MINISTRY OF ECONOMY

National Energy Transition Roadmap

Energising the Nation, Powering Our Future

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Foreword by
Prime Minister

As we embark on the journey to build a better Malaysia, the progress that we pursue goes beyond strong institutions, leading technology and world-class infrastructure. The main objective is focused on empowering the *rakyat*, so Malaysians will emerge as a cohesive society with high integrity, mutual respect and unity. One of the key principles of Malaysia MADANI is 'sustainability', which broadly relates to growing responsibly in the realm of energy transition and sustainable development.

Ergo, the National Energy Transition Roadmap (NETR) is pivotal to accelerating our green and sustainable growth agenda. The NETR is a significant milestone for Malaysia, which comprehensively charts our nation's trajectory towards a brighter, cleaner, and more resilient future. In line with the Ekonomi MADANI framework, it is a declaration of the country's commitment to future generations and a testament to our resolve in addressing the pressing challenges of our times.

The Twelfth Malaysia Plan, spanning the years 2021 to 2025, and the National Energy Policy 2022-2040, have laid the groundwork while the NETR will ensure Malaysia forges ahead in this transformative journey. Against the backdrop of a dynamic global energy landscape mired with the energy trilemma of security, affordability, and sustainability at its core, the world is racing for solutions. Malaysia too is resolute in overcoming these challenges and the NETR demonstrates our unwavering determination in this regard. Reducing Malaysia's carbon footprint is one of the catalysts to transforming the economy on a more sustainable path. It is also an agenda to generate new sources of growth, creating business and trade opportunities, and consequently, knowledge workers.

In the pursuit of a net-zero future, the journey requires not just technological innovation, but a comprehensive shift in our mindset, strategies, and policies. The NETR encapsulates the aspirations of all stakeholders, from industry leaders, to ordinary Malaysians who envisions a harmonious coexistence with our planet. It reiterates Malaysia's commitment to social justice, inclusivity, and balanced progress.

On this momentous journey, it is important to remember that the transition to a low-carbon future is not merely a policy objective but a moral imperative. It is a commitment to the well-being of our children and the generations to come. It is an investment in the sustainability of our communities, our industries, and our environment. Through NETR, the government aspires to trailblaze a development path that is not solely hinged on energy, but a larger collective resolve of stewardship and responsibility.

In all sincerity, I trust that NETR will inspire us to take bold steps, to forge collaborations, and to harness our collective strength in the pursuit of a sustainable and prosperous future. It affirms that progress and sustainability are not mutually exclusive and requires critical decisions and changes to be made. I urge each and every Malaysian, to be united and resolute as envisioned in the Malaysia MADANI, to march forward and lead towards a more sustainable and resilient future.

ANWAR BIN IBRAHIM
29 August 2023

Preface by
Minister of Economy

The Twelfth Malaysia Plan, spanning 2021-2025 (Twelfth Plan), articulates our commitment to achieve net-zero GHG emissions by 2050. Concurrently, the National Energy Policy 2022-2040 (DTN) lays the foundation for an equitable energy transition that is fair and inclusive for everyone.

Globally, the energy sector faces a rapid transformation while balancing the energy trilemma of security, affordability, and sustainability. Energy transition is also gaining momentum both domestically and internationally.

To accelerate our energy transition efforts, we have developed the National Energy Transition Roadmap (NETR). This roadmap is vital for steering Malaysia's shift from traditional fossil fuels-based economy to a high-value green economy. The NETR requires a whole-of-nation approach, encompassing federal and state governments, industry, general public, and international community.

Ten flagship catalyst projects of the NETR, which cover six energy transition levers namely, energy efficiency (EE), renewable energy (RE), hydrogen, bioenergy, green mobility, and carbon capture, utilisation and storage (CCUS) was launched on July 27th 2023. These flagship projects are

expected to attract investment of more than RM25 billion, create 23,000 job opportunities and reduce GHG emissions by more than 10,000 Gg CO_2eq per year.

Additionally, the NETR establishes the pathway for national energy mix, GHG emission reduction and energy transition initiatives. This reinforces Malaysia's commitment to net-zero emissions as early as 2050 despite contributing only 0.8% to global GHG. By 2050, NETR initiatives are expected to deliver 32% reduction in GHG emissions for the energy sector compared to the 2019 baseline – reaching 4.3 MtCo_2eq emission per capita.

The Ministry has undertaken an extensive consultative approach involving policymakers, industry stakeholders, technology experts, and businesses to analyse and appraise best practices, lessons learned, and both existing and proposed initiatives. As we move ahead, the NETR will serve as a guiding beacon, offering clarity and coherence in formulating policies and executing strategies for the energy sector's transition into a low-carbon future.

RAFIZI RAMLI
29 August 2023

Executive Summary

Malaysia is blessed with a strategic location, vast amounts of natural resources, potential renewable energy and a growing pool of talents who are appreciative of a green economy. One of the tenets of Ekonomi MADANI is spurring Malaysia's green growth for climate resilience. Malaysia has been recognised as the best country in Southeast Asia in the Energy Transition Index 2023 by the World Economic Forum. The feat shows that Malaysia is on the right track to drive our strategic shift and economic restructuring into new growth areas.

Malaysia is committed to low-carbon development aimed at restructuring the economic landscape to a more sustainable one. In this context, the National Energy Transition Roadmap (NETR) sets the goal to accelerate energy transition and change the way energy is generated to improve climate resilience. NETR has developed the Responsible Transition (RT) Pathway 2050 to shift Malaysia's energy systems from fossil fuel-based to greener and low-carbon systems. The Total Primary Energy Source (TPES) modelling indicated that our energy demand will increase marginally at 0.2% annually from 95 Mtoe in 2023 to 102 Mtoe in 2050. The RT Pathway 2050 has also shown promising decarbonisation results as evidenced by the phasing out of coal and the reduction of fossil-fuel reliance from 96% in 2023 to 77% in 2050. Natural gas is set to be not only a transitional fuel, but also the primary contributor of TPES at 57 Mtoe (56%) followed by renewables that include solar, hydro and bioenergy, which collectively contribute 23% of TPES in 2050 from a mere 4% in 2023.

NETR outlines 50 initiatives under the six energy transition levers and five enablers, in addition to the 10 flagship projects and initiatives announced in July 2023. The energy transition financing will be undertaken through a combination of grants, loans, rebates, incentives, and other investments to support the whole-of-nation approach. NETR aims to power our future by unlocking potentials in new growth areas and delivering progress and prosperity to Malaysian households and businesses. The successful implementation of NETR will uplift GDP value from RM25 billion in 2023 to RM220 billion and generate 310,000 jobs in 2050.

NETR is not just a document about measures to meet Net-Zero GHG emissions target. NETR represents a new way of thinking to fundamentally transform Malaysia's economy and livelihoods for a stronger and more resilient future.

Section 1 : Introduction

Malaysia is a small open economy with gross domestic product (GDP) of RM1.79 trillion and gross national income (GNI) per capita of USD11,780 in 2022. Its population stood at 32.7 million people in 2022 and is expected to reach 40 million by 2050. Meanwhile, the urbanisation rate was 75% in 2020, and is expected to reach 85% by 2040. Economic and population growth, as well as rapid urbanisation, will drive a rise in energy demand, which is expected to increase by 2% annually until 2050.

The economy transitioned from an agricultural and commodity-based to manufacturing and services in the 1980s. It continues to be a producer of finite quantities of oil and gas, which contributed approximately 13% to GDP in 2021. Availability of indigenous gas resources have ensured secure energy supply at affordable prices.

As the nation evolves and lifestyles change, environmental sustainability gains more focus in business and policy decisions, and this has implications on people's livelihoods. Rapid urbanisation and climate change require a timely adjustment of the way we live, commute and interact with our surroundings, including the way in which we consume and produce energy.

The Domestic Energy Landscape

Based on the National Energy Policy, 2022-2040 (DTN), the energy sector contributed approximately 28% of GDP and employed 25% of the total workforce in Malaysia. In addition, it is a key source of national income, with petroleum-related products contributing 31% of fiscal income, and energy exports constituting 13% of total export value. The energy sector also benefits more than 10 million customers by providing daily access to electricity supply and enabling mobility through reliable supply of fuels. Jobs and business opportunities created in the energy sector, as well as economic multipliers in energy-related supply chains, also contribute positive to the socioeconomic development of the nation.

Defining Energy Transition - energy transition is a structural shift in energy systems, characterised by a transition towards cleaner sources of energy, increased use of RE, and a significant reduction in carbon emissions. The energy transition is expected to occur at an accelerated pace, driven by rapid technological advances and robust climate change policies.

Fossil fuels continue to contribute the largest share of Malaysia's energy supply, and have a significant influence in shaping the country's energy landscape. As of 2020, four energy sources dominated the national total primary energy supply (TPES) mix. Natural gas constituted the largest portion at 42.4%, followed by crude oil and petroleum products at 27.3% and coal at 26.4%. Renewables, comprising hydropower, solar and bioenergy, constituted just a mere 3.9%.

Historically, the power sector in Malaysia has been operated as a vertically integrated monopoly system. Over time, it has undergone various stages of liberalisation. The power sector was privatised with the aim of attracting investments as well as enhancing efficiency and productivity to ensure a sufficient supply. Additionally, the government has encouraged the involvement of independent power producers (IPPs) to improve the reliability of the electricity supply and address the shortage of generation capacity in meeting the demand.

Natural gas plays an important role as a transitional fuel in energy transition. The government has implemented Third Party Access (TPA) in 2017 to provide healthy competition among industry players, including the IPPs. This will facilitate the shift towards market-based pricing for power and non-power sectors, thus ensuring reliable gas supply at competitive prices.

Similarly, the government intends to reform the power sector further by establishing a TPA framework to supply fuel sources, and access to the grid infrastructure and the retail market. In addition, the government will embark on electricity tariff restructuring initiative. These measures will ensure cost reflective prices, enable higher penetration of RE and enhance Malaysia's competitive advantage.

Malaysia has been recognised as the best country in the Southeast Asia in the Energy Transition Index 2023 by the World Economic Forum. The index considers system performance and the country's readiness to switch to a more environmentally friendly energy sources. The recognition shows that Malaysia is on the right track to drive our strategic shift and economic restructuring into new growth areas. This is further supported by Malaysia's various advantages such as a strategic location, diverse RE sources and a high level of skills to become a regional leader in energy transition.

Section 2: Case for Malaysia Energy Transition

Malaysia's Carbon Footprint

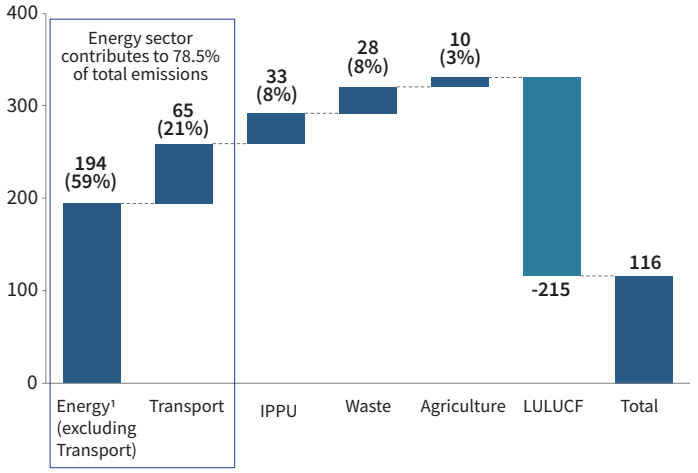
The energy sector has long contributed to Malaysia's development and growth. Yet emissions have also increased in tandem with this progress, necessitating an urgent need to transition towards a low carbon economy. This will involve meeting the country's climate commitment to cut 45% carbon intensity against GDP by 2030 compared to the 2005 baseline.

Growth in the energy sector drives development in various related industries, creating spin-offs through employment, capital inflows and investments, besides supporting the energy service companies' ecosystem. However, the energy sector has been the country's largest contributor of greenhouse gas (GHG) emissions. A summary of Malaysia's GHG inventory in 2019, based on the Fourth Edition of the Biennial Update Report (BUR4) submitted to the United Nations Framework Convention on Climate Change (UNFCCC), is as shown in Exhibit 2.1.

In 2019, the energy sector emitted 259,326.11 Gigagram CO_2 equivalent ($GgCO_2eq$), or 78.5% of total emissions. This was followed by industrial processes and product use (IPPU) at 10%, waste at 9% and agriculture at 3%. The BUR4 report also listed climate mitigation actions undertaken in the energy sector, such as the use of EE measures, energy-efficient vehicles, RE, biodiesel and switching from coal to natural gas for power generation.

Exhibit 2.1: Malaysia's GHG Inventory in 2019

Malaysia's GHG inventory, $MtCO_2eq$ (2019) from BUR4



1 Refers to emissions from energy industries, manufacturing industries and construction, other sectors and non-specified energy emissions, and fugitive emissions from fuels.

Source: Malaysia's Fourth Biennial Update Report submitted to the UNFCCC (2022)

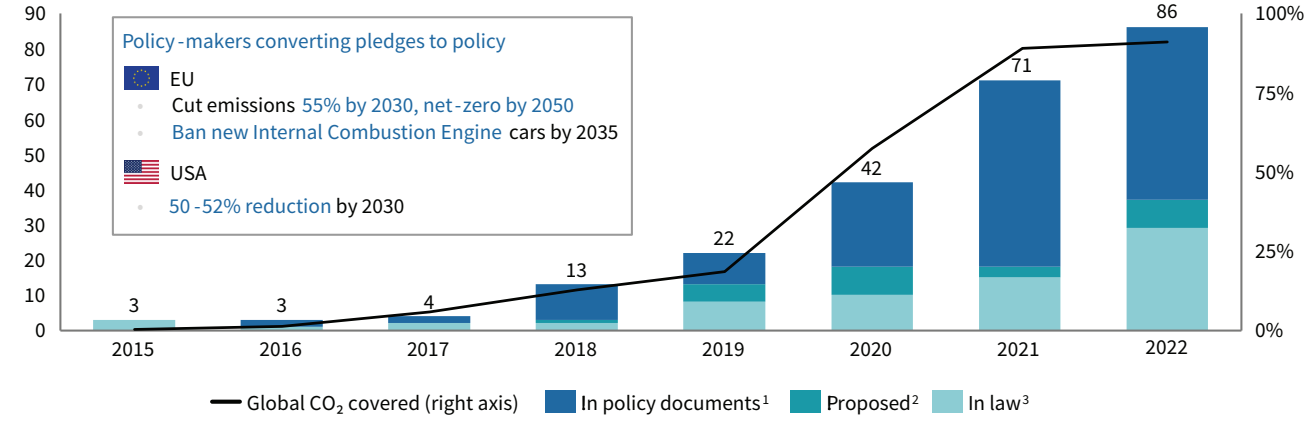
The Global Race Towards Net-Zero

There is a palpable shift in the worldwide stance on sustainability. By 2022, approximately 140 countries had pledged net-zero commitments. Of these countries, 86 have formulated policy documents and frameworks to achieve the respective net-zero pledges. Increasing adoption of cleaner energy alternatives will be vital to steer this transition. In 2022, the adoption of solar and wind energies and electric vehicles (EVs), as well as conservation efforts limited the emissions growth to below 1%. Despite these mitigation efforts, the overall emissions trajectory continues to rise, emphasising the need for nations to deepen their commitment and enhance adoption of low-carbon solutions in addressing the climate challenges.

Exhibit 2.2: Number of countries with net-zero policies

Net-zero pledges cover 88% of global emissions

Countries (#)



1. In policy document = a net zero pledge has been proposed but does not have legally binding status 2. Proposed = a net zero pledge has been proposed to parliament to be voted into law 3. In law = a net zero pledge has been approved by parliament and is legally binding
Note: In law includes 2 countries that already achieved net zero (Suriname and Bhutan)

Source: Energy & Climate Intelligence Unit

On 29 March 2023, the United Nations General Assembly (UNGA) passed a significant resolution requesting the International Court of Justice (ICJ) to outline the legal responsibilities of states concerning climate mitigation and adaptation. The current trajectory of climate change poses a threat to the global economy, trade and financial system, with potential losses amounting to nearly 10% of GDP by 2050. A critical factor in addressing climate change is the energy sector, which according to the International Energy Agency (IEA), is responsible for 73.2% of GHG emissions worldwide. In limiting the global warming to 1.5°C above pre-industrial level as outlined in the Paris Agreement, IEA's Net Zero by 2050 pathway suggests that the world economy should consume 7% less energy in 2050 than at present.

In 2022, the European Union (EU) introduced the Carbon Border Adjustment Mechanism (CBAM), aimed at preventing carbon leakages in the trade value chain. The current scope of CBAM covers industries that are important to Malaysia, such as iron, steel, aluminium, fertiliser, electricity and hydrogen. It is estimated that 57% of Malaysia's total exports will be affected by the implementation of CBAM. Further, the United States (US) introduced the Inflation Reduction Act (IRA) in 2022, which prioritises the production of and demand for domestically produced clean energy goods and services over foreign imports.

The Benefits of Energy Transition

The urgency for Malaysia's shift to sustainable energy is fuelled by global commitments, particularly the Paris Agreement and the need to fortify economic diversification and energy security. In addition, industry related to the energy transition has the potential to be a new source of growth that can benefit from the global market. The IEA reports that investment in the development of the clean energy industry is expected to reach USD1.7 trillion in 2023. The focus of global investment is on the development of the RE, EE and strengthening the grid and energy storage.

Moreover, corporations and enterprises confront a rapidly changing market landscape where carbon costs will reshape business dynamics and potentially strain competitiveness. Meanwhile, the imminent realities of climate change, exemplified by rising sea levels, extreme weather events, and escalating heatwaves highlight the direct and tangible impacts on rakyat's daily lives.

Beyond mitigating risks, the energy transition presents Malaysia with the opportunity to restructure its economy and maximise the potential for green growth that balances sustainability, enhances GDP, creates jobs and meet the needs of *rakyat* and businesses.

Malaysia's Policy Responses

The five-year development plan covers socioeconomic policy planning that sets out the country's direction and growth targets as well as the allocation of the development expenditure. The Twelfth Plan, outlines the aspiration for the nation to achieve net-zero GHG emissions as early as 2050. The plan emphasises Malaysia's approach to effectively manage its energy transition. It recognises the complex and interconnected nature of energy systems and acknowledges the need to balance the energy trilemma. The approach not only ensures that energy policies and programmes are environmentally responsible but also takes into consideration the socioeconomic implications.

The DTN lays the groundwork for a transformation in the energy landscape. The energy transition is expected to occur at an accelerated pace, driven by rapid technological advancement and robust climate change policies. The DTN's Low Carbon Nation Aspiration 2040 (LCNA 2040) seeks to transform

the primary energy supply, moving to cleaner, RE sources. LCNA 2040 emphasises low-carbon policies, including:

- Restricting the development of new coal power plants while the renewables share is being increased
- Driving EE practices
- Encouraging the adoption of EVs
- Increasing public transport's modal share
- Improving carbon footprint accounting and sustainability reporting

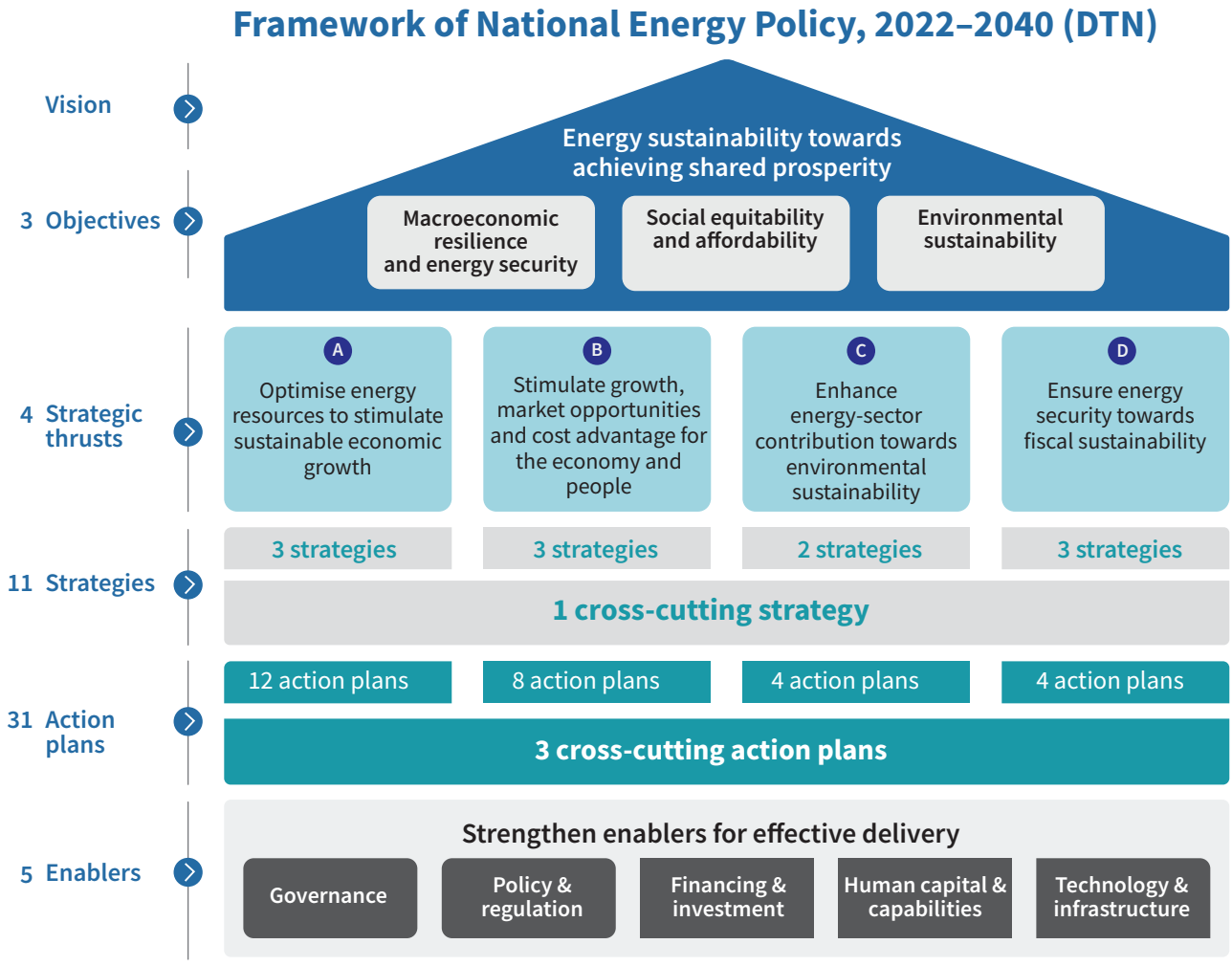
These progressive aspirations will ensure the energy sector is resilient to future challenges and in a good position to seize the opportunities arising from the energy transition. The DTN is supported by four strategic pillars, 12 strategies, 31 action plans and five enablers, as shown in Exhibit 2.3.

What is the Energy Trilemma?

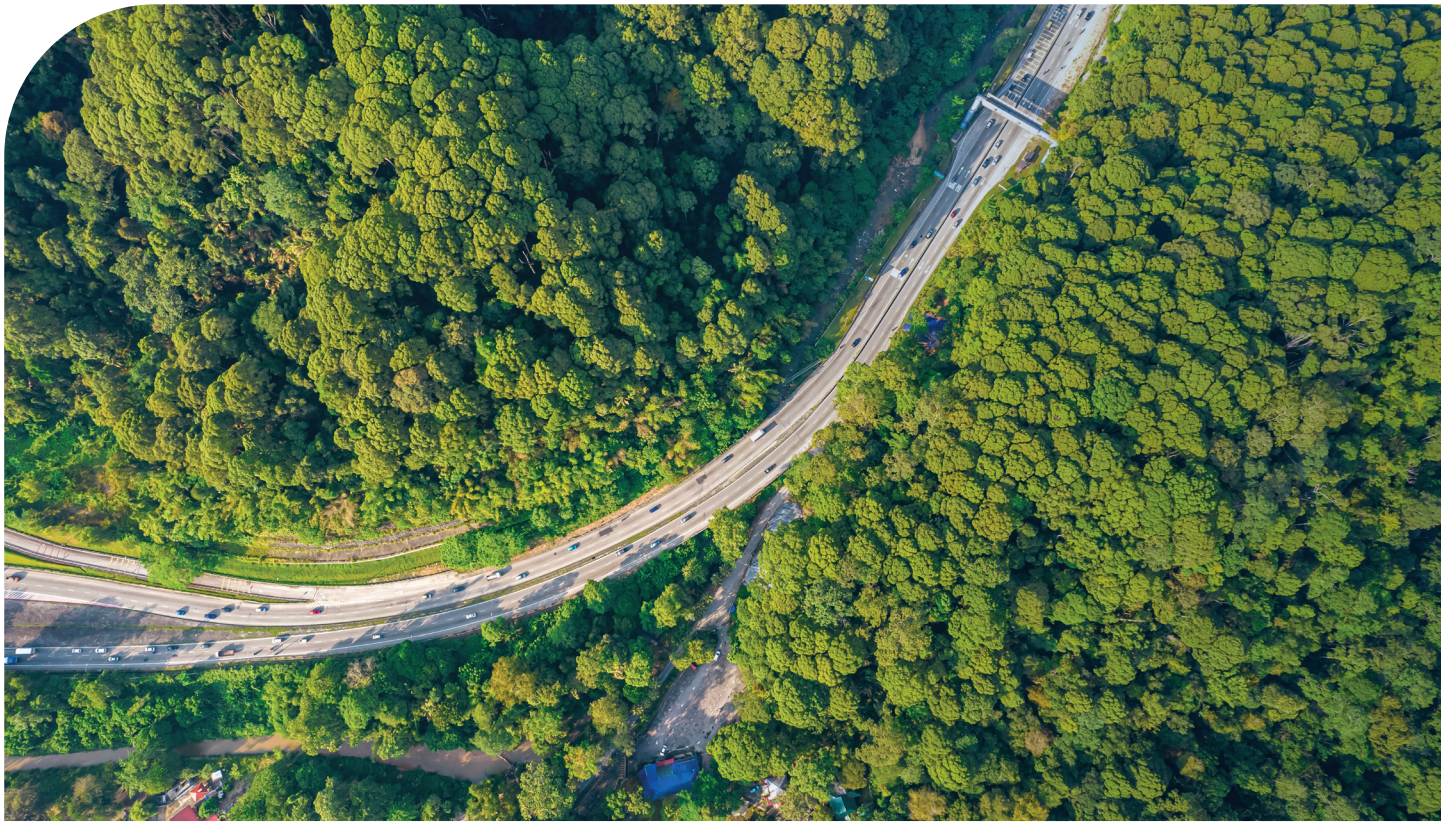
The energy trilemma refers to the interconnectedness of energy security, affordability and environmental sustainability.

These three objectives are often in conflict with each other. Addressing the energy trilemma requires a delicate balancing act and often involves making trade-offs. Solutions to the energy trilemma also commonly include a mix of policies, innovations, and investments that aim to harmonise these three objectives to the greatest extent possible while acknowledging their inherent trade-offs.

Exhibit 2.3: The DTN Framework



Section 3: National Energy Transition Roadmap (NETR)



The Ministry of Economy leads the development of the NETR with invaluable support from the Steering Committee and the Technical Committee. These committees comprise representatives from ministries, agencies and private sector, as shown in Exhibit 3.1 to help ensure a collaborative and comprehensive approach to the development process.

In addition, the Project Team includes representatives from the Energy Commission (ST), Sustainable Energy Development Authority (SEDA), Malaysian Green Technology and Climate Change Corporation (MGTC), PETRONAS and Tenaga Nasional Berhad (TNB) to leverage the diverse expertise in ensuring NETR's strategies and plans meet the needs of the wider stakeholders.

To ensure inclusive participation in the development of NETR, the Ministry of Economy organised a workshop on 17 April 2023 as a platform for discussions and information exchange between ministries, agencies, the private sector and industry associations, including those from Sabah and Sarawak.

Exhibit 3.1: The NETR Steering Committee and Technical Committee members

The ministry has also undertaken more than 100 engagements and consultations to gather feedback and ensure the accuracy and validity of the NETR data and initiatives. This feedback has played a crucial role in shaping the scope of the roadmap and in fine-tuning the catalyst projects, initiatives, and enablers of the NETR.

The Project Team undertook a comprehensive scoping and stocktaking process of macro and sectoral policies, including the Twelfth Malaysia Plan, the DTN, BUR4, the National Energy Efficiency Action Plan (NEEAP), Malaysia Renewable Energy Roadmap (MyRER), Malaysia Energy Transition Outlook (METO), National Low Carbon Cities Masterplan, Green Technology Master Plan Malaysia 2017-2030, Low Carbon Mobility Blueprint, and GHG emissions reduction plans from the state governments and private sector. The team also collaborated with the Ministry of Finance (MOF), Bank Negara Malaysia (BNM) and Securities Commission (SC) to explore suitable energy transition financing.

The development of the NETR is divided into two parts as shown in Exhibit 3.2. Part 1 outlines the 10 flagship catalyst projects and impact initiatives based on six energy transition levers, namely EE; RE; hydrogen; bioenergy; green mobility; and carbon capture, utilisation and storage (CCUS). The six levers are further supported by five enablers: financing and investment; policy and regulation; human capital and just transition; technology and infrastructure; and governance and implementation.

Part 2 focuses on establishing the energy mix, GHG emissions reduction pathway, selected targets and initiatives. Targeted investments, people strategies and international cooperation planning, as well as policy and regulatory frameworks, will be strengthened to develop the talent, technology and infrastructure needed to scale-up and sustain decarbonisation efforts.

Exhibit 3.2: Parts 1 and 2 of the NETR

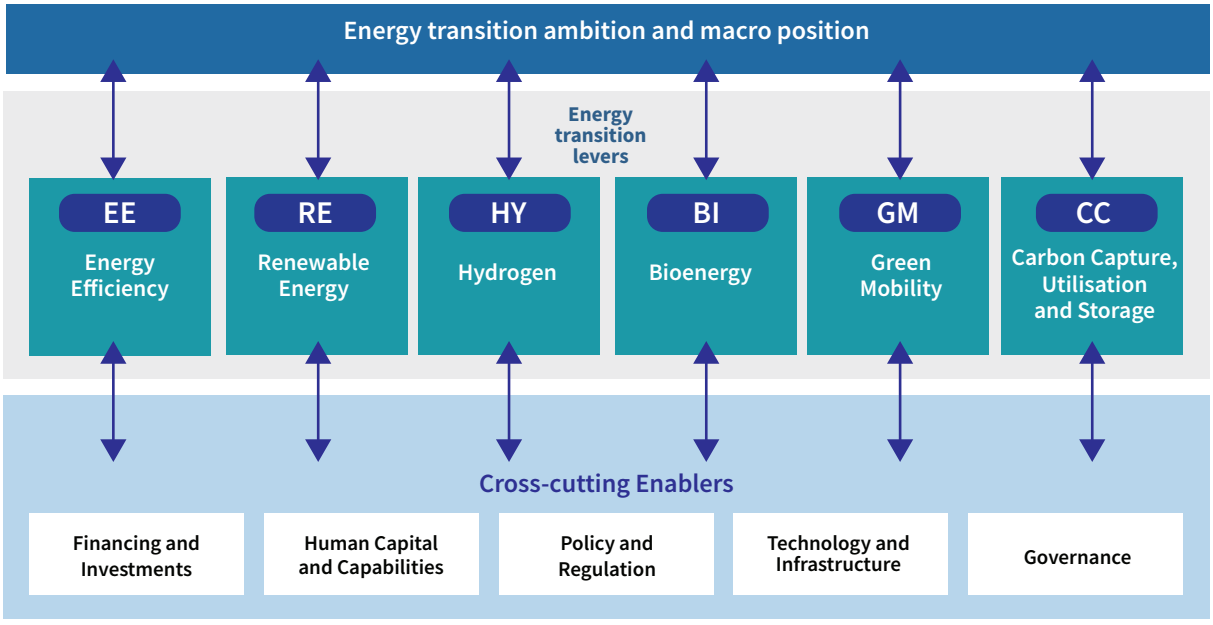
NETR Part 1

Identify flagship catalyst projects and initiatives

6 Energy Transition Levers	10 Flagship Catalyst Projects
Energy Efficiency (EE)	Efficient Switch
Renewable Energy (RE)	Renewable Energy Zone (RE Zone)
	Energy Storage
	Energy Secure
Hydrogen	Green Hydrogen
	Hydrogen for Power
Bioenergy	Biomass Demand Creation
Green Mobility	Future Mobility
	Future Fuel
Carbon Capture, Utilisation and Storage (CCUS)	CCS for Industry

NETR Part 2

Establish low-carbon pathway, energy mix and emission target reduction for the energy sector



Guiding Principles

There are four guiding principles of the NETR, as shown in Exhibit 3.3. The first principle highlights the importance of aligning the energy sector based on national aspirations and commitments to sustainable development.

The second principle emphasises that the energy transition must be just, inclusive and cost-effective. It acknowledges the challenges that exist for low-income and vulnerable populations. The NETR aims to ensure that the benefits and opportunities from the energy transition trickle down to every segment of society, leaving no one behind.

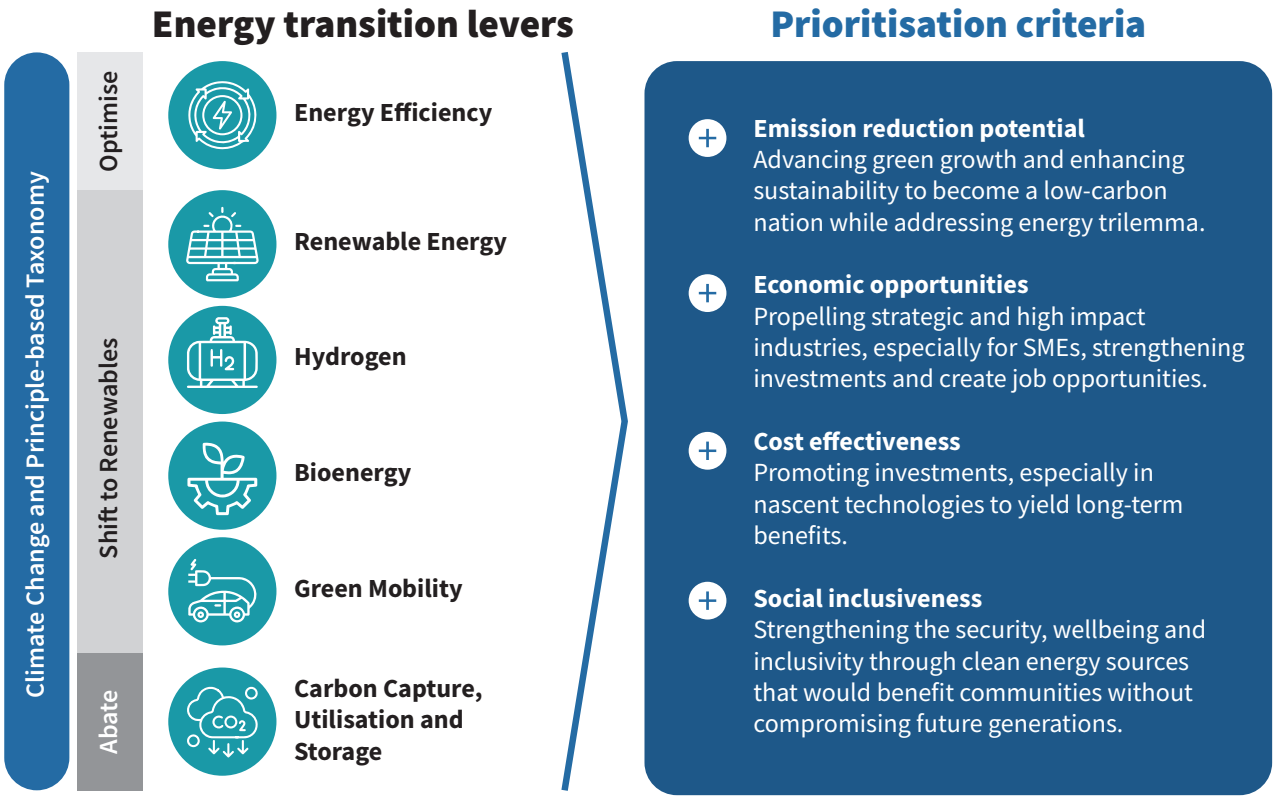
The third principle stresses the need for effective governance and a whole-of-nation approach. Collaboration among all stakeholders is crucial to create a vibrant energy industry ecosystem that supports sustainability and facilitates the transition to a low-carbon economy.

The fourth principle highlights the significance of creating high-impact job opportunities and enhancing small and medium enterprises (SMEs) involvement in the ecosystem.

Exhibit 3.3: The four guiding principles of NETR

In terms of project evaluation, the NETR subscribes to the Climate Change and Principle-Based Taxonomy defined by Bank Negara Malaysia (BNM). In addition, the proposals are further assessed in accordance with the themes of the Twelfth Plan, namely: resetting the economy; strengthening security, wellbeing and inclusivity; and advancing sustainability. Projects and initiatives are also evaluated based on their potentials to reduce GHG emissions, provide economic opportunities, promote cost-effective solutions and deliver benefits to the *rakyat.* The six energy transition levers and project prioritisation criteria are as shown in Exhibit 3.4.

Exhibit 3.4: Energy transition levers and project prioritisation criteria



Review of Renewable Energy Policies

In line with the development of the NETR, the Ministry of Economy has also collaborated with NRECC to review and update existing policies on RE, leading to the following decisions:

- Increase the target for installed RE capacity from 40% in 2040 to 70% by 2050. The higher target is expected to generate new economic opportunities by attracting multinational companies, especially RE 100 companies, to operate in Malaysia
- Expand RE development based on the concept of a self-contained system to encourage investment in the RE value chain and diversify RE programmes according to the principle of willing buyer, willing seller
- Scale-up the installation of solar systems in government buildings
- Allow cross-border RE trade through the establishment of an electricity exchange system.

The establishment of RE exchange system will position Malaysia as a regional hub for RE while giving added impetus to, and building on, the ASEAN Power Grid (APG) initiative. Malaysia is currently one of the key members participating in the Lao PDR-Thailand-Malaysia-Singapore Power Integration Project (LTMS-PIP), the pathfinder to advance cross-border power trade among ASEAN Member States under the APG.

The government is also cognisant of the need to bolster the national power grid to accommodate higher RE uptake. This may come in the form of future-proofing Malaysia Electricity Supply Industry (MESI) elements, including introducing smart grid features and enabling the grid for third party access.

Complementary Plans

Within the whole-of-nation approach, there has been a steady development of new policies and strategies to complement NETR in strengthening Malaysia's low-carbon transition. Among others include:

- the Nationally Determined Contribution (NDC) Roadmap, Long-Term Low Emissions Development Strategies (LT-LEDS) and Future Proofing MESI by the NRECC
- the Carbon Pricing Instrument developed by the Ministry of Finance (MOF)
- the National ESG Industry Framework, the New Industrial Master Plan (NIMP) and the Chemical Industry Roadmap (CIR) by the Ministry of Investment, Trade and Industry (MITI)
- the Hydrogen Economy and Technology Roadmap (HETR) by the Ministry of Science, Technology and Innovation (MOSTI)
- the National Biomass Action Plan by the Ministry of Plantation and Commodities (KPK).

Natural gas will continue to play a pivotal role in Malaysia's energy landscape as the nation moves towards a low carbon economy. To this end, the Ministry of Economy is in the midst of developing the Natural Gas Roadmap (NGR) to optimise the value of indigenous natural gas resources, increase the domestic natural gas use, enhance the security of supply and access to cost-competitive natural gas, and position natural gas to support Malaysia's energy transition.

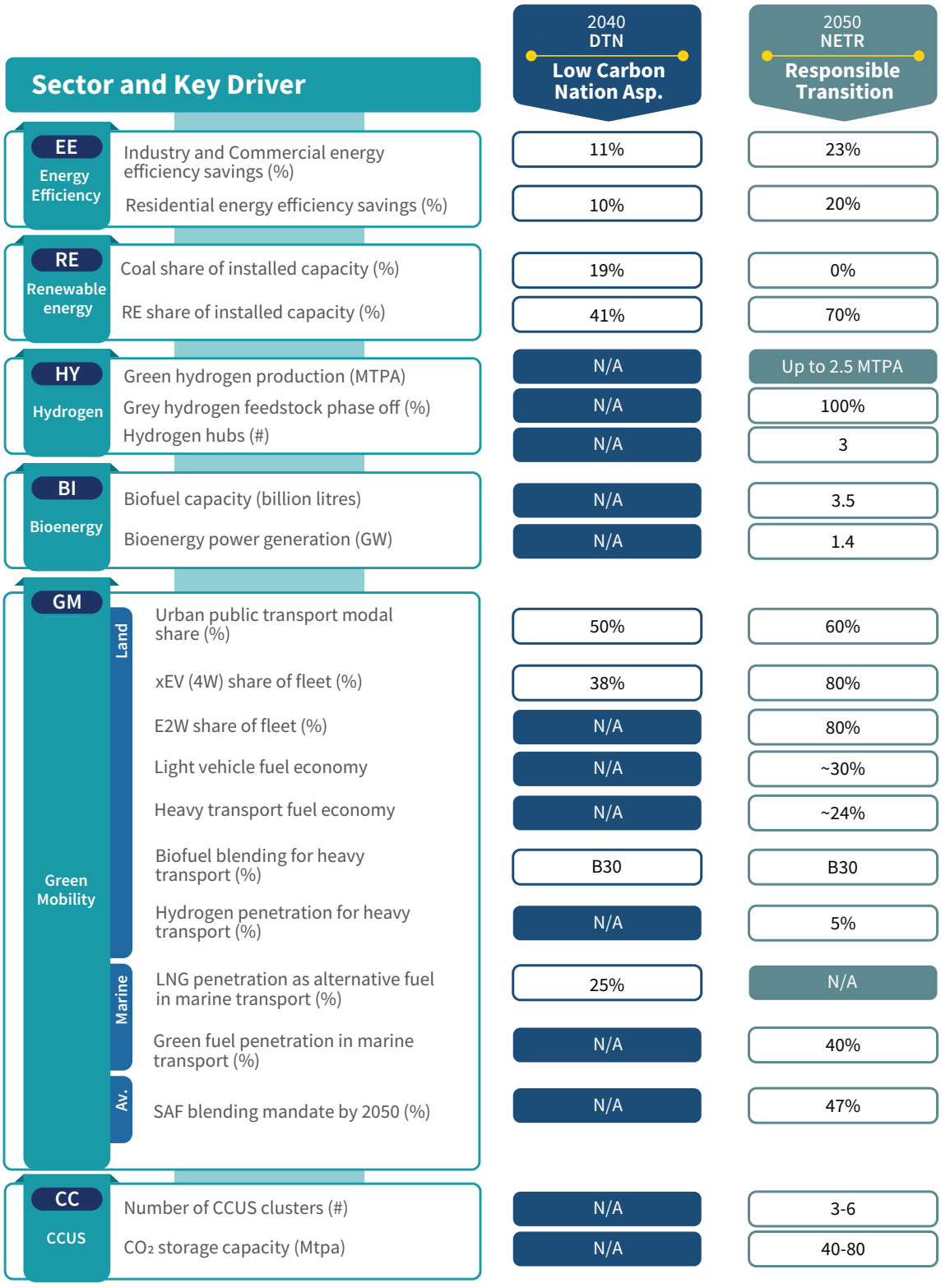
Section 4 : Energy Transition Ambition and Macro Position

The NETR is rooted in Malaysia's overarching aspirations, charting a course for the energy system that is aligned with decarbonisation targets. It strikes the right balance between environmental mitigation and the need to bolster net socioeconomic values such as GDP and job creation. NETR's Responsible Transition (RT) scenario will support Malaysia's pursuit of achieving net-zero as early as 2050.

RT scenario represents the best-fit ambition for the nation, considering current technology developments, global trends and local context. The NETR's RT aims to accelerate the pace of energy transition, with improved ambition across all six levers, as outlined in Exhibit 4.1.

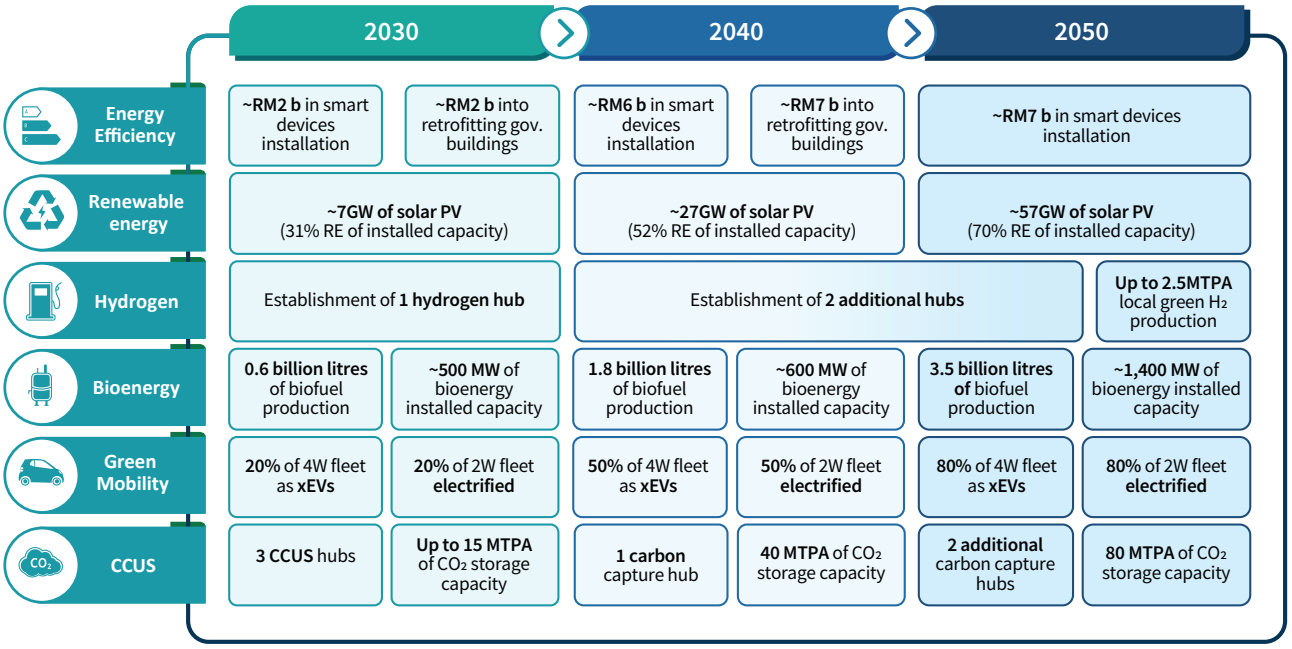
Moving forward, the government will re-calibrate ambition levels to capitalise on new and emerging technologies, potentially reviewing targets where possible. This approach follows the Paris Accord's Global Stocktake process, which evaluates progress on meeting Paris Agreement goals and identifies any remaining gaps and opportunities for increased action.

Exhibit 4.1: Targets across NETR's six energy transition levers



The stated ambition will generate significant investment opportunities across all six levers, as outlined in Exhibit 4.2. The realisation of these investments will create tangible impact for *rakyat* and businesses.

Exhibit 4.2: Potential investment opportunities and impact of NETR's RT



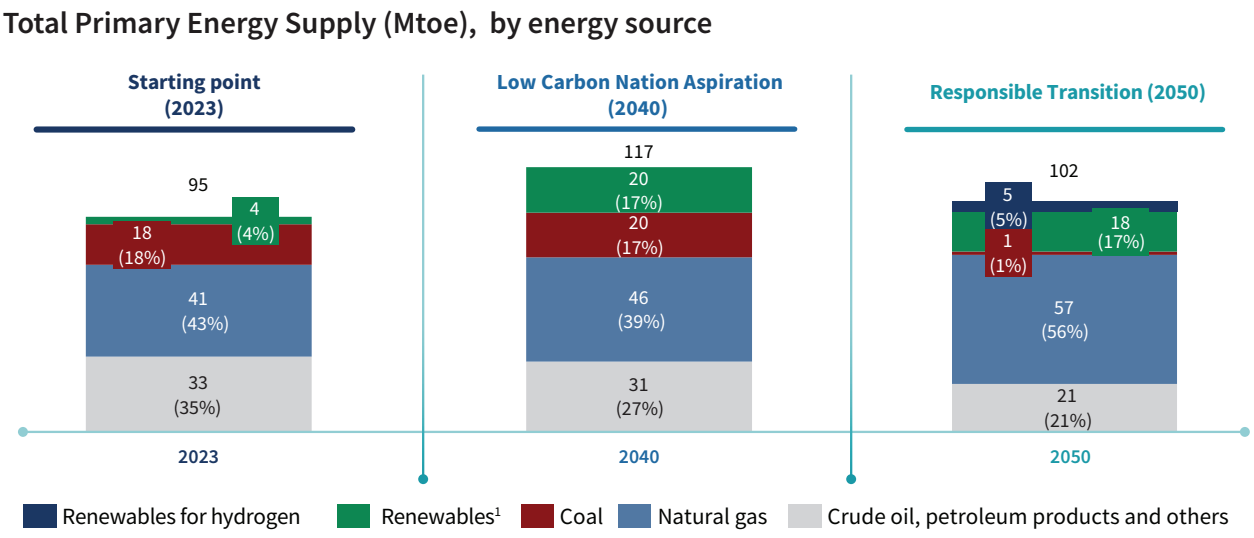
Energy System Pathway

NETR's RT pathway is designed to accelerate Malaysia's energy transition journey while balancing the energy trilemma. Towards this, the RT pathway will achieve the following by 2050:

- Increased use of RE in the power generation mix
- Close to fully phased-out coal from the power generation mix
- Broad based energy efficiency initiatives pursued, particularly from the demand side management that include optimising energy consumption across key sectors, namely residential, commercial, industrial, and transport to prevent wastage and indirectly prolong the lifespan of indigenous resources
- The shift to electrification and biofuels expedited in the transport sector.

This RT will help Malaysia to shift from traditional, fossil fuel-based energy systems to a greener, low-carbon energy framework, as shown in Exhibit 4.3. With this transition, coal will be close to fully phased-out, while RE will increase from 4% in 2023 to 22% in 2050. Natural gas is set to play a significant role, accounting for 56% of TPES by 2050.

Exhibit 4.3: Malaysia's projected TPES by 2050



1. Includes bioenergy, solar, hydropower and hydrogen

Given the importance of energy in sustaining economic growth and socioeconomic development, the NETR recognises the need to ensure progressive scaling up of RE in meeting the 70% installed capacity target in the power mix by 2050. The potential risks of over-reliance on natural gas will be mitigated by ensuring RE capacity readiness as well as developing energy storage to address RE intermittency issues. As an additional measure, Malaysia will continue to explore other non-carbon energy sources that include RE imports through regional interconnectors.

Socioeconomic Outcomes

The NETR's RT pathway has been evaluated along the energy trilemma. Overall, this pathway is set to ensure eenergy security, energy equity and economic development as well as improve Malaysia's environmental sustainability, as shown in Exhibit 4.4.

Exhibit 4.4: RT impact across the Energy Trilemma

		2023	2030	2040	2050	Total
1 Energy Security	Power system HHI[1]	0.36	0.32	0.30	0.35	-
	Import dependence	-	Reduce imported coal with indigenous natural gas	Increased import of natural gas	Increased import of natural gas (and potentially RE)	Increased import of natural gas
2 Energy Equity and Economic Development	Incremental system costs *(RM per kW)*	-	1,476	3,097	1,924	-
	Total investment required[2] *(RM b)*	~10-20	~200-220	~460-480	~560-580	~1,200-1,300
	Direct job creation vs. 2022[3] *(jobs)*	~ 110,000	~270,000	~350,000	~310,000	-
	GDP impact vs. 2022 *(RM b)*	~20-25	~60-80	~150-170	~200-220	-
3 Environmental Sustainability	GHG emissions reduction *(% $MtCO_2eq$ reduced vs. 2019)*	-	(4%)	(26%)	(32%)	(32%)
	Emissions per capita *($MtCO_2eq$ per capita)*	7.5	6.8	4.9	4.3	-

1. HHI = Herfindahl–Hirschman index, which is a measure of market concentration. Lower is better as it indicates higher diversity in power system mix; 2. 2030 investment refers to 2024-2030, 2040 investment refers to 2031-2040, 2050 investment refers to 2041-2050; 3. Job creation includes key new growth areas such as low carbon transport (EV ecosystem build out), energy efficiency, power system transition and grid upgrades (solar, gas, hydro), and supply chain impacts

Energy Security

The RT aims to achieve a notable 70% RE installed capacity mix for power sector. Despite this, Malaysia will continue to maintain diversification of its power generation mix, with the power system Herfindahl-Hirschman Index (HHI) remaining stable throughout projected period to 2050.

However, there are concerns about Malaysia's growing dependence on fuel import particularly natural gas imports. Given the anticipated rise in reliance on natural gas and crude oil by 2050, there is a heightened need to focus on ensuring energy security. Moving forward, Malaysia will look to reduce this dependence on natural gas by scaling up of RE capacity and exploring potential non-carbon energy sources.

In the meantime, proactive initiatives are being undertaken to secure natural gas, such as necessary infrastructure and commercial arrangements for importation, including long-term agreements to stabilise fuel imports. At the same time, it is crucial to ensure that natural gas prices for domestic consumers reflects market parity. This will enhance the attractiveness of Malaysia as an investment destination for upstream sector as well as incentivise third party suppliers to enter the domestic gas supply market, spurring the operationalisation of TPA for gas market.

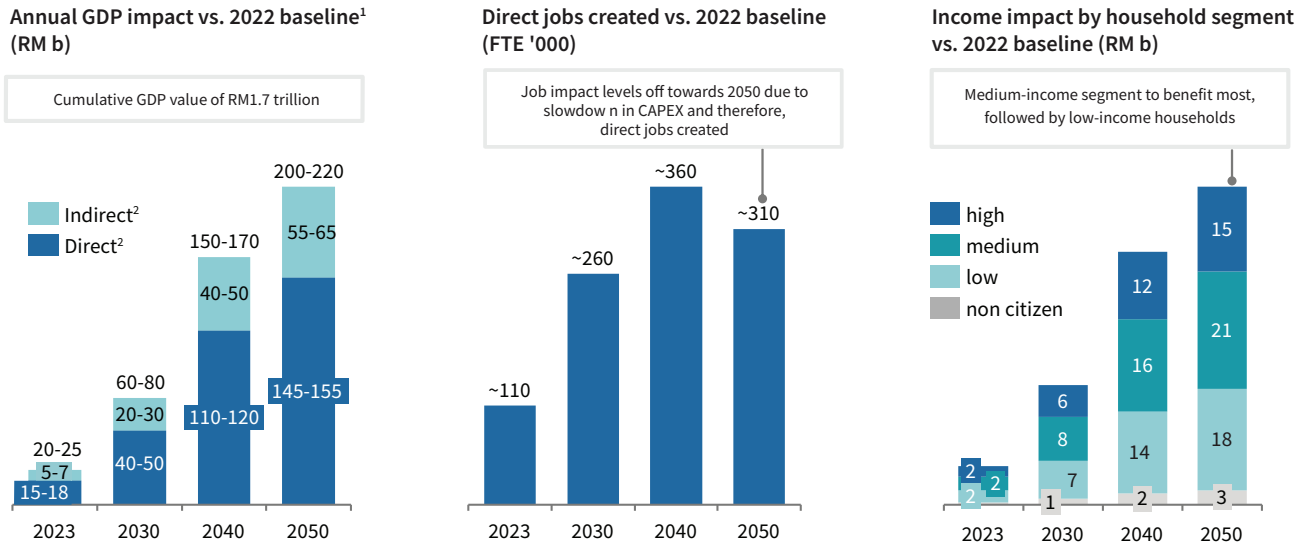
Energy Equity and Economic Development

By 2050, Malaysia is expected to face higher system costs due to the investments required to rapidly increase RE's installed capacity within the country's power generation mix. Though this trajectory might see an uptick in system costs, such an increase is inevitable given the potential scenarios of higher reliance on natural gas import in the power generation mix following the projected diminishing of Malaysia's gas reserves by 2050.

Although there will be higher system costs, the RT is poised to significantly bolster Malaysia's economic development. The energy transition will catalyse growth in nascent areas such as green mobility ecosystems, RE, energy storage, and alternative new energy ecosystems. Taking a pioneering role in these emerging areas will enhance Malaysia's competitive edge, which will yield positive outcomes for both GDP and job creation.

The RT is estimated to generate investment opportunities totalling between RM1.2 trillion and RM1.3 trillion by 2050. These investments will contribute additional GDP of RM220 billion and create approximately 310,000 green growth job opportunities in 2050. Economic benefits will be felt across the social spectrum, with medium- and low-income households expected to be the biggest beneficiaries of income gains, as shown in Exhibit 4.5.

Exhibit 4.5: Socioeconomic outcomes for Malaysia



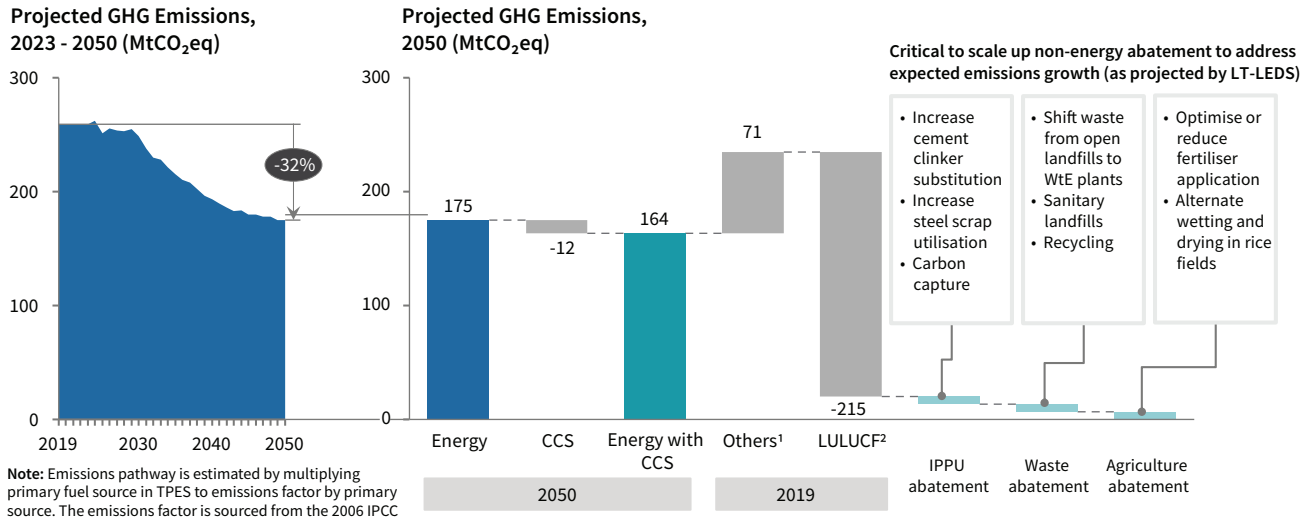
1. Cumulative GDP for 2023-2029, 2030-2039 and 2040-2050 are RM ~RM115 b, ~RM520 b and ~RM1,030 b totaling up to ~RM1,700 b by 2050; 2. Indirect impact includes induced (resulting increase in incomes to households due to the increased labour and capital demand from the direct and indirect effects) and indirect effects (subsequent ripple effects in the interlinked sectors of the economy resulting from changes in demand and production induced by the initial direct shock on the primary sector)

The government recognises the need to carefully manage the energy transition, given the varying impact on jobs nationwide. While the energy transition will foster job creation particularly in new green growth areas, other non-green areas may experience a decline. This further underscores the importance of greening the economy in a way that is as fair and inclusive as possible for everyone, especially for communities affected by energy transition.

Environmental Sustainability

The RT will significantly improve Malaysia's performance on environmental sustainability. Not accounting for the use of carbon capture in the energy sector, Malaysia will achieve 32% reduction in energy sector's GHG emissions compared to the 2019 baseline, as shown in Exhibit 4.6. This translates to emissions reduction to 4.3 $MtCO_2eq$ per capita, from 7.9 $MtCO_2eq$ per capita in 2019.

Exhibit 4.6: Projected GHG emissions reduction



Note: Emissions pathway is estimated by multiplying primary fuel source in TPES to emissions factor by primary source. The emissions factor is sourced from the 2006 IPCC Guidelines for National Greenhouse Gas Inventories. The objective of this method is to provide directional guidance on policy decisions and is not intended as a submission to UNFCCC nor any other international bodies.

1. Includes IPPU (industrial processes and product use), waste and agriculture
2. LULUCF = land use, land-use change and forestry

Utilising carbon capture and storage (CCS) in the energy sector will further bolster Malaysia's journey towards attaining net-zero to deliver an additional 5% reduction in GHG emissions, which translates to 4.1 $MtCO_2eq$ per capita. Scale-up of CCS in the energy sector will also drive the technology to become more economically feasible in other sectors such as industrial processes and product use (IPPU).

Other sectors, such as IPPU, agriculture, waste as well as land-use, land-use change and forestry (LULUCF) will play a critical role towards achieving net-zero target. Greater focus will be placed on adopting abatement levers across IPPU, waste and agriculture, while protecting natural assets in LULUCF, which functions as a natural carbon offsetting mechanism.

Summary of Benefits

RT's accelerated ambition aims to not only propel Malaysia's energy shift towards achieving the net-zero ambition, but also to generate meaningful socioeconomic outcomes for the nation through GDP growth, jobs creation and income generation in future proof green industries, as shown in Exhibit 4.7.

Exhibit 4.7: Benefits of NETR

Rakyat

- Addition of **310,000 jobs** in future-proof sectors across the country
- Balanced economic outcomes with **70% of income** gains to benefit **medium- and low-income households**
- **Better quality of life** and **health outcomes** with lower emissions
- **Greater empowerment** to reduce carbon footprint
- **Up-skilling support** for just transition

Business

- **RM120-180 billion investment opportunities** in co-funded government facility for energy transition
- **Investment opportunities** for green growth across energy transition value chain, up to **RM1.2-1.3 trillion**
- Lower carbon footprint with cleaner **energy mix** and **energy efficiency** to future-proof trade and investment position
- **Enhanced talents** with up-skilling of the workforce

Government

- **10-15% uplift** in GDP value with spurring of new growth areas
- **32% reduction in energy sector emissions,** supporting climate change commitments
- Enhanced **energy self-sufficiency**
- Enhanced **diversification of fiscal income** with new growth
- Carbon footprint reduction to **future-proof industries** and generate **Green FDI**

Section 5: Energy Transition Levers and Key Initiatives

NETR emphasises on six energy transition levers that will unlock economic opportunities and reduce impact to the environment. Of the six, EE stands out as the most important lever as it is cost effective and promotes resource optimisation. RE offers diversification from traditional fossil fuels through adoption of sustainable energy sources. The focus on hydrogen recognises its potential as a clean and emerging energy carrier that can be utilised, particularly by the transportation sector. Given that energy transition pathway is country specific, bioenergy lever leverages Malaysia's abundant biomass resources, particularly from agriculture, offering both economic value and a cleaner energy source. Meanwhile, from demand perspective, green mobility lever addresses the significant emissions from the transportation sector and aligns with urbanisation trends, advocating for cleaner urban transportation. Lastly, CCUS offers a solution for hard-to-abate industrial emissions, with potential repurposing of Malaysia's existing petroleum facilities.

Energy Efficiency

Overview

EE offers effective long-term solutions to lower energy intensity and reduce CO_2 emissions. It meaningfully improves all dimensions of the energy trilemma, by reducing demand to improve energy security, lowering costs for users to enhance energy equity and minimising emissions from energy production to elevate environment sustainability.

EE is not a new concept for Malaysia. In 2015, the Government unveiled the NEEAP, detailing a 10-year strategy to improve EE in power consumption for residential, commercial and industrial sectors. Currently, the Plan is on track to achieve its target of reducing electricity demand by 8% by 2025.

Malaysia must broaden its focus beyond just electricity and incorporate a wider range of energy outputs, such as thermal energy. The forthcoming Energy Efficiency and Conservation Act (EECA) bill, expected to be tabled in Parliament by the end of this year, marks a significant step in this direction. NETR will drive the attainment of RT Pathway 2050 that is both sustainable and able to propel economic growth through the efficient use of energy.

Key Targets

NETR proposes the following targets:

- By 2040, achieve energy savings of 21% compared to business-as-usual scenario, specifically:
  - Residential: 15%
  - Industrial and commercial: 22%
- By 2050, achieve energy savings of 22% compared to business-as-usual scenario, specifically:
  - Residential: 20%
  - Industrial and commercial: 23%

The targets mark a significant leap from the goals previously declared in the DTN at 10% for residential and 11% for industrial and commercial by 2040.

Challenges

In Malaysia, the adoption of energy-efficient appliances is hindered by a lack of awareness regarding their benefits and availability, which led to scarcity of demand and supply for these products. Moreover, there is a disconnect between building owners and tenants, as owners are burdened with investing in energy-efficient upgrades while tenants benefit from the resulting cost savings. Additionally, the scope of the Minimum Energy Performance Standards (MEPS) encompasses only a narrow range of appliances. This constrains the potential for comprehensive energy savings across residential, commercial and industrial. Meanwhile, the nascent market of energy service companies (ESCOs) faces obstacles such as limited returns on investment as well as lack of demand and viable funding opportunities.

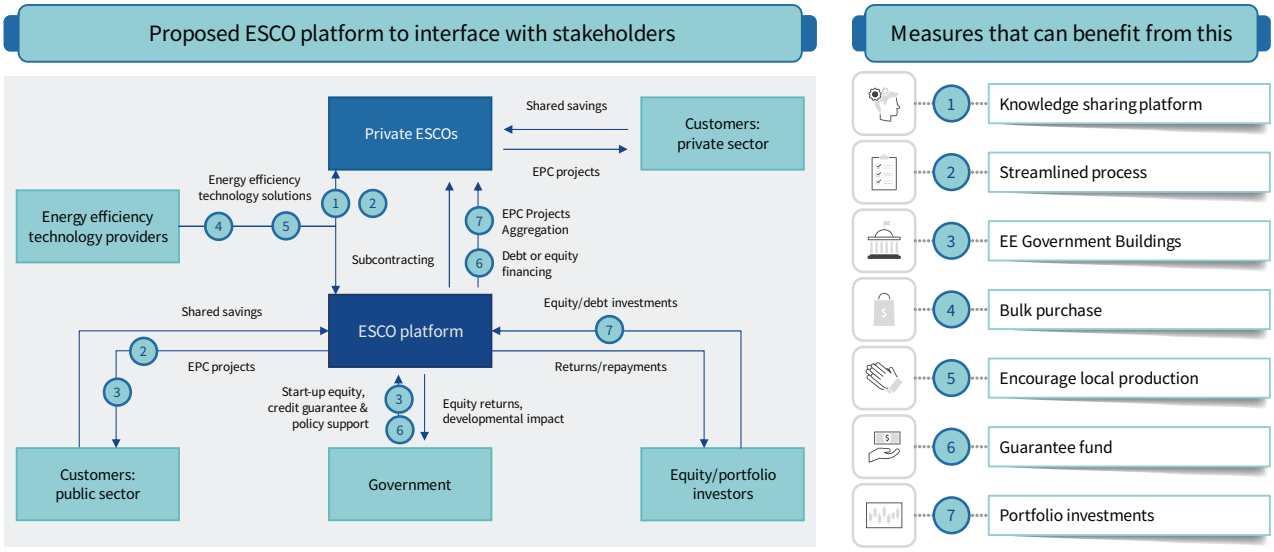
Key Initiatives

Energy Transition Lever: Energy Efficiency		
Code	**Initiatives**	**Champions**
EE1	**Improve EE awareness** ○ Promote awareness for energy-efficient appliances and equipment through public awareness programmes ○ Redesign the 5-star labelling standards to emphasise monetary savings in addition to the technical energy savings	NRECC ST
EE2	**Improve existing Minimum Energy Performance Standards (MEPS) and 5-star rating bands** ○ Increase the number of MEPS-covered equipment ○ Establish an accelerated MEPS progression timeline for key critical appliances align with ASEAN Plan of Action for Energy Cooperation (APAEC) standards ○ Revise the bands for appliances with high 5-Star ratings penetration through periodic reviews	ST
EE3	**Enforce mandatory audits for large commercial and industrial buildings** ○ Implement mandatory investment-grade audits focusing on high-energy-consuming commercial and industrial sector ○ Establish reporting protocol as well as a strict monitoring mechanism	ST
EE4	**Establish green building codes for energy-intensive residential and commercial buildings** ○ Establish a mandatory national standard that outlines EE parameters for both new residential and commercial buildings as well as retrofit for existing building to meet a minimum Building Energy Intensity (BEI) level ○ Mandate disclosure of building energy performance for commercial buildings	ST SEDA
EE5	**Establish an ESCO platform** ○ Establish a public ESCO platform to coordinate public building retrofits with private ESCOs ○ streamline funding and create a single financial mechanism in the form of a revolving fund through ESCO platform	ST
EE6	**Launch a major EE retrofit initiative amongst government buildings** ○ Identify energy inefficient public buildings (e.g., offices with BEI >200 = ~60-70%[8] of existing building) ○ Develop medium to long-term EE government building retrofit program and implement project via ESCO platform	KKR JKR

ESCO Platform

The ESCO platform is an integrated platform for government building retrofits which connects private ESCOs with government projects, as shown in Exhibit 5.1. The central role of this platform would be to serve as an intermediary that enables amalgamation of government building retrofitting projects and comprehensive public-private coordination in domestic ESCO market, and simplifies the engagement for private ESCOs. A thriving ESCO ecosystem not only drives retrofit adoption for buildings, but further maximises energy savings potential to reduce GHG emissions.

Exhibit 5.1: Proposed structure of ESCO platform and its complementary measures



[1]Malaysia Renewable Energy Roadmap

Renewable Energy

Overview

Fossil fuel sources still dominate the national power landscape, and contributed 33% of Malaysia's GHG emissions in 2019. Transitioning to low-emission RE is vital to decarbonise the national power system. It is equally crucial that Malaysia strikes the right balance between sustainability, security, and affordability as it navigates the energy trilemma towards a more resilient, low-carbon power ecosystem.

Malaysia is blessed with substantial RE resources, with almost 290 GW[1] of technical potential estimated across the country. Solar photovoltaic (PV) technical potential alone is estimated to reach 269 GW. Just a small fraction of this RE potential has yet been realised, with just over 9 GW of installed capacity, and greater than 95% untapped technical potential.

Over the last decade, the Government of Malaysia has established long-standing programmes and supporting policies to catalyse rollout of RE technologies. These programmes have helped stimulate significant RE growth over the past decade. Since 2011, solar PV remains the most encouraging segment of the national RE landscape with an installed capacity compound annual growth rate (CAGR) of 48%, expanding from 0.1 GW to 2.6 GW.

Malaysia has also successfully established itself as a major international hub for PV components manufacturing, building a globally recognised green energy industry. Six out of 10 of the world's largest solar PV companies operate in Malaysia, listing Malaysia as one of the top exporters in the global solar PV industry.

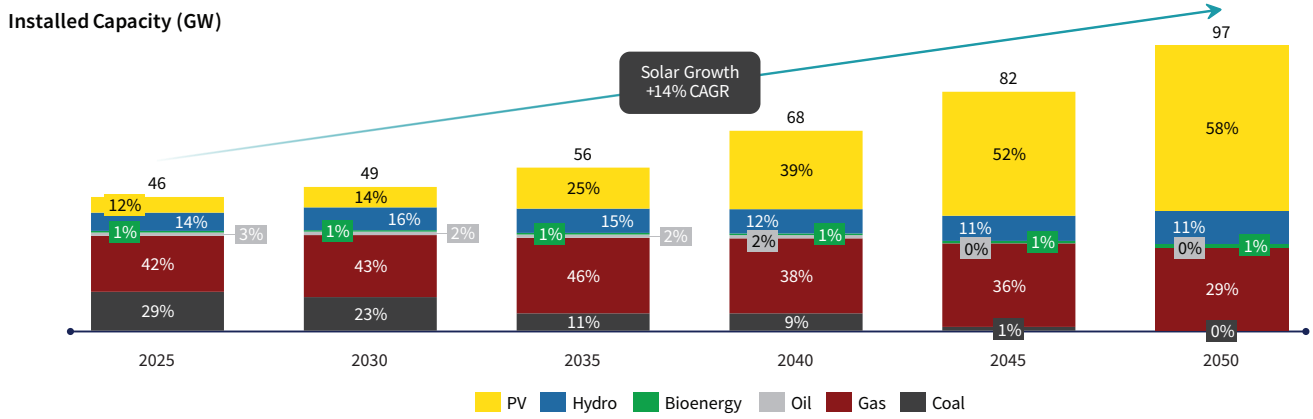
Key targets

In May 2023, the Government reaffirmed its commitment to unlock economic opportunities through a low-carbon transition, setting out the ambitious target to achieve 70% RE installed capacity in the power mix by 2050. NETR aims to reinforce this ambition and inform an accelerated RE rollout by affirming two essential targets:

- Target 1: 70% RE installed capacity share by 2050
- Target 2: No new coal power plant

In alignment with these strong RE ambitions, an accelerated pathway is needed to scale RE uptake in Malaysia over the next three decades.

Exhibit 5.2: Projected power system installed capacity mix 2050



NETR outlines several key observations for the dynamics of Malaysia's power mix as the nation progresses along this pathway:

- Renewables will constitute the majority share of installed capacity by 2050. However, the contribution of RE to the total generation mix will be comparatively lower than fossil fuels, particularly natural gas. This reflects the inherent low-capacity factor associated with solar, compared against the high-capacity factor of gas.
- The share of coal-fired power generation is expected to ramp down over time, driven by natural retirement timelines of existing coal-fired power plants. No new coal-fired power generation will be developed, leading to almost complete phase out by 2045.
- Gas is expected to act as a lower-carbon transition fuel away from baseload coal, and will be the dominant source of fuel for baseload power.
- The ambition to achieve 70% RE share of installed capacity by 2050 is expected to be achieved, predominantly driven by solar PV installation. Significant solar capacity growth is required in the next three decades, with 59 GW of installed capacity by 2050.

Challenges

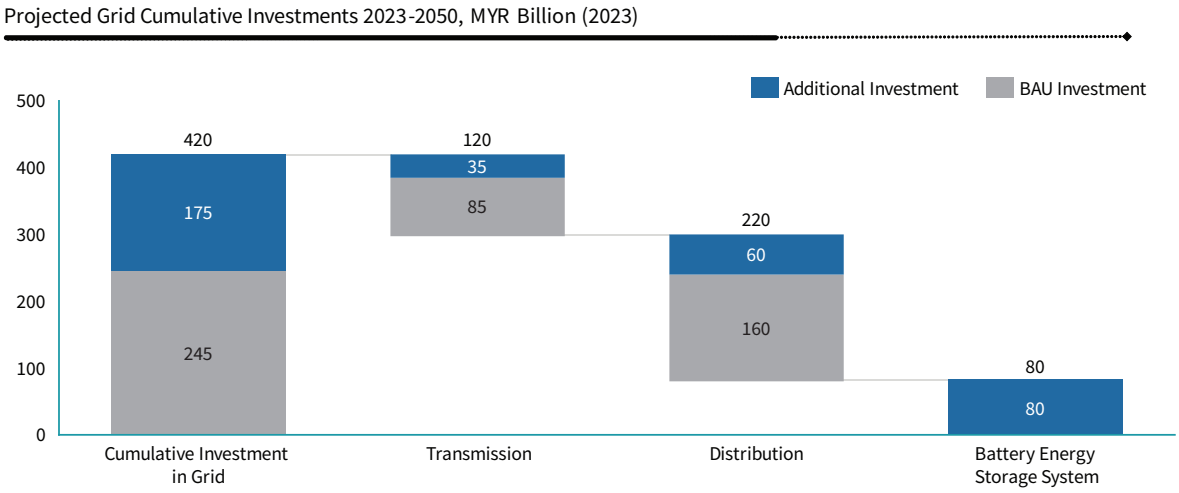
The current challenges faced by large-scale-solar (LSS) development have hindered its scalability and efficiency. The scattered development approach and lengthy permitting processes lead to higher fixed development costs, limiting the potential of LSS projects to significantly contribute to RE efforts. Regulatory barriers and a technology-agnostic LSS bidding mechanism further impedes the growth of innovative solar technologies like floating solar and agrivoltaic. These limitations highlight the need for more streamlined and supportive frameworks to encourage broader adoption of RE solutions.

Additionally, issues such as prolonged land acquisition processes and the exclusivity of the Net Offset Virtual Aggregation (NOVA) programme to commercial and industrial customers limit the adoption of RE. The lack of common alignment on timing, quantification and funding mechanism of grid investment presents challenges in meeting RE targets. Overcoming grid limitations to accommodate higher RE penetration is essential, so is the development of a TPA regulatory framework to address supply-demand mismatches for corporate green power. Furthermore, the absence of RE exchange platform inhibits the potential to capitalise on price premiums associated with exporting RE and sharing of reserves. Transparent price discovery mechanisms for willing buyer-willing seller are also lacking. Addressing these multiple challenges is crucial in fostering the growth of RE on a larger scale.

Key Initiatives

Energy Transition Lever: Renewable Energy		
Code	**Initiatives**	**Champions**
RE1	**Establish solar parks for accelerated deployment of utility-scale solar** ○ Identify suitable plots of land for development of solar parks through close collaboration among federal government, state governments and utility companies to enable decarbonisation of hard-to-abate industries ○ Enhance current LSS mechanism to improve financial sustainability for developers	NRECC ST MEESty ECoS SEDA
RE2	**Promote floating solar and agrivoltaic technology** ○ Remove existing regulatory barrier inhibiting floating solar and agrivoltaic (e.g. to amend existing hydropower power purchase agreements) ○ Roll out clear guidelines for floating solar and agrivoltaic ○ Adopt distinct bidding categories in future LSS auction to ensure fair competition	
RE3	**Expand virtual aggregation model for rooftop solar** ○ Expand virtual aggregation mechanism (e.g. NOVA program) to government and residential buildings for leasing and aggregation of rooftop space and sale to offtakers ○ Scale-up corporate and industrial solar rooftop programme	
RE4	**Develop plan for accelerated investments of transmission and distribution** ○ Establish amount, timing and mode of funding for grid infrastructure investment to reduce grid constraints while balancing energy trilemma (Exhibit 5.3) ○ Provide incentives for RE development and power storage facilities to improve system flexibility and address RE intermittency	NRECC, ST & TNB MEESty & SEB ECoS & SESB
RE5	**Develop TPA framework for sourcing of RE** ○ Develop TPA framework with transparent mechanism for wheeling fee calculation to bridge demand-supply gap for green electricity ○ Allow solar developers amongst Corporate Green Power Programme (CGPP) to sell excess power to the Single Buyer - unlocking additional sources of revenue and boosting investor interest	NRECC ST & TNB
RE6	**Set up RE exchange hub to enable cross-border RE trading** ○ Establish physical enabler (e.g. special purpose vehicle) to act as the market aggregator ○ Develop regulations for implementation of RE exchange hub and cross-border RE trading ○ Establish new or upgrade interconnection with neighbouring countries ○ Monetise excess power generated through bi- or multi-lateral power trading arrangements with neighbouring countries	NRECC ST

Exhibit 5.3: Projected power system cumulative investments



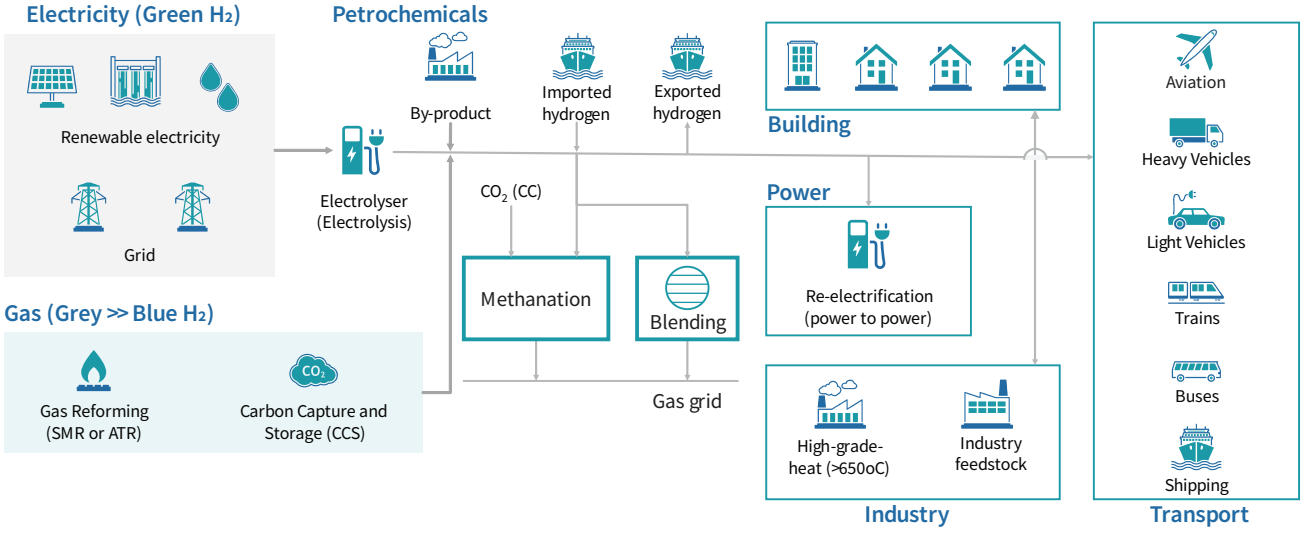
Hydrogen

Overview

Hydrogen presents itself as a versatile and future-proof source of low-carbon energy carrier. The transformative potential of a hydrogen economy not only reduces carbon footprint but also offers new economic opportunities, diversify fuel sources, and facilitates the effective monetisation of natural resource endowments, such as solar and hydroelectric capabilities.

Hydrogen holds significant promise as an alternative to natural gas in various sectors including industry, transportation and power generation, as shown in Exhibit 6.6. By harnessing the potential of hydrogen, Malaysia could become a forerunner in advancing the energy transition while diversifying its economy and enhancing its energy security.

Exhibit 5.4: Hydrogen with multiple potential supply chain and end-use applications



Three main types of hydrogen set to reshape our energy landscape:

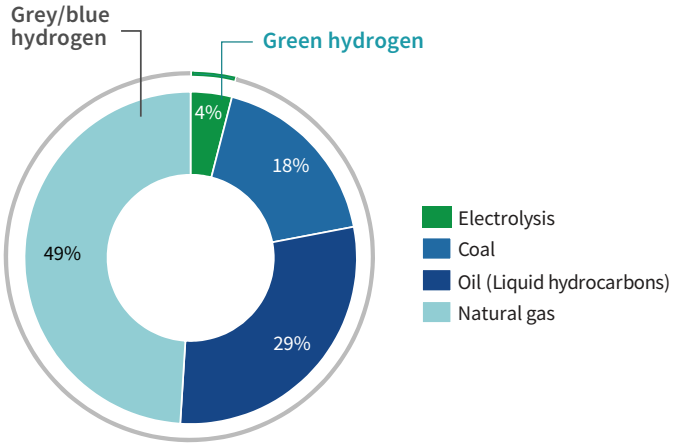
Grey Hydrogen:
Mainly produced by reforming fossil fuels, grey hydrogen currently stands as the most economically viable form of hydrogen. However, its production releases CO_2, making it a less sustainable option.

Blue Hydrogen:
Grey hydrogen with an additional step of carbon capture and storage (CCS). Up to 90% of CO_2 typically released during the production of grey hydrogen is captured. Blue hydrogen serves as a crucial stepping stone towards a fully green hydrogen economy.

Green Hydrogen:
Generated from renewable sources such as hydroelectric or solar power and produces only oxygen as a by-product.

Global Production of Hydrogen by type

Today, green hydrogen represents **only 4%** of total production globally



Malaysia has embarked on this journey to tap into the potential of hydrogen. This is particularly evident in Sarawak, where projects such as H2ornbill and H2biscus, in collaboration with Japanese and South Korean partners respectively, have made significant strides. These initiatives are congruent with Sarawak's Hydrogen Economy Roadmap, focusing on utilising hydrogen to transform Sarawak into a developed state by 2030. Looking ahead, the forthcoming HETR will further augment Malaysia's hydrogen ambitions.

Key targets

NETR proposes the following targets:

- Blue Hydrogen: To completely phase out the use of grey hydrogen as a feedstock by 2050.
- Green Hydrogen: To produce up to 2.5 Mtpa of green hydrogen by 2050 from RE such as hydroelectric power and solar.
- Low-carbon Hydrogen Hubs: To establish one low-carbon hydrogen hub by 2030, and an additional two hubs by 2050, bringing the total to three hubs.

Challenges

Despite its potential, hydrogen adoption is not without challenges in terms of technical and commercial feasibility. In terms of production, there is a limited supply of electrolysers in the global market, lack of technical capabilities and expertise as well as the high CAPEX to produce green hydrogen.

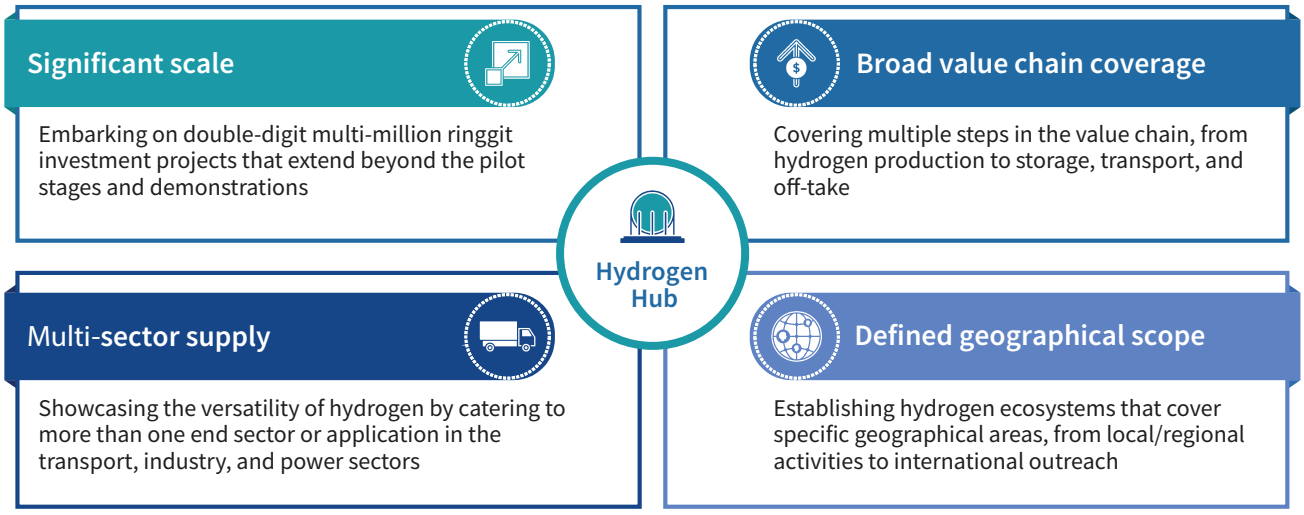
Electrolysers, which use electricity to split water to produce hydrogen using RE sources such as solar or hydro in the context of Malaysia make up around a third of the total cost of hydrogen production. Improvements in electrolyser efficiency or reductions in overall costs can provide Malaysia with a significant competitive advantage.

From a policy and regulatory view, there is a lack of policy support, defined standards, and regulations governing hydrogen. For instance, the appropriate overarching act to govern hydrogen might be allotted between the Gas Supply Act 1993 and the Renewable Energy Act 2011.

Key initiatives

Energy Transition Lever: Hydrogen		
Code	**Initiatives**	**Champions**
HY-1	**Establish low-carbon hydrogen standards and regulations** ○ Adopt low-carbon hydrogen standard to ensure consistent definition of low-carbon hydrogen with global trading partners ○ Establish domestic guarantee of origin certification to meet the standards of importing countries ○ Introduce hydrogen-specific regulations relating to transportation and storage ○ Streamline permitting process for hydrogen projects for expedited approval	MOSTI
HY-2	**Develop domestic green electrolyser manufacturing capabilities** ○ Fund electrolyser research and development (R&D) projects in local universities targeting efforts that reduce manufacturing costs ○ Provide financial incentives for electrolyser R&D activities by the private sector	MOSTI
HY-3	**Reduce Levelized Cost of Hydrogen (LCOH) for low-carbon hydrogen** ○ Establish hydrogen hubs to optimize economics of low-carbon hydrogen (Exhibit 5.5) ○ Establish financial incentives for large-scale manufacturing of low-carbon hydrogen and electrolyser ○ Facilitate partnerships between foreign electrolyser technology providers and local manufacturers for knowledge transfer	MOSTI MITI
HY-4	**Stimulate demand for low-carbon hydrogen** ○ Explore bilateral agreements with key importing countries to develop low-carbon hydrogen value chain, catalyse project development and secure long-term green hydrogen offtakes ○ Provide incentives for development of hydrogen refuelling stations and purchase of hydrogen fuel cell vehicles ○ Explore hydrogen co-firing with coal as a technology to reduce GHG emissions in the short term	MOSTI MITI

Exhibit 5.5: Key characteristics of a hydrogen hub



Bioenergy

Overview

Bioenergy covers biomass, biogas, and biofuels, and offers a key source of renewable primary energy supply. Biomass and biogas are used as zero-carbon energy supply sources for power generation. Biofuel, primarily in the form of biodiesel, is used across the transport industry. In 2019, bio-based products contributed 1% of TPES, comprising 648 kilotonnes of oil equivalent (ktoe) of biodiesel, 204 ktoe of biomass, and 118 ktoe of biogas.

Bioenergy is widely categorised based on the type of feedstock used to produce it:

- First-generation bioenergy is primarily derived from food crops such as palm oil
- Second-generation bioenergy is derived from non-food biomass such as agricultural waste residue, forest residue, livestock waste, fisheries waste, used cooking oil (UCO), as well as municipal solid waste (MSW)
- Third-generation bioenergy is derived from algae, and reflects a technologically nascent industry that is not yet economically viable, but has the potential to emerge as a competing feedstock source of bioenergy

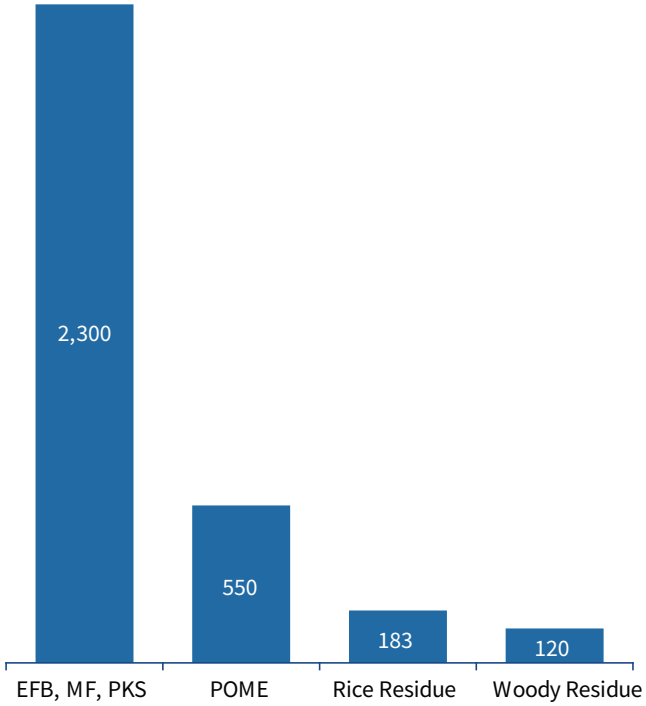
Due to concerns such as land competition and food security, second generation feedstock is viewed as the current most favourable bioenergy feedstock. NETR aims to capitalise Malaysia's strong bioenergy potential, with focus on two key segments, namely agriculture-related bioenergy and non-agriculture waste such as UCO and MSW.

Palm oil related residue consist of the majority of potential bioenergy generation potential in Malaysia, as shown in Exhibit 5.6. Hence, NETR will place its focus on addressing challenges relating to palm oil biomass in agriculture-related bioenergy.

Malaysia generates 13.9 million tonnes of MSW annually, with this number expected to rise in coming years. Therefore, MSW represents a significant, and expanding, source of bioenergy. It has the potential to serve as feedstock for power generation (waste-to-energy) and for biofuel in transportation. Additionally, Malaysia also has a large bioenergy potential from UCO with an estimated potential of approximately 240 kilotonnes per year.

Interventions on both demand-side and supply-side will optimise the use of bioenergy in Malaysia's energy system. These efforts support energy security by introducing bioenergy as an alternative fuel for power generation and as a means for rural electrification via local microgrids. Additionally, bioenergy stands as a carbon-neutral energy source, paving the way for decarbonisation in transportation, industrial applications and power generation. Moreover, by enhancing the adoption of bioenergy, socio-economic growth opportunities will emerge for SMEs and rural communities throughout the biomass value chain.

Exhibit 5.6: Bioenergy Generation Potential in Malaysia (MW)



Source: MyRER

Key targets

Bioenergy acts as a key enabler to support energy transition. Given this, NETR outlines two key targets to support and enable other energy transition levers:

- Increase biorefinery capacity to 3.5 billion litres by 2050
- Increase biomass and biogas power generation capacity to 1.4 GW by 2050

Challenges

It is crucial that Malaysia addresses several major bottlenecks in order to support an effective energy transition. For agriculture-related bioenergy to achieve its intended objectives, the government recognises the supply and demand challenges that must be addressed. Supply challenges include potential concentration risk of bioenergy feedstock, negative global perception and acceptance of palm oil biomass, supply security of biomass and high aggregation cost of bio-based feedstock. Demand challenges include limited local demand for bioenergy.

For non-agricultural waste, the government will address four key challenges such as low UCO collection rate, high usage of open landfills, unattractive economics of waste-to-energy plants and low national recycling rate.

Key initiatives

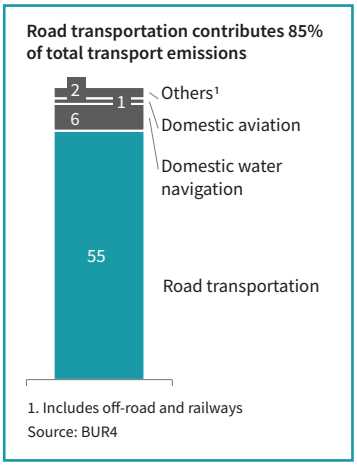
Energy Transition Lever: Bioenergy		
Code	**Initiatives**	**Champions**
BI-1	**Explore alternative bioenergy feedstock** ○ Explore bamboo as a feedstock ○ Support R&D of third-generation bioenergy (algae)	KPK
BI-2	**Enhance attractiveness of palm oil biomass** ○ Enhance acceptance of palm oil biomass (e.g. crude palm oil and palm oil mill effluent) to reduce indirect land use change (ILUC) charges ○ Obtain sustainable aviation fuel (SAF) certification from international bodies	KPK
BI-3	**Address challenge of supply security** ○ Facilitate biomass clustering to catalyse aggregation and reduce aggregation cost ○ Scale-up UCO collection via increasing awareness campaigns and UCO collection facilities	KPK
BI-4	**Catalyse local demand for bioenergy** ○ Establish SAF blending mandates starting with 1% ○ Establish B30 mandate for land transport by 2030 when palm oil gas oil (POGO) spreads are projected to be economically viable ○ Upgrade nodal point at economically feasible clusters of mills ○ Facilitate incentives through Feed-in-Tariff (FiT) or other mechanism for co-firing in coal power plant	KPK SEDA
BI-5	**Improve solid waste management policies** ○ Explore landfill tax and quota or landfill ban to drive reduction in open landfills ○ Explore expansion of de-risking revenue sources and co-funding of waste-to-energy (WtE) plants to ensure financial sustainability ○ Accelerate recycling target and increase recycling infrastructure investments	KPKT

Green Mobility

Transportation remains a prominent contributor to GHG emissions in Malaysia, primarily driven by the emissions from internal combustion engine (ICE) vehicles, as shown in Exhibit 5.7. The land transport segment is a key driver of these emissions, accounting for 55 $MtCO_2eq$, constituting 85% of total transport emissions.

The adoption of green mobility practices and technologies is imperative to address these substantial emissions burden. This section delves into the transport sector, segmented into several critical categories, namely land transport consisting of light and heavy vehicles, aviation, and marine transport.

Exhibit 5.7: Transport sector's GHG emissions



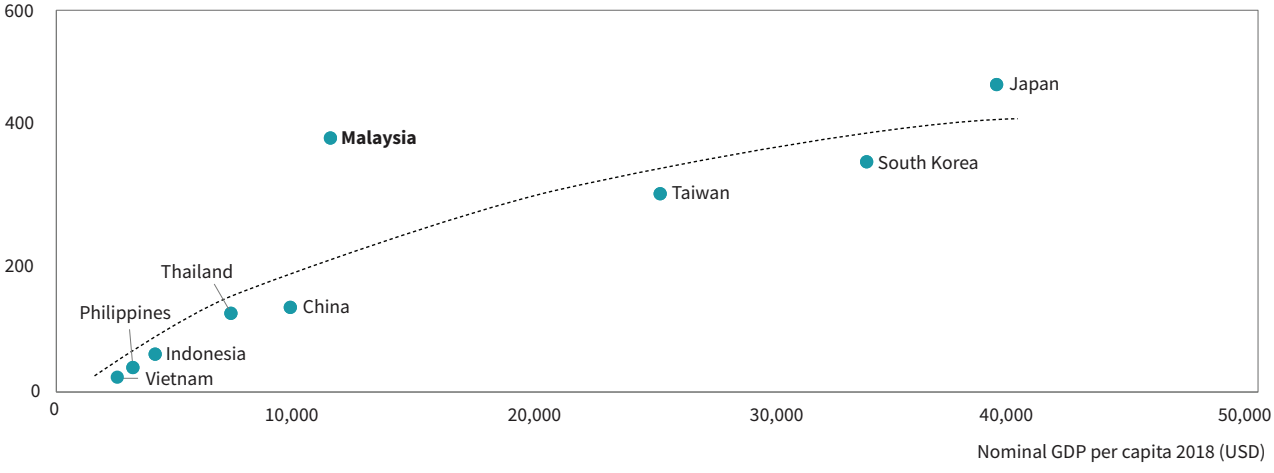
Land transport (Light vehicle)

Overview

Malaysia boasts a substantial fleet of private passenger vehicles, ranking among nations in the East Asian region with the highest car ownership, as shown in Exhibit 5.8. This prevailing sector dynamic drives significant negative impacts to the nation, including elevated carbon emissions within the transport sector, urban traffic congestion, and compromised air quality. Addressing the challenges requires focus across three key area i.e. transport modal shift, fuel economy and electrification.

Exhibit 5.8: Car ownership in East Asia

Car ownership penetration, 2018 (per 1000 people)



Source: Economist Intelligence Unit

Key targets

The NETR builds on existing national targets outlined by the Low Carbon Mobility Blueprint (LCMB) and the DTN targets. By 2050, the NETR aims to:

- Elevate the public transport modal share to reach 60%
- Accelerate the penetration of xEV (4W) share of the vehicle fleet to 80%
- Accelerate the penetration of electric two-wheelers' (E2W) share of the vehicle fleet to 80%
- Foster robust local EV manufacturing capabilities to achieve 90% local xEV manufacturing
- Continue improvements in ICE fuel economy

Challenges

The transition to green mobility in land transport, specifically in light vehicles, is met with several challenges. These include inadequate public transport infrastructure and connectivity, slow adoption of sustainable public transportation and the need to comply with the ASEAN fuel economy standards. Additionally, the lack of affordable EV models and slow expansion of charging infrastructure as well as disparity in upfront costs between E2W and ICE 2W hinders the transition.

Key initiatives

Energy Transition Lever: Green Mobility (Land Transport – Light Vehicle)		
Code	**Initiatives**	**Champions**
GM-LV1	**Drive public transport modal share shift to 40% by 2040 and 60% by 2050** ○ Financially support the ongoing or future buildout of public transport infrastructure to facilitate modal share shifts ○ Facilitate electrification of public transport	MOT
GM-LV2	**Improve light vehicle fuel economy** ○ Establish robust methodology to measure fuel economy ○ Strengthen fiscal policy measures based on fuel economy ○ Determine long-term fuel standards	MOT
GM-LV3	**Accelerate electrification of light vehicles segment (E4W)** ○ Incentivise investments to build local manufacturing capacity and capability ○ Continue co-funding of public charging infrastructure ○ Implement stringent emissions standards to limit non-EEV manufacturing ○ Expand product awareness and model availabilities of EVs ○ Identify key localisation opportunities in EVs ○ Reduce regulatory challenges in ramping up EV adoption including for setting up of charging infrastructure (e.g., right-to-charge regulation, approval process for charge point operator license, review of Uniform Building By-Laws)	MITI
GM-LV4	**Accelerate electrification of light vehicles segment (E2W)** ○ Incentivise E2W purchase or leasing cost to expedite total cost of ownership parity with ICE 2W, targeting B40 household ○ Foster the expansion of E2W model availability through local manufacturing or support for foreign manufacturers' setup ○ Monitor E2W charging infrastructure development and establish battery charging standards for public and home charging	MITI

Land transport (Heavy vehicle)

Overview

The heavy vehicle sector can be segmented into three sub-categories: (1) light commercial vehicles (LCV) weighing below six tonnes, (2) medium-duty trucks (MDT) weighing six to 15 tonnes, and (3) heavy-duty trucks (HDT) exceeding 15 tonnes. In contrast to light vehicles, the feasibility of alternative fuels for heavy vehicles remains limited. Within this context, MDTs and HDTs are currently in the respective pilot phase of adopting alternative fuels. For MDTs and HDTs, there exists uncertainty regarding the potential alternative fuels of the future. Addressing the challenges of energy transition in heavy vehicle sector require emphasis in four key areas, namely transport modal shift, fuel economy, biodiesel blending and fuel switching.

Key targets

The NETR targets are guided by the DTN and the Logistics and Trade Facilitation Master Plan. In line with these frameworks, the NETR aims to:

- Maintain the pathway towards achieving 5% share of rail freight modal utilisation by the year 2030
- Embrace emerging regional benchmarks pertaining to fuel efficiency
- 5% of heavy vehicles utilise hydrogen by 2050
- Maintain DTN's biodiesel blending targets to B30 by 2030

Challenges

The potential for greater fuel efficiency improvement exists for heavy vehicles, as advancement in technology can lead to substantial emissions reduction. However, it is hampered by potential cost impact of increasing mandated biodiesel blend rates that could affect industry player uptake abilities, limited visibility into optimal heavy vehicle powertrain and lack of available infrastructure to support new fuels of the future.

Key initiatives

Energy Transition Lever: Green Mobility (Land Transport – Heavy Vehicle)		
Code	**Initiatives**	**Champions**
GM-HV1	**Enhance demand-side management with fuel economy** ○ Set common indicators and methodologies to measure fuel economy ○ Evaluate and utilise selected levers to meet estimated fuel efficiency target ○ Encourage vehicle replacement through targeted incentives	MOT
GM-HV2	**Implement B30 biodiesel blending mandate** ○ Comprehensive review of biodiesel blending programme to ensure achievable blending rate ○ B30 to be mandated by 2030 when POGO spreads are projected to be economically viable	KPK
GM-HV3	**Introduce future powertrains for heavy vehicles** ○ Track advancement in technology of future fuel powertrain ○ Explore the utilisation of hydrogen for long-haul trucks and battery electric vehicles (BEV) for short-to-medium-haul trucks	MGTC

Aviation

Overview

In line with the Paris Agreement, the International Civil Aviation Organization (ICAO) has adopted a Long-term Global Aspirational Goal (LTAG) for international aviation of net-zero carbon emissions by 2050. Similarly, the International Air Transport Association (IATA) has committed to Fly Net Zero by 2050. The success of these targets rely on three key levers, namely improvement of operational efficiency, adoption of sustainable aviation fuel (SAF) and advancement of new and emerging aircraft technologies.

The 41st ICAO Assembly adopted the LTAG for international aviation of net-zero carbon emissions by 2050 in support of the UNFCCC Paris Agreement's temperature goal. Malaysia as a member state of ICAO, supports LTAG as a collective global aspirational goal. In line with this goal, NETR is poised to promote the adoption of SAF, recognising its potential to deliver substantial reduction in all emissions.

SAF represents a valuable low-carbon opportunity in Malaysia's journey towards reducing aviation emissions, derived from biological feedstocks such as vegetable oils and UCO. Within SAF's production framework, two primary sources were identified as key alternatives; biofuels and synfuels. Hydroprocessed esters and fatty acids (HEFA) emerged as the front-runner technical pathway in the near term, while alcohol-to-jet (ATJ) and gasification-integrated Fischer-Tropsch (GFT) harbour immense potential and are poised to shape the long-term SAF landscape.

Key targets

NETR proposes the following targets:

- Adopt ICAO's LTAG of net-zero carbon emissions by 2050 for international aviation
- Up to 47% SAF blending mandate by 2050

Challenges

The aviation sector in Malaysia faces several key challenges in its transition towards green mobility. These challenges include lack of clarity and guidance on the implementation of aviation decarbonisation levers despite commitment towards long-term global targets. Additionally, there is limited demand signal that could effectively catalyse the domestic production of SAF. Compounding these issues is the argument surrounding the suitability of palm oil as a SAF feedstock due to concerns related to indirect emissions and other sustainability criteria. This consequently impacts the life cycle emission values in the sector's pursuit of sustainable alternatives.

Key initiatives

Energy Transition Lever: Green Mobility - Aviation		
Code	**Initiatives**	**Champions**
GM-AV1	**Establish overarching aviation decarbonisation roadmap** ○ Develop aviation decarbonisation roadmap collaboratively alongside key stakeholders with four main elements: (i) foster industry-driven advancement through collaboration with private stakeholders, (ii) address essential decarbonisation levers, (iii) outline policy intervention tailored to each lever, and (iv) establish milestones and monitor progress.	MOT
GM-AV2	**Implement SAF blending mandate** ○ Establish an initial 1% SAF blending mandate to encourage demand ○ Incentivise investments in SAF production and infrastructure ○ Develop a comprehensive framework for progressive escalation of blending mandates in the long run	KPK
GM-AV3	**Undertake palm oil-feedstock emissions study** ○ Re-evaluate emissions related to POME and ILUC to bolster adoption of SAF derived from palm oil ○ Ensure palm oil for SAF production is sourced in a sustainable manner	KPK

Marine

Overview

Decarbonisation of the marine transport sector presents an opportunity for Malaysia to position itself as a green fuel bunkering hub since Malaysia's ports account for 24% to 26% of annual container throughput within ASEAN. This sector currently employs a combination of two primary fuel categories—diesel and fuel oil. Fuel oil can be additionally categorised into variants such as high sulphur fuel oil (HSFO), low sulphur fuel oil (LSFO), and other distillates including marine gas oil (MGO).

The evolution of marine transport sector operations is expected to include a diversified fuel landscape, characterised by the coexistence of e-ammonia and e-methanol, without a definitive consensus on which fuel will emerge as the industry frontrunner in the long term. Both e-methanol and e-ammonia present promising prospects for fostering economic expansion in Malaysia, given the nation's strategic aspirations within the hydrogen economy.

Currently, Malaysia's journey entails a gradual, medium-to long-term shift towards the adoption of e-methanol and e-ammonia, contingent upon their commercial viability. Biofuels will continue to be utilised as a short-term solution until e-ammonia and e-methanol reach large-scale commercial viability.

Key targets

NETR proposes the following target:

- Low-carbon fuel penetration of 40% by 2050 in marine transport

Given that International Maritime Organisation (IMO) has shifted its focus from desulphurisation to decarbonisation, DTN's target of LNG penetration target of 25% in marine transport will be dropped.

Challenges

The progression of Malaysia's marine transport towards green mobility encounters several challenges concerning the availability of more sustainable fuel alternatives. These challenges encompass the limited capacity for biofuel production, which is further compounded by the growing demand for sustainable biofuels for marine bunkering. Furthermore, the early stage of development of e-ammonia technology and the high cost of hydrogen, presently hinder economic viability of e-ammonia. Additionally, transitioning to e-methanol necessitates adjustments in vessel designs and engines to guarantee the technical feasibility of this promising future fuel.

Key initiatives

Energy Transition Lever: Green Mobility -Marine		
Code	**Initiatives**	**Champions**
GM-MA1	**Unlock market opportunities of biofuel in marine bunkering** ○ Research, conduct pilots, and drive technical and commercial viability of domestic biofuels usage in onboard equipment and marine bunkering fuel ○ Encourage early adoption of domestic biofuels in shipping industry to position biofuel for fuel exports	KPK
GM-MA2	**Unlock market opportunities of future fuels in marine bunkering** ○ Keep track and selectively adopt pilot projects for alternative fuels and determine country strategy for these fuels as commercial viability is reached ○ Enhance competitiveness of domestic ports in future fuel marine bunkering by providing incentives, lowering costs of fuel supply and enhancing refueling efficiency ○ Develop plan for domestic coastal ships to adopt future fuels in the medium- to long-term	MOT

Carbon Capture, Utilisation and Storage

Overview

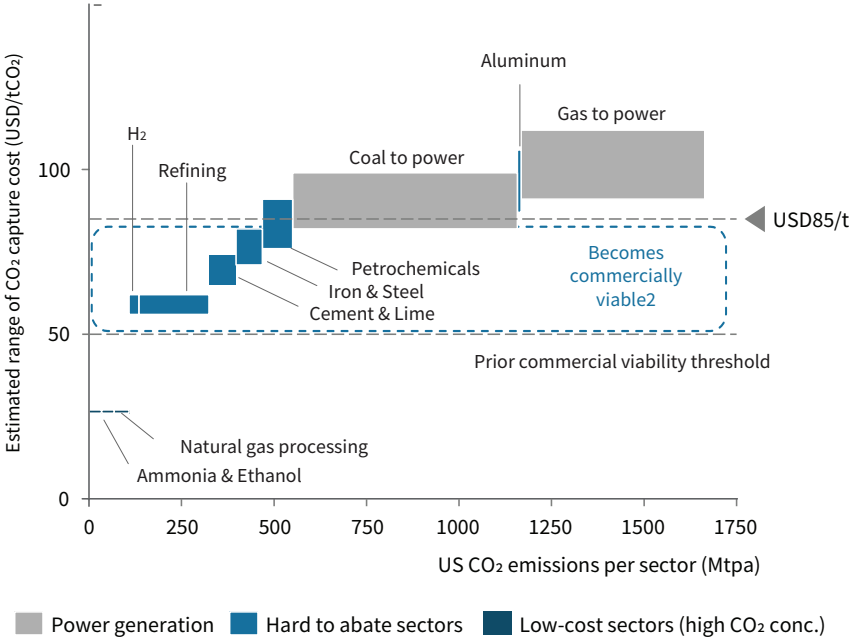
CCUS plays a pivotal role in energy transition. The IEA posits that reaching net-zero will be extremely challenging without CCUS and its role will extend to almost all parts of the global energy system. The contribution of CCUS will grow over time as technology improves, cost reduces and cheaper abatement options in some sectors are exhausted.

Globally, there is a growing trend towards building a robust CCUS ecosystem using a cluster or hub strategy. This method encourages emitters within the same cluster to invest and utilise shared CCUS infrastructure, such as CO_2 pipelines and storage facilities to reduce the overall cost of CCUS.

Based on the IEA's projections, there is a noticeable disparity between the current capacity of CCUS and the anticipated future needs. The current gaps in CCUS adoption can be traced back to its nascent stage and high implementation costs. Establishing comprehensive CCUS systems encompassing CO_2 capture, transport, and storage, demands substantial capital investment, thus posing a significant hindrance to widespread adoption. However, with the costs of CCUS technologies on a steady decline, and given the forecasted rise in carbon pricing, the economic viability of CCUS is predicted to gain considerable momentum in the coming years.

Viability of CCUS in each industry is influenced by factors such as regulations, carbon pricing and production processes. Emission-intensive industries, especially in regions with stringent regulations and clear policies i.e. carbon tax, are more inclined to adopt CCUS to mitigate their carbon footprint.

CCUS cost-curve, US emissions USD/ton of CO_2 captured[1]



1. Not exhaustive; 2. Commercial viability based on US IRA 45Q tax credits

Source: NETR CCUS Tool

As an energy producing country, there is a pressing need for Malaysia to balance economic interests, energy security, and environmental sustainability. CCUS will help Malaysia in meeting net-zero aspiration by reducing carbon emissions, especially in hard-to-abate industries. Utilising captured CO_2 also catalyses the emergence of new industries, fuelling Malaysia's green growth for climate resilience.

Over 20 countries worldwide have incorporated CCUS into their plans to reach net-zero emissions, highlighting its prominent role in energy transition. While Malaysia has yet to develop policy and regulatory framework on CCUS, Budget 2023 has introduced several tax incentives for companies undertaking in-house CCS activity, companies undertaking CCS activity and companies using CCS services. This approach highlights CCS' role as a new source of economic growth and in achieving net-zero GHG emissions.

Key targets

NETR proposes the following targets:

- By 2030:
  - Develop 3 CCUS hubs (2 in Peninsular Malaysia, 1 in Sarawak)
  - Total storage capacity up to 15 Mtpa
- By 2050:
  - Develop 3 carbon capture hubs
  - Total storage capacity between 40 to 80 Mtpa

Challenges

Malaysia faces challenges in developing CCUS due to the technology's nascent status. The country lacks regulatory framework and governance necessary to galvanise CCUS development. Given the high costs associated with CCUS technology, incentives and access to funding with competitive rates are needed to motivate emitters to adopt CCUS. Internationally, government support has been the primary catalyst for the adoption of CCUS amongst emitters and for the development of CCUS hubs.

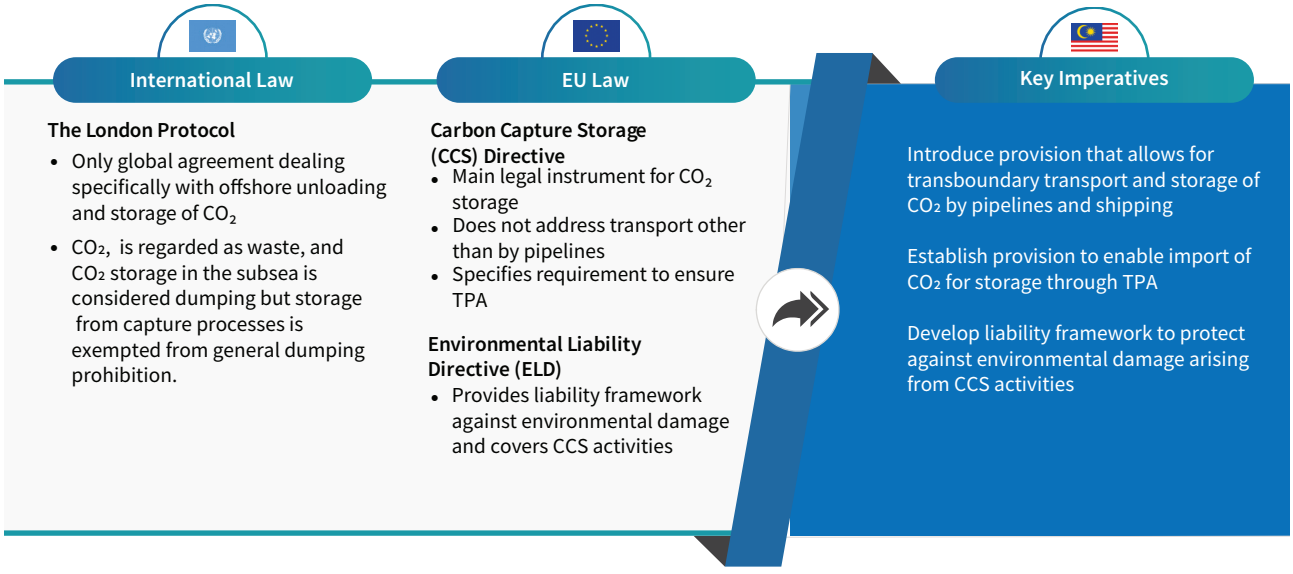
Malaysia has yet to accede to regulations such as the London Protocol and the EU CCS Directive to enable the transboundary transport and storage of CO_2. Although transboundary transport and storage of CO_2 is a potential source of growth, Malaysia has not developed its domestic policy on CCUS to allow for the integration of international regulations into domestic regulatory framework. For the seamless import and storage of CO_2 within Malaysian borders, aligning with these established international regulations is paramount.

Whilst the main objective of capturing CO_2 through CCUS is geared towards storage, there are instances where the utilisation of CO_2 proves both economically and commercially viable. Such opportunities are still lacking and deserve exploration. Strategic government incentives and specific mandates can act as catalysts, encouraging the use of CO_2 in sectors such as precast concrete, urea production, and other applicable areas.

Key initiatives

Energy Transition Lever: Carbon Capture, Utilisation and Storage (CCUS)		
Code	**Initiatives**	**Champions**
CC1	**Develop CCUS-specific policies and regulations** ○ Develop policy and regulatory framework to facilitate the implementation of CCUS projects ○ Establish governance structure of CCUS by clearly defining roles of each ministry and agency ○ Amend existing regulations (e.g. Exclusive Economic Zone Act 1984 [Act 311] and National Land Code) to incorporate key enablers for CCUS development	Ministry of Economy
CC2	**Strengthen CCUS adoption through provision of incentives across all relevant sectors and facilitate hub development** ○ Establish carbon pricing instrument to drive the adoption of carbon capture technology for stationary emitters ○ Enhance incentives to reduce cost, enable access to funding and encourage adoption of CCUS technologies (e.g., public catalytic funds, tax credits, contract for difference)	MOF Ministry of Economy
CC3	**CC3 - Facilitate CCUS Hub infrastructure development** ○ Explore collaboration with potential investors and financiers to fund and catalyse investments in CCUs infrastructure for hub development	Ministry of Economy
CC4	**Establish transboundary CO_2 agreement** ○ Negotiate and introduce transboundary CO_2 regulatory agreement encompassing the provisions on transboundary movement and storage of carbon, liability and cost sharing (Exhibit 5.9)	Ministry of Economy
CC5	**Promote local utilisation of CO_2 in industry** ○ Set specific mandates within use case (e.g. cured concrete and urea)	MITI

Exhibit 5.9: International transboundary CO_2 provisions and lessons for Malaysia

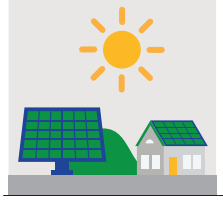


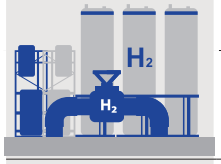
Section 6 : NETR Flagship Catalyst Projects and Initiatives

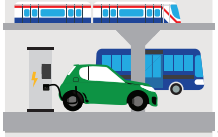
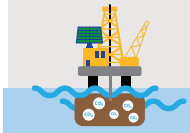
The Ministry of Economy has received an extensive list of proposals for energy transition projects and initiatives from ministries and businesses. Based on the evaluation process and guiding principles established by NETR, 10 flagship catalyst projects and initiatives were identified. These flagship projects are expected to generate an estimated total investment of more than RM25 billion, create 23,000 job opportunities and reduce GHG emissions of more than 10,000 Gg CO_2 equivalent per year.

The flagship catalyst projects and initiatives will have several modalities to demonstrate the varying level of technology and solutions needed to address energy transition. As such, each modality will be championed by different entities displaying their unique approach in supporting Malaysia's energy transition advancement. The 10 flagship catalyst projects and initiatives and their implementation modalities are outlined in Exhibit 6.1.

Exhibit 6.1: Flagship catalyst projects and initiatives

Energy Transition Levers	Flagship	Modalities	Champion
Energy Efficiency (EE) 	Efficient Switch	**Energy Efficiency and Conservation Act (EECA)** The Energy Efficiency and Conservation Bill to regulate energy-intensive users, buildings and products will be tabled in Parliament in the fourth quarter of 2023.	NRECC
		Energy Audit for Rail Sector Railway operators to perform energy audit exercise under the Energy Audit Conditional Grant (EACG 2.0) aimed at establishing the current energy consumption baseline, identifying potential energy savings in their premises and lowering utility costs.	MOT
Renewable Energy (RE)	Renewable Energy Zone (RE Zone)	**Integrated RE Zone** A large-scale integrated sustainable development spanning the entire energy supply chain, from generation and energy storage to efficient demand management and consumption. A pilot RE Zone will be established encompassing an industrial park, zero-carbon city, residential development and data centre.	Khazanah Nasional Berhad
		Solar Park Centralised LSS parks co-developed by TNB, in partnership with SMEs, cooperatives, and state economic development corporations. These parks will consist of 100 MW deployment per site across 5 sites in several states.	TNB
		Hybrid Hydro-Floating Solar PV (HHFS) Development of 2500 MW HHFS potential at TNB hydro dam reservoirs will increase RE generation close to 24-hour availability. The hydro plant acts as energy storage by conserving the water in the reservoir during peak hours and discharging it during non-peak, while providing quick response to the duck curve. Lower investment by utilising existing hydro infrastructure as compared to battery energy storage system (BESS) and solar PV. Potential scaling up for future green hydrogen feedstock in collaboration with other hydrogen producers such as Gentari as the green electron offtaker.	TNB
		Residential Solar The construction of 4.5 MW solar capacity across 450 homes in City of Elmina and Bandar Bukit Raja. Up to 10 kW solar capacity per house through rooftop leasing with offtake within the township by high-demand users from the commercial or industrial sector.	Sime Darby Property
	Energy Storage	**Energy Storage System (ESS)** Development of utility-scale ESS to enable higher penetration of variable RE in Malaysia.	NRECC Energy Commission
	Energy Secure	**Sabah Energy Security Initiative** An integrated initiative is underway to secure the long-term energy supply and support the socioeconomic development of the state. This includes: the development of LSS and small hydropower plants; the formulation of policy and regulatory framework on biowaste to ensure a consistent supply of feedstock; and the feasibility of geothermal for power generation.	Energy Commission of Sabah

Energy Transition Levers	Flagship	Modalities	Champion
Hydrogen 	Green Hydrogen	**Sarawak Hydrogen Hub** Implementation of three integrated projects to produce green hydrogen will propel Sarawak as a regional green hydrogen hub. These projects involve the development of a green hydrogen production plant in Kuching by 2025 for domestic use, and two plants in Bintulu by 2027, mainly for export purposes. Sarawak State Government through SEDC Energy is collaborating with strategic partners to develop the state into a green hydrogen hub.	SEDC Energy
	Hydrogen for Power	**Co-Firing of Hydrogen and Ammonia** Green hydrogen and ammonia co-firing in collaboration with PETRONAS to decarbonise TNB generation plants.	TNB
Bioenergy 	Biomass Demand Creation	**Biomass Clustering** Development of biomass clusters with a centralised plant using aggregated feedstock from multiple neighbouring mills. Biomass clustering is expected to improve economies of scale as well as securing larger and more reliable feedstock.	KPK NRECC SEDA
		Biomass Co-firing Co-firing initiative at the existing 2100 MW Tanjung Bin Power Plant by burning biomass along with coal. Biomass sources include empty fruit bunch (EFB) pellets, wood chips, wood pellets, bamboo pellets, coconut husk and rice husk. A pilot phase of co-firing will commence in 2024 with the scale-up potential to a minimum of 15% biomass co-firing capacity by 2027.	KPK Malakoff

Energy Transition Levers	Flagship	Modalities	Champion
Green mobility	Future Mobility	**EV Charging Stations** Installation of 10,000 EV charging stations by 2025 along highways and at selected commercial buildings in collaboration with strategic partners, among others, TNB, Plus Malaysia Berhad (PLUS), Permodalan Nasional Berhad (PNB), Gentari and Sunway Group.	MITI
		Mobile Hydrogen Refuelling Station Introduction of the first mobile hydrogen refuelling station for transportation in Peninsular Malaysia, in collaboration with NanoMalaysia Berhad, PETRONAS, United Motor Works (UMW) and the MGTC.	MOSTI
		Public Transport Electrification This project involves electrification of first and last mile public transport and upgrading infrastructure and electrical lines at bus depots for charging, with maintenance, repair and overhaul (MRO) opportunities for local SMEs.	MOT Prasarana
		Solar Photovoltaic (PV) Installation for Rail Operations The Rail Sector Energy Management and Renewable Energy (EMRE) Action Plan entails the installation of Solar Photovoltaic (PV) systems for non-traction electricity usage in rail operations such as stations and depots.	MOT
	Future Fuel	**Biofuels Hub** A bio-refinery will be developed in Pengerang, Johor, to serve as a catalyst for creating hubs to produce a range of bio-based products, including SAF, hydrotreated vegetable oil (HVO), advanced sustainable fuel (ASF) and biochemicals.	PETRONAS
CCUS	CCS for Industry	**Regulatory Framework** Development of policy and regulatory framework to facilitate the implementation of CCUS projects, including transboundary carbon movement.	Ministry of Economy
		**Kasawari and Lang Lebah CCS** Implementation of CCS catalyst projects for Kasawari and Lang Lebah high-CO_2 gas fields in collaboration with the Sarawak Government, which are expected to be in operation by 2026 and 2028 respectively. CCS technology will be used to capture CO_2 from the gas production field and store it in the depleted fields.	PETRONAS

Section 7: Cross-Cutting Enablers

A series of cross-cutting enablers will be vital to expedite Malaysia's energy transition journey. These enablers assume a crucial role in addressing underlying structural impediments and disparities inherent in the nation's shift towards a low-carbon energy mix. As such, five key cross-cutting enablers and twelve initiatives that seamlessly align with enablers highlighted in DTN have been identified (Exhibit 7.1).

Exhibit 7.1: Cross-cutting enablers and initiatives

Cross-cutting Enablers		Initiatives
Financing and Investments	1	Establish National Energy Transition Facility
	2	Mobilise and attract private capital flow for energy transition sectors
	3	Roll out carbon pricing mechanism
Policy and Regulation	4	Launch National Gas Roadmap
	5	Rationalise energy subsidies
Human Capital and Just Transition	6	Establish green skills taxonomy and ensure strategic workforce planning
	7	Develop and roll out targeted green skilling programmes
	8	Develop and implement community support programmes
	9	Enhance energy literacy and energy efficiency awareness among students, SMEs and energy consumers
Financing and Investments	10	Develop a National Energy Knowledge Hub for public access
	11	Accelerate development of domestic industries for green manufacturing and adoption of green technologies
Corporate and Implementation	12	Establish National Committee on Energy Transition under the National Energy Council (MTN)

Financing and Investments

Overview

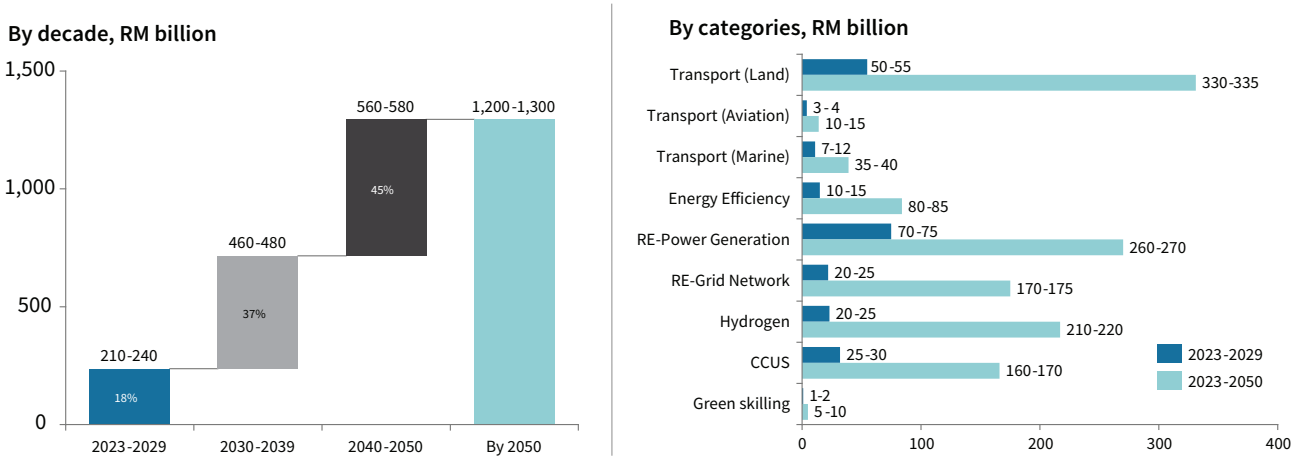
Financing Malaysia's energy transition constitutes a significant undertaking that requires the adept utilisation of a wide spectrum of funding channels. The overarching objective is to achieve energy transition targets while ensuring fiscal sustainability. This enabler identifies the existing financing gaps and recommends a series of initiatives aimed at expediting the influx of capital investments and leverage diverse capital pools to achieve NETR targets.

Estimation of investment needs

NETR anticipates that Malaysia will require an investment of RM1.2 trillion to RM1.3 trillion by 2050, based on the financial requisites, as shown in Exhibit 7.2. In this decade, 18% of funding is required primarily in RE power generation and green mobility. Investment in RE power generation entails the expansion of solar PV and hydropower, and strengthening of grid infrastructure. For green mobility, the investments are for the expansion of public transportation, amplification of domestic EV production capacities, and increased manufacturing of EV charging infrastructure.

Hydrogen and CCUS technologies will also require significant investments considering their nascent status, necessitating substantial scale-up efforts. The commitment in improving energy efficiency, advancing sustainable aviation and marine transport capabilities, and establishing green skilling programmes also demands substantial investments.

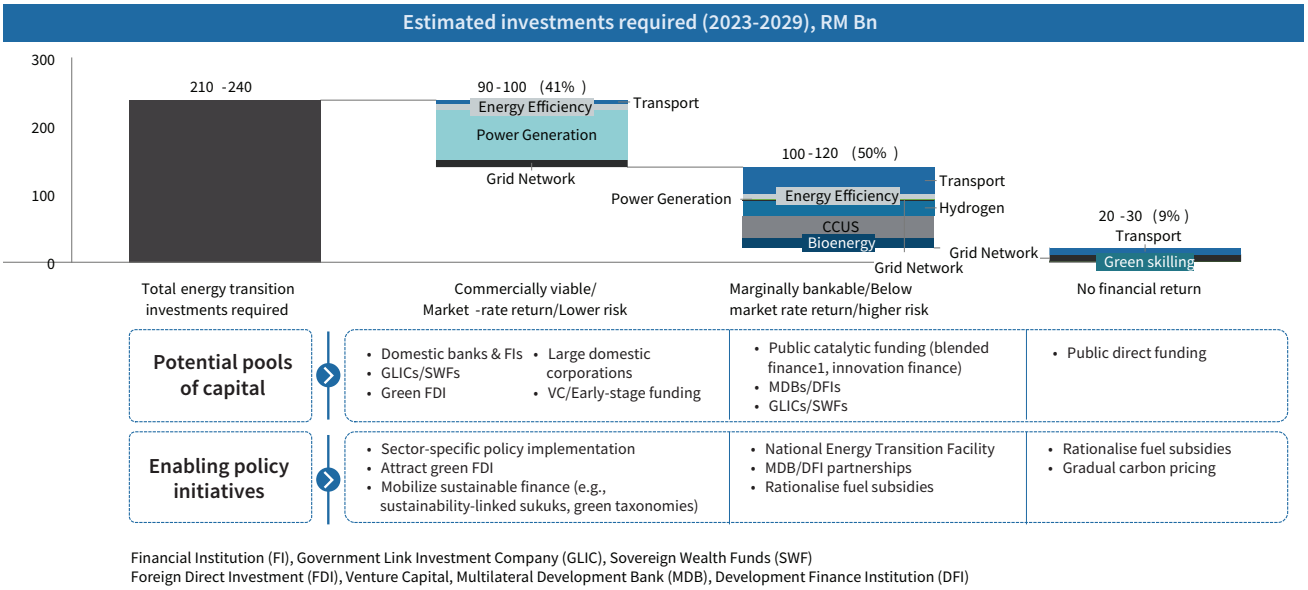
Exhibit 7.2: Malaysia's energy transition financing needs



Note: NETR financing needs are additive and do not include business-as-usual investment required or projects already being financed (e.g., transmission and distribution, ongoing public transport projects) Source: PLEXOS, NETR team analysis

The utilisation of diverse capital pools will be leveraged to facilitate energy transition, as shown in Exhibit 7.3. Energy transition projects are categorised according to their potential financial yields and the nature of funding that could be mobilised.

Exhibit 7.3: Short-term national energy transition financing needs



Financial Institution (FI), Government Link Investment Company (GLIC), Sovereign Wealth Funds (SWF)
Foreign Direct Investment (FDI), Venture Capital, Multilateral Development Bank (MDB), Development Finance Institution (DFI)

Focusing on Malaysia's immediate energy transition needs, a significant proportion of projects will be classified as marginally bankable or yielding below-market returns. This is primarily due to significant investments in the EV value chain, hydrogen infrastructure, CCUS technologies, as well as the rapid advancement of the energy efficiency sector in Malaysia, which mostly are at a nascent stage.

Investments in RE power generation, such as solar PV and hydropower, along with grid enhancements, are categorised as commercially viable or with market-rate returns. These projects typically possess the capacity to secure funding from capital markets and domestic financial institutions but require robust policy support to accelerate adoption.

Projects that yield no financial returns pertain to investments fulfilling public service obligations or those that are aligned with a social-focused mandate. This encompasses initiatives such as upskilling and reskilling programmes aimed at aiding the workforce impacted by the energy transition as well as enhancing nationwide public transportation infrastructure.

Challenges

Given that energy transition is a capital-intensive endeavour, energy transition projects are still surrounded by apprehensions on the commercial viability of initiatives that might be characterised as technologically immature or those that have not yet reached commercial scale. In the context of Malaysia, the unproven markets refer to CCUS, green hydrogen, BESS and SAF.

Certain projects are deemed small-scale initiatives and fail to attract the attention of major investors and financial institutions. This translates into higher development costs that directly affect the project developers. Notable examples of projects are energy efficiency and bioenergy, which frequently face scalability challenges.

Some projects are faced with implementation risks such as construction-related uncertainties, developmental risks, and the vulnerability of offtaker arrangements. Examples include hydropower and bioenergy, which further complicate the projects' roll-out.

The last challenge is the scarcity of viable projects. The existing pipeline of feasible energy transition initiatives fails to provide clear and compelling opportunities for prospective investors and financial institutions. Consequently, the discrepancy in areas deemed ready for commercial financing, such as solar farms persists between shovel-ready projects and the actual allocation of financial resources.

Key Initiatives

Enabler: Financing and Investment		
Code	**Initiatives**	**Champions**
EN1	**Launch a National Energy Transition Facility (NETF)** ○ Launch initial seed fund amounting to RM2 billion ○ Explore the catalytic blended finance platform, aimed at expediting the mobilisation and deployment of capital to enhance the accessibility of funds, streamline investment processes, and ensure a seamless flow of financial resources towards energy transition projects.	Ministry of Economy
EN2	**Mobilise and attract private capital for energy transition sectors** ○ Attract private capital from the green foreign direct investments (FDI), international and domestic capital markets, venture capital (VC), and private equity (PE) ○ Accelerate adoption of innovative sustainable finance instruments e.g. sustainability-linked/green/SDG financing, bonds and sukuk, blended finance structures ○ Develop capacity building programme to upskill FIs and fund managers in collaborations with Joint Committee on Climate Change (JC3) and financial industry training institutes ○ Scale-up sustainable finance literacy, awareness programmes and technical capacity building targeting SMEs by JC3 including through pilot programmes such as Greening the Value Chain ○ Expedite VC investments in high-risk, early-stage energy ventures in suitable areas	MITI BNM SC
EN3	**Roll out carbon pricing mechanism** ○ Implement a phased and meticulously calibrated carbon pricing mechanism that sends clear market signals on decarbonisation while simultaneously creating an additional capital pool for investments in energy transition ○ Roll out communication strategy to seek buy-in from the businesses and rakyat	MOF NRECC

Policy and Regulations

Overview

The DTN plays pivotal role as the foundational compass and principal policy reference for the energy sector, while NETR operationalises DTN for an accelerated energy transition. Strengthening the governance and regulatory framework will ensure continued growth and enhanced innovation along with the evolving competition and market dynamics.

Challenges

The energy transition is confronted with a set of intricate policy and regulatory challenges. Economic distortions arising from energy subsidies can hinder the adoption of sustainable energy practices and technologies. Balancing energy equity for low-income households poses another complex issue, requiring policies that ensure access to clean energy without exacerbating financial burdens. Moreover, addressing the increasing demand for natural gas while striving for reduced reliance on fossil fuels necessitates carefully developed regulations that steer the energy landscape towards a sustainable future.

Key Initiatives

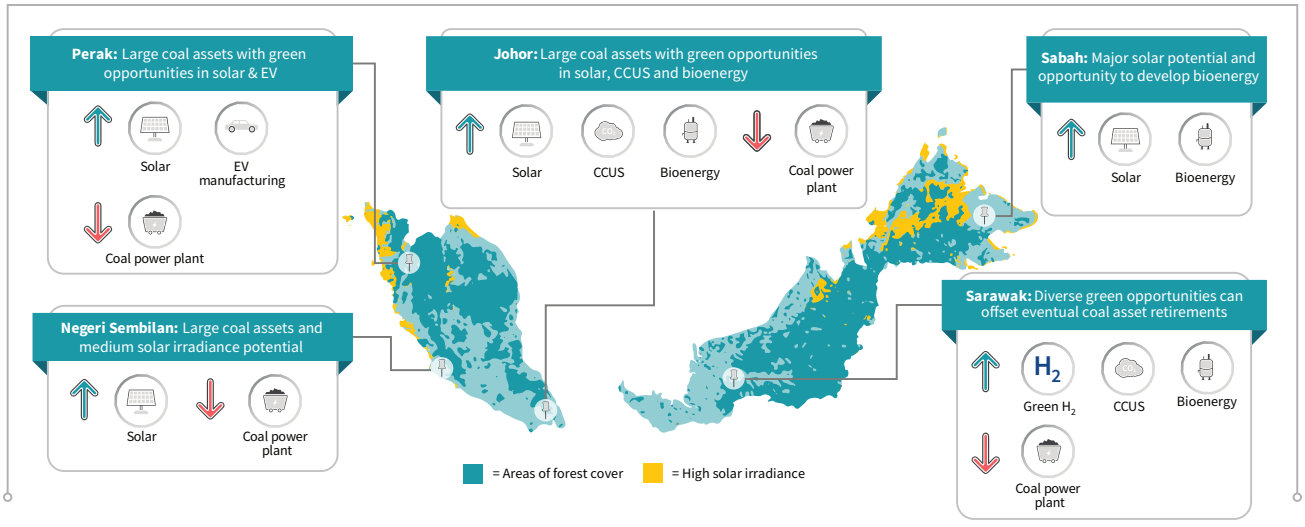
Enabler: Policy and Regulation		
Code	**Initiatives**	**Champions**
EN4	**Rationalise energy subsidies** ○ Develop a targeted subsidy mechanism based on needs ○ Ensure transparency and effective communication on subsidy removal ○ Leverage Pangkalan Data Utama (PADU) to facilitate targeted subsidies	MOF Ministry of Economy KPDN NRECC
EN5	**Launch the Natural Gas Roadmap (NGR)** ○ Optimise country value-add of indigenous natural gas resources ○ Enhance competitiveness of upstream oil and gas to meet domestic demand and energy transition needs (sustainability and security) ○ Plan and execute timely, and cost-effective build-out of gas infrastructure	Ministry of Economy

Human Capital and Just Transition

Overview

The growth of capacity and competencies is crucial in augmenting the energy sector's workforce. The ability of the workforce to adapt will also play a key role in ensuring employment growth and a just energy transition. In terms of socioeconomic ramifications, a localised and focused approach is needed to address energy transition challenges at a national and state level, as shown in Exhibit 7.4. This underscores the necessity for coordinated efforts within each state to effectively address and leverage green economic prospects and challenges.

Exhibit 7.4: Illustrative view of green economic opportunities and challenges at a state level

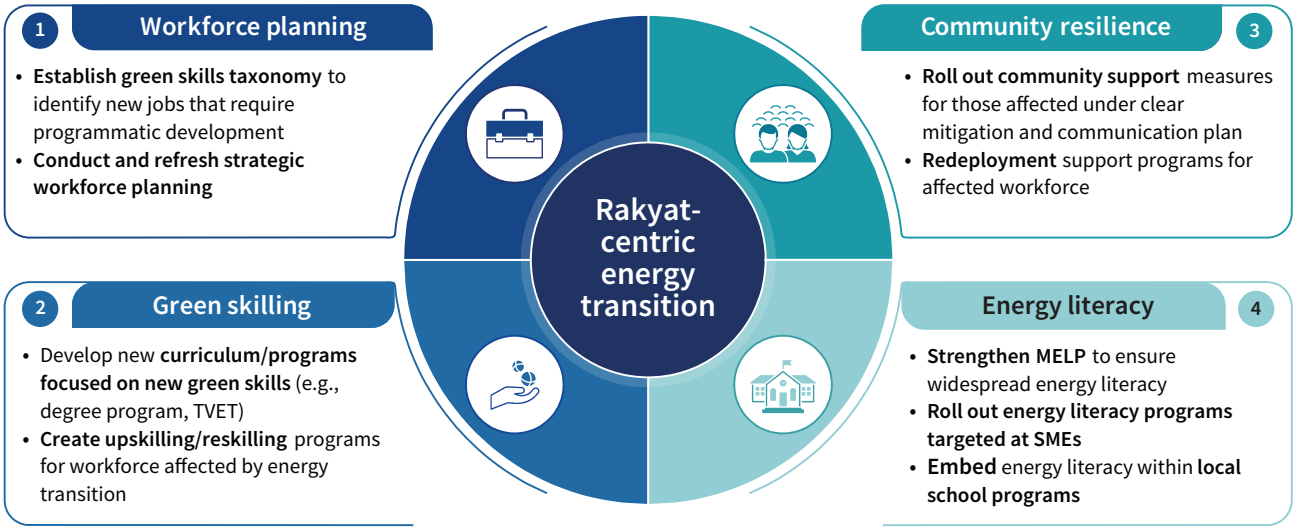


Challenges

Navigating the human capital aspects of the energy transition presents multifaceted challenges. The diminishing job opportunities in GHG-intensive sectors like oil and gas, ICE vehicle manufacturing and fossil fuel-based power generation necessitate strategies to transition workers to new employment opportunities. Bridging the gap between existing workforce skill sets and the emerging demand for green skills, such as in hydrogen and CCUS, requires targeted training and upskilling initiatives. Moreover, addressing low energy literacy levels is vital to ensure informed decision-making and active participation in the transition to a more sustainable energy landscape. An equitable and just energy transition must address these challenges to create a workforce prepared for the future while upholding social inclusivity.

Key Initiatives

Enabler: Human Capital and Just Transition		
Code	**Initiatives**	**Champions**
EN6	**Establish green skills taxonomy and ensure strategic workforce planning** ○ Develop green skills taxonomy that defines the essential skills needed for a just transition towards a sustainable workforce ○ Facilitate a strategic alignment between workforce demand and supply based on the green skills taxonomy and competency standards of present and future industry requirements ○ Establish a task force to develop strategic plans for the future of the energy sector's workforce	Sector-specific agencies
EN7	**Develop and roll out targeted green skilling programmes** ○ Implement reskill and upskill programmes for affected workforce ○ Establish strategic partnerships with local universities and industry partners to enhance green skills ○ Enhance TVET and tertiary programmes for new green sectors	Sector-specific agencies
EN8	**Develop and implement community support programmes** ○ Develop a clear mitigation and communication plan for affected community and region ○ Implement targeted community support programmes	Sector-specific agencies
EN9	**Enhance energy literacy and energy efficiency awareness among students, SMEs and consumers** ○ Strengthen the Malaysia Energy Literacy Program (MELP) to catalyse a significant change in public perception and behaviour towards energy utilisation ○ Encourage SMEs to incorporate EE practices in their business ○ Implement energy literacy and awareness programmes at educational institutions	Sector-specific agencies TNB



Summary of key initiatives for human capital and just transition

Technology and Infrastructure

Overview

Technology is a key determinant of success in unlocking new economic opportunities across the nation's energy transition journey. It is crucial to facilitate conditions to foster innovation and new technology applications to create technological advantages across the energy sector. In addition, the scaling up of major energy infrastructure investments will be required to safeguard energy security, improve energy access and enhance environmental sustainability. Support will also be needed to encourage innovation especially for technologies at early stages of the maturity curve, but with high potential benefits and scalability.

Challenges

The energy transition encounters significant technological and infrastructure challenges. The slow gradual uptake of sustainable practices within domestic industries impedes the swift transition to cleaner energy sources. The absence of a robust energy knowledge platform tailored for SMEs and businesses hinders the dissemination of effective energy transition strategies. Addressing these hurdles is essential to accelerate the integration of sustainable technologies and the establishment of supportive infrastructure, fostering a more efficient and effective transition towards a greener energy landscape.

Key Initiatives

Enabler: Technology and Infrastructure		
Code	**Initiatives**	**Champions**
EN10	**Accelerate development of domestic industries for green manufacturing and adoption of green technologies** ○ Develop programmes tailored to support SME involvement in the green value chain in the form of technical expertise and financial support	MITI
EN11	**Develop a National Energy Knowledge Hub for public access** ○ Establish a one-stop centre for energy transition data, information and programmes under the purview of MTN	Ministry of Economy

Governance and Implementation

Energy sector governance and planning represent a complex and multi-faceted undertaking due to the wide scope and cross-sectoral nature of energy related decision-making. The energy sector is governed by ministries, agencies and regulators based on responsibilities defined in respective legislations. Energy demand planning intersects across key sectors, namely transport, industrial, residential and commercial. Meanwhile, cross-sector collaboration with relevant stakeholders is needed for energy supply planning covering multiple energy sources such as oil, natural gas, coal and RE.

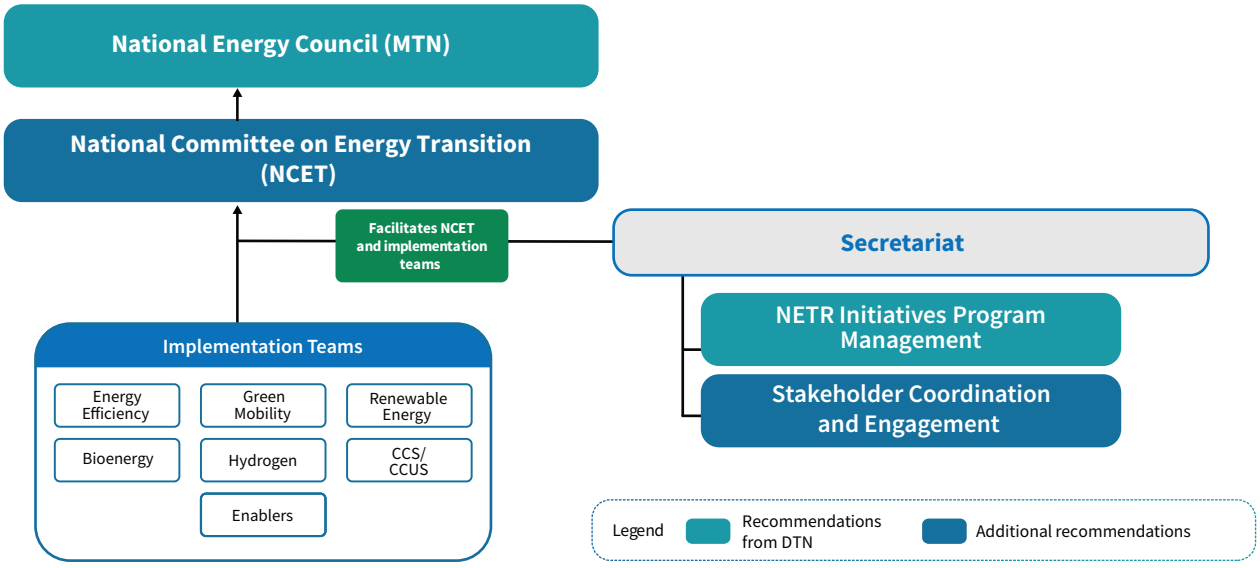
Challenges

The intricate nature of energy-related concerns and the fragmented governance of energy matters pose significant challenges during energy transition. Currently, the energy sector is governed by various ministries with different sectoral policies and priorities. This has led to inefficient energy planning and decision making.

Key Initiatives

Enabler: Technology and Infrastructure		
Code	**Initiatives**	**Champions**
EN12	**Establish National Committee on Energy Transition under the National Energy Council** ○ Introduce the National Committee on Energy Transition (NCET) spearheaded by the Minister of Economy to monitor the implementation of NETR projects	Ministry of Economy

Exhibit 7.5: National Committee on Energy Transition under the National Energy Council



Section 8: Conclusion

The NETR is critical for Malaysia to navigate the complexity of energy transition on a large scale, especially the shift from a traditional fossil fuel-based economy to a high-value green economy. It will also reinforce the country's commitment as a responsible stakeholder aiming to achieve its net-zero GHG aspirations as early as 2050, despite contributing 0.8% to global GHG emissions.

Future energy pathways will be nationally determined and based on the country's unique circumstances and priorities. Over the next three decades, Responsible Transition pathway sets the direction to meet growing energy needs and reduce GHG emissions. Malaysia will focus on improving energy efficiency, enhancing RE and bioenergy, reducing GHG emissions, greening mobility, accelerating innovation to commercialise hydrogen and CCUS technologies as well as strengthening energy infrastructure. These actions will be accompanied by strategies to unlock capital flows in support of the energy transition with energy security as the cornerstone.

NETR will set the agenda and signal to the market the intended direction of the government in exploring new energy sources, developing future capabilities and shaping market demand in green economy. This further supports Malaysia's commitment to a just energy transition that benefits the rakyat, creates business opportunities and supports technological innovation through a coordinated whole-of-nation approach.

Ministry of Economy
PUTRAJAYA

August 2023

Abbreviations

	Definition
ASF	Advanced sustainable fuel
ATJ	Alcohol to Jet
AC	Alternating current
AP	Approved Permit
APAEC	ASEAN Plan of Action for Energy Cooperation
APG	ASEAN Power Grid
AZEC	Asia Zero Emission Community
ADB	Asian Development Bank
IF-CAP	Infrastructure Financing and Capital Market Products for Asia-Pacific
ASEAN	Association of Southeast Asian Nations
BNM	Bank Negara Malaysia
BEV	Battery electric vehicles
BESS	Battery energy storage system
B40	Bottom 40% income group
BEI	Building energy intensity
BAU	Business as usual
CV	Calorific value
CAPEX	Capital expenditure
CBAM	Carbon Border Adjustment Mechanism
CCS	Carbon capture and storage
CCU	Carbon capture and utilisation
CCUS	Carbon capture, utilisation and storage
CO_2	Carbon dioxide
CORSIA	Carbon Offsetting and Reduction Scheme for International Aviation
CIR	Chemical Industry Roadmap
CCPT	Climate Change and Principle-based Taxonomy
CCGT	Combined cycle gas turbine
CAGR	Compound annual growth rate
CGPP	Corporate Green Power Programme
DFIs	Development finance institutions
DC	Direct current
USD/GJ	Dollar per gigajoule produced

	Definition
ECRL	East Coast Rail Link
E4W	Electric four-wheelers
E2W	Electric two-wheelers
EV	Electric vehicles
xEV	Electrified vehicles, including hybrids
EFB	Empty fruit bunch
ST	Energy Commission
ECOS	Energy Commission of Sabah
EE	Energy efficiency
EECA	Energy Efficiency and Conservation Act
EEV	Energy efficient vehicle
EMRE	Energy Management and Renewable Energy
EPC	Energy Performance Certificate
ESCOs	Energy service companies
ESS	Energy storage system
EU	European Union
FiT	Feed-in-tariff
FIs	Financial institutions
FDI	Foreign direct investments
4W	Four-wheel vehicle
FTE	Full-Time Equivalent
GFT	Gasification Fischer-Tropsch
$GgCO_2eq$	Gigagram of CO_2 equivalent
Gt	Gigatonnes
GW	Gigawatt
GLICs	Government-linked investment companies
GHG	Greenhouse gas
GDP	Gross domestic product
HDT	Heavy-duty trucks
HHI	Herfindahl-Hirschman index
HSFO	High sulphur fuel oil
HOAs	Home-owner associations
HR	Human resources
HHFS	Hybrid Hydro-Floating Solar PV

Abbreviations

	Definition
H_2	Hydrogen
HETR	Hydrogen Economy and Technology Roadmap
HEFA	Hydroprocessed esters and fatty acids
HVO	Hydrotreated vegetable oil
ILUC	Indirect land use change
IPPU	Industrial processes and product use
IRA	Inflation Reduction Act
ICE	Internal combustion engine
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
IMO	International Maritime Organization
ISCC	International Sustainability and Carbon Certification
JC3	Joint Committee on Climate Change
ktoe	Kilotonnes of oil equivalent
kW	Kilowatt
LULUCF	Land-use, land-use change and forestry
LTMS-PIP	Lao PDR-Thailand-Malaysia-Singapore Power Integration Project
LSS	Large-scale solar
LCOH	Levelised cost of hydrogen
LCV	Light commercial vehicles
LNG	Liquefied natural gas
LGe/100km	Litres of gasoline equivalent per 100 kilometres
LTAG	Long-term Global Aspirational Goal
LCMB	Low Carbon Mobility Blueprint
LCNA 2040	Low Carbon Nation Aspiration 2040
LSFO	Low sulphur fuel oil
MESI	Malaysia Electricity Supply Industry
MELP	Malaysia Energy Literacy Program
METO	Malaysia Energy Transition Outlook
MyRER	Malaysia Renewable Energy Roadmap
BUR4	Malaysia's 4th Biennial Update Report Under the United Nations Framework Convention On Climate Change

	Definition
MGTC	Malaysian Green Technology And Climate Change Corporation
MGO	Marine gas oil
MRV	Measurement, reporting, and verification
MDT	Medium-duty trucks
$MtCO_2eq$	Megatonne of CO_2 equivalent
MW	Megawatt
Mtoe	Million tonnes of oil equivalent
MTPA	Million tonnes per annum
MEPS	Minimum Energy Performance Standards
MEESty	Minister of Energy and Environmental Sustainability Sarawak
KPDN	Ministry of Domestic Trade and Cost of Living
NRECC	Ministry of National Resources, Environment and Climate Change
MOF	Ministry of Finance
MITI	Ministry of Investment, Trade and Industry
KPKT	Ministry of Local Government Development
KPK	Ministry of Plantation and Commodities
MOSTI	Ministry of Science, Technology and Innovation
MOT	Ministry of Transport
KKR	Ministry of Works
MDBs	Multilateral development banks
MSW	Municipal solid waste
NCET	National Committee on Energy Transition
MTN	National Energy Council
NEEAP	National Energy Efficiency Action Plan
DTN	National Energy Policy 2022-2040
NETF	National Energy Transition Facility
NETR	National Energy Transition Roadmap
NGR	National Gas Roadmap
NTP	National Transport Policy
NDC	Nationally Determined Contribution
NOVA	Net Offset Virtual Aggregation

Abbreviations

	Definition
NEB	New England Biolabs
NIMP	New Industrial Master Plan
OEMs	Original equipment manufacturers
POME	Palm oil mill effluent
POGO	Palm oil vs low-sulphur gasoil
PADU	Pangkalan Data Utama
PNB	Permodalan Nasional Berhad
PPAs	Power purchase agreements
PE	Private equity
PLUS Berhad	Projek Lebuhraya Utara Selatan Berhad
JKR	Public Works Department
RE	Renewable energy
R&D	Research and development
RT	Responsible Transition
RM	Ringgit Malaysia
LT-LEDS	Roadmap Long-Term Low Emissions Development Strategies
SESB	Sabah Electricity Sdn. Bhd.
SEB	Sarawak Energy Berhad
SC	Securities Commission
SEDC	Sarawak Economic Development Corporation Energy
SMEs	Small And Medium Enterprises
PV	Solar photovoltaic
SWFs	Sovereign wealth funds
ST	Suruhanjaya Tenaga/Energy Commission
SRI	Sustainable and responsible investment
SAF	Sustainable aviation fuel
SDGs	Sustainable Development Goals
SEDA	Sustainable Energy Development Authority
TVET	Technical and vocational education and training
TNB	Tenaga Nasional Berhad
IATA	The International Air Transport Association
Twelfth Plan	The Twelfth Malaysia Plan, 2021-2025
TPA	Third Party Access

	Definition
TCO	Total cost of ownership
TPES	Total Primary Energy Supply
2W	Two-wheelers
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
UNGA	United Nations General Assembly
UTM	Universiti Teknologi Malaysia
UTP	Universiti Teknologi PETRONAS
UNITEN	Universiti Tenaga Nasional
UCO	Used cooking oil
VC	Venture capital
WtE	Waste-to-energy
WWF	World Wildlife Fund

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