forests, **e.g., The Sabah Forestry Department's Action Plan on Forest Plantation Development 2022-2036** targets to achieve 0.4 million ha of plantation forest by 2036.

Conserve and enhance carbon stock

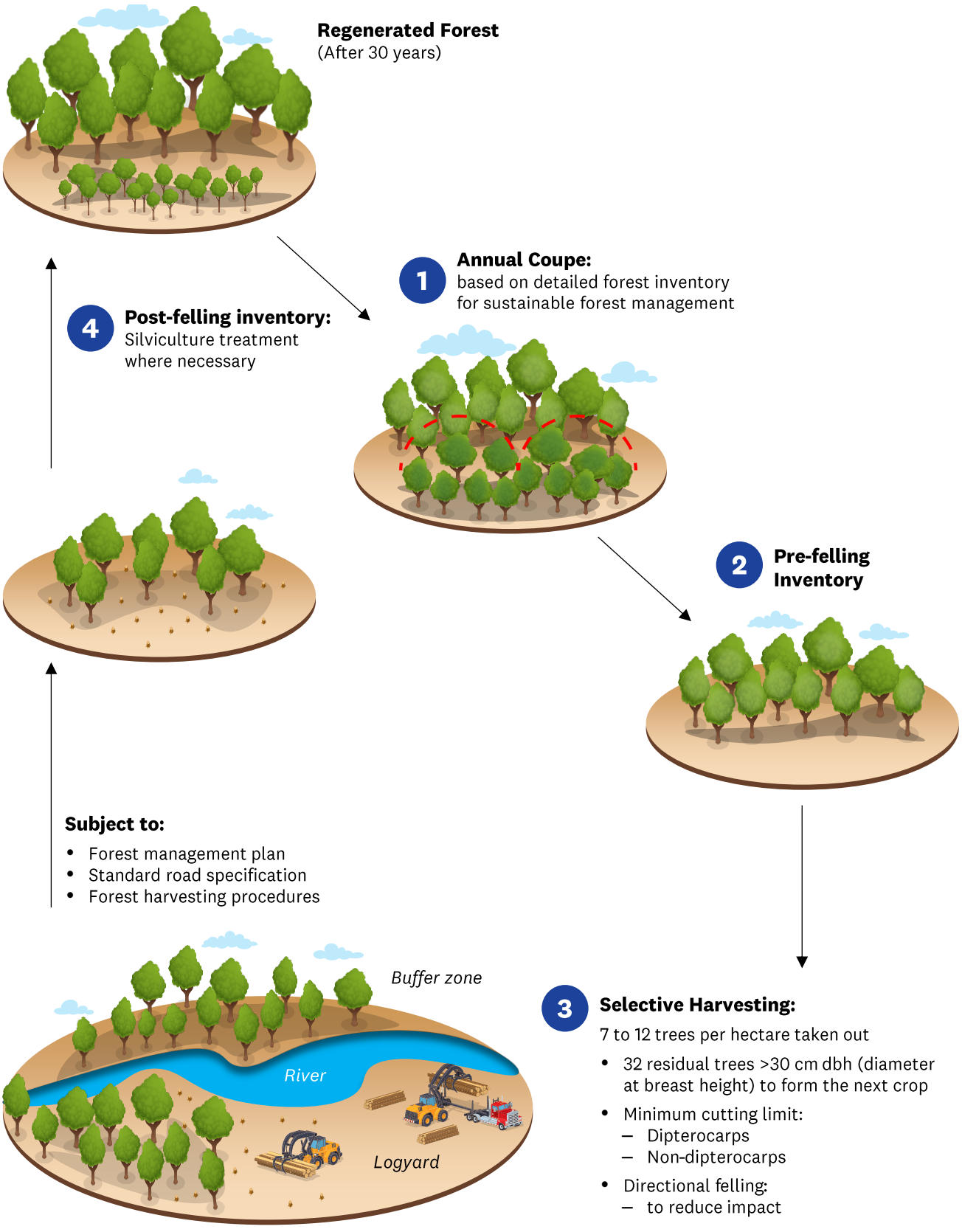
To achieve conservation of carbon stock, the National Policy on Biological Diversity and the National REDD Plus Strategy has set a target that by 2030, at least 20% of terrestrial areas and inland waters and 10% of coastal and marine areas are to be conserved through a representative system of protected areas and other effective area-based conservation measures. As at 2019, protected forest areas account for 10% of total land area. Included within this is a target to double the number or size of community conserved areas by 2030 compared to 2016 levels.

By 2030, important terrestrial corridors are also targeted to be identified, restored and protected. This includes strengthening the implementation of the revised Central Forest Spine (CFS) Master Plan for Ecological Linkages (PIRECFS 2022) in Peninsular Malaysia for 10 primary corridors being actively protected and managed by 2030 and strengthening the implementation of terrestrial connectivity under the Heart of Borneo (HoB) initiative, with a 10% increase of protected areas within the HoB by 2030.

Likewise, the Sabah Forest Policy has targeted for at least 30% of its land area to be under Totally Protected Areas (TPA) by 2025 compared to 26% as at 2019. The state of Sarawak also has a Land Use Policy target of 1 million ha of TPA and 6 million ha of Permanent Forest Estates (PFE).

Both the National Policy on Biological Diversity and National REDD Plus Strategy also set targets for the enhancement of carbon stock, including restoration of vulnerable ecosystems and habitats with 50% of all mapped vulnerable ecosystems legally protected by 2025, 20% of all identified degraded vulnerable ecosystems in 2020 are under rehabilitation programs by 2025, 10,000 ha of degraded peat swamp forests have been rehabilitated by 2025, and at least 200,000 ha of degraded sites are being actively restored by 2030.

Exhibit 6-21
Malaysia's Selective Management System (SMS)



SOURCE: Source: NRES, Modified Proposed Forest Reference Levels for REDD Plus Results Based Payments under UNFCCC, June 2019

Sectoral enablers

Key enablers required to protect and restore forest land at scale include:

- **Developing centralised land use optimisation capabilities**, which would enable a centralisation of data on land use and land cover with harmonised definitions, that would allow for optimisation of LULUCF removals at a national portfolio level;
- **Increasing the productivity of plantation forests**, which could help reduce the logging pressure on natural forests while maintaining a minimum level of upstream log supply for the downstream timber industry in Malaysia;
- **Ramp-up incentives or regulatory action to increase adoption of sustainability standards** for example the Malaysian Timber Certification Scheme and Forest Stewardship Council accreditation; and
- **Development of a carbon pricing system**, including the local capacity and capability to develop Nature Based Solution projects at sufficient scale.

Summary of LULUCF sector strategy and initiatives

Strategy 12: Protection and restoration at scale

12.1 Reduce annual average deforestation rates

- Enforce policy by KPK in the National Agricommodity Policy to ban conversion of forest land for any cropland expansion purposes
- Identify and classify idle land with potential as additional cropland (to enable zero deforestation for cropland)
- Develop centralised land use optimisation capabilities
- Employ smarter long term settlement and urban development planning to minimise "urban sprawl" and conversion of stateland forests to settlement land e.g., 4th National Physical Plan

12.2 Expand Sustainable Forest Management practices

- Maintain cutting limits of 85m^3/ha up to 2050 (WEM) and 75m^3/ha (WAM)
- Comply with the Annual Allowable Coupe (AAC) to balance the volume of timber production with the capacity of production forest areas in the PRF
- Increase share of certified forest areas from 29% in 2020 to 50% in 2030
- Increase log production from plantation forests to reduce pressure on natural forests
- Expand alternative sources of raw materials e.g. OPT, kenaf, biomass to reduce pressure on natural forests
- Increase downstream value-added processing of timber to offset lower upstream supply volumes

12.3 Conserve and enhance carbon stock

- Increase forest areas that are protected or conserved to maintain carbon stocks and biodiversity levels, e.g., By 2030, at least 20% of terrestrial areas and inland waters, and 10% of coastal and marine areas are conserved through an effectively managed and ecologically representative system of protected areas and other effective area-based conservation measures
- Increase resources and funds to enable conservation and enhancement of carbon stock
- Rehabilitate or restore degraded forest areas, including peatland, to enhance carbon stock per ha, e.g., rehabilitate 10,000ha of degraded peat swamp forests by 2025, actively restore 200,000ha of degraded sites by 2030

Waste

Sectoral starting point

Waste accounted for 9% (28 $MtCO_2e$) of Malaysia's emissions in 2019. This largely stems from industrial wastewater treatment and discharge (50% of emissions), with a majority attributed to Palm Oil Mill Effluent (POME) emissions. Solid waste disposal sites represent the second largest driver (40% of waste emissions), mainly from unmanaged waste disposal sites. Emissions grew at a CAGR of 2% per annum between 2005 and 2019, driven by population and economic growth, as well as increased urbanisation.

As of 2012, Malaysia's municipal solid waste (MSW) generation per capita was 1.17kg per capita per day. Additionally, composition comprised of 45% food waste, 20% plastic and other inerts, 10% diapers, 10% paper, 5% garden waste, 5% textiles, and 5% other. A study is ongoing to estimate updated composition figures.

Waste generation could increase with urbanisation and population growth – with potential growth in volume and evolution in composition. Malaysia's MSW generation per capita could grow over time based on observed patterns in other economies. Additionally, waste composition could also shift based on a country's development due to changes in consumer behaviour. This in turn can be influenced by waste policies and general awareness – for example, while paper consumption based on the countries benchmarked are higher for countries with higher GDP per capita, Japan established a paper recovery industry for citizens to sell paper waste and achieved an 80% recovery rate.

The Ministry of Housing and Local Government (KPKT) is currently undertaking a study to project the growth in waste generation and composition over time. Finalised figures from this study shall be updated in the emissions projections and reported in future disclosures.

Pathways across each scenario

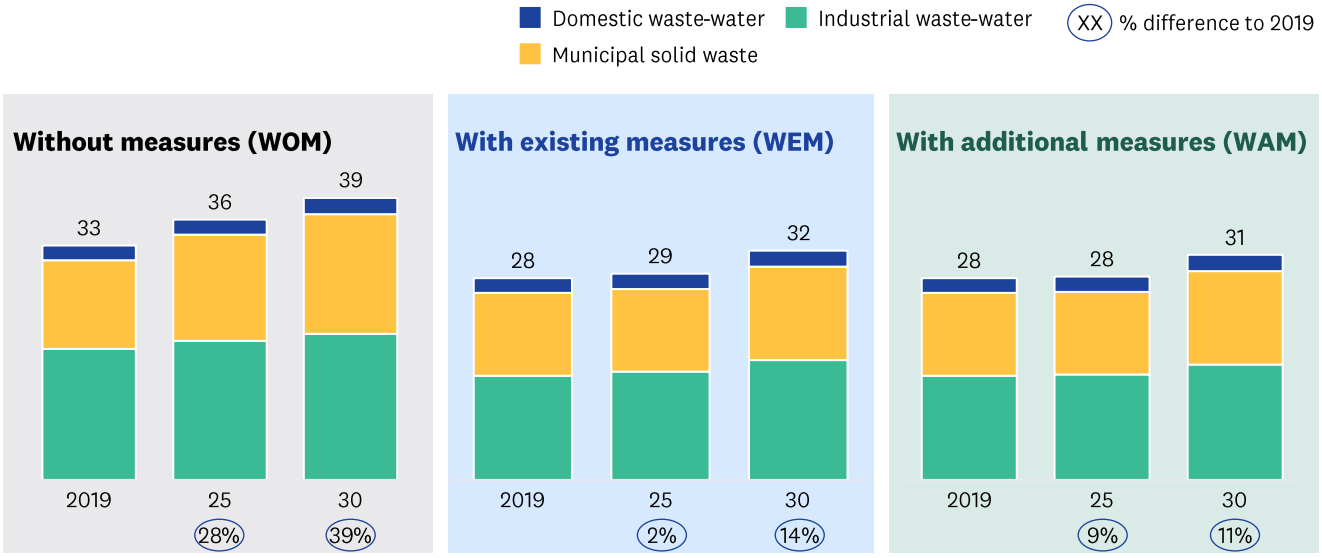
With existing measures, emissions could increase by 14% in 2030 compared to 2019 (to 32 $MtCO_2e$). With additional measures, emissions could increase by 11% in 2030 compared to 2019 (to 31 $MtCO_2e$) as the emission reductions will be realized 2035 onwards. The waste sector's decarbonisation pathways under the WEM and WAM scenario are further illustrated in Exhibit 6-22.

The exhibit also shows the two key mitigating levers that underpin these scenarios and shape the waste sector's emissions trajectory. These are:

- **Recycling:** The share of MSW that is separated and recycled; and
- **Waste-to-wealth (WTW):** The number and capacity of WTW technologies deployed, with a primary focus on incinerators and POME biogas facilities.

Exhibit 6-22
Waste Sector Emission Scenarios

Waste sector emissions pathways, $MtCO_2e$



Lever		Today, 2019	Without measures (WOM), 2030	With existing measures (WEM), 2030	With additional measures (WAM), 2030
Recycling	**Recycling levels,** % of waste	**28%** (across all waste types)	**0%** (due to no abatement measures)	**40%** (across all waste types)	**40%** (across all waste types)
Waste-to-wealth	**Incinerators,** # incinerator plants set up[1]	**1 plant**	**0 plants**	**6 plants** (through 2030)	**6 plants** (through 2030)
	POME biogas capture facilities, % penetration	**28%**	**28%**	**39%**	**40%**

1 WTW Abatement potential based on a single plant being able to process 1000 tonnes per day - exact plant capacities to be further verified with KPKT

SOURCE: KPKT, RMK-12 document, press search

ALL VALUES PENDING FINALIZATION POST OUTCOME OF KPKT'S STUDY ON SOLID WASTE COMPOSITION, CHARACTERISTICS, AND EXISTING PRACTICE OF SOLID WASTE RECYCLING IN MALAYSIA (EXPECTED TO BE COMPLETED IN 2024)

Box 6
Waste-to-wealth

The deployment of waste-to-wealth technologies, which converts waste into energy or products (e.g., fertiliser) that can generate revenue or cover the cost of conve rsion. While incinerators and biogas capture facilities are currently the primary focus of Malaysia's WTW technologies due to economic and technological feasibility, additional levers exist such as composting facilities, anaerobic digestion, pyrolysis, and refuse-derived fuel.

Key sectoral strategies

Targets

Several targets and initiatives have been introduced to tackle waste in Malaysia. Chief amongst these are plans for greater recycling and POME biogas capture facilities penetration. The following are the mitigation efforts driving each scenario:

"With existing measures" mitigation strategy (based on policies prior to 2022):

- **Recycling:** 40% recycling rate achieved by 2025
- **WTW:** Six incinerators and 55% POME biogas capture facilities

"With additional measures" raise or add to the levers in WEM, and, for the waste sector, remain similar (as additional strategies are only assumed to be implemented post 2030).

Comparing these targets and their outcomes against the five decarbonisation objectives (where relevant):

- **Self sufficiency** could improve over time given the decreased reliance on virgin materials (e.g., plastics) in both WEM and WAM, and increased recovery of biogas in WAM;
- **Economic development** could improve as investments in WTW increase;
- **Job creation** could improve as a side effect of catalytic investments in WTW; and
- **Sustainability** could marginally improve as more waste is diverted from landfills.

Initiatives and path forward

Separation at source

Waste management can typically be categorised into six consecutive tiers (see Box on the Waste Management hierarchy), including separation as a critical enabler tier. A principle driver determining the volume of waste disposed of (and that can be treated or recycled along the value chain) is the proportion of generated waste that is separated and sorted.

Separation and sorting is a critical enabler in unlocking decarbonisation levers for the sector, as waste becomes increasingly comingled when passed through the value chain, preventing further treatment. As a result, while mechanised forms of separation and sorting exist, separation at source or by hand, although more labour-intensive, is the most effective form of separation given that it typically occurs at source or early in the waste generation process. Malaysia has implemented a 'Separation-at-Source' Policy, making it compulsory for several states to separate their waste at-source.

Improved separation at-source could also improve the economic viability and feasibility of WTE technologies. This is through ensuring a sufficient supply of feedstock to support the sustainability and viability of and WTW technologies. An illustration of the criticality of separation at source in the waste value chain can be found in Exhibit 6-24.

Initiatives that could improve separation at source among consumers and businesses include:

- Expansion of awareness programmes and successful programmes (e.g., 'Trash-to-Cash' programmes) to further increase separation rates;
- Implementation of terms and conditions for compliance with construction waste management, including separation at source for construction, hazardous, and solid waste types; and
- Indirect initiatives such as implementation of Extended Producer Responsibility (EPR).

Recycling

Increased separation and recycling are highly interlinked. Both require relevant policies and infrastructure to induce behavioural change. A review of international case studies suggests that cultivating accountability within all parties (e.g., individuals, communities, businesses) is the cornerstone of both enabling separation at scale and increasing recycling rates.

At present day, there are several existing public and private initiatives to encourage recycling in Malaysia. These range from the plastic bag ban by 2025 or implementation of costs of plastic bags in some states to establishment of several private Material Recovery Facilities (MRFs) across the nation.

Behavioural change is a key enabler of increasing recycling rates. Initiatives that could enable an increase in recycling rates among consumers and businesses include:

- Improve ease of recycling through designing and implementing smart waste initiatives (e.g., apps to locate nearby recycling stops and zero waste stores, continued deployment of Drive-Thru-Recycling Centres, continued incentives for Reverse Vending Machines).

Exhibit 6-23
Overview of waste sector decarbonisation strategies

Waste: Increased recycling and waste-to-wealth levers could accelerate the waste sector's decarbonization, enabled by higher separation at-source
NON-EXHAUSTIVE

	1 | Recycling at-scale	2 | Waste-to-wealth	
	Use 'carrots and sticks' to incentivize recycling	**Organic waste management**	**POME biogas recovery**
	% recycling rate	*# compost or anaerobic digestion plants*	*% mills with POME biorecovery*
From (today)	**30%**	**-**	**30%**
2030	**40%**	**1 plant**	**40%**
Potential enablers	• **Polluter-pays approach** e.g., charge per tonne • **Ban on types of waste** e.g., untreated organic waste • **Clean and dry material recovery facilities** • **Educational campaigns** • **Apps for citizens to locate recycling stops** and zero waste stores • **Smart waste technologies** • **Integrated waste sector forums** for NGOs, government, and private sector players	• **Separation-at-source** policies (see recycling enablers) • **Partner with key industry players to secure demand** e.g., cement for RDF • **Access export markets** to offtake products • **Invest in grid connectivity** to enable access for power generation offtake • **Invest in logistics** for transportation to off-takers	• **Expansion of FiT scheme** to include POME-to-biogas plants • **Incentives to install bio-CNG conversion facilities** where a mill is not attractive for inter-connection to the grid • **Mill cluster scheme** to aggregate CH_4 captured from mills that are too small • **Infrastructure development** – improving access/ connectivity of mills to the local or national grid

SOURCE: Government websites, press search

- Tightening regulations around waste disposal to improve both separation and recycling rates (e.g., adopting a 'pay-as-you-throw' approach, instituting a ban on certain types of waste such as untreated organic waste);
- Scaling up of clean and dry material recovery facilities;
- Implementing an EPR framework with appropriate accompanying legislation;
- Increasing the demand for circular economy or recycled goods (including through Government Green Procurement); and
- Managing single use plastics through reducing use and implementing new standards for plastic production to improve recyclability.

Waste-to-wealth

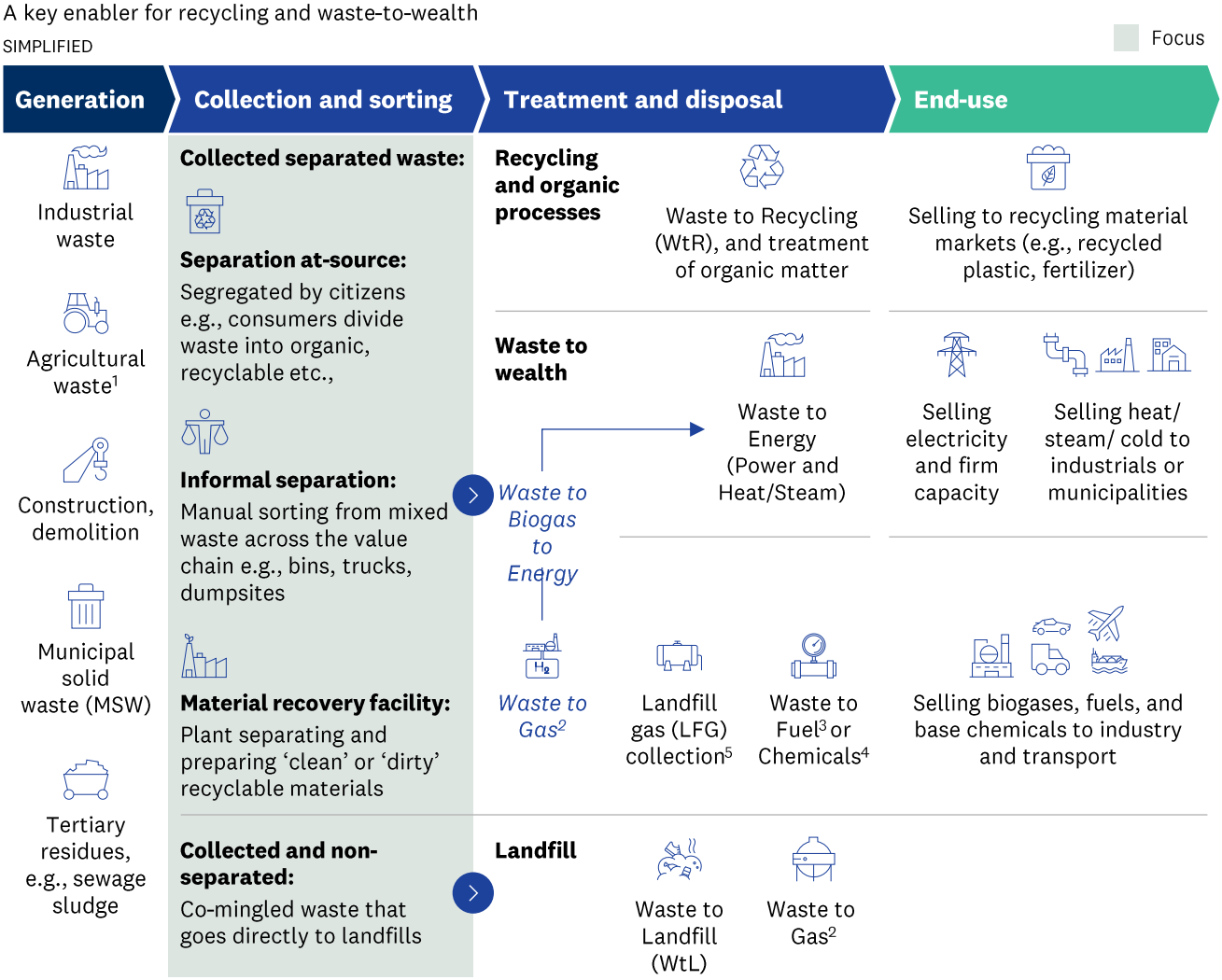
Across all WTW technologies studied for MSW, incineration and POME biogas recovery facilities could be the most viable technology given the relatively high abatement potential and high techno economic feasibility. However, composting could also be a viable alternative given favourable economics and should suitable off takers be found for the fertiliser by-product.

Beyond improved separation-at-source to ensure a secure of supply for WTW technologies, other critical regulatory and policy measures are needed to ensure sufficient demand to support their economic viability as shown in Exhibit 6-25. Initiatives that could improve the adoption of WTW technologies include:

Exhibit 6-24
Waste Value Chain

Flow of waste across the value chain is highly dependent on the level of waste separation
A key enabler for recycling and waste-to-wealth

SIMPLIFIED



1 Crop waste, animal waste, processing waste
2 Pyrolysis, gasification, or anaerobic digestion of organic waste producing syngas (CO, CO_2, H_2) or biogas (CH_4)
3 Fermentation of sugars or Gas-to-Liquids processes producing bioethanol, diesel, jet fuel, or gasoline; or conversion to RDF
4 Methanol synthesis and gasoline conversion producing methanol, or ethanol
5 Mix of CH_4 and CO_2 (50/50), by product of anaerobic digestion of organic material

SOURCE: Expert interviews

- Increasing the number of facilities to support increased recovery (e.g., waste to energy plants, biogas capture facilities, MRFs);
- Investing in infrastructure to improve grid connectivity and the transportation logistics of waste output to off takers;
- Increasing the capacity and quota of the Feed-in-Tariff (FiT) programme for biomass and biogas-to-energy;
- Partnering with key industry players and facilitating the development of supply chains to ensure sufficient offtakers / demand for WTW outputs (e.g., compost); and
- Exploring the potential of CCUS in incinerators when viable to mitigate emissions from the incineration process.

Mitigation measures being undertaken in the domestic wastewater treatment process include biogas capture, and pilots by stakeholders such as Indah Water Konsortium (IWK) that are currently exploring the co-blending of sludge with food waste to create fertiliser as part of their exploration of WTW technologies.

Sectoral enablers

Education and awareness

While important for the decarbonisation of all sectors, behavioural change is a particularly critical unlock for the decarbonisation of the waste sector. It is important to ensure that consumers are encouraged and influenced to adopt green practices in waste disposal – especially as the

Exhibit 6-25
Enablers to unlock Waste-to-Wealth Measures

Enablers to improve separation at source and waste-to-wealth

NON-EXHAUSTIVE

SUPPLY:
Separation at-source for feedstock

Policies
- Polluter-pays approach e.g., charge per tonne
- Ban on types of waste e.g., untreated organic waste
- Financial incentives for recycling i.e., fee per tonne

Infrastructure
- Dry material recovery facilities
- Free recycling points or bins with regular collection
- Waste-to-energy plants e.g.,, incinerators with CCUS, RDF, composting plants

Education and awareness
- Educational campaigns e.g., zero waste week, school visits, composting awareness
- Community zero waste stores and markets e.g., car boot sales, thrift stores, recycled waste stores

Partnerships
- Integrated waste sector forums for NGOs, government, and private sector-players to engage and align on waste topics and initiatives

Digital
- App to identify recycling plants and zero waste shops
- Smart waste technologies e.g., smart bins, garbage truck weighing mechanisms, e-waste kiosks

DEMAND:
Off-takers for products

Policies
- Engage power stakeholders on FiT scheme to increase capacity and quota for biomass and biogas-to-energy

Partnerships
- Partner with key industry players to secure demand e.g., RDF for cement players, compost for agriculture players
- Access export markets to potentially offtake products from WTW e.g., fertiliser

Infrastructure
- Invest in grid connectivity to enable access for power generation offtake
- Invest in logistics for transportation of output to offtakers e.g., RDF and compost

SOURCE: KPKT, Low Carbon Cities Masterplan, DOSM, SWCorp, press search

enabler of separation and sorting is most effective when done at source.

Raising awareness on best practices for separation and recycling is important to enable behavioural change. Nationwide campaigns, such as a Zero Waste Week, could inspire greater mindfulness on reducing, re-using, and recycling waste at home, at the workplace, and in public.

Education and awareness can also be done through the scaling of innovative, smart initiatives such as Drive-Thru-Recycling centres and Reverse Vending Machines. This presents an opportunity to also draw attention to existing initiatives and infrastructure in-place, to increase their utilisation.

Green financing

The viability of WTW technologies is heavily contingent on economics, namely the upfront capital expenditure, attractiveness of FiT, and tipping fees.

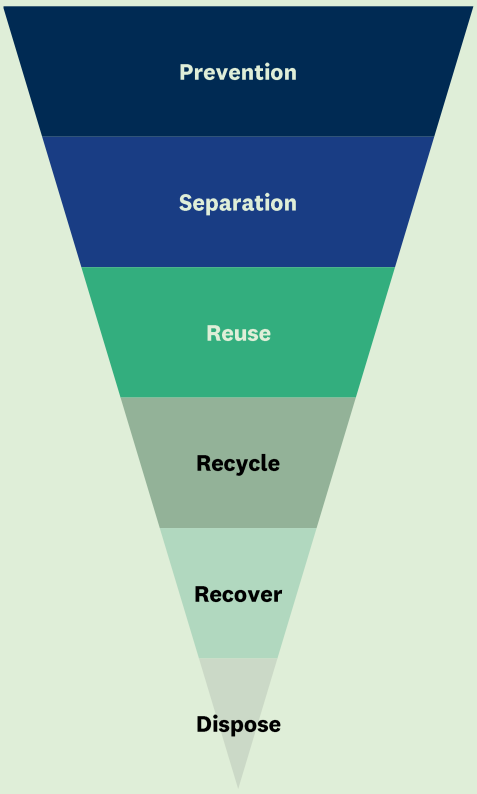
Green financing could be leveraged to enable investment in recycling and WTW infrastructure, from material recovery facilities, compost facilities, to incinerators with CCUS (when economically viable). These would entail project financing, with these facilities either being run independently by public or private players.

However, securing a consistent supply of waste feedstock from the concessionaires and demand from the FiT quotas would be essential to ensuring the long-term feasibility of the technologies. As such, public and private partnerships in the waste sector are vital to encouraging investment and implementation of these technologies.

Box 7
Waste management hierarchy

The waste management hierarchy outlines the overall flow of waste, from generation to the end-state. It outlines the potential for decarbonisation drivers (i.e., how waste can be 'eliminated' at each stage before reaching landfills) and the efficacy of these drivers (e.g., addressable volume of feedstock for technologies such as recycling is limited to the volume of waste that can be separated). The waste management pyramid is shown in Exhibit 6-26. In the exhibit, it can be seen that separation is the key unlock to ensuring viability of treatment of waste at every other stage of the process. Prevention, at the top of the hierarchy, is typically difficult for developing economies such as Malaysia.

Exhibit 6-26
Waste Management Hierarchy



	Description	Opportunities
Prevention	• Measures taken before a substance, material or product has become waste	• Reduce waste generation by product/process redesign, optimization, scrap reduction
Separation	• Enabler to unlock % waste that is reuse, recycled, recovered waste	• Encourage waste separation at-source and MRFs to segregate waste types
Reuse	• Products or components are used again for the same purpose for which they were conceived	• Leverage network for opportunities: suppliers, customers (e.g., second grades), local industrial facilities, no profit organizations
Recycle	• Waste is reprocessed into new materials for the original or other purposes. It includes composting of organic material	• Higher segregation drives more available opportunities for recycling and higher savings
Recover	• Waste-to-energy recovery for heat, power and chemicals production use • Processing into fuel pellets	• Only if none of the above is suitable • Preference for high efficiency heat and power plant or co-processing (e.g., cement production)
Dispose	• Typically landfill • Other disposal: biodegradation of liquid, sludgy discards in soils, release into sea	• Landfill could be replaced by disposal with energy recovery • Landfill retrofit to capture value: landfill gas (LFG) collection; mechanical biological treatment to recover biogas/biomass

SOURCE: European Commission

Summary of waste strategy and initiatives

★ New initiative ★ Dependent on inflection point being met

Strategy 13: Separation at Source

13.1 Increase separation at source among consumers and businesses

- Expand awareness programmes and successful programmes (e.g., 'Trash-to-Cash' programme) to further increase separation rate
- Implement terms and conditions for compliance with construction waste management, including segregation at source for construction waste, hazardous waste, and solid waste
- Implement incentive programs within municipals to encourage local businesses to participate in waste separation efforts (i.e., tax-exemptions, rewards for businesses that constantly separate waste)

Strategy 14: Recycling at Scale

14.1 Improve recycling rates among consumers

- Improve ease of separating and recycling recyclable goods through smart waste initiatives (e.g., zero waste stores, continued deployment, upgrade, and acceleration of Drive-Thru-Recycling Centres, ongoing tax incentive for sponsorship of RVM)
- ★ Tighten regulations around waste disposal to improve both separation and recycling rates (e.g., pay-as-you throw, ban on certain types of waste such as untreated organic waste)
- Scale up clean and dry material recovery facilities

14.2 Improve recycling rate among businesses

- Complete and implement EPR framework across multiple sectors, with appropriate accompanying legislation
- Increase demand for circular economy goods through increasing Government Green Procurement of goods with recycled content, and encouraging use of recycled goods in GGP
- Reduce use of single use plastics in Malaysia through initiatives to reduce incidence (e.g., 20 sen per plastic bag charge at select registered premises)
- Implement new standard for plastic production to improve plastic recycling rate, and recyclability of plastic packaging

Strategy 15: Waste to Wealth

15.1 Improve feasibility of energy recovery infrastructure

- Increase number of facilities (e.g., WTEs, biogas capture facilities, MRFs) to support increased recovery
- Invest in infrastructure to improve grid connectivity and transportation logistics of energy (e.g., captured biogas through upgrading nodal point at economically viable cluster of mills, WTE generated electricity) to offtakers

15.2 Improve economics of energy recovery infrastructure

- Increase capacity and quota of the FiT programme for WTE
- Partner with key industry players and facilitate the development of supply chains to ensure sufficient offtaker / demand for WTE outputs (e.g., compost)
- Develop action plans to improve circularity of key waste types (e.g., bamboo, rubber) through exploring waste management initiatives and alternative applications
- Promote and utilise recycled effluent and reclaimed water

07

Cross sectoral strategy 1:
Energy Efficiency (EE)

Cross sectoral strategy 2:
Hydrogen

Cross sectoral strategy 3:
Carbon capture and storage (CCUS)

Enabler 1:
Monitoring, Reporting, and Verification (MRV) and Governance

Enabler 2:
Carbon Pricing

Enabler 3:
Green financing

Enabler 4:
Small and Medium Enterprises (SME) and Micro, Small, and Medium Enterprise (MSME) Empowerment

Enabler 5:
Awareness and behavioural change

Enabler 6:
Talent and capabilities development

Technology transfer and international partnership

Cross-sectoral strategies and enablers


H_2

The previous chapter highlighted sectoral strategies and enablers (and cross sectoral strategies, where relevant) that could shape Malaysia's decarbonisation trajectories. These 15 sectoral strategies were summarised in Exhibit 20.

Sectoral strategies alone will be insufficient to enable Malaysia's Net Zero aspirations. In addition to the 15 sectoral strategies and supporting policies, three cross-cutting strategies have also been identified:

- Energy efficiency (EE);
- Hydrogen; and
- Carbon capture, utilisation and storage (CCUS);

Additionally, six enablers as well as technology transfers and partnerships will be crucial to support these decarbonisation strategies across all sectors. These are:

- Green financing;
- Talent development;
- Carbon pricing;
- SME and MSME empowerment;
- Awareness and behavioural change;
- Monitoring, reporting, verification, and governance; and
- Technology transfers and partnerships.

Cross sectoral strategy 1
Energy Efficiency (EE)

Context

In 2019, fuel combustion activities generated 237 $MtCO_2e$ of emissions across power generation and industrial production. Improving energy efficiency can reduce emissions intensity of fuel production, while addressing the rising costs of energy production.

Given the potential for EE driven decarbonisation, EE initiatives have been a key decarbonisation initiative in multiple sectors (e.g., IPPU, power) - and the focus of several notable policies to date. These include the NEEAP, the NETR, and the EECA.

EE also offers a means to further both sustainability and affordability goals in Malaysia – with many EE initiatives already being cost saving today. These include software upgrades that enable Advanced Process Control, operational improvements in furnaces and kilns, 5-star rated home electrical appliances.

Summary of existing policies and initiatives

In several subsectors including those in IPPU, decarbonisation through EE can bring dual benefits of enabling these players to achieve EE savings and contribute to emissions reductions efforts in Malaysia, while also enabling them to realise long term cost and operational efficiencies.

Improving energy efficiency has been in focus for Malaysia since 2015, with NEEAP targeting EE in the industrial, commercial and residential sectors. Subsequent national plans since 2015 have laid out progressively ambitious EE targets, including the NEP in 2022 and NETR in 2023. The latest targets aim to generate up to 22% energy savings across the industrial, commercial, and residential sectors by 2050. Initiatives launched to date have included:

- **Energy efficiency saving programmes and campaigns**, such as the implementation of Minimum Energy Performance Standards, Sustainability Achieved Via Energy Efficiency (SAVE) programme, Energy Audit Conditional Grant, and Building Energy Index Labelling programme;
- **Energy literacy and EE awareness improvement programmes**, such as those targeting students, SMEs and consumers under the NETR, and commitments to enhance existing policies and programmes aimed at promoting energy efficiency and implementing energy-saving measures in the industrial, commercial and residential sectors; and
- **Enhanced compliance and regulation**, particularly through the recently passed EECA – which mandates compulsory energy audits of large commercial and industrial electricity and gas consumers.

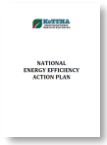
Challenges and potential enhancements required

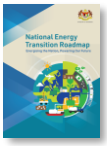
Ensuring regulations are in place and ensuring compliance will be a key unlock to supporting the meeting of EE targets – given how player specific EE initiatives are. These include the recently announced compliance measures under the

Exhibit 7-1
Energy efficiency targets and initiatives

Energy efficiency initiatives in Malaysia are supported through ambitious targets, policies and regulations

EE policies and legislation published to date


National Energy Efficiency Action Plan, 2015 (NEEAP)

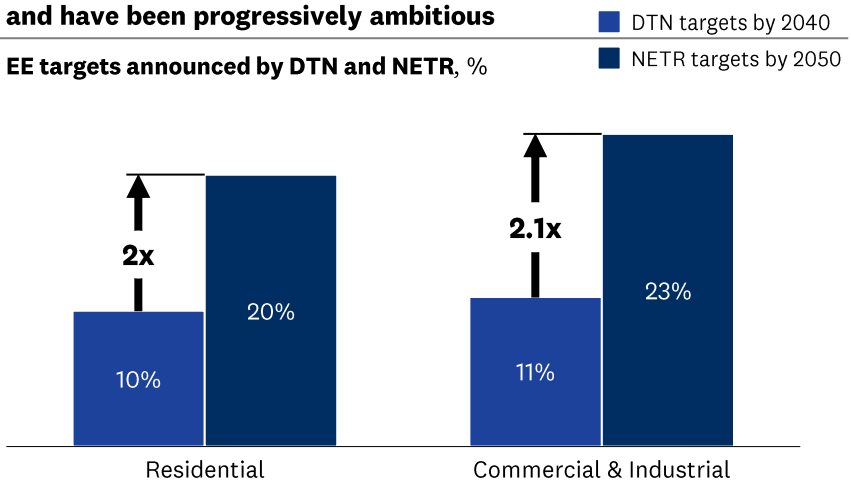

National Energy Policy, 2022 (DTN)

National Energy Transition Roadmap, 2023 (NETR)

Passed 2023
Energy Efficiency and Conservation Act (EECA),

EE saving targets build on each other, and have been progressively ambitious

EE targets announced by DTN and NETR, %



2x
Increased **residential** EE savings targets by 2050

2.1x
Increased **commercial and industrial** EE savings targets by 2050

Initiatives to improve efficiency are multi-faceted, including technological and regulatory levers

Regulatory compliance and standards
- Mandatory Minimum Efficiency Performance Standards (**MEPS**)
- **Green building codes** for energy-intensive residential and commercial buildings
- **Energy Audits** and Management in Commercial, Industrial and Government Facilities

Adoption of new technologies
- Promotion of **5-star rated appliances**
- Adoption of **4IR digital technologies** to improve awareness and drive energy efficiency

Alignment of incentives
- Establish an **ESCO platform**

Public sector led initiatives
- Launch a major **EE retrofit initiative** amongst government buildings

SOURCE: NEEAP, DTN, NETR

EECA, passed in 2023, that aims to enforce compliance for large consumers. Targets, in turn, are highly tied themselves to regulations and compliance measures. More stringent enforcement and compliance can enable a more accurate baselining of energy consumption by stakeholders such as the Energy Commission, and can enable the setting and raising of future EE targets.

Incentives are also a key driver of EE implementation. This is a result of many EE initiatives requiring capital expenditure retrofits (e.g., for industrial and commercial players), the purchasing of new appliances (e.g., for domestic consumers), or energy audits that enable the development of individual entities' EE initiative setting, baselining, or planning. Incentives (or the lack thereof) could therefore make players' adoption of EE initiatives more or less of an obstacle.

Another form of addressing this challenge involves the establishment of an Energy Services Company (ESCO) platform – which seeks to address this challenge by coordinating public building retrofits with private ESCOs. These enable the connecting of different stakeholder groups through a single platform that facilitates the ease of raising funding and dispensing incentives.

Additional EE initiatives can therefore build on existing policies – and continue to further raise EE targets among consumers (particularly large industrial consumers). An example of this is the Sabah Energy Efficiency Action Plan, an EE roadmap specific to Sabah that builds on the NEEAP.

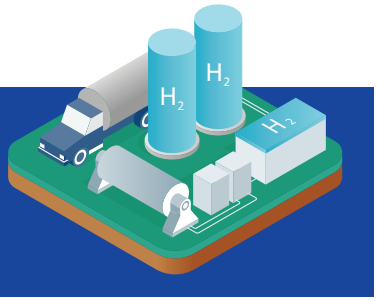
Summary of existing and potential future cross-sectoral strategies and initiatives
Energy effiency

★ New initiative ★ Dependent on inflection point being met

Raise EE savings targets among domestic, industrial, and commercial consumers

- Improve existing MEPS and 5-star ratings bands
- Enforce mandatory audits for large commercial and industrial buildings
- Establish green building codes for energy intensive residential and commercial buildings
- Strengthen incentive schemes to encourage industrial players to pilot or adopt EE initiatives
- Establish an Energy Service Company platform
- Launch a major EE retrofit initiative amongst government buildings
- Promote cogeneration in industries and commercial buildings through the removal of barriers
- Incorporate EE in new building designs and constructions
- Engage industry players to understand challenges in adopting EE and RE
- Strengthen incentive schemes to encourage industrial players to pilot or adopt EE initiatives
- Develop and implement the Sabah Energy Efficiency Action Plan
- Target EE savings among O&G players via operational excellence (e.g., optimization of operations, roadmap design and implementation)

Cross sectoral strategy 2
Hydrogen



Context

Malaysia has ambitions to become a key player in the global hydrogen industry. Hydrogen offers a means to accelerate Malaysia's energy transition while contributing towards its economic and energy security goals. Harnessing Malaysia's domestic resources (e.g., RE) for low carbon hydrogen production can allow Malaysia to benefit form both a decarbonisation and economic perspective while also supporting global decarbonisation efforts.

The production of blue and green hydrogen provides a low-carbon fuel for industrial, power generation and transportation applications. Domestic hydrogen demand could rise to as high as 2.5 MTPA by 2050. This is driven primarily from three key uses:

- Hydrogen-fuel heavy duty vehicles;
- Co-firing of gas-fired power plants with hydrogen; and
- Industrial use of hydrogen as a feedstock in ammonia and steel production.

However, the techno-economic viability of hydrogen in Malaysia is dependent on two factors: supply availability (including feedstock availability to ensure a stable supply of hydrogen), and cost. Given the nascency of commercial scale low carbon hydrogen, the levelised cost of hydrogen will have to significantly reduce over time to ensure adoption and limitation of unintended costs to the end consumer (e.g., in material costs or electricity prices).

Summary of existing policies and initiatives

To meet domestic and global demand for hydrogen, Malaysia plans to commence local production by 2025 and targets up to 2.5 MTPA of green hydrogen by 2050. Sarawak plans to begin large-scale commercial production of green hydrogen by 2027, with two major production projects (H2biscus and H2ornbill) expected to be operational in Bintulu. In line with Malaysia's ambitions in the hydrogen sector, the Ministry of Science, Technology, and Innovation (MOSTI) published the Hydrogen Economy and Technology Roadmap (HETR) in 2023. Key initiatives include:

- Establishing a National Hydrogen Economy and Technology Steering Committee to provide direction, facilitate and monitor national hydrogen initiatives, and oversee the hydrogen exports;
- Developing collaborative platform(s) to form government-to-government (G2G) relations with countries in hydrogen-related areas for demand-driven research and development and market-driven delivery;
- Forming business-to-business (B2B) partnerships through collaboration between Malaysia and targeted countries for export and import of hydrogen, collaboration, technology, and knowledge exchange;
- Reviewing, identifying, and developing regulatory measures and standards for the Hydrogen Economy; and
- Adopting and harmonising hydrogen taxonomy, technical code, and safety standards at a national level.

Box 1
Low carbon hydrogen

There are three fundamental ways to produce hydrogen:

- Grey: where hydrogen is synthesised via Steam Methane Reforming or Auto-Thermal Reforming processes using coal or natural gas as a feedstock;
- Blue: with processes similar to grey with additional infrastructure to capture and store carbon emitted during the process; and
- Green: where hydrogen is produced via electrolysers that are powered by RE. Hydrogen can therefore serve as a stable, non-intermittent RE source – as well as be developed from an RE source.

Given the production of emissions in the grey hydrogen production process, low carbon hydrogen typically refers to blue and green hydrogen.

As part of the NETR, further initiatives to support support Malaysia's hydrogen ambitions have been outlined. These include providing financial incentives and support for research and development projects at local universities to build local electrolyser manufacturing capabilities as well as establishing hydrogen hubs to facilitate large-scale manufacturing of low-carbon hydrogen – with the aim of reducing the levelised cost of hydrogen.

Additional initiatives that could be considered in the future could include the scaling of hydrogen cofiring in gas power plants. This builds on the HETR's targets to pilot hydrogen cofiring at gas power plants to assess domestic techno economic viability, with a pilot study expected to be completed by 2035.

Challenges

Malaysia recognises that the hydrogen opportunity is not without challenges. Financing will be a key enabler – as the NETR has identified potential financing needs of up to RM 220 billion by 2050. Additionally, production of low-carbon hydrogen will require either mature CCUS infrastructure to enable sequestration (from the production of blue hydrogen), or sufficient land to enable the plant up of hydropower and solar capacity (for the production of green hydrogen). MITI, MIDA and MOSTI are seeking to work in collaboration to continuously engage stakeholders to identify the right incentives and facilities to unlock investment into hydrogen development in Malaysia – including from international sources, and for pre-commercialisation scale projects.

While technical feasibility in some applications are emerging (e.g., cofiring in gas power plants, industrial applications), hydrogen could only be widely adopted should the levelised cost of hydrogen reduce – with significant reductions in costs targeted by MOSTI in the HETR over time. This is critically important given that the adoption of hydrogen while costs remain high could lead to unintended consequence to end users, particularly within the Affordability objective within the five decarbonisation objectives (as the price of goods such as industrial materials and power increases as a result).

As highlight in the previous chapter, hydrogen can offer an alternative strategy to decarbonisation for hard to abate and high emitting sectors such as power, transport, and IPPU. However, this is contingent on the reduction in levelised cost of low carbon hydrogen over time – in itself potentially impacted by the availability of green financing to support research and development and scaling of production to enable a stable domestic supply chain. As a result, in line with Malaysia's intention to pursue a balance and just transition, further developments in hydrogen will be monitored and studied for their techno-economic feasibility.

Summary of existing and potential future cross-sectoral strategies and initiatives Hydrogen

★ New initiative ★ Dependent on inflection point being met

Establish clear policies, frameworks, and governance

- Establish and adopt low carbon hydrogen, standards, and regulations
- Establish National Hydrogen Economy and Technology Steering Committee to provide direction, facilitate and monitor the national hydrogen initiatives and oversee the hydrogen export operation to be reported to National Science Council (NSC)
- Develop and establish collaborative platform(s) to form G2G and B2B relations with countries and private sector partners (internationally and domestically) in hydrogen-related areas for the purposes to import and export, R&D, and as other forms of collaboration
- Set up a centralised database and impact tracking system which include monitoring and evaluation component (M&E) on TRL and status of technology development across the hydrogen value chain in Malaysia
- Establish regulatory sandbox to pilot H_2 production or H_2 co-firing

Set up enabling infrastructure to ensure security of supply

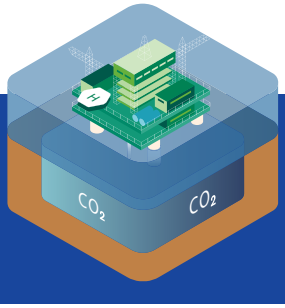
- Develop localised hydrogen infrastructure for production, including green electrolyser manufacturing capabilities
- Reduce levelised cost of hydrogen for low-carbon hydrogen (e.g., through funding and subsidies, increasing commercial viability of RE feedstock)

★ Ensure commercial viability and availability of feedstock to ensure security of supply for hydrogen for domestic consumption and export through developing and maintaining a portfolio on feedstock availability and hydrogen production projects

Explore and stimulate demand from key sectors

★ Reduce barriers to hydrogen adoption among sectors expected to adopt use (e.g. through subsidies)

★ Develop and establish integrated low carbon and hydrogen industrial cluster and hubs at production and end-use sectors



Cross sectoral strategy 3
Carbon capture, utilisation and storage (CCUS)

Context

CCUS technology aims to reduce the emissions of greenhouse gases produced through industrial processes and power generation. This is achieved through the capture of point source emissions at generating facilities, which are then transported and injected into geological formations underground. Such geological formations can include depleted oil and gas reserves, saline aquifers, or underground coal seams. The captured carbon can also be recycled and utilised for some industrial applications – some of which are being piloted today.

Malaysia, as an energy producing nation, has access to oil and natural gas reserves in the coastal waters between Peninsular Malaysia, Sabah and Sarawak. By 2050, depletion across these fields could represent to 2.4 giga tonnes (GT) of CO_2 storage potential.

Given abundant domestic storage potential, Malaysia has ambitions to develop CCUS as a decarbonisation strategy. CCUS could principally enable decarbonisation within the IPPU, power and oil and gas sectors – as fuel combustion emissions across these sectors can be hard to abate. Additionally, Malaysia's ambitions to become a leading hydrogen player could also require CCUS technology – as blue hydrogen requires the sequestration of carbon in its production process. Accordingly, cumulative domestic CCUS demand could reach 1.5 $GtCO_2e$ by 2050.

Excess storage capacity and Malaysia's geographic position at the centre of South-East Asia could also enable Malaysia to position itself as a regional CCUS hub. In addition to economic development potential, this can also enable Malaysia to support regional and international decarbonisation efforts.

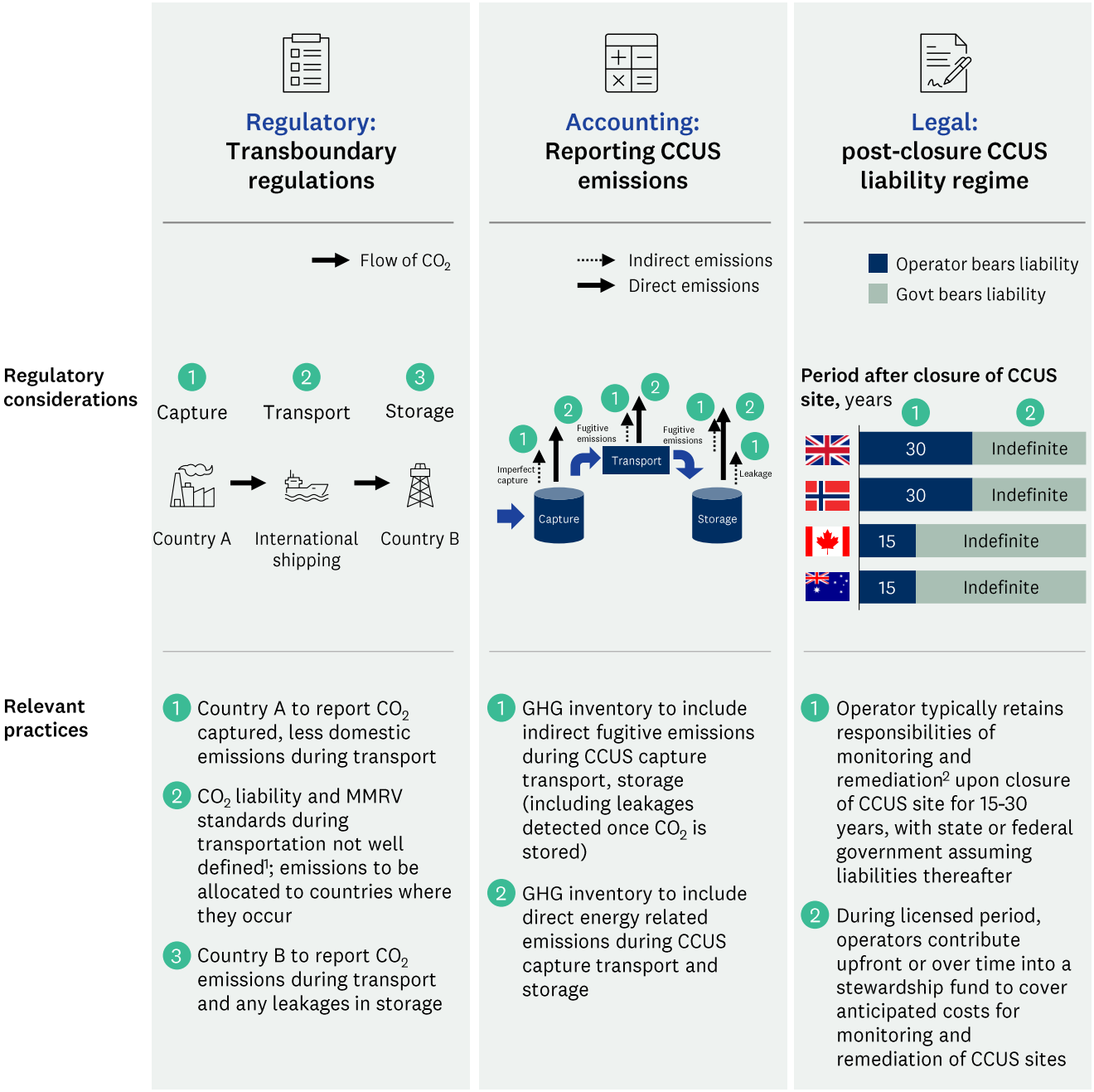
Additionally, regulatory, accounting, and legal practices should also be carefully considered and defined when developing a CCUS ecosystem. For example, guidance on transboundary CCUS reporting and operator fiduciary responsibilities could provide clarity to CCUS operators in the long term. Exhibit 7-2 details potential regulatory, accounting, and legal practices to be considered when developing a CCUS framework. The Malaysian government recognises these regulatory challenges and is developing a CCUS framework to govern these activities, further detailed in the next subchapter.

Summary of existing policies and initiatives in Malaysia

Enabling CCUS at scale will require regulatory, financial and technological support. To that end, the Malaysian government has embarked on the following initiatives to develop the local CCUS industry. These include:

- **Regulatory framework:** The Government, led by *Kementerian Tenaga, Teknologi Hijau, dan Air* (KeTTHA), partnered with the Global CCUS Institute to develop the Malaysian CCUS Capacity Development Program. As part of this program, legal and regulatory challenges were identified in relation to implementing CCUS within a Malaysian context. The CCUS Legal and Regulatory Framework Workshop was held in Lumut, Perak in 2013, and explored how a potential CCUS project could be regulated under existing frameworks in Malaysia. More recently, the NIMP 2030 also seeks to develop a carbon capture and storage CCUS framework and governance mechanisms for industry development using a cluster-based approach. This includes the strengthening of existing carbon management regulation and introduction of a carbon tax, to encourage adoption. Further, the 12th Malaysia Plan Mid-Term Review (RMK-12 MTR) also highlights the Government's intention of developing a regulatory framework for CCUS, including a regime to coordinate the implementation of CCUS at national and state levels as well as address considerations such as transboundary movement according to international protocols (further detailed in Exhibit 7-2). The MTR also highlighted the forthcoming establishment of a coordination unit to drive the planning, implementation and monitoring of CCUS;
- **Financial support**: In 2023, the Government proposed tax incentives to encourage investment into CCUS technologies. Companies undertaking in-house CCUS activities or purchasing CCUS services could be eligible for tax deductions and exemptions between 2023 to 2027;
- **Technological pilots**: CCUS pilot projects at Kasawari and Lang Lebah's high CO_2 gas fields have been announced and are expected to be operational by 2026 and 2028 respectively. These projects intend to capture and store CO_2 emitted from gas production. Under the NIMP 2030, the Government is also seeking to roll out Malayia's first CCUS cluster in the East Coast, targeting hard-to-abate sectors; and

Exhibit 7-2
Key regulatory, accounting, and legal issues to be considered when developing a CCUS framework



1 Fugitive emissions during CO_2 transportation follows principles used international bunkering (for CO_2 shipping) and natural gas transportation (for CO_2 pipelines)
2 A study by the Global CCUS Institute suggests that over a 100-year period, there is a 99% chance that damages from CO_2 leakage would cost less than $0.50/t$CO_2$

SOURCE: IPCC guidelines, IEA, press search

- **Bilateral collaboration**: Under the NIMP 2030, the Government has committed to explore G2G agreements to facilitate collaboration between countries on CCUS.

Challenges and potential enhancements required

Unlocking the CCUS potential in Malaysia requires enhanced regulatory, financial and technological support (including technological transfers). Clarity over CCUS monitoring and liability provisions are important to foster business transparency and confidence, particularly in relation to transboundary carbon transactions. This clarity could be provided through a national CCUS governance framework that coordinates and legislates across these matters.

Further, enabling CCUS in Malaysia could require investment of over RM200 billion by 2050. Catalytic investments, partnerships with private sector players

and carbon pricing are needed in tandem to improve the economic viability of CCUS.

Finally, usage of CO_2 in industrial applications (e.g., precast concrete and urea production) can be fostered to supplement the CCUS industry. Government incentives and strategic partnerships can assist technology transfer from global centres of expertise towards local Malaysian businesses.

As highlighted in the previous chapter, CCUS, while a promising strategy that could enable accelerated decarbonisation of hard-to-abate sectors, is also an emerging technology and remains nascent to-date. CCUS viability in Malaysia within the power and IPPU sector applications (as well as its secondary role in enabling the viability of low cost low carbon hydrogen) is a key inflection point that could enable Malaysia's Net Zero aspirations. This in itself is also dependent on another inflection point, the availability of green financing to support deployment, given the capital expenditure intensity of carbon capture projects. As a result, in line with Malaysia's intention to pursue a balance and just transition, further developments in CCUS will be monitored and studied for their techno-economic feasibility.

Additional initiatives that could therefore be considered in the future could include the piloting of carbon capture on gas power plants power plants to study domestic techno-economic feasibility. Should techno-economic feasibility (i.e., this inflection point) be met, Malaysia could then consider the deployment of carbon capture on gas power plants at scale.

Summary of existing and potential future cross-sectoral strategies and initiatives Carbon Capture, utilisation, and storage (CCUS)

★ New initiative ★ Dependent on inflection point being met

Establish clear policies, frameworks, and governance

- Develop a CCUS regulatory framework, defining operator liability and transboundary CCUS provisions, as well as capture and storage regulations, to provide clarity to users and operators at both national and state levels
- Explore G2G bilateral agreements to facilitate collaboration between countries
- Establish a coordination unit to drive planning, implementation, and monitoring of CCUS
- Establish regulatory sandbox to pilot & scale CCUS in O&G & manufacturing sectors

Set up enabling infrastructure for capture, storage, and transport

- Encourage adoption of CCUS investment and initiatives through incentives (e.g., 100% investment tax allowance for qualifying CCUS capex, tax deduction from fees incurred for use of CCUS service)

Explore and stimulate demand from key sectors

- *Relevant post-2030 - refer to Malaysia's Long Term Low Emissions Strategy report*

Enabler 1
Monitoring, Reporting, and Verification (MRV) and Governance

Context

Monitoring, reporting, and verification (MRV) refers to the processes undertaken to measure and track emissions produced. It is a transparency and accountability mechanism that enables the meeting of commitments by stakeholders and countries – and the production of results (e.g., reports such as the Biennial Update Reports and National Communications) to domestic and international stakeholders.

MRV guidelines for reporting by developing countries are non-prescriptive, and provide guidance to leverage existing arrangements within the country. The UNFCCC[1] sets out 10 principles for MRV guidelines that should be adhered to by developing countries. These are:

- General;
- Voluntary;
- Pragmatic;
- Non-prescriptive;
- Non-intrusive and country driven;
- Takes into account national circumstances and national priorities;
- Respects the diversity of Nationally Appropriate Mitigating Actions (NAMAs);
- Builds on existing domestic systems and capacities;
- Recognises existing domestic measurement, reporting, and verification systems; and
- Promotes a cost effective approach.

Governance and institutional arrangements revolving around MRV in Malaysia are currently focused on reporting requirements – and are further detailed in the following subchapter.

Summary of current MRV and governance arrangements

As shared in chapter 4, governance and institutional arrangements with respect to MRV and broader climate decision making already exist in Malaysia today. These arrangements have, to date, enabled Malaysia to meet its reporting requirements under the UNFCCC. This governance structure has also been used to enable discussions of key climate issues at the sectoral and national levels given wide representation of technical experts, sectoral stakeholders, cross-ministerial policymakers, and federal and state government leadership. A summary of key committees and entities involved in climate decision making today can be found in Exhibit 7-3. These include entities that largely oversee cross-sectoral policymaking (i.e., cabinet) and entities that oversee technical, sector specific discussions (e.g., Technical Working Groups).

These committees and entities take part in sectoral monitoring and reporting, sectoral verification, and cross-sectoral verification activities – an illustration of which can be seen in Exhibit 7-4. Broadly:

- In **sectoral monitoring and reporting**, sectoral data is first reported by sectoral stakeholders (e.g., industry players, ministries, non-governmental organisations, other key sectoral committees) to NRES to be compiled. NRES then convenes TWGs to perform necessary emissions intensity calculations on the data and mitigating actions reported, with the TWG also overseeing the use of this data in projections where required. The TWG also oversees reporting and endorsement of the results;
- In **sectoral verification**, NRES (sometimes in parallel to the sectoral monitoring and reporting process above), conducts internal and external verification of sectoral results. Internal verification is conducted as part of the BUR/BTR inventory compilation and quality assurance/ quality control (QA/QC) processes, while external verification involves advisors and experts' input; and
- In **cross-sectoral decision making**, cabinet affirms and approves policies that are cascaded through MTPIN and ministries for implementation. Cross-sectoral decisions can also arise from technical issues that are escalated through the TWG, Technical Steering Committee for Climate Change (TSCCC), National Steering Committee for Climate Change (NSCCC), and MTPIN. While climate decision making is often debated through MTPIN, time-sensitive matters may also be escalated to cabinet directly given the cadence of current MTPIN sittings.

[1] In Decision 21/CP.19, Annex C

Exhibit 7-3
Key committees and entities involved in climate decision making today

Committe/Entity	Responsibility	Members	Meeting cadence
Cabinet	**Highest policy decision-making body**	**Led by the PM,** made up of **Cabinet ministers**	Weekly
***Majlis Tindakan Perubahan Iklim Negara* (MTPIN)**	**Provide direction on climate change related matters** between federal and state government	Chaired by PM, made up of **key cabinet and state leaders** relevant to climate change decision making	Twice a year
National steering committee on Climate Change (NSCCC)	**Formulates and implements policies** to address and adapt to climate change	Chaired by NRES KSU, made up of **state and federal level ministries, NGOs and agencies**	As required, minimum twice a year
Technical Steering Committee on Climate Change (TSCCC)	**Coordinate preparation of NC and BUR** and recommend approval of final GHG inventory	**Technical and sectoral experts and relevant policymakers**	As required, typically once every 2-3 months
Technical Working Groups[1]	Provide **technical Inputs** towards preparation of NC and BUR/BTR	Representation from **ministries, academia, the private sector, Industry and NGOs**	As required, typically every 2-3 months
Thematic Sub-working Groups	Provide specified (e.g. **sectoral**) **support to TWG** in preparation of reporting	Representation from **government agencies**	As required to support TWG

1 Comprises Inventory, Mitigation, Adaptation, Finance and Needs, Research and Systematic Observation, Transparency related Activities
SOURCE: MY NRC RAP and LT LEDS team discussions with stakeholders

Challenges and potential enhancements required

The UNFCCC is expected to introduce an enhanced transparency framework (ETF) in the coming years, that is expected to introduce changes in reporting and review of mitigating actions and emissions. This is particularly through reporting requirements in the Biennial Transparency Report (BTR), that will supercede the BURs. This is expected to require further detail and transparency on each nation's progress on implementing and meeting their committed NDC targets, adaptation plans, enhancements in GHG inventory reporting, and mandatory reporting on domestic MRV (given a change in legal requirements).

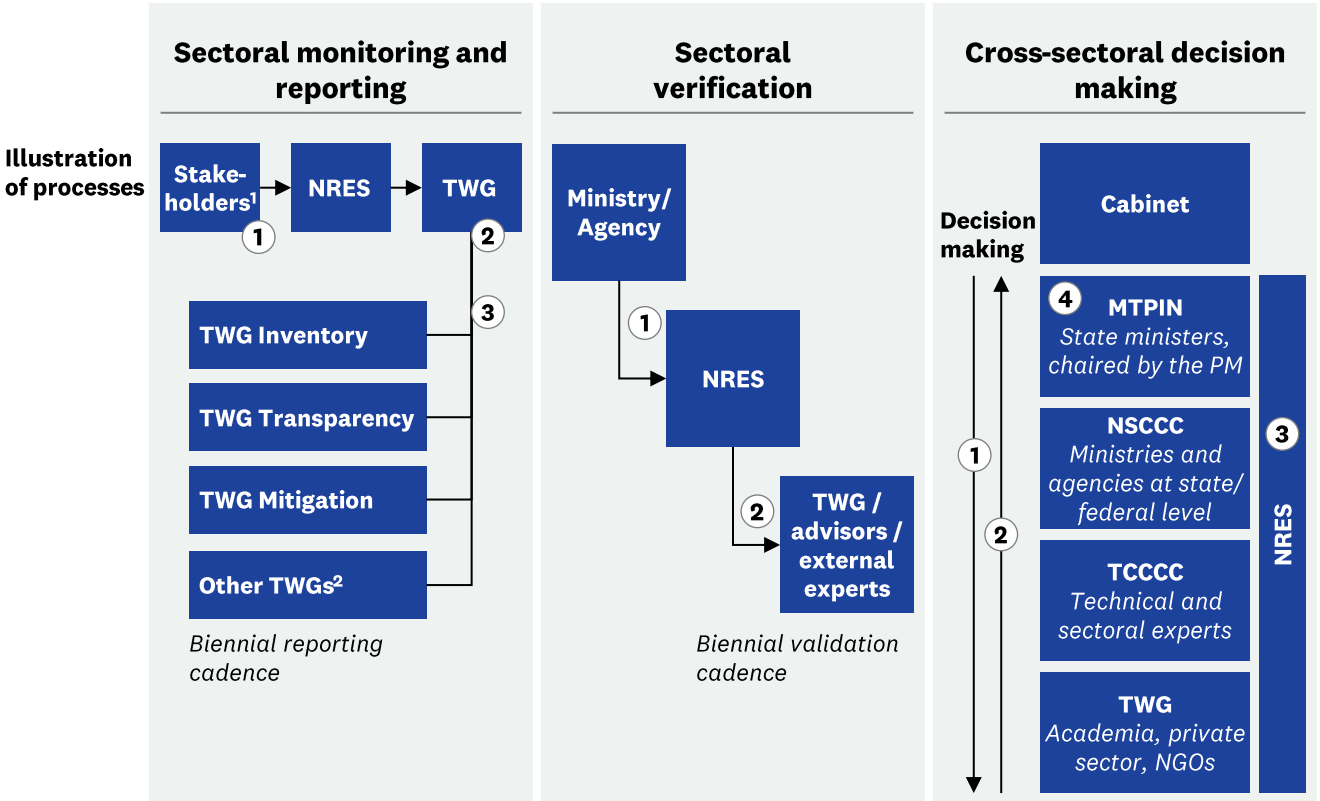
In addition to the growth of reporting obligations, complexity of mitigating actions will grow over time as the interconnectedness and scale of these strategies grow. For example, chapter 6 showcased the many interdependencies between sectors (e.g., between power and IPPU and transport). MRV arrangements may need to be enhanced to ensure ability of existing frameworks to accommodate this increased complexity across sectors, and against announced sectoral targets.

Finally, given the need to more closely monitor achievement of emissions reduction targets and pathways, entities' roles and MRV activities should be enhanced to reflect this within the existing structure of climate policymaking. This could mean a shift in existing MRV structures from reporting to more holistic problem solving on mitigating actions required for Malaysia to maintain its emissions trajectory and meet stated commitments (as well as update this document and its projections, as a living document). A potential future state process, enhanced to account for analyses of achieved pathway against projections and discussion of further mitigating actions that may be required, is illustrated in Exhibit 7-5.

Additionally, to address challenges of expected increased accountability and complexity in mitigating actions, Malaysia could also consider:

- Enabling legislation that enshrines climate targets currently under development in Malaysia as the Climate Change Act); and
- Pursuing development of an integrated reporting platform for mitigating actions (e.g., through partnerships with universities) – similar to ASEAN peers such as Indonesia (National Low Carbon Action Planning-Monitoring Application, or AKSARA) and Singapore (Emissions Data Monitoring and Analysis, or EDMA) .

Exhibit 7-4
Sectoral MRV and cross-sectoral decision making processes in Malaysia

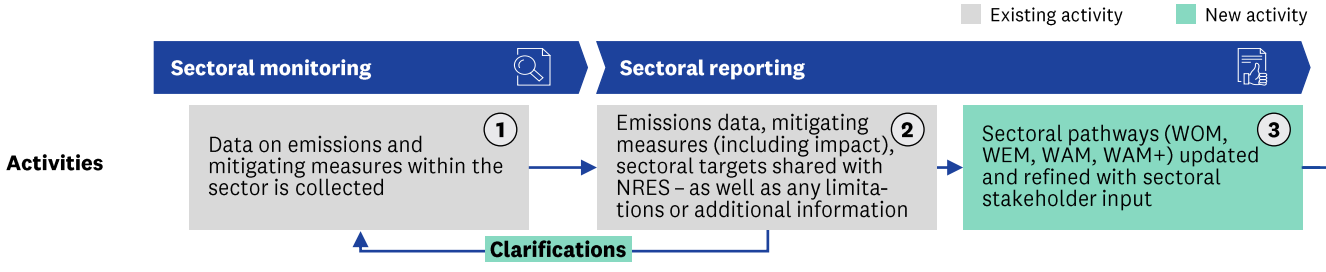


	Sectoral monitoring and reporting	Sectoral verification	Cross-sectoral decision making
Description	**Emissions by respective ministries** are reported to NRES for compilation, with final review conducted by the TWG	**Informal verification** performed by NRES and TWG committee members during working forums	**Policy decisions and technical initiatives across ministries** are syndicated with TWG, with final endorsement from MTPIN or NSCCC before Cabinet discussion
Details	1 **Stakeholders to report** on emissions data and mitigating actions to NRES – reported separately by sector 2 **NRES to compile** information, and perform necessary emissions intensity calculations, **utilising spreadsheets** 3 **Results reported and endorsed by TWG** Inventory and Mitigation; TWG Transparency oversees emissions projections	1 **Internal validation** as part of BUR inventory compilation and QA/QC processes 2 **External verification** by TWG chairs / advisors / external experts; members of **TWG** Inventory, Mitigation and Transparency groups also provide **cross sectoral validation**	1 **Policy decisions** arise from cabinet decisions and are communicated through MTPIN or directly to ministries for implementation 2 **Technical decisions** (e.g., advising on decarbonisation initiatives or targets) are proposed by TWG for eventual endorsement by NSCCC 3 **NRES** facilitates decision making and implements climate change policies 4 **NSCCC may suggest to revise the decarbonisation target** to be considered by MTPIN and Cabinet.

1 E.g. Ministries, industry players, regulators, agencies, and industry associations
2 I.e. TWG on Finance, Technology and Needs; TWG on Research and Systematic Observation; TWG on Vulnerability and Adaptation

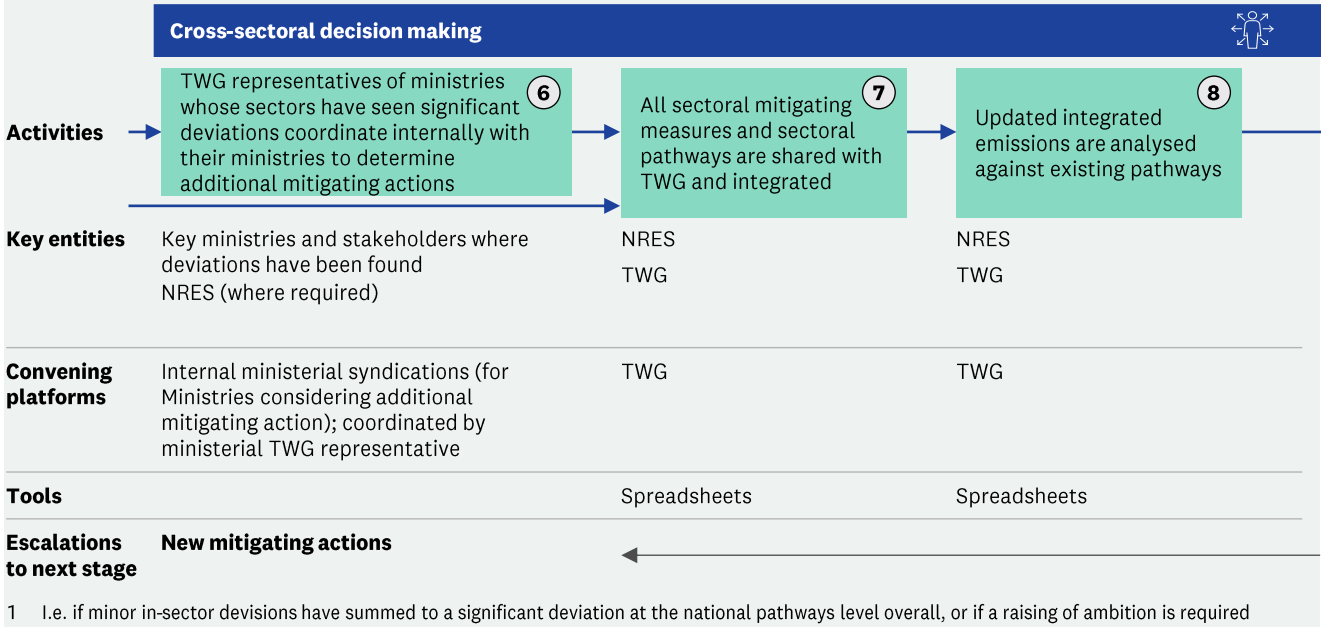
SOURCE: NRES, BUR 2019, MY NDC RAP and LT LEDS team discussions with stakeholders

Exhibit 7-5
Potential future state for sectoral MRV and cross-sectoral decision making



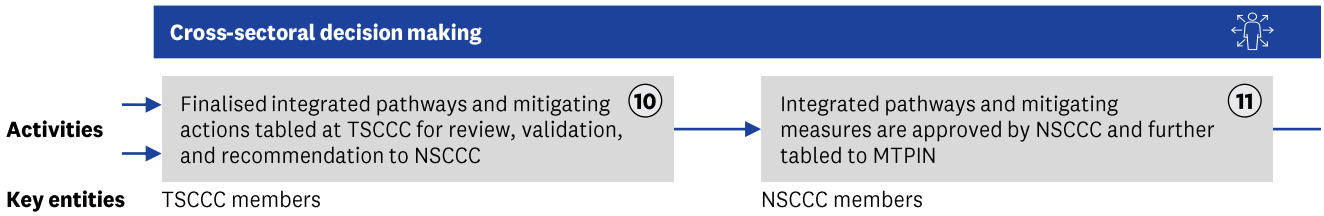
Key entities	Key ministries and stakeholders (industry associations, players, regulators) NRES[1]	Key ministries NRES	TWG members NRES (as TWG co-chair) SWG members
Convening platforms	Varies by sector	TWG	TWG SWG
Tools	Varies by sector	Varies by sector	Spreadsheets Energy modelling software
Escalations to next stage	Data limitations, **lower than expected impact or adoption of mitigating measures**		

1 Provides guidance on data required and requests support from other ministries



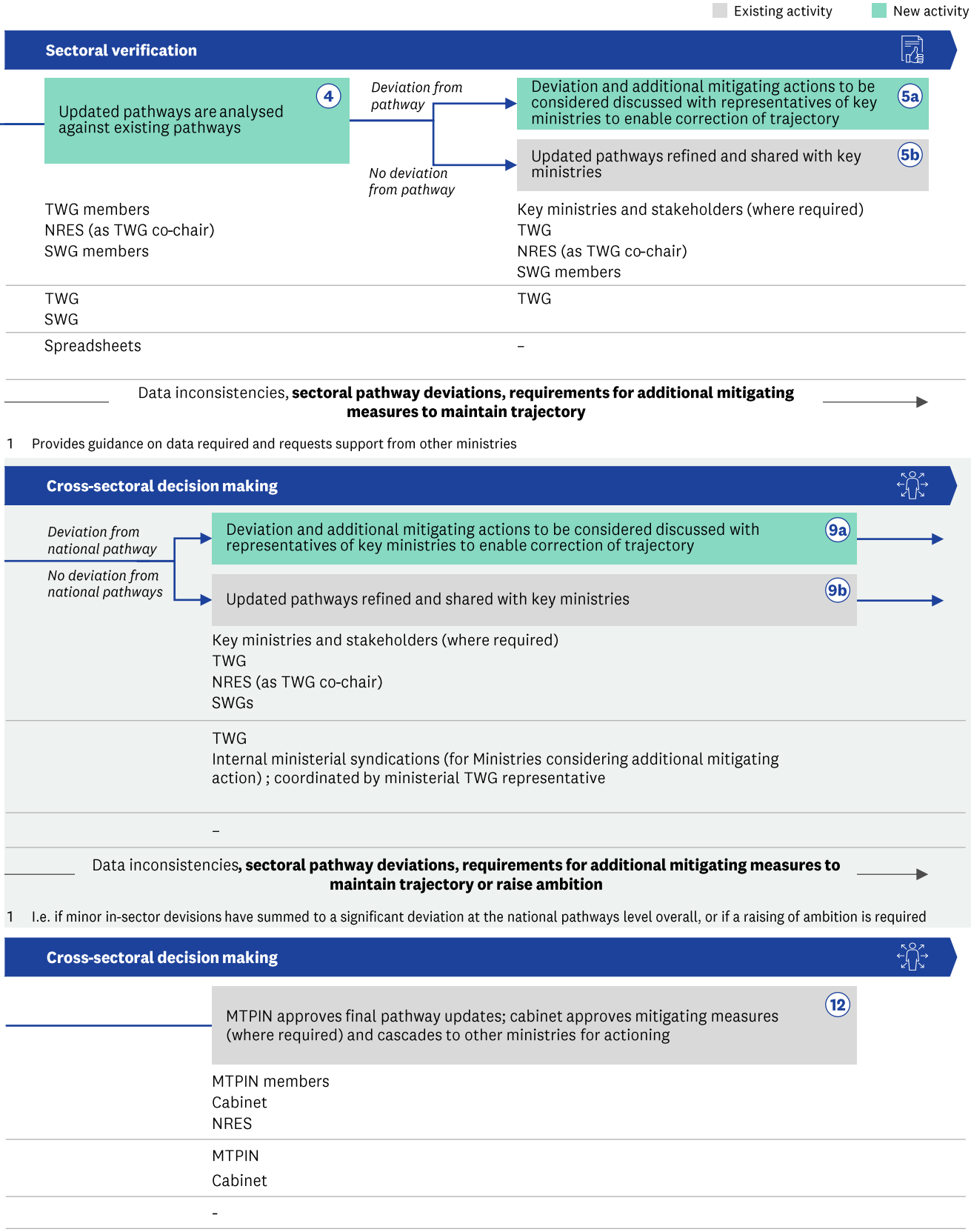
Key entities	Key ministries and stakeholders where deviations have been found NRES (where required)	NRES TWG	NRES TWG
Convening platforms	Internal ministerial syndications (for Ministries considering additional mitigating action); coordinated by ministerial TWG representative	TWG	TWG
Tools		Spreadsheets	Spreadsheets
Escalations to next stage	**New mitigating actions**		

1 I.e. if minor in-sector devisions have summed to a significant deviation at the national pathways level overall, or if a raising of ambition is required



Key entities	TSCCC members NRES	NSCCC members NRES
Convening platforms	TSCCC	NSCCC
Tools	-	-
Escalations to next stage	**Sectoral pathway deviations, additional mitigating measures to maintain trajectory or raise ambition**	**Significant key changes in sectoral and national pathways**

1 I.e. if minor in-sector devisions have summed to a significant deviation at the national pathways level overall, or if a raising of ambition is required


Existing activity
New activity
Sectoral verification
Updated pathways are analysed against existing pathways
4
Deviation from pathway
No deviation from pathway
Deviation and additional mitigating actions to be considered discussed with representatives of key ministries to enable correction of trajectory
5a
Updated pathways refined and shared with key ministries
5b
TWG members
NRES (as TWG co-chair)
SWG members
Key ministries and stakeholders (where required)
TWG
NRES (as TWG co-chair)
SWG members
TWG
SWG
TWG
Spreadsheets
–
Data inconsistencies, sectoral pathway deviations, requirements for additional mitigating measures to maintain trajectory
1 Provides guidance on data required and requests support from other ministries
Cross-sectoral decision making
Deviation from national pathway
No deviation from national pathways
Deviation and additional mitigating actions to be considered discussed with representatives of key ministries to enable correction of trajectory
9a
Updated pathways refined and shared with key ministries
9b
Key ministries and stakeholders (where required)
TWG
NRES (as TWG co-chair)
SWGs
TWG
Internal ministerial syndications (for Ministries considering additional mitigating action) ; coordinated by ministerial TWG representative
–
Data inconsistencies, sectoral pathway deviations, requirements for additional mitigating measures to maintain trajectory or raise ambition
1 I.e. if minor in-sector devisions have summed to a significant deviation at the national pathways level overall, or if a raising of ambition is required
Cross-sectoral decision making
MTPIN approves final pathway updates; cabinet approves mitigating measures (where required) and cascades to other ministries for actioning
12
MTPIN members
Cabinet
NRES
MTPIN
Cabinet
-

Enabler 2
Carbon pricing

Context

Carbon pricing is a mechanism that aims to 'price' the cost of emissions and tie them to their sources. Carbon prices aim to encourage polluters to adopt decarbonisation solutions (which usually involve capex expenditure or other enabling investments) through increasing the relative price of polluting versus decarbonisation.

A related but separate mechanism to carbon pricing is carbon markets – which is a market mechanism and trading system that enables the buying and selling of carbon credits. Carbon markets allow companies (or individuals) to buy 'credits' based on their calculated emissions levels and offset their emissions. Credits are ultimately issued to fund carbon removal or reduction projects – and can only be used once.

Enabling Malaysia's Net Zero journey will require decarbonisation initiatives that are not in the money today, and will require the incentivising of investments. As a result, a combination of carbon pricing and carbon markets would be required to support Malaysia's decarbonisation aspirations.

Summary of existing policies and initiatives

Malaysia recognises that economic incentives are needed for decarbonisation at scale. Accordingly, the federal and state Governments have begun pursuing pursued carbon market and carbon pricing legislations and tax incentives. Examples of initiatives introduced thus far include:

- **Bursa Malaysia's Voluntary Carbon Market**: Implementation of a voluntary carbon market (VCM) in collaboration with NRES. Under the 2024 National Budget the Government has announced exploration of a tax deduction of up to RM 300,000 for companies that incur MRV costs relating to the development of carbon projects to encourage participation in the VCM;
- **State level carbon trading**: A Nature Conservation Agreement (NCA) has been signed in Sabah involving the buying and selling carbon credits that cover 2 million ha of Sabah's forest reserves; and
- **Assessment of the feasibility of implementing carbon pricing instruments**: A study has been launched by MOF, and is expected to be completed by April 2024.

Challenges and potential enhancements required

Carbon pricing and investments stimulated by carbon markets will be a critical enabler of Malaysia's Net Zero aspirations. A balanced and just transition could require carbon pricing of USD 60-80 per tCO_2e in the long term through 2050.

Given the recency of carbon pricing initiatives in Malaysia, three key initiatives could improve the viability of carbon pricing mechanisms in Malaysia over time. These include:

- **Improved regulatory clarity**. Current carbon pricing legislation is under development by NRES to include references to corresponding adjustments under Article 6 of the Paris Agreement;
- **Implementation of carbon pricing, post study completion**. Carbon pricing will be a key enabler of adoption of many decarbonisation strategies (e.g., CCUS, switching to low carbon alternatives in the IPPU sector);
- **Enhancement of carbon market mechanisms**. Compliance Carbon Markets (CCMs) can increase the adoption of carbon pricing among market participants in Malaysia, building on the progress made under VCMs today; and
- **Increased coordination between state and federal actors**. Establishing a national framework for managing carbon stocks can prevent double counting of corresponding adjustments, given that state actors are beginning to engage in carbon trading with private sector players.

Enabler 3
Green financing

Context

RM 300 – 400 billion in investments up to 2030 could be required to enable Malaysia's Net Zero transition, with significant investments potentially required in energy subsectors such as power and transport – see exhibit 7-6 Between now and 2030, key investments could be required in grid sale solar (RM 60 billion), energy storage systems (RM 60 billion), EV production (RM 50 billion), Distributed RE generation (RM 40 billion), and Hydrogen (RM 20 billion).

Malaysia's Net Zero strategy comprises 15 sectoral strategies – across each, the deployment and mobilisation of climate finance is pivotal. Three essential components underpin the effective deployment and mobilisation of climate finance:

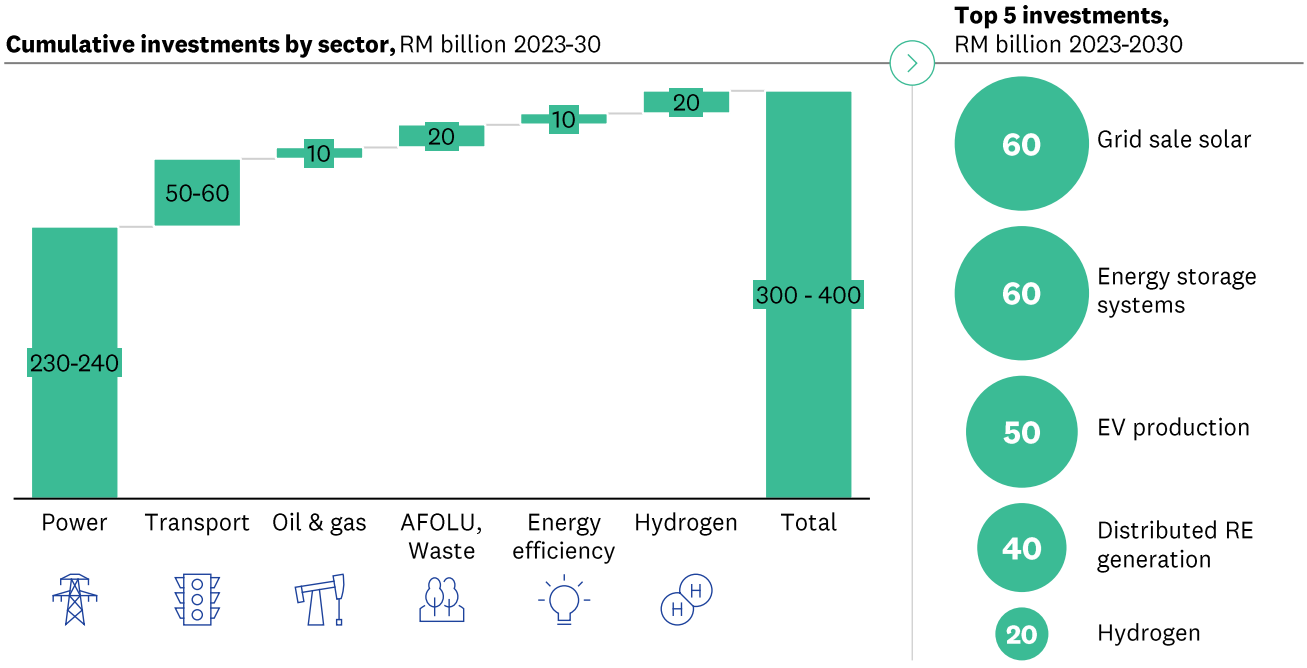
- **Supply of financing from funders** – funders each differ in institutional priorities, levels of risk appetites, and may have unique challenges (e.g., regulatory requirements and constraints);
- **Demand from viable projects** – projects should be technologically mature, and meet the investment requirements of financiers; and
- **Clarity in national and sectoral climate targets and policy** – with this clarity being able to serve as an effective guidepoint, and being complemented by favourable institutional frameworks that enables financial flows.

Summary of existing policies and initiatives

Accelerating techno-economic viability of emerging technologies will be key to enabling a balanced and just transition in Malaysia. To scale green financing in the country, Malaysia has:

- **Standardised classification by developing key green financing taxonomies and frameworks** including the Sustainable and Responsible Investment (SRI) Taxonomy, Climate Change and Principle-based Taxonomy (CCPT) 2021, and SRI-linked Sukuk Framework 2022. Furthermore, Bursa Malaysia mandates sustainability reporting for all listed companies and has introduced the Finance for Good Index (FTSE4 Good Bursa Malaysia Index);

Exhibit 7-6
Investment opportunity of RM 300-400 billion up to 2030 for Malaysia's Net Zero transition



SOURCE: Expert and stakeholder interviews, press search

- **Announced multiple cross-sectoral decarbonisation funding initiatives under the 2024 National Budget** including the introduction of the Electric Motorcycle Usage Incentive Scheme to consumers with an annual income of below RM120,000 that provides a RM2,400 rebate to buyers, extension of the NEM programme until 31 December 2024, RM200 million for Ecological Fiscal Transfer for Biodiversity Conservation in 2024 and the Government-pioneered issuance of a biodiversity sukuk of up to RM1 billion to fund replantation efforts of degraded forests (among others) that will in turn generate carbon credits;
- **Committed RM 2 billion in blended financing from the Government** in support of NETR projects; and
- **Announced various other financing initiatives under other recent sectoral roadmaps such as the HETR and NIMP 2030** including subsidies and incentives for hydrogen-related sectors, exploration of launch of a SDG linked bond or *sukuk*, a National Hydrogen Fund for projects in research and development and commercialisation phases, and the introduction of an Industrial Development Fund and Strategic Co-Investment Fund, to boost financing for industry decarbonisation.

The Government has also announced an intention to rationalise energy subsidies. This will enable the development of a targeted, needs-based subsidy mechanism that can ensure that vulnerable populations remain protected as Malaysia continues on its decarbonisation journey.

Challenges and potential enhancements required

A significant portion of low-emission assets and projects are not "bankable" today – as they include nascent technologies such as CCUS and hydrogen. Blended finance mechanisms could provide higher returns or lower risks for private sector investors and institutions. MOE has announced a National Energy Transition Facility (NETF) with the aim of exploring the catalytic potential of a blended finance platform, as well as RM 2 billion in initial seed funding within the NETR.

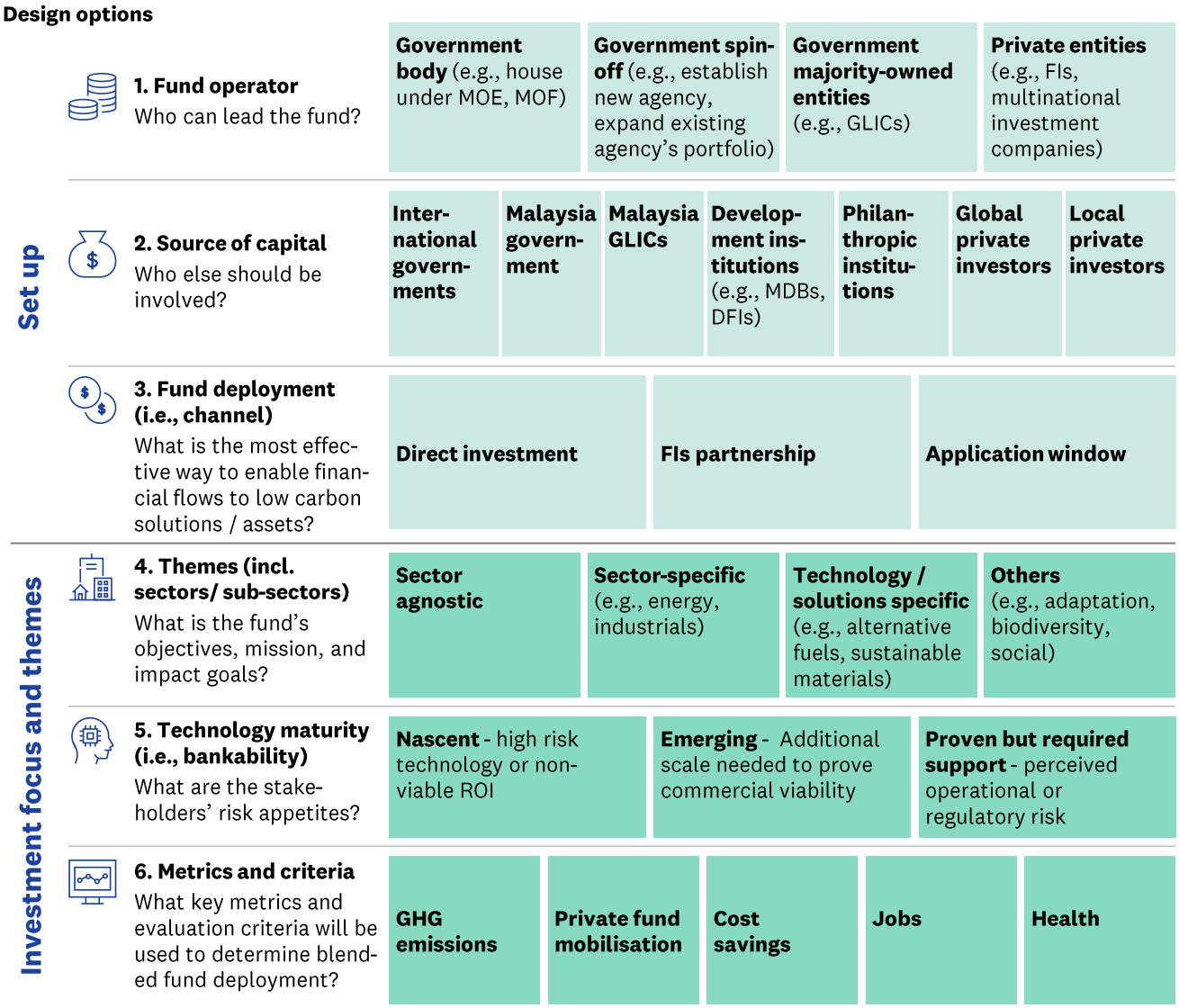
Exhibit 7-7 highlights options for different public-led vehicles for providing blended finance for non-bankable projects.

Exhibit 7-7
Public-led vehicles

Options for public-led vehicles for providing blended finance for non-bankable projects

	Subordinated debt and equity, first-loss	Concessional finance	Outcome and impact based financing	Guarantees and insurance	Grants and technical assistance
Overview	Public investor taking a lower priority for repayments	Repayable capital offered on terms more generous than commercial terms	Financing upon accomplishment of measurable targets	A promise of repayment to investors in case of default	Capital provided by DFIs or philanthropies without seeking financial return
Focus	De-risking investments	Increase returns for private investors	Small to medium projects with measurable targets	De-risking medium and large projects	Development and high-risk projects
Private sector role	Usually provides the senior debt or equity	Usually provides debt at market rates	Low private participation	Privates can both provide the guarantees or benefit from it	Low private participation in the development stages
Success factors & lessons learned	Established instruments for de-risking Adaptable instruments effective in different situations	Allows to align risk and return for private investors Financial and impact additionality is contested	Capital financially rewarding impact and rigorous impact reporting Complex scalability due to the usual high amount of stakeholders	Familiar to the financial market and larger institutional investors Requires a large asset size and financial knowledge	Require less financial knowledge. Good supporting instrument. Criticized for cumbersome bureaucracy and lack of effectiveness

Exhibit 7-8
Key design choices for blended finance fund



Moreover, there are six key design choices for the design of a blended financing fund – further shown in Exhibit 7-8.

Private capital could also be a key source of funds – and mobilisation of these funds for decarbonisation initiatives will be crucial. This includes attracting investments from green foreign direct investment focused funders, international and domestic capital markets, venture capital, and private equity. The mobilisation of private capital can also support innovation in nascent sectors with emerging business models such as long duration storage and demand management.

Additionally, green financing will be a critical enabler across all sectors given the capex expenditure and enabling mechanisms (e.g., incentive schemes, technical support) required. As highlighted in chapter 5 and this chapter, availability of green financing is also an inflection point that could determine Malaysia's speed and scale of decarbonisation given its ability to support key infrastructure development projects (e.g., hydrogen production infrastructure, carbon capture, transport, and storage infrastructure).

Finally, given the importance of SMEs and MSMEs to the Malaysian economy and in recognition of the unique challenges they face in decarbonisation, particular attention could be given to support SMEs and MSMEs. SMEs and MSMEs may face relatively higher increased compliance costs and capital expenditure for asset retrofits (e.g., software and hardware upgrades) could be significant. While the Government has already introduced numerous programmes to support SMEs and MSMEs in their decarbonisation journeys (e.g., BNM's RM1.1 billion Tech and Green Facility and Low Carbon Transition Facility of RM1 billion made available on a matching basis), continued support from both the private and public sector will be key.

Enabler 4

Small and Medium Enterprises (SME) and Micro, Small, and Medium Enterprise (MSME) Empowerment

Context

SMEs are the backbone of the Malaysian economy, accounting for 97% of total business establishments, generating 40% of GDP and providing employment for over 7 million people.

Supporting SMEs and MSMEs in decarbonisation will be crucial. In addition to the decarbonisation of SMEs and MSMEs being key to enabling Malaysia to achieve its Net Zero aspirations, these companies also typically form a significant proportion of Multinational Companies' (MNCs) supply chains.

Empowering SMEs and MSMEs to manage their own decarbonisation strategies also protects them against pressures from MNCs that may seek to decarbonise their own supply chains as part of their own Net Zero commitments or external headwinds (e.g., CBAM).

Summary of existing policies and initiatives

Given the importance of sustainability and the criticality of SMEs and MSMEs to the Malaysian economy, several sustainability focused programmes have been launched targeting SMEs and MSMEs. These range from capability building to financing, and include:

- **The MATRADE MTC-MSME Benchmarking Programme (2022)**, which incorporated segments that supported MSMEs on understanding major global trends and identifying critical elements of sustainability to be adopted and implemented;
- **Financing programmes targeted to SMEs and MSMEs looking to fund green or low carbon projects** such as UOB's U-Green Financing programme, Credit Guarantee Corporation Malaysia's support programme that provides support to low carbon projects, and the Green Technology Financing Scheme; and
- **MITI's National Industry ESG Framework (iESG)** launched to complement the NIMP 2030 – that aims to provide guidance to the manufacturing sector including guiding SMEs and MSMEs towards environment, social, and governance (ESG) based compliance (covering standards, capacity building, financing and market mechanism).

Challenges and potential enhancements required

SMEs and MSMEs in Malaysia are anchored and specialised in different industries, and as such are diverse and unique. Sectors with a particularly high SME and MSME penetration include the agriculture sector (particularly smallholder agropreneurs and farmers) and IPPU (i.e., smaller industry players).

Given the fragmented nature of the SME and MSME landscape, it would be critical to overcome informational and coordination challenges. Additionally, stakeholders have cited other factors such as high costs involved in green investments (e.g., equipment retrofitting, compliance costs) and focus on post-COVID recovery (as opposed to decarbonisation) as being additional challenges to SME and MSME decarbonisation.

In this spirit, the recently launched NIMP 2030 recognises that pursuit of decarbonisation alongside the reinvigoration of economic growth and ensuring resiliency is key – and calls for a reconfiguration of strategies and policies to meet this challenge. Toward this end, embedding awareness and capability building programmes within financing programmes could facilitate common, economy wide understanding across the diversity of SMEs and MSMEs within the local ecosystem. Examples of these are programmes currently under development as part of MITI's iESG Framework.

Enabler 5
Awareness and behavioural change

Context

The *Rakyat* and the private sector play an important role in Malaysia's decarbonisation journey. As a result, awareness and behavioural change is an important first step to embedding green behaviours at the grassroots level. Examples of decarbonisation levers that are dependent on awareness and behavioural change across sectors include:

- Power: awareness of distributed generation and solar leasing programmes that encourage distributed generation adoption;
- Transport: awareness of xEV models in the market, relative benefits of EVs vs. ICE, and behaviours that can influence fuel efficiency and public transport use;
- IPPU: awareness of software upgrades (e.g., that drive dual benefits of EE savings and cost efficiencies) and low carbon alternatives that can be adopted within each subsector; and
- Waste: awareness of regulations around separation at source, and behavioural change that can drive higher recycling rates.

Inspiring behavioural change is therefore essential to achieving Net Zero in Malaysia. Green education and awareness programmes could inspire citizens to adopt greener practices and more careful consumerism – and have been observed in both the private and public sector.

Practices that can drive behavioural change and more thoughtful consumerism include reducing, reusing, and recycling waste, decreasing excessive consumption (e.g., household energy), as well as purchasing goods and services backed by more sustainable practices (e.g., sustainably sourced goods, labour rights protected).

Summary of existing policies and initiatives

Malaysia has pursued a host of public and private green education and awareness initiatives. These include public sector led initiatives such as:

- **NETR's host of education-related initiatives to spur awareness**. These ranged from community support programmes to enhancing energy literacy and energy efficiency awareness among students, SMEs, consumers, and establishing a one-stop centre for energy transition data, information and programmes under the purview of Majlis Tenaga Negara (MTN);
- **HETR's hydrogen awareness focused initiatives**. These aim to strengthen the knowledge required for the continuous enhancement of hydrogen skills for future needs, such as the development of a dedicated continuous professional development programme (CPD) in hydrogen for experts and educators, and effective and fun Science, Technology, Engineering and Maths (STEM) education that integrates hydrogen components;
- **Setup of public sector bodies**. These include bodies such as Yayasan Hijau, which was established to educate youths on the importance of green technology and sustainable living. Programmes include Single Use Plastic Campaigns, National Science Week, and green audit programmes in schools; and
- **Cultivation of a sectoral 'champion'**. NIMP 2030 seeks to raise awareness of private-sector best practice through embedding the identification and creation of decarbonisation role models as a specific mission based project.

Other civil organisations championing green awareness across different sectors include Zero Waste Malaysia, Zero Emission Vehicle Association, Friends of Earth Malaysia and more.

The private sector has also rolled out initiatives to further greener practices among its employees. For example, the Business Council for Sustainable Development (BSCD) Malaysia is a CEO-led platform to raise awareness, share knowledge, and build capacity among companies. It has established BCSD Academy to provide training on select topics, from Sustainability and ESG Foundations to Carbon Footprinting and Reporting. In addition, retail space owners also actively encourage better waste management practices by rolling out recycling programmes (e.g., One Utama and Ikano Power Centre).

Challenges and potential enhancements required

Behavioural change is one of the most crucial enablers to driving changes in economy-wide approaches to decarbonisation – but is also one of the most difficult to mobilise on. Challenges include:

- Limited integration of climate change in school syllabi;
- Technical climate change concepts requiring simplification for communication and mass consumption; and

- Urban-rural divides and generational gaps in climate change awareness and education.

Going forward, additional awareness programmes can be implemented to further induce behavioural change in Malaysia. This could include formalising climate change topics in schools, rolling out national campaigns on the concept and implications of climate change, or developing a communications plan to raise awareness and participation in existing and new green initiatives (e.g., public transport adoption, waste separation for recycling).

Enhanced enforcement can also ensure compliance – for example, the RMK-12 MTR highlighted strengthening of waste management through involving over 250,000 premises in a waste separation enforcement exercise. Extension and continuation of these exercises and programmes can inculcate behavioural change over the long term.

Enabler 6
Talent and capabilities development

Context

Malaysia's journey to Net Zero and the transition towards greener technologies involve significant investments in new, catalytic green sectors such as hydrogen and green manufacturing (e.g., green steel, EVs). As a result, these investments could lead to 350,000-500,000 additional jobs being created in these future-proof sector.

However, this could require significant reskilling and upskilling as the requirements for new skills grow (e.g., project management, grid installation, ESG related skills including reporting and emissions tracking capabilities, engineering capabilities in new technologies such as hydrogen).

Capability building and talent development can stem from a variety of programmes – including apprenticeships, TVET, and higher education institutions. More specifically, these can also include on-the-job training and capability development, developed and implemented in partnership with the private sector.

Summary of existing policies and initiatives

In response to the energy transition, a pivotal focus has been placed on the reskilling of talent. Recent Government announcements and roadmaps showcase this emphasis on talent development through identifying talent and capability development as a key enabler and developing and enhancing programmes accordingly. A Green Jobs Malaysia Portal was also launched in 2021 by the Malaysian Green Technology And Climate Change Corporation(MGTC) for companies to offer green vacancies that reduce the environmental impact of enterprises and economic sectors.

Other examples of recently announced and ongoing initiatives include:

- **Under the 2024 National Budget**, RM6.8 billion allocated towards upskilling and reskilling initiatives inclusive of RM 1.6 billion for Human Resources Development Corporation to train 1.7 million workers, RM100 million to provide industry-recognised certification to TVET graduates, and provisions to promote well-being of vulnerable groups (e.g., extension of tax incentives for women returning to work);
- **Under the NETR**, preparing for the transition to green skills (away from GHG intensive sectors) through initiatives that propose establishing a green skills taxonomy to facilitate strategic workforce planning, developing and rolling out targeted green skilling programmes, and developing and implementing support programmes for affected communities and regions;
- **Under the HETR**, leveraging hydrogen talent development to cater to job losses among low-skilled workers and increasing awareness in hydrogen-related education and career pathways via initiatives such as developing a TVET syllabus or module on hydrogen technologies, designing professional courses on building core green skills for the unemployed and low-income groups, and

providing certification for hydrogen jobs under ISO 17024 – Accredited Personnel Certification; and

- **Under the NIMP 2030**, fostering talent development and attraction in critical sectors such as those related to energy transition and sustainability by leveraging mynext and MYFutureJobs for strategic workforce planning to address long-term talent requirements, introducing a progressive wage system policy, improving policies to enable accelerated access to high-skilled foreign talents, and raising the profile of high-tech manufacturing careers.

Challenges and potential enhancements required

The NDC RAP is designed to harmonise environmental conservation with economic advancement. Inclusive capability building in new green sectors is key to a balanced, and just transition. This particularly includes ensuring that talent development encourages and enables equitable participation from all segments of society, including vulnerable groups and communities.

Additionally, as capability and talent development can encompass a broad range of skills, it will also be critical to ensure that initiatives and programmes designed are relevant and addresses the needs of the talents of today. Feedback from the iESG programmes and learnings from lighthouse cases (such as the NIMP 2030's target to identify an industry decarbonisation 'champion') can serve as case studies on the challenges capabilities that will need to be built among industry players, including SMEs and MSMEs.

Box 2
The Barefoot Solar Project

The Barefoot Solar Project provides capability building to rural women with no formal education in solar technology installation and maintenance. As Solar Engineers, the women go through training in India and return to their home villages with the knowledge of how to install and maintain solar panels that can be connected to village-wide solar lanterns. The capabilities and knowledge are then retained in the village, as these women are then able to train other villagers in turn. Three villages in Sabah have been powered through the efforts of women trained in the programme.

Technology transfer and international partnership

Context

Tackling climate change requires a collective and concerted effort. Malaysia is committed to fostering collaboration within (e.g., public and private partnerships, cross-sectoral and stakeholder partnerships as the core of Malaysia's MRV mechanisms) and across borders (e.g., G2G partnerships) to scale decarbonisation efforts.

Additionally, five inflection points key to shaping Malaysia's Net Zero trajectory have been identified. They are:

- Carbon capture for gas power plants, or green technology viability in power;
- Carbon capture for industries such as iron and steel;
- Hydrogen costs (low carbon and green hydrogen);
- Economic viability of nature-based solutions especially removals; and
- Green financing for green technology.

Technology transfers and international partnerships underpin all five of these inflection points – with domestic developments being highly incumbent on international developments for each of the five inflection points. These inflection points, in turn, are the cornerstone of a balanced and just transition pathway for Malaysia.

Summary of existing policies and initiatives

To date, Malaysia has focused on developing partnerships across several decarbonisation topics, such as hydrogen, CCUS, and adaptation initiatives. These include:

- **Fostering international collaboration on innovative technologies**. For example, PETRONAS and ENEOS Corporation have signed a Memorandum of Understanding to jointly develop a competitive and clean hydrogen supply chain between Malaysia and Japan. Both companies share an aspiration to achieve Net Zero by 2050;
- **Facilitating knowledge exchanges on international best practices with international partners (including through G2G mechanisms)**. In 2022, Malaysia and the UK strengthened ties on climate co-operation. The partnership covers five areas: collaboration on climate and biodiversity issues, knowledge sharing, promoting scientific and technical collaboration, supporting private green finance, and promoting outreach activities. Furthermore, on a city-level, Kuala Lumpur has been part of the global C40 Cities network that unites 100 mayors on climate action by fosters collaboration and knowledge sharing. As a participant of ASEAN, Malaysia is also a supporter and active participant in ASEAN Power Grid projects;
- **Forging climate-focused public and private partnerships.** Efforts are already ongoing – for example, the ChargEV project is a joint venture between Yinson Green Technologies (M) Sdn Bhd and GreenTech Malaysia Alliances Sdn Bhd (GTMA), a wholly-owned subsidiary under the Malaysian Green Technology and Climate Change Corporation (MGTC). This collaboration to develop Malaysia's public charging infrastructure also extends to other key stakeholders for the implementation of the public chargers, such as POS Malaysia, Sime Darby Property, and Starbucks

08

Risk and uncertainties

There are four critical risks to Malaysia's achievement of its NDC target. These are:

- Missing sectoral decarbonisation-related goals;
- International sales of carbon credits; and
- Overall growth in emissions due to demand and supply factors.

Taken together, should these implementation risks be unmanaged and left to materialise, Malaysia could face higher risk of missing its NDC targets in 2030.

Each sector has relevant decarbonisation goals that contribute directly to the nation's overall decarbonisation journey. Certain goals, such as achieving scheduled LSS plant ups in the power sector, 50% forest cover in AFOLU, 15 – 20% xEV sales penetration in the transport sector, or flaring and venting reduction in oil and gas, are critical in enabling effective mitigation of emissions. Missing these targets may be a result of several factors, such as a lack of financing, capability or stakeholder alignment, insufficient relevant infrastructure, limited or slower-than-expected technological viability, or sufficient governance structures to oversee mitigation efforts. For example, limited green investments could hamper the roll-out of LSS infrastructure. Additionally, as outlined in previous chapters, decarbonisation is not a zero sum game – and economic growth in some key sectors can also result in the growth of emissions. For example, industries in the IPPU sector are critical to the economy – but emissions from these industries are also hard to abate with currently available technologies. Thus, a balanced approach is required to manage emissions growth to ensure that economic impacts are effectively managed.

In addition to sectoral targets, slower real GDP growth could also impact Malaysia's achievements in 2030 – given that Malaysia has set an emissions intensity reduction target against GDP. Slower than expected nominal GDP growth or fluctuations in expected inflation could place the intensity target at risk.

Internationally Transferred Mitigation Outcomes (ITMOs) resulting from the sale of carbon credits could also impact Malaysia's achievement of its NDC targets due to corresponding adjustments under Article 6 of the Paris Agreement. As Malaysia is endowed with an abundance of natural assets that contribute to a sizeable sink, there could be a potential for Malaysia to participate in the international sale of carbon credits. Lack of coordination and alignment on the quantum of carbon credits that can be generated and sold on the international market could result in a significant growth in net emissions.

Lastly, changes in macroeconomic demand or supply may also affect the emission scenarios. For example, higher population growth could drive increased power consumption and vehicle ownership, which may lead to increased emissions if energy sources remain as per business-as-usual in the WEM scenario. In addition, increased manufacturing activity to cater for unexpected increases in demand and new infrastructure projects could also lead to higher emissions. It is therefore important that this report is treated as a living document, and that these projection targets are constantly monitored and revised where necessary.

In addition to the four risks outlined above, a key area of uncertainty is data availability and granularity. Projections and scenario estimates could shift as more data becomes available over time – particularly as MRV mechanisms become more stringent. Furthermore, scientific and research advances could also result in changes in the emission factors adopted by the international community. Adopting these new emissions factors for emissions projections could also result in changes in the emissions pathways.

The realisation of these risks can have physical and reputational knock-on effects. A lack of mitigation and adaptation actions could lead to more extreme weather patterns in Malaysia, resulting in a higher likelihood of flooding and heatwaves. Tackling these risks would be imperative to avoid additional economic, social, and environmental cost from increased natural hazards.

09

Climate risk resilience and adaptation

Climate risk resilience and adaptation measures are an important component of the national response to address climate change as highlighted in Malaysia's First Update of Nationally Determined Contribution 2021 (NDC 2021) to the UNFCCC.

Malaysia's updates on the Nationally Determined Contribution (NDC) in 2021 highlighted revised projections of future changes, underlining the nation's vulnerability to climate risks. Recognizing that Malaysia is continually vulnerable to the negative effects of climate change, such as flooding, coastal erosion, droughts, etc. As described in chapter one of this report, the country has experienced increased minimum, mean and maximum air temperatures. The rainfall intensity has also increased. Over the last two decade more weather extremes had been experienced by the country. Major floods occurred in 2010, 2012 and 2014, 2021 and 2022 with the 2014 northeast monsoon floods being one of the worst in recorded history. In 2016, a very strong El Niño resulted in prolonged dry periods and associated water shortages, heat waves and wild fires. Consequently, economic losses have also increased.

The Global Goal on Adaptation (GGA) or the United Arab Emirates (UAE) Framework for Global Climate Resilience put forth at COP28 stresses the importance of having a clear framework and targets to guide global adaptation efforts and enhance support for adaptation in developing nations.

Malaysia aims to align its efforts with the Global Goal on Adaptation (GGA) by 2030. First, Malaysia will conduct an impact assessment, which would update the country's hazard assessments and establish early warning systems by 2027. Second, Malaysia plans to develop a transparent, gender-responsive National Adaptation Plan (MyNAP) by 2030. Finally, Malaysia aims to progress in implementing its plans to reduce social and economic impacts by 2030.

Malaysia has updated its climate risk and adaptation assessment in its Fourth National Communication (NC4). In addition, Malaysia is currently developing the National Adaptation Plan (MyNAP) to ensure that the country's efforts, specifically the planning and implementation of adaptation measures are coordinated and effective.

MyNAP will be funded by the Global Climate Fund under the UNFCCC and will be developed in collaboration with foreign and local institutions. MyNAP will focus on five (5) main sectors (i) Water security and water resources; (ii) Agriculture and food security; (iii) Infrastructure, energy and built environment (including cities); iv) Forestry and biodiversity; and (v) Public health.

Exhibit 9-1 summarizes the impact of climate risks and vulnerabilities across sectors and sub-sectors in Malaysia. Full details of the assessment could be found in Malaysia's Fourth National Communication (NC4).

Exhibit 9-1
Summary of Sectoral Impact and Vulnerability Assessments for NC3 and NC4

	Extreme Event			
Sub-sector	**Flood**	**Dry spell**	**Wet**	**Sea level rise / coastal inundation**
Reservoir Storage and Dam Security		✓	✓	
Flood risk management	✓			✓
Groundwater Security				✓
Coastal Erosions				✓
Rice	✓	✓		✓
Oil Palm	✓	✓		✓
Rubber	✓	✓	✓	✓
Cocoa	✓	✓		
Livestock	✓	✓		
Fisheries & Aquaculture	✓	✓		
Inland forest			✓	✓
Peat Swamp Forest			✓	✓
Mangrove Forest			✓	✓
Terrestrial Fauna (Birds, Orangutan, Elephant, Tiger, samba deer)	✓	✓		
Marine Ecosystem (Coral reefs, marine turtle, marine mammals)				✓
Cities	✓	✓		✓
Built Environment	✓	✓		✓
Road	✓			✓
Rails	✓			✓
Ports & Jetties	✓	✓		✓
Airports	✓	✓		✓
Solid waste Facilities	✓	✓		✓
Sewerage Facilities	✓			✓
Water supply Facilities	✓	✓		
Flood relief Centres	✓			✓
Electricity Generation, Transmission and Distribution	✓	✓	✓	✓
Oil & Gas	✓	✓		✓
Healthcare Facilities	✓			✓
Vector Borne Diseases (Dengue & Malaria)	✓	✓		
Food and water Borne Diseases	✓			
Leptospirosis	✓			
Heat Related Illness		✓		

SOURCE: Malaysia Fourth National Communication (NC4)

10

Conclusion

Decarbonisation is a complex endeavour – and Malaysia's success in achieving the pathways discussed in this document hinge on three core imperatives.

Firstly, the ability to balance tradeoffs against the five decarbonisation outcomes to ensure the maximization of benefits for the *Rakyat*, industry, and country – while ensuring the minimization of unintended consequences. Decarbonisation will require careful consideration of tradeoffs and multifaceted strategies to minimise unintended consequences. However, conversely, the road to achieving Malaysia's NDC commitments and Net Zero ambitions is paved with opportunities for green business building. Preparing for decarbonisation across each sector enables Malaysia to seize opportunities in emerging industries and trends, including new growth areas identified by the NIMP 2030 such as renewable energy and electric vehicles. This is aligned to Malaysia MADANI values of innovation, sustainability, and prosperity, as well as Government aspirations to develop capabilities in new areas of high value added manufacturing.

Secondly, the ability to ensure implementation excellence across all decarbonisation strategies. Analyses of Malaysia's Net Zero pathways at a national level in chapter 5 and sectoral deep dives in chapter 6 show the criticality of each sector's efforts to that of the overall country's, and that Net Zero cannot be achieved by a single sector alone. Malaysia can only achieve Net Zero if concerted effort is undertaken by all stakeholders in every sector, in collaboration with each other. Implementation excellence will also be key to ensure the minimisation of risks – particularly in ensuring that targets and metrics in each sector are met as planned in their respective roadmaps and policies.

Finally and thirdly, the ability to galvanise stakeholders towards this anchor purpose. Given the interdependencies across sectors' decarbonisation strategies and this interconnectedness expected to grow over time, a whole-of country and whole-of-Government approach is key to enabling Malaysia's decarbonisation aspirations. Support from international peers and partners from both a technology transfer and financing perspective will also be critical in enabling adoption of the latest and most feasible advancements in technology across these sectors.

Given innovations that are moving at pace, the NDC RAP is intended as a living document that will continue to serve as a guide to orient Malaysia's decarbonisation strategy. The publication of these documents represents Malaysia's commitment to safeguarding the planet, Malaysia's biodiversity, and the future for generations to come – while ensuring that current vulnerable generations remain protected, and are able to contribute to Malaysia's sustainable development in the years to come. Cooperation from every segment of society will be required to enable Malaysia to prepare and face the greatest challenge of this generation as a united *Rakyat* – and the Government looks forward to working with all stakeholders in achieving a balanced and just transition for Malaysia together.

Appendix

Acronym	Full term
AAC	Annual allowable cut
AFOLU	Agriculture, forestry, and land use
AKSARA	Indonesia's National Low Carbon Action Planning-Monitoring Application
AWD	Alternate wetting and drying
B2B	Business to business
BCSD	Business Council for Sustainable Development
BESS	Battery energy storage system
BEV	Battery EV
BF BOF	Blast furnace-basic oxygen furnace
BNM	Bank Negara Malaysia (Central Bank of Malaysia)
BPI	Bahagian Perubahan Iklim
BTR	Biennial Transparency Report
BUR4	Fourth Biennial Update Report
CAGR	Compound Annual Growth Rate
CBAM	Carbon Border Adjustment Mechanism
CCUS	Carbon Capture, Utilisation and Storage
CCM	Compulsory carbon market
CCPT	Climate Change and Principle-based Taxonomy
CCS	Carbon Capture and Storage
CHP	Combined Heat and Power
CoC	Chain of Custody
CPD	Continuous professional development
CPO	Crude Palm Oil
DAKN 2030	Dasar Agrikomoditi Negara 2030 (National Agricommodity Policy 2030)
DG	Distributed generation
DOA	Department of Agriculture
DOSM	Department of Statistics Malaysia
DRI	Direct Reduced Iron
EAF	Electric Arc Furnace
ECoS	Energy Commission of Sabah

Acronym	Full term
ECRL	East Coast Rail Link
EDMA	Singapore's Emissions Data Monitoring and Analysis
EE	Energy efficiency
EECA	Energy Efficiency Conservation Act
EPR	Extended producer responsibility
ESCO	Energy services company
ESG	Environment, social, and governance
ETF	Enhanced Transparency Framework
FCEV	Fuel cell electric vehicles
FiT	Feed-in-Tariff
G2G	Government to government
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLC	Government linked companies
HDV	Heavy duty vehicles
HETR	Hydrogen Economy and Technology Roadmap
HHI	Herfindahl-Hirschman Index
HVO	Hydrotreated vegetable oil
ICE	Internal combustible engine
IF	Induction Furnace
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial processes and product use
ITMOs	Internationally Transferred Mitigation Outcomes
ITTO	International Tropical Timber Organisation
IWK	Indah Water Konsortium
JPPPET	Jawatankuasa Perancangan dan Pelaksanaan Pembekalan Elektrik dan Tarif
KeTTHA	Kementerian Tenaga, Teknologi Hijau, dan Air (Ministry of Energy, Green Technology, and Water)
KPIs	Key Performance Indicators
KPK	Ministry of Plantation and Commodities
KPKT	Kementerian Pembangunan Kerajaan Tempatan (The Ministry of Housing and Local Government)

Acronym	Full term
KSAS	Kawasan Sensitif Alam Sekitar
KSM	Kementerian Sumber Manusia (Ministry of Human Resources)
LCMB	Low Carbon Mobility Blueprint
LDAR	Leak detection and repair
LDES	Long duration energy storage
LNG	Liquefied natural gas
LRT	Light Rail Transit
LT-LEDS	Long Term Low Emissions Development Strategy
LULUCF	Land Use, Land Use Change, and Forestry
MAFS	Ministry of Agriculture and Food Security
MEESTy	Ministry of Energy and Environmental Sustainability
MEPS	Minimum energy performance standard
METO	Malaysia Energy Transition Outlook
MGTC	Malaysian Green Technology And Climate Change Corporation
MIDA	Malaysian Investment Development Authority
MITI	Ministry of Investment, Trade, and Industry
MNC	Multi-national corporation
MOE	Ministry of Economy
MOF	Ministry of Finance
MOSTI	Ministry of Science, Technology, and Innovation
MOT	Ministry of Transport
MRF	Material Recovery Facilities
MRT	Mass Rapid Transit
MRV	Monitoring, reporting, verification
MSME	Micro, small, and medium enterprises
MSW	Municipal Solid Waste
MTCC	Malaysian Timber Certification Council
$MtCO_2e$	Million tonnes of CO_2 equivalent
MTIB	Malaysian Timber Industry Board
MTN	Majlis Tenaga Negara

Acronym	Full term
MTPIN	Majlis Tindakan Perubahan Iklim Negara
NAMA	Nationally Appropriate Mitigating Action
NAP	National Agrofood Policy
NCA	Nature Conservation Agreement
NDC RAP	Nationally Determined Contributions Roadmap and Action Plan
NEEAP	National Energy Efficiency Action Plan
NEEAP 2.0	National Energy Efficiency Action Plan 2.0
NEM	Net Energy Metering
NEP	National Energy Policy
NETR	National Energy Transition Roadmap
NIMP 2030	New Industrial Masterplan 2030
NRES	Ministry of Natural Resources and Environmental Sustainability
NSCCC	National Steering Committee for Climate Change
PFC	Perfluorocarbon
POME	Palm oil mill effluent
PRF	Permanent Reserved Forests
QA/QC	Quality assurance/quality control
RE	Renewable energy
REDD	Reducing emissions from deforestation and forest degradation
RMK-12	Rancangan Malaysia ke-12 (12th Malaysia Plan)
RMK-12 MTR	Rancangan Malaysia ke-12 Mid Term Review (12th Malaysia Plan Mid Term Review)
RSPO	Roundtable on Sustainable Palm Oil
SAVE	Sustainability Achieved Via Energy Efficiency
SB Sabah	Single Buyer of Sabah
SCM	Supplementary cement materials
SCORE	Sarawak Corridor of Renewable Energy
SDG	Sustainable Development Goals
SEB	Sarawak Energy Berhad
SEDA	Sustainable Energy Development Authority
SE-RAMP	Sabah Energy Roadmap and Masterplan

Acronym	Full term
SFM	Sustainable forest management
SME	Small and medium enterprises
SMS	Selective management system
SOGA	Skills in Oil and Gas programme
SRI	Sustainable and Responsible Investment
SSR	Self Sufficiency Ratio
STEM	Science, Technology, Engineering, and Maths
SWG	Sector Working Group
TCO	Total cost of ownership
TPA	Third Party Access
TPES	Total Primary Energy Supply
TSCCC	Teschnical Steering Committee for Climate Change
TVET	Technical and Vocational Education and Training
TWG	Technical Working Group
UNFCCC	United Nations Framework Convention on Climate Change
UPEN	Unit Perancangan Ekonomi Negeri (Economic Planning Unit of State)
VCM	Voluntary carbon market
VOC	Volatile organic compound
VRE	Variable renewable energy
VRU	Vapour recovery units
WAM	With additional measures
WEM	With existing measures
WOM	Without Measures
WTE	Waste to energy
WTW	Waste to wealth
xEV	Electric vehicle