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SOCIO-ECONOMIC IMPACTS OF THE ENERGY TRANSITION

MALAYSIA

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ABBREVIATIONS

ACE	ASEAN Centre for Energy
1.5-S	1.5°C Scenario
ASEAN	Association of Southeast Asian Nations
CO_2	carbon dioxide
DTN	National Energy Policy, 2022–2040
EJ	exajoule
ETWI	Energy Transition Welfare Index
EV	electric vehicle
FiT	feed-in-tariff
GDP	gross domestic product
GHG	greenhouse gas
GVA	gross value added
GW	gigawatt
ktoe	kilotonne of oil equivalent
MIDA	Malaysian Investment Development Authority
$MtCO_2eq$	million tonnes of carbon dioxide equivalent
MW	megawatt
MYR	Malaysian ringgit
NDC	Nationally Determined Contribution
ND-GAIN Index	Notre Dame Global Adaptation Initiative Index
NETR	National Energy Transition Roadmap
OECD	Organisation for Economic Co-operation and Development
PES	Planned Energy Scenario
PV	photovoltaic
TFEC	total final energy consumption
TJ	terajoules
USD	United States dollar

Unless otherwise stated, the exchange rate used throughout the document is USD 1 = MYR 4.42 based on the UN exchange rate (UN Treasury, n.d.) as of 15 April, 2025.

EXECUTIVE SUMMARY

Over the past few decades, Malaysia has sustained strong economic growth, with average annual gross domestic product (GDP) growth exceeding 4%. The country's performance has been underpinned by robust policies and targeted structural reforms, and its growth prospects are good, supported by rising domestic demand, the emergence of high-tech industries and the post-pandemic recovery of global markets. Such dynamics place Malaysia on a sustained growth path for at least the next several years.

The increasing challenges from climate change, however, are likely to impede economic development, exacerbate social inequalities and strain environmental sustainability. Being one of the world's most ecologically diverse countries, Malaysia is sensitive to all forms of hazards including floods, landslides and droughts. Low-income households are among the most adversely affected by such events. They are often more exposed and located closer to extreme weather conditions, have limited access to public services and lower resources to cope with the consequences. Tackling these challenges calls for a comprehensive set of mitigation and adaptation measures that will strengthen community resilience and enhance risk-sharing mechanisms.

The energy sector is the largest greenhouse gas emitter in the country, so transforming it is critical for reducing emissions. Economic growth, clean energy and social well-being are strongly intertwined that accelerating the energy transition must be at the centre of Malaysia's long-term climate strategy. Protecting the environment and fostering sustainable economic development cannot be achieve without a low-carbon, climate-resilient energy system that benefits everyone.

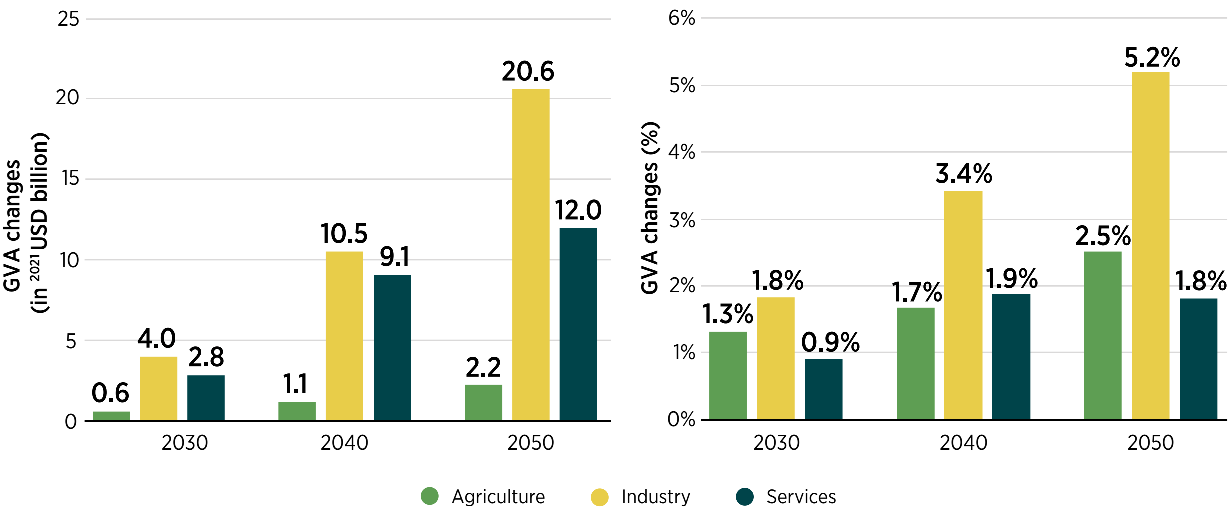
Malaysia has adopted several policies and initiatives to advance the energy transition. In the latest submission of its Nationally Determined Contribution, in 2021, it committed to an unconditional 45% reduction in greenhouse gas emission intensity (measured as carbon dioxide per unit of GDP) by 2030, relative to 2005 levels. The country has also announced a national target of net-zero emissions by as early as 2050, as reflected in its National Energy Policy, and is preparing a Long-Term Low Emission Development Strategy.

The *Ekonomi Madani* (2023) framework anchors several of Malaysia's policies, such as the National Energy Transition Roadmap, the New Industrial Master Plan 2030 and the 13th Malaysia Plan (2026-2030). The country has also introduced several mechanisms to support the energy transition; for example, the Net Energy Metering scheme, feed-in tariffs, Solar for Self-consumption (SelCo), the Low Carbon Energy Generation Programme and large-scale solar programmes. These policies are designed to promote economic growth that is inclusive and equitable, by sustaining GDP growth while accelerating the transition to a renewable energy-based system.

The report assesses the socio-economic impacts of Malaysia's energy transition to support the alignment of its energy transition with sound sectoral policies. The macro econometric model used in this study is a single quantitative framework which combines Malaysia's economy and its energy sector. The analysis measures the impacts of energy transition pathways on GDP, employment and social welfare, and provides insights into the design of policies to support a just and inclusive transition. Under IRENA's Planned Energy Scenario (PES), Malaysia's economy is expected to grow with compound annual growth rates of 3.5% per year over 2024-2030, while from over 2031-2040 and during 2041-2050, it would record around 4.1% and 2.9% respectively.

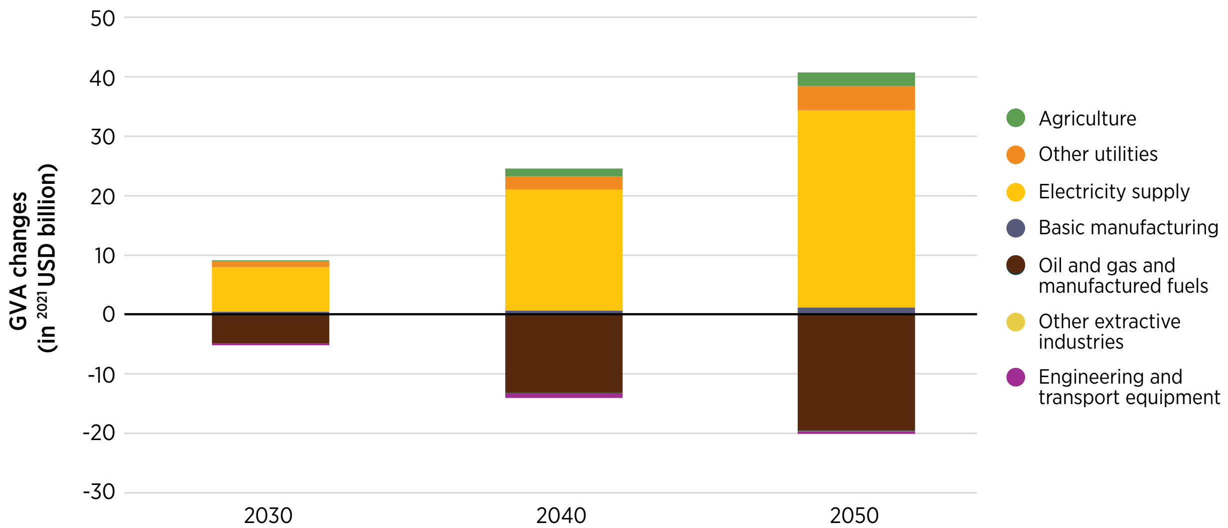
Under the 1.5°C Scenario, Malaysia's GDP will increase by an additional 2.4% compared with the PES over the 2024-2050 period. This shows there are significant economic gains to be expected from the energy transition. The industrial sector exhibits substantial growth of gross value added (GVA) when compared with the PES. The industry GVA expands by 1.8% by 2030, 3.4% by 2040 and 5.2% by 2050 (Figures S1 and S2), all due to the clean energy transition. Electricity supply contributes an additional USD 35 billion by 2050 under the 1.5°C Scenario. Investments in energy efficiency and renewables, along with increased export values and improved trade performance, fuel the positive performance of the engineering and construction sectors, leading to higher growth than projected under the PES. The services sector also shows more growth, relative to the PES, at 0.9% by 2030, 1.9% by 2040 and 1.8% by 2050.

Figure S1 Changes in gross value added between the 1.5˚C Scenario and the PES, by sector, in USD billions (left) and in % (right), 2030-2050



Notes: GVA = gross value added; USD = US dollar.

Figure S2 Changes in gross value added in industrial sectors, 2030-2050 (in USD billions)

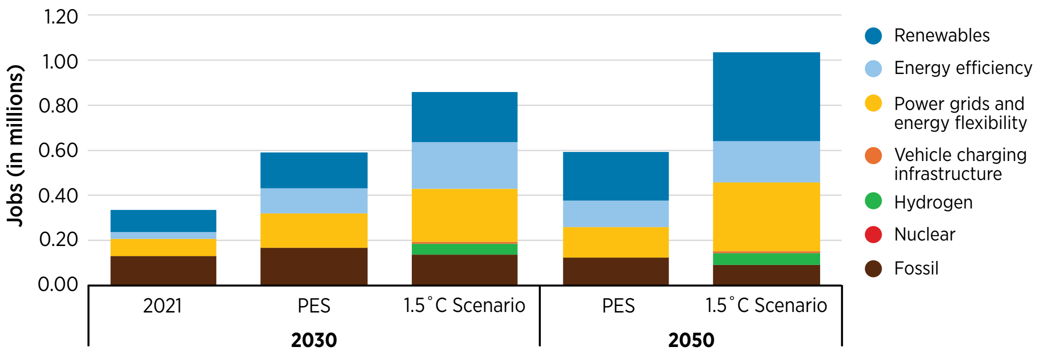


Notes: GVA = gross value added; USD = US dollar.

Under the 1.5°C Scenario, employment is on average 1.4% higher than under the PES over 2024-2050. Sectors including electricity supply, basic manufacturing, public services and business services are expected to exhibit varying degrees of job growth. Malaysia's labour market has demonstrated resilient development over the years. The unemployment rate has been low, productivity has been increasing, and labour market conditions have improved. Advancing the energy transition opens the possibility for Malaysia to address some of its structural challenges (*e.g.* youth unemployment, skill mismatch and brain drain), by creating more and higher-paying, skill-intensive jobs in the domestic labour market.

In the energy sector, the number of jobs is expected to reach over 1.0 million under the 1.5°C Scenario. This is nearly double the figure (0.6 million) projected under the PES. By 2050, under the 1.5°C Scenario, over 35% of energy sector jobs (over 390 000 jobs) rely on renewables, while the share of fossil sectors falls to 9% (Figure S3). Job growth between 2030 and 2050 is mainly driven by the renewables sector and related technologies, such as power grids, energy flexibility and energy efficiency. This job growth compensates for job loss in fossil fuels.

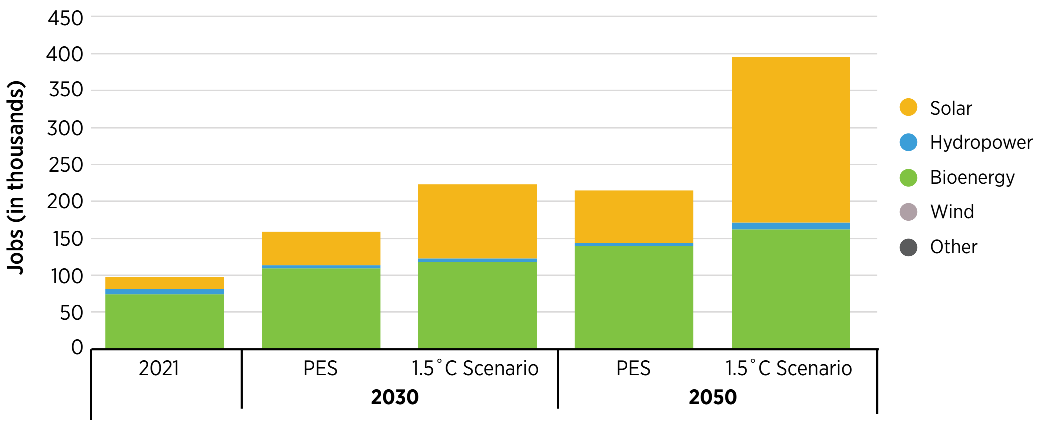
Figure S3 Overview of energy sector jobs in Malaysia under the 1.5°C Scenario and PES, by sector, 2021-2050 (in millions)



Notes: PES = Planned Energy Scenario.

The growth in renewable energy jobs is more pronounced under the 1.5°C Scenario. An estimated 400 000 jobs are created in 2050. Solar (*i.e.* photovoltaic) and bioenergy dominate the renewable energy job market, at roughly 224 000 solar (*i.e.* photovoltaic) jobs and roughly 160 000 bioenergy jobs in 2050. Hydropower, which will have grown 35% relative to 2021, is expected to contribute almost 10 000 jobs in 2050. There is a difference of more than 180 000 jobs between the PES and the 1.5°C Scenario in 2050 (Figure S4).

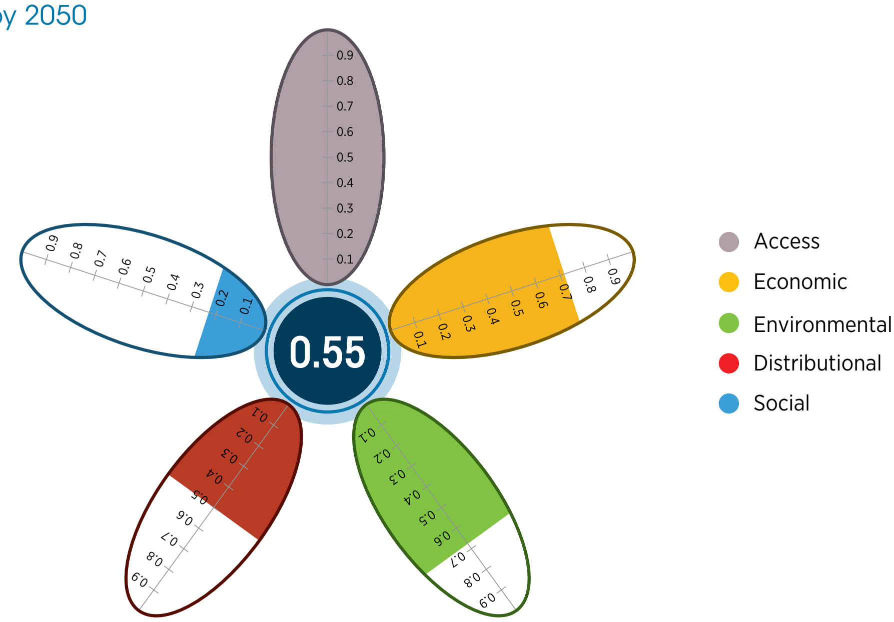
Figure S4 Renewable energy jobs in Malaysia under the PES and 1.5°C Scenario, 2021-2050 (in thousands)



Notes: Other = tidal/marine and geothermal; PES = Planned Energy Scenario.

By 2050, Malaysia's score on the IRENA Energy Transition Welfare Index (ETWI) is projected to reach 0.55 under the 1.5°C Scenario (Figure S5) – an improvement from the score of 0.29 under the PES. The welfare improvement is mostly driven by remarkable progress in the environmental and economic dimensions of the ETWI. Detailed results from the ETWI clearly indicate which dimensions require policy intervention and which areas show promise. The analysis points to the benefits of expanding energy access through rural electrification and renewable energy deployment and also stimulating economic performance through increasing domestic consumption and investment by 2050.

Figure S5 IRENA's Welfare Index and dimensional welfare indices for the 1.5°C Scenario by 2050



Notes: The five petals represent the absolute values of the five dimensions of the Welfare Index, on a scale from 0 (low performance) to 1 (high performance). The number in the centre represents the absolute value of the overall Welfare Index, also on a scale of 0 to 1.

Targeted energy policies could further improve socio-economic outcomes in Malaysia, especially in the social and distributional dimensions. Climate-related policy instruments that reduce distributional inequality, combined with the integration of social investments in climate strategies, might yield larger welfare gains for Malaysia in the future.

Holistic policies to drive the energy transition offer a viable pathway for Malaysia to achieve its economic, environmental and social objectives. Inclusive approaches are as well necessary for the equitable distribution between regions and social groups. Given persistent structural inequalities and gaps in social protection, Malaysia is well-placed to benefit from the opportunities created by the energy transition along the support of the international community, to promote more equitable and resilient development.

CHAPTER 1
INTRODUCTION

Malaysia's economy has demonstrated resilience and a strong recovery following the COVID-19 pandemic, supported by robust macroeconomic policies and targeted reforms (IMF, 2025). Inflationary pressure eased, and expected inflation fell to 1.8% in 2024 from 2.5% in 2023 (Malaysia MoE, 2025a). The phaseout of fuel subsidies and tightened monetary policies helped stabilise prices. Strong domestic demand and a rebound in exports and investments were projected to accelerate economic growth in Malaysia to 4.9% in 2024 and 4.7% in 2025 (OECD, 2024). Further, structural reforms and investments targeted inclusive growth, social protection and environmental sustainability. With strong policies, improving fiscal discipline and a commitment to inclusive development, Malaysia is well positioned to maintain its socio-economic momentum (OECD, 2024).

In the coming years, as Malaysia aims to transition from an upper-middle-income country to a high-income country, the government has to implement structural reforms to reinforce economic growth while balancing a number of external challenges. Key concerns include rising global geopolitical tensions, which have contributed to an economic slowdown in China, its largest trading partner and provider of renewable energy financing; and pressing domestic concerns, including high rates of inequality and inadequate structural changes needed to boost productivity.

The key threat nonetheless remains climate change. Malaysia is a tropical country in Southeast Asia with a diverse topography and a coastline of more than 4 800 kilometres; over 50% of its land is under forest cover. It is among the most ecologically diverse countries in the world. Being a tropical and coastal country, Malaysia has high exposure to the risks of climate change and natural hazards, such as floods, landslides and drought, among others (ADB, 2021).

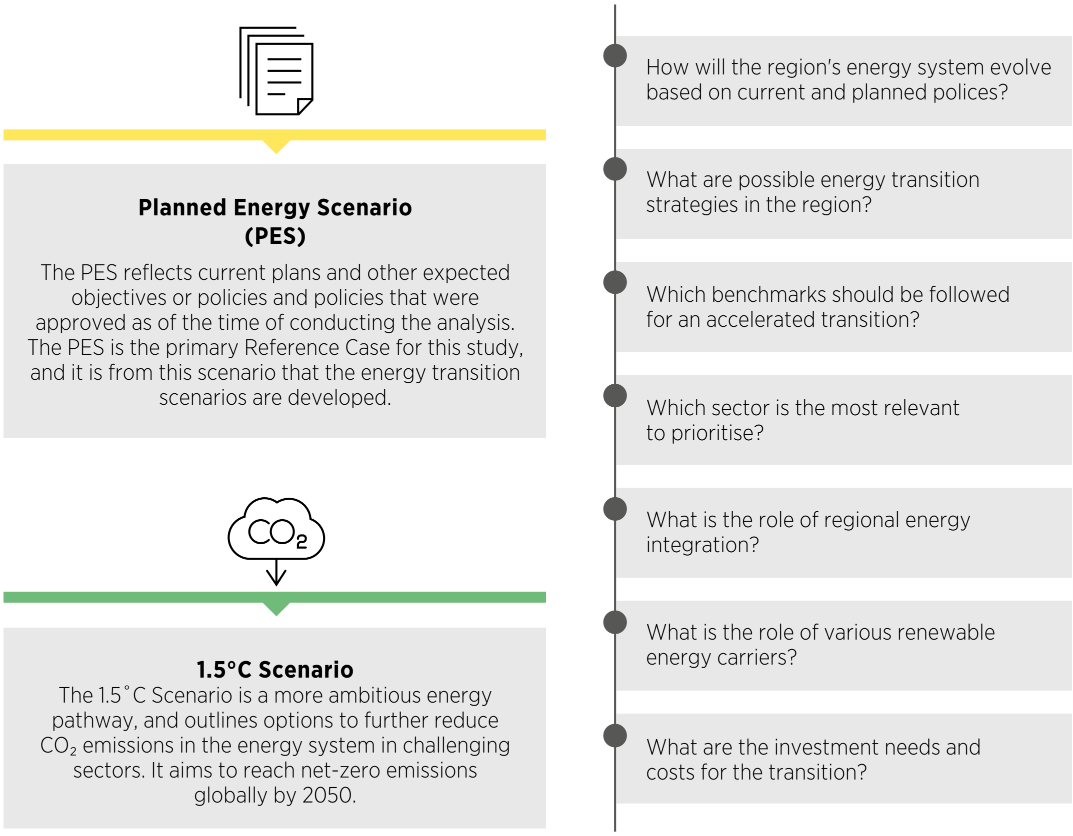
Malaysia has recognised the immediate and future risks and implemented multiple robust policies in response. *Ekonomi Madani* (2023) anchors several of Malaysia's policies, such as the National Energy Transition Roadmap (NETR), the New Industrial Master Plan 2030 and the 13th Malaysia Plan (Malaysia MITI, 2023; Malaysia MoE, 2021, 2023a, 2025b). These policies aim to sustain gross domestic product (GDP) growth while bolstering societal development and grappling with environmental challenges, thus fostering inclusive and equitable economic growth in Malaysia.

Malaysia's latest submission of its Nationally Determined Contribution (NDC), in 2021, commits the country to an unconditional 45% reduction in greenhouse gas (GHG) emission intensity (measured in terms of carbon dioxide [CO_2] per unit of GDP) by 2030, relative to 2005 levels. To further demonstrate its commitment to low-carbon development, Malaysia submitted its First Biennial Transparency Report to the United Nations Framework Convention on Climate Change in 2024 (Malaysia MoNRES, 2024). The report provides details on GHG emission reductions, mitigation measures, adaptation initiatives and the support needed and received covering the period 1990-2021. Malaysia has announced a national target of achieving net-zero emissions by as early as 2050, as reflected in its National Energy Policy, and is preparing its Long-Term Low Emission Development Strategy.

The energy sector accounted for 78.5% of the country's total emissions in 2019 (Malaysia MoE, 2025c). In the same year, energy-intensive industries contributed 28% of Malaysia's GDP, and energy exports constituted 13% of the overall export value (Malaysia MoE, 2023b).

Malaysia is advancing regional and international initiatives to accelerate its energy transition. In 2025, Malaysia's chairmanship of the Association of Southeast Asian Nations (ASEAN) presented an opportunity to promote regional power system integration through the ASEAN Power Grid and regional co-operation in renewable energy. ASEAN is actively developing the next version of the ASEAN Plan of Action for Energy Cooperation for 2026-2030, with targets upheld by the pillars of energy security, affordability, accessibility and sustainability (ACE, 2025).

Figure 1 A comparison of the Planned Energy Scenario (PES) and the 1.5°C Scenario



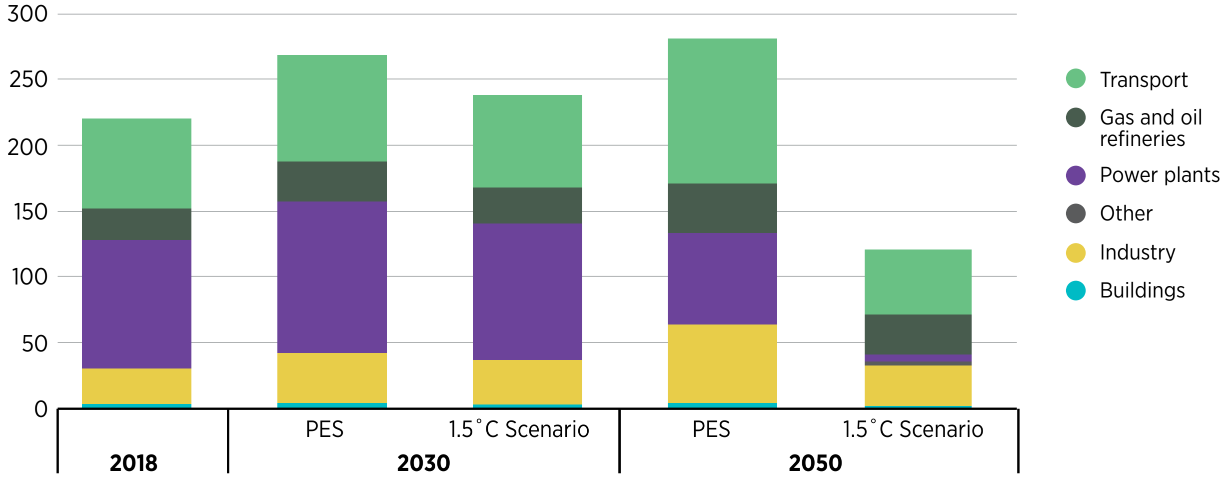
Source: (IRENA, 2023a).
Note: CO_2 = carbon dioxide.

As a key driver of socio-economic development as well as the country's largest emitter, the energy sector plays a dual role in advancing climate targets and supporting the national agenda for a greener economy. To support Malaysia in its energy transition, the International Renewable Energy Agency (IRENA) conducted an analysis that draws on its *Energy transition assessment* (formerly renewable readiness assessment), *Renewable energy roadmap* toolkit and *power system flexibility assessment* to chart possible energy pathways to 2050 (IRENA, 2023a). IRENA's *Malaysia energy transition outlook* (IRENA, 2023a) outlines a comprehensive, renewables-focused, long-term plan for a cleaner and more sustainable energy system. IRENA presents two pathways – the Planned Energy Scenario (PES) and the 1.5°C Scenario. Figure 1 provides explanations of both scenarios.

IRENA estimates that energy sector emissions were roughly 220 million tonnes of CO_2 equivalent ($MtCO_2eq$) in 2018. The power sector contributed the largest share (47%), followed by transport (33%). Under the PES, emissions are projected to increase to 280 $MtCO_2eq$ by 2050. While power sector emissions decline amid increased renewable electricity generation, especially from solar photovoltaic (PV), transport and industrial emissions continue to increase.

However, significant emission reductions can be expected after 2030 if the energy targets outlined under the 1.5°C Scenario are achieved and investments in end-use technologies are realised. Emissions can be reduced 58% by 2050 under the 1.5°C Scenario, relative to the PES (Figure 2). The most substantial reductions appear in the power sector. They result from the deployment of carbon capture and storage technology, solar PV and battery storage, which significantly reduce the use of power plants powered by fossil fuels. Additional efforts in CO_2 removal will be needed for Malaysia to reach its carbon neutrality target by 2050.

Figure 2 Energy emissions ($MtCO_2$), by sector, 2018-2050



Source: (IRENA 2023a).

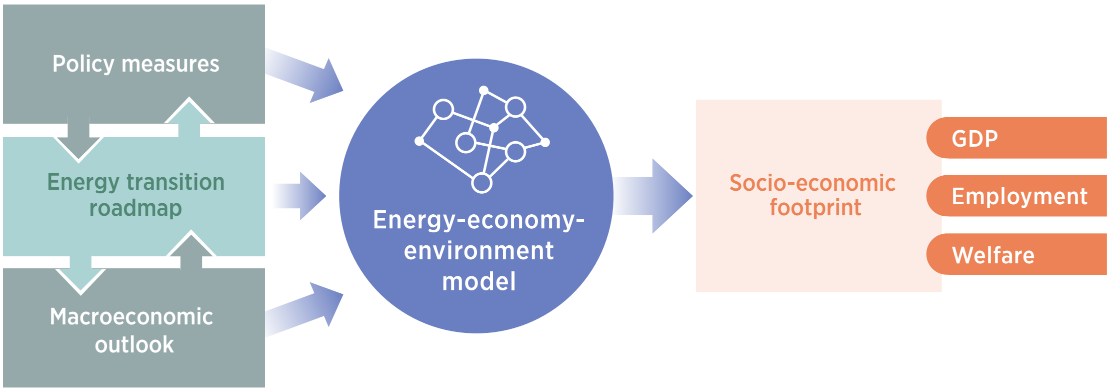
Notes: "Others" include energy emissions in the agriculture sector and fugitive energy emissions. $MtCO_2$ = million tonnes of carbon dioxide; PES = Planned Energy Scenario.

Such ambitions and targets would lead to a different technological supply and demand landscape, as detailed in Chapter 2, and would require additional effort. However, the energy transition is not simply a matter of technology – that is, switching to renewable energy sources; most importantly, it is about societal and institutional change, with far-reaching implications for any development trajectory. For policy makers, key questions include: how will different energy transition pathways shape Malaysia's socio-economic future, and which policy instruments will be most effective in supporting the nation's goals? This report evaluates the socio-economic consequences of transition pathways at different levels of ambition and informs decision making that aligns with the country's energy ambitions and broader development goals.

The socio-economic analysis is conducted using a macro econometric (E3ME) model,[1] which integrates the global energy system and national economies into a single quantitative framework (Figure 3). The model sheds light on the trade-offs between economic prosperity and employment, while examining welfare aspects, including the distributional implications of different policy choices. Policy makers need to be aware of how such decisions will affect people's well-being and overall welfare, and of the potential gaps and hurdles that could affect progress. This report aims to provide valuable insights and recommendations to Malaysian policy makers, ensuring that the country's transition to a low-carbon economy is both just and equitable, creating jobs while reducing inequalities.

[1] *The E3ME model (www.e3me.com) is used to assess socio-economic impacts. Energy mixes and related investments, based on the "World Energy Transitions Outlook 2023" (IRENA, 2023b), are used as exogenous inputs for each scenario, as well as climate- and transition-related policies.*

Figure 3 Socio-economic assessment framework



Note: GDP = gross domestic product.

This report discusses the socio-economic differences between the PES and the 1.5°C Scenario, using the same inputs and assumptions as the *Malaysia energy transition outlook* (IRENA, 2023a). Under the PES, Malaysia's economy is expected to register strong growth (Table 1). IRENA's analysis (using the E3ME model) measures the socio-economic footprint of various policy baskets in support of a just and inclusive transition (carbon pricing, international collaboration, subsidies, progressive fiscal regimes to address distributional aspects, investments in public infrastructure and spending on social initiatives). These policy baskets also include policies that encourage the deployment, integration and promotion of energy transition technologies.

Table 1 Population and GDP growth projections under the PES

VARIABLE (CAGR %)	2024-2030	2031-2040	2040-2050
GDP	3.5	4.1	2.9
Population	1.0	0.7	0.4

Notes: CAGR = compound annual growth rate; GDP = gross domestic product.

The report is structured as follows: Chapter 2 outlines trends in Malaysia's energy sector and related policies in the context of climate change and the energy transition. Chapter 3 delves into the findings of IRENA's macroeconomic analysis to consider the socio-economic impacts of different policies up to 2050. An assessment of how the energy transition might affect GDP, job creation and welfare is provided. Chapter 3 not only explores the socio-economic impacts of the energy transition but also highlights its connection to prevailing trends. Chapter 4 presents policy recommendations for a just and inclusive energy transition.

CHAPTER 2

THE ENERGY TRANSITION IN THE CONTEXT OF OVERALL SOCIO-ECONOMIC DEVELOPMENT

As is the case with most countries, Malaysia's economy is inextricably linked with the energy sector. Rich energy resources, including oil, natural gas and renewables, have been crucial in driving industrial growth, infrastructure development and overall economic resilience. This chapter will investigate some of the inter-linkages between the economy and energy sector, including cross-cutting policies and market trends. It will also highlight some of the challenges and opportunities for sustainable development in the country.

2.1 SYNERGIES BETWEEN THE ENERGY SECTOR, AND ECONOMIC AND INDUSTRIAL DEVELOPMENT

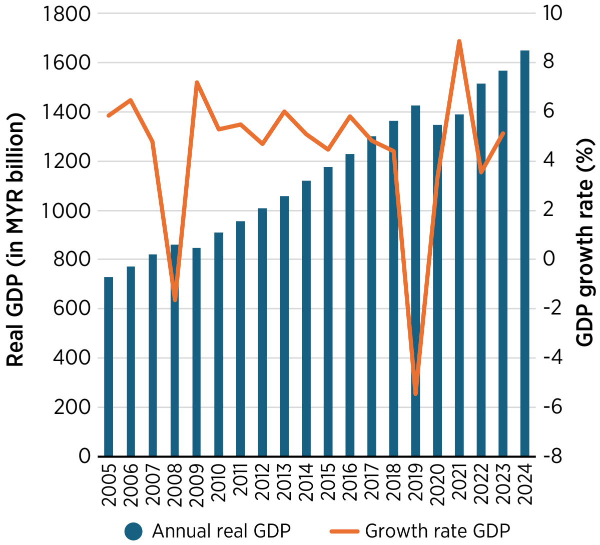
After years of sustained economic growth, Malaysia stands on the verge of becoming a high-income economy. In 2024, Malaysia's real GDP grew 5%, bringing total GDP to USD 372 billion (MYR 1645 billion). This growth rate was more than the 4.5% average seen among ASEAN nations, and was supported by resilient domestic demand, sustained export expansion and broad-based positive performance across all major economic sectors. It demonstrated Malaysia's robust economic momentum (Malaysia MoF, 2025).

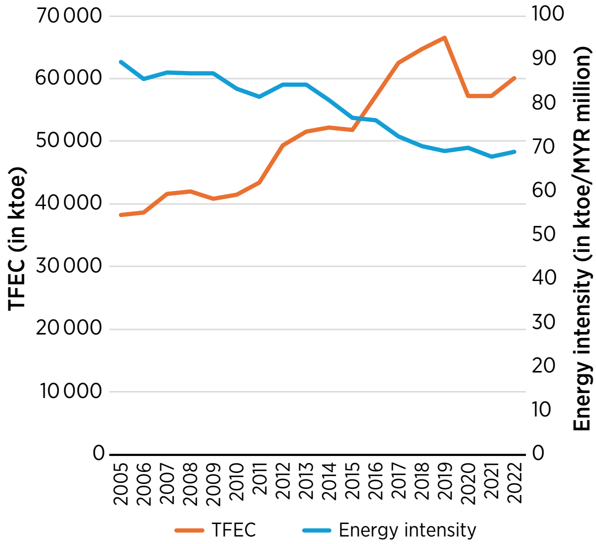
Malaysia's GDP is projected to reach USD 390 billion (MYR 1724 billion) in 2025. Annual GDP growth is expected to remain strong, at 4.5-5.5%, outperforming the ASEAN average (roughly 4.6%) (Malaysia MoF, 2025). Inflation remained moderate in Malaysia by the end of 2024, at around 2%, while labour market conditions were favourable, with the unemployment rate remaining low, at 3%. Private sector activity will dominate the forecasted 6% growth in domestic demand, reflecting strong consumer (and private investor) confidence (Malaysia MoF, 2025). This growth will contribute roughly five percentage points to overall GDP growth.

Malaysia's energy sector has been a key driver of the economy. Energy-intensive industries make a nearly 30% contribution to Malaysia's GDP and employ 25% of the total workforce, equivalent to four million people (Malaysia MoE DoSM, n.d.). The energy sector plays a critical role in not only powering industrial growth but also sustaining livelihoods, especially across manufacturing, construction and transport.

As Malaysia's economic activities remain closely tied to its energy sector, energy decoupling – an essential way to achieve economic growth while reducing energy-related environmental impacts – remains limited. As shown in Figure 4, Malaysia's total final energy consumption (TFEC) has increased in tandem with economic growth. Energy intensity fell to 69 kilotonnes of oil equivalent per million Malaysian ringgit in 2022, suggesting energy gains from production processes and energy used. Recent trends in TFEC and improvements in energy efficiency indicate that GDP is outpacing energy consumption, and Malaysia's economy is growing alongside improved energy productivity.

Figure 4 Real GDP (MYR billions) and its annual growth rate (%) (left) versus total final energy consumption (ktoe) and energy intensity (ktoe/MYR millions) (right)



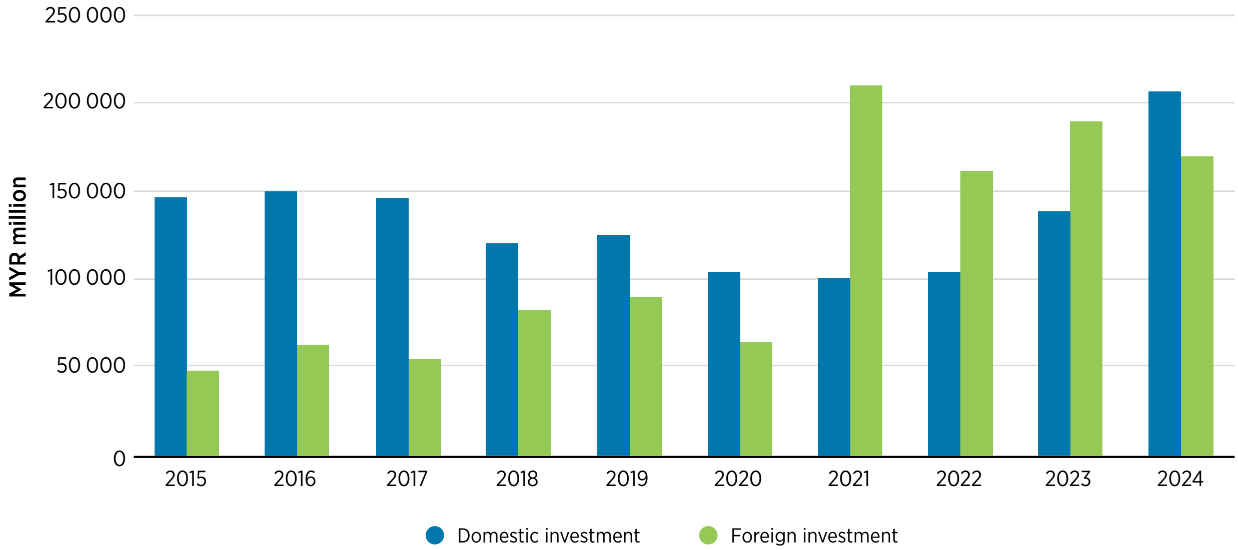


Source: (Malaysia MoE DoSM, n.d.; MyEnergyStats, n.d.).

Notes: Energy intensity refers to the ratio of total primary energy supply and GDP. GDP = gross domestic product; ktoe = kilotonne of oil equivalent; MYR = Malaysian ringgit; TFEC = total final energy consumption.

In 2024, Malaysia received USD 85.5 billion (*i.e.* MYR 378 billion) in total investment value; USD 47.1 billion (or MYR 208 billion) were domestic investments and USD 38.5 billion (or MYR 170 billion) were foreign direct investments. Total investment increased 14.9% from 2023 to 2024 (that is, by USD 74.4 billion or MYR 329 billion). Between 2015 and 2020, Malaysia's investment landscape was largely dominated by domestic investments. A significant shift occurred in 2021 when foreign direct investment began to outpace domestic contributions. By 2024, domestic investment again surpassed foreign direct investment, and a nearly 50% increase was observed in domestic investments over 2023[2] (Figure 5). In 2025, Malaysia was planning to achieve a 5% growth in investments.

Figure 5 Approved investment (MYR million) in the Malaysian economy, 2015-2024



Source: (MIDA, 2025).

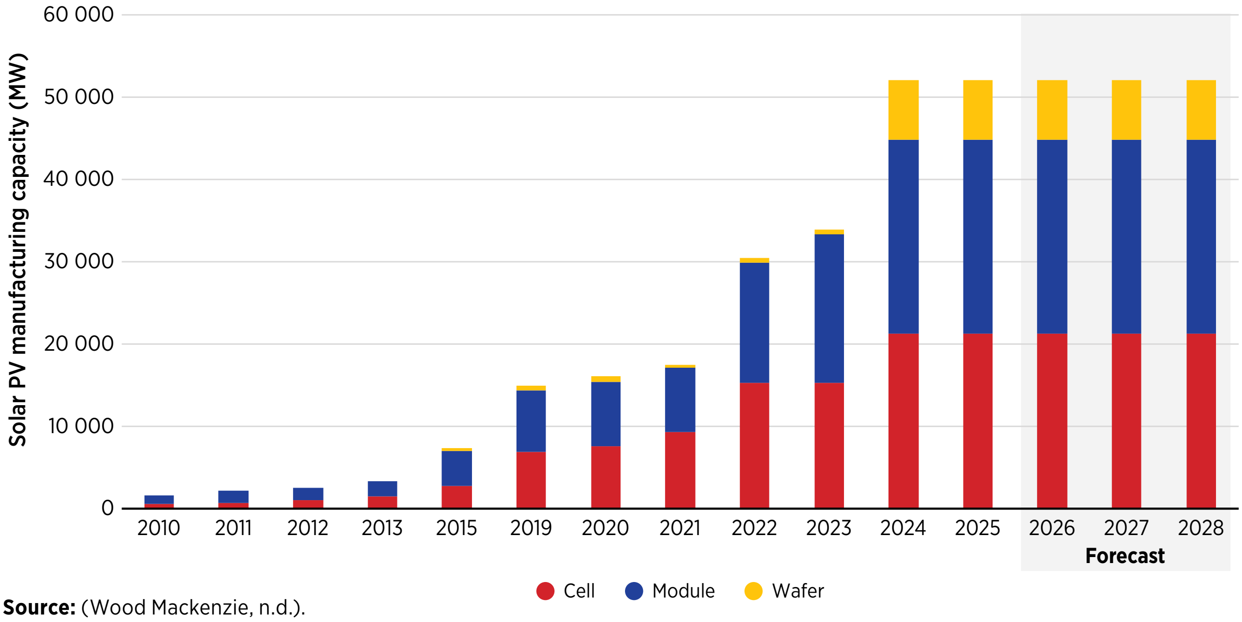
Note: MYR = Malaysian ringgit.

[2] *The surge in domestic investments and strong performance of foreign investment were driven by heightened investor interest in the digital sector.*

Overall green investment[3] reached USD 4.5 billion (MYR 20 billion) in 2024 across more than 900 projects. Green mobility alone accounted for USD 2.3 billion (*i.e.* MYR 10 billion), constituting 52% of the total. These investments were driven by advances in electric vehicles (EVs), and the use of sustainable fuels in aviation and marine transportation. The Ministry of Investment of Malaysia plans to reach its EV-related strategic investment target of USD 4.5 billion (MYR 20 billion) by 2025 and USD 9 billion (MYR 40 billion) by 2030. Renewable energy investments[4] in Malaysia doubled from USD 0.3 billion (MYR 1.4 billion) in 2023 to USD 0.7 billion (MYR 3 billion) in 2024, creating 692 additional job opportunities. Malaysia's energy strategies target a gradual reduction of the country's dependence on fossil fuels, while accelerating diversification of the national energy mix over the coming years and decades (MIDA, 2025).

Malaysia is also establishing itself as a major manufacturing hub for renewable energy, featuring an export-oriented base and deep linkages with foreign suppliers (primarily Chinese). The country had over 52 gigawatts (GW) of solar PV manufacturing capacity in 2024, spanning wafer production (7.2 GW), cell manufacturing (21.3 GW) and module assembly (23.6 GW) (Wood Mackenzie, n.d.). Notably, Malaysia is the only Southeast Asian country with significant silica reserves and reported upstream polysilicon production of 14.6 GW in 2024 (Wood Mackenzie, n.d.). Major manufacturers like First Solar, Jinko Solar, LONGi and Risen Energy operate vertically integrated facilities in the country. Malaysia also hosts battery cell production (EVE Energy), semiconductor manufacturing and hydrogen electrolyser production (Sarawak Energy) (SE4ALL, 2023). Malaysia's production of solar PV alone constitutes 4% of the global supply of renewable energy technologies, and the country ranks third in the world in solar cell and PV production (IEA, 2022a). Figure 6 shows Malaysia's solar PV manufacturing capacity by component between 2010 and 2028.

Figure 6 Malaysia's solar PV manufacturing capacity (MW), by component, 2010-2028



Source: (Wood Mackenzie, n.d.).
Notes: MW = megawatt; PV = photovoltaic.

Solar PV trade plays a crucial role in Malaysia's economy. Trade in cumulative PV-grade polysilicon, wafer, cell and module contributed roughly 10% of the national trade surplus between 2017 and 2021 (IEA, 2022b). In 2023, Malaysia ranked third in the world in exports of photosensitive semiconductor devices (including PV cells/modules) worth approximately USD 6.6 billion (WITS, 2023).

[3] *Green investments consist of six distinct levers: green mobility, energy efficiency, circular economy, bioenergy, renewable energy and hydrogen.*

[4] *They include manufacturing and service activities, such as solar PV, hydropower, transmission and distribution, and battery storage solutions.*

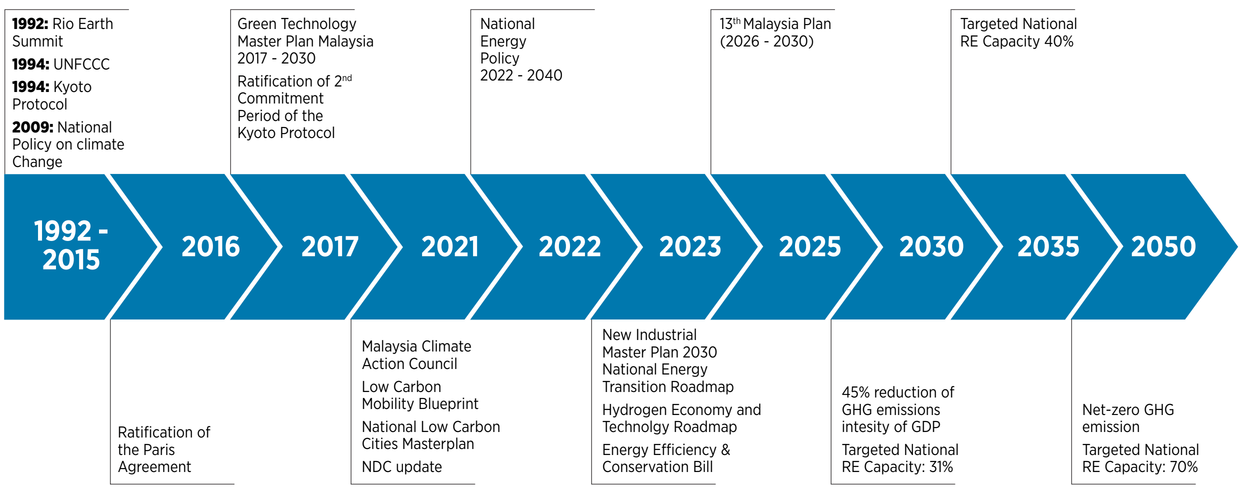
Malaysia's solar PV manufacturing industry is on the rise, mainly due to a pro-business policy environment, competitive labour costs and targeted financial support. The Malaysia Investment Development Authority provides a one-stop facilitation model that connects firms to local suppliers and talent and fosters research and development partnerships between industry and academia. Skilled talent and the maturity of the local supply chain drive down production costs, while multi-year tax holidays, corporate tax relief and the Green Technology Financing Scheme reduce capital expenditure and financing burdens. Combined with reliable logistics, favourable access to export markets and strong ties to Western buyers, these advantages position Malaysia as a promising destination for foreign investments and a dynamic hub for PV manufacturing (ADB, 2023).

In addition to supporting manufacturing capacity for renewable energy components, Malaysia has also introduced and institutionalised mechanisms to allow cross-border renewable electricity trade. The government approved the Cross-Border Electricity Sales for Renewable Energy scheme in 2023 and subsequently launched Energy Exchange Malaysia (ENEGEM) as the digital platform operated by Single Buyer[5] to facilitate structured auctions for green electricity between Malaysia and Singapore. The pilot phase of the digital platform permitted the transmission of up to 300 megawatts (MW) of renewable electricity via the existing Peninsular Malaysia–Singapore grid. The inaugural auction was held in June 2024, and the first electricity deliveries commenced in December 2024. These supplies are bundled with renewable energy certificates and delivered on a flat 24-hour profile over a one-year period. Governance is ensured through the Guide for Cross-Border Electricity Sales and oversight by an exchange committee consisting of representatives from ministries, regulators, the Single Buyer and grid operators (Single Buyer, n.d.).

2.2 OVERARCHING NATIONAL ENERGY POLICIES AND STRATEGIC PLANS

The Malaysian government has announced several overarching policies and strategic plans for the national energy transition. All of them align with developments in the evolving energy industry (Figure 7). Key policies include the 13th Malaysia Plan (2026-2030), the Malaysian National Energy Policy (2022-2040) and the NETR (Malaysia MoE, 2022, 2023a, 2025b). The 13th Malaysia Plan (2026-2030) marks a strategic shift in Malaysia's national development framework, with an aim to "restructure national development for a better future". The plan outlines three core dimensions: (1) high and sustainable income, (2) quality and inclusive life and (3) sustainable environment – reflecting the government's long-term commitment to strengthening good governance and public sector reform and to improving the standard of living (Nurginias Ibrahim and Zazreen Zainudin, 2025a).

Figure 7 Timeline of Malaysia's key energy transition policies and strategic plans



Source: (Central Bank of Malaysia, 2023a).

Notes: GDP = gross domestic product; GHG = greenhouse gas; NDC = Nationally Determined Contribution; RE = renewable energy; UNFCCC = United Nations Framework Convention on Climate Change.

[5] *Single Buyer is the entity authorised by the Minister pursuant to the Electricity Supply Act (ESA) 1990 to conduct electricity planning and manage electricity procurement services for Peninsular Malaysia.*

In 2022, the Malaysian government launched the National Energy Policy 2022-2040 (*Dasar Tenaga Negara*, DTN), as a comprehensive action guide for the energy sector. One of its key pillars was the Low Carbon Nation Aspiration (LCNA 2040) to help realise economic gains from an energy transition aligned with the policy's vision and objectives. Key components of LCNA 2040 include financing energy efficiency practices and incentivising EV adoption. Implementing the DTN is projected to generate an annual contribution of USD 2.9 billion (MYR 13 billion) to GDP, create 207 000 jobs (most in the green economy sector) and align the CO_2 reduction target with the 2021 NDC, among other impacts. Additionally, measures seek to unlock the potential of indigenous renewable energy (*e.g*. solar, bio-based, hydro-electric) in the primary energy mix and target greater diversification in fuels and the substitution of imported non-renewable energy. This is specifically to increase domestic self-sufficiency in energy to 48-72%, and to fortify energy security (Malaysia MoE, 2022).

Following the 13th Malaysia Plan and the DTN, the NETR was launched to accelerate the clean energy transition (Malaysia MoE, 2023a). Its role is to provide a clear framework for achieving an updated target of 70% for installed renewable energy capacity by 2050. The ten catalyst projects of the NETR cover six energy transition levers: energy efficiency; renewable energy; hydrogen; bioenergy; green mobility; and carbon capture, utilisation and storage. These flagship projects are expected to attract investment of more than USD 5.7 billion (MYR 25 billion), create 23 000 job opportunities and reduce GHG emissions by more than 10 $MtCO_2eq$ every year. In 2025, key initiatives under this framework – including solar parks, floating-hydro hybrid systems, and pilot zero-carbon industrial zones and green hydrogen hubs – were launched.

The NETR establishes the pathway for the national energy mix, reduction in GHG emissions and energy transition initiatives. This reinforces Malaysia's commitment to net-zero emissions as early as 2050 with its current contribution of around 0.8% to global GHG emissions. By 2050, initiatives under the NETR are expected to deliver a 32% reduction in energy sector GHG emissions relative to the 2019 baseline – per capita emissions of 4.3 $MtCO_2eq$ (Malaysia MoE, 2023a).

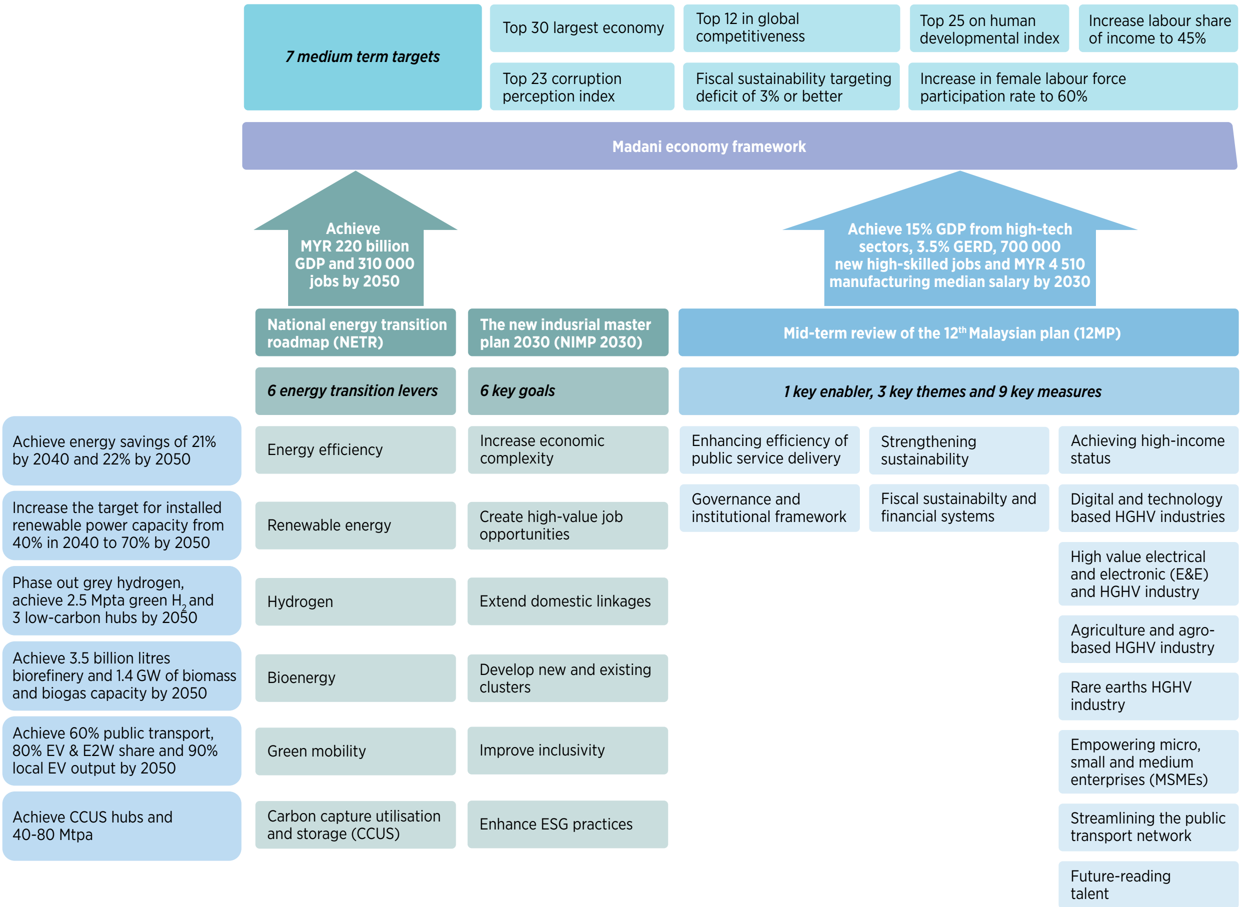
Malaysia's 2025 budget reinforces the country's commitments to the NETR and allocates USD 67.9 million (MYR 300 million) through the National Energy Transition Facilitation Fund to accelerate key initiatives. The substantial increase from the USD 22.6 million (MYR 100 million) allocated in 2024 highlights that renewable energy, energy efficiency and carbon management are all national priorities. Some renewables and low-carbon initiatives were launched and advanced in 2024, including the commissioning of a biomass co-firing system and hybrid hydro-floating solar projects. Large-scale solar programmes (LSS5) as well as a rooftop solar scheme were also launched, with a target of at least 2 000 MW solar PV capacity by 2026 (MIDA, 2025). The Corporate Renewable Energy Supply Scheme was also launched in 2024. It aims to improve corporate access to green electricity supply and enables large corporate consumers to purchase renewable energy directly from independent power producers (Single Buyer, n.d.).

Malaysia has established renewable energy targets across various policy frameworks. Its NDC targets a 45% reduction of GHG emission intensity per unit of GDP by 2030 from 2005 levels, in accordance with the Paris Agreement (UNFCCC, 2021). In 2021, the Ministry of Energy and Natural Resources of Malaysia crafted a national strategic plan guiding renewable energy development in the country. The target was a 31% share of renewables in installed capacity by 2025, and a 40% share by 2035. The energy aspiration milestone was extended further, to a target of 70% renewable installed capacity by 2050. Under the NETR, Malaysia aims to reach cumulative renewable capacity of 18 000 MW by 2035 and 55 000 MW by 2050, from 9.5 GW in 2024. As a result, carbon emission intensity of GDP from the power sector is projected to fall 45% by 2025 and 60% by 2035, relative to the 2005 baseline (GlobalData, 2024).

Malaysia introduced several specific renewable energy policies to complement its renewable energy agenda (*e.g*. the Net Energy Metering scheme, feed-in tariffs [FiTs], Solar for Self-consumption [SelCo], the Low Carbon Energy Generation Programme and large-scale solar programmes) (IRENA, 2023a). The FiT scheme mandates distribution licensees to purchase electricity generated from renewable sources at a fixed premium rate. By 2021, the Sustainable Energy Development Authority had awarded 174 672 MW of FiT quotas for biogas, biomass and small hydropower resources (IRENA, 2023a). Recognising the FiT scheme's effectiveness in driving the adoption of renewable energy and lowering carbon footprints, the government expanded the programme by allocating an additional 187 MW of quotas for biogas, biomass and small hydropower projects in 2022 (Malaysia MoNRECC, 2023).

These evolving policy frameworks reflect Malaysia's broader, co-ordinated effort to include the energy transition in the country's long-term socio-economic development agenda. This effort demonstrates a growing commitment to align decarbonisation goals with industrial competitiveness, job creation and inclusive economic growth (Figure 8).

Figure 8 Alignment of key goals and socio-economic targets across Malaysia's major policy frameworks (MADANI, NETR, NIMP 2030, 12MP Midterm Review)



Adapted from: (IMF, 2024; Malaysia MITI, 2023; Malaysia MoE, 2021, 2023a, 2023c).

Notes: 12MP = 12th Malaysia Plan; B = billion; ESG = environmental, social and governance; GDP = gross domestic product; GERD = gross domestic expenditure on research and development; H_2 = hydrogen; HGHV = high growth high value; Mtpa = million tonnes per annum; NETR = National Energy Transition Roadmap; NIMP = New Industrial Master Plan; MYR = Malaysian ringgit; xEV = electric vehicle covering types like HEV (hybrid electric vehicle), PHEV (plug-in hybrid electric vehicle), BEV (battery electric vehicle) and FCEV (fuel-cell electric vehicle); E2W = electric two wheeler.

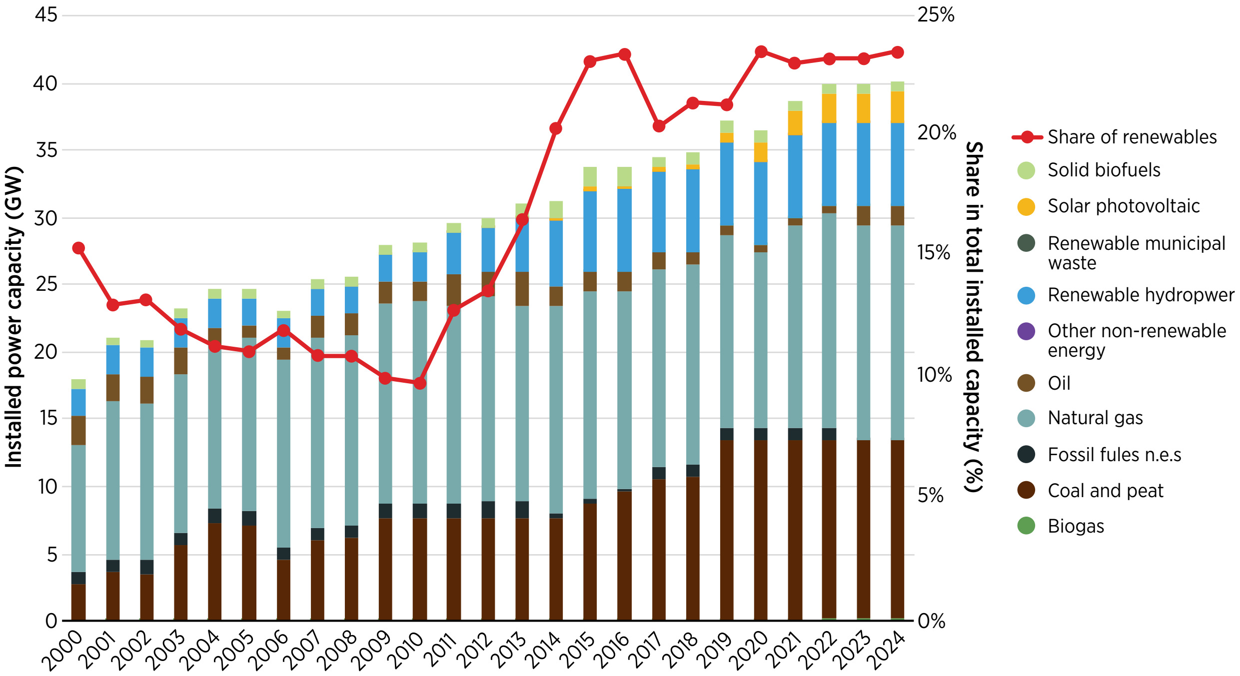
2.3 CHALLENGES IN MALAYSIA'S ENERGY LANDSCAPE

Fossil fuels support the majority of energy supply in Malaysia. In 2023, Malaysia's total primary energy supply was approximately 95 million tonnes of oil equivalent, with natural gas accounting for 43%, crude oil and petroleum products for 35%, coal for 18% and renewable energy (including bioenergy, solar, hydropower and hydrogen) for only 4% (Rahman, 2025). This substantial reliance on fossil fuels and the growing dependence on energy imports pose significant challenges to energy affordability and security in Malaysia in the long term.

As domestic demand continues to grow and domestic energy reserves dwindle, Malaysia is becoming increasingly import dependent. Its oil and gas reserves have been steadily declining. Total crude oil reserves are estimated at just 3.6 million barrels, and while natural gas remains the largest contributor to energy supply, production growth has slowed, with around 16% of the domestically consumed natural gas being imported in 2022 (Rahman, 2025). Peninsular Malaysia relies entirely on imported coal for power generation, with approximately 70% being sourced from Indonesia (UNCTAD, 2025). Rising import dependence makes Malaysia more vulnerable to global price volatility and supply chain disruptions, while expansion of strategic stockpiles remains costly given the reduced domestic output. These structural vulnerabilities highlight Malaysia's need to diversify its energy mix, reduce its dependency on imported energy and accelerate the deployment of renewable energy, as outlined in its National Energy Policy 2022-2040 (Malaysia MoE, 2022).

Despite Malaysia's dependency on fossil fuels, its potential in renewable energy is enabling a move towards cross-sector electrification. Between 2020 and 2024, Malaysia's total installed power capacity increased from 36 GW to 40 GW, of which natural gas and coal accounted for three-quarters. By 2024, renewable energy capacity had reached 23.6% of the total installed capacity, driven by hydropower and distributed generation, as shown in Figure 9 (IRENA, 2025a).

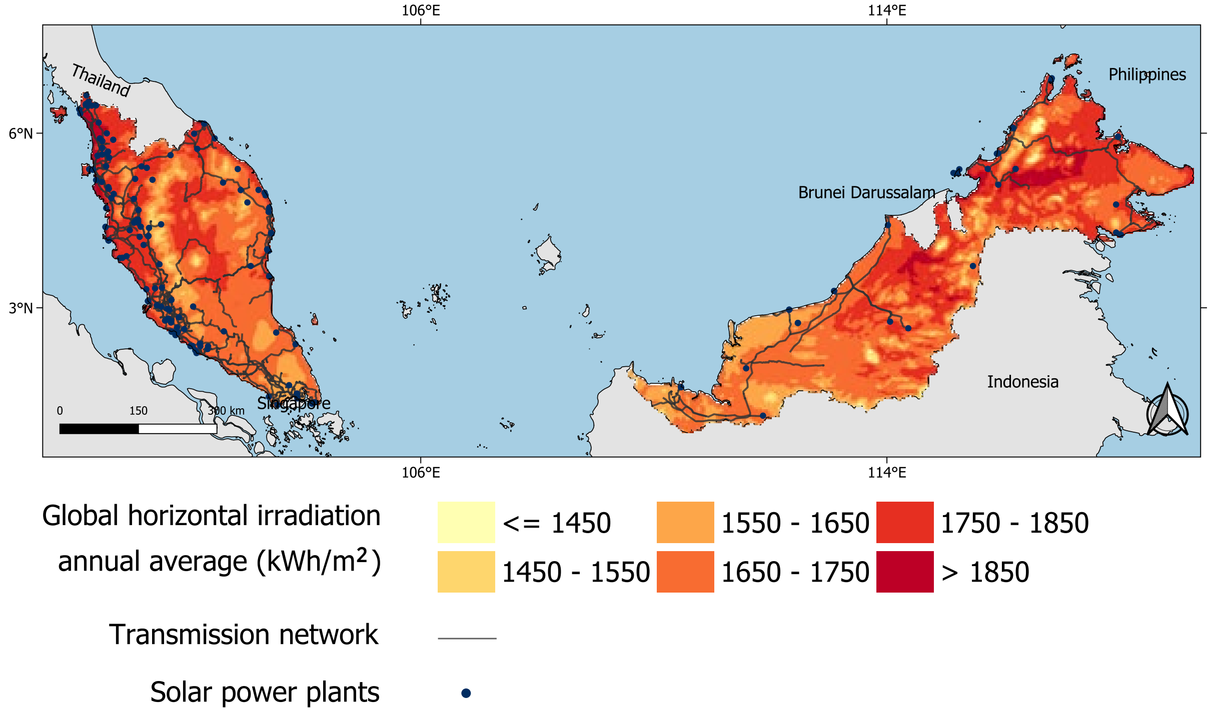
Figure 9 Installed power capacity mix (GW) and share of renewables in total installed power capacity (%) in Malaysia, 2000-2024



Source: (IRENA, 2025a).
Notes: GW = gigawatt; n.e.s. = not elsewhere specified.

Malaysia's renewable energy resources - from solar and hydropower to bioenergy - present great opportunities to reshape the country's energy landscape. With average annual global horizontal irradiance of 1 715 kilowatt hours per square metre (kWh/m^2) in Malaysia (Figure 10), there is significant potential for solar energy development. The existing transmission lines shown in Figure 10 portray a large area of untapped potential in Malaysia. As of 2024, Malaysia had roughly 4.3 GW of total installed solar PV capacity.

Figure 10 Global horizontal irradiation with transmission networks and powerplants in Malaysia



Sources: (ESMAP, 2019; Global Energy Monitor, n.d.; Transmission network: OpenStreetMap contributors, n.d.) Base layer: UN GLobal Boundaries L06, n.d.

Notes: kWh/m^2 = kilowatt hours per square metre.

Disclaimer: This map is provided for illustration purposes only. Boundaries and names shown on this map do not imply the expression of any opinion on the part of IRENA concerning the status of any region, country, territory, city or area, or of its authorities, or concerning the delimitation of frontiers or boundaries.

But while renewable energy holds considerable potential in Malaysia – and targets and supportive policies are in place – the energy transition faces persistent challenges, prompting the government to implement a range of initiatives and strategies to bridge existing gaps.

Financing constraints

The capital investments required for the country's energy transition are substantial. The NETR estimates total financing needs of USD 271-294 billion (MYR 1.2-1.3 trillion) by 2050 (Malaysia MoE, 2023a). IRENA estimates that, under the 1.5°C Scenario, renewable energy needs USD 47 billion in total cumulative investments by 2030 and USD 375 billion by 2050 (IRENA, 2023a). While large-scale renewable energy projects often have access to funding from domestic and international commercial banks, as well as Malaysia's sukuk bond market, capital mobilisation for early-stage and small-scale projects continues to face challenges (EY, 2023). Small-scale green projects have limited economies of scale, carry high commercialisation risks and have limited financing options. They rely predominantly on project-based loans. Transitional initiatives in sub-sectors such as EV infrastructure, energy efficiency and sustainable technologies yield low commercial returns and carry financial uncertainties, diminishing their appeal to investors (Malaysia MoE, 2023a).

Some fiscal incentives are already in place to address the financing gaps and attract renewable energy project developers. These include the Low Carbon Transition Facility under Bank Negara, Green Technology Financing Scheme, Green Investment Tax Allowance and Green Income Tax Exemption. In 2023, Malaysia established the National Energy Transition Facility with an initial seed fund of MYR 2 billion, aiming to leverage the blended finance platform to make funds more accessible and streamline investment processes.

Grid capacity and connectivity challenges

Scale-up of major energy infrastructure and integration of clean energy into the national grid will require substantial improvements in grid capacity, connectivity and new energy infrastructure across Malaysia. Insufficient grid inter-connections remain a prominent challenge in rural Sabah and Sarawak, where outdated grid technology hinders the provision of reliable electricity services. The development of off-grid and hybrid renewable energy systems could present an opportunity to expand electricity access and reduce energy poverty in rural areas (IRENA, 2023a). Under the Low Carbon Mobility Blueprint, Malaysia targeted the establishment of 10 000 public EV charge points by the end of 2025. As of March 2025, roughly 4 161 charging points had been installed, putting the country nearly halfway to its target (MEVnet, 2025).

To bridge the infrastructure gaps, the government has made grid modernisation a development priority and is leveraging public-private partnerships to expedite the expansion of EV charging networks. Grid upgrades through digital transformation and smart-grid applications has become a high priority on the policy agenda. At the regional level, cross-border co-operation is emerging as a solution to connectivity challenges. The Lao People's Democratic Republic–Thailand–Malaysia–Singapore Power Integration Project is a multilateral power trade initiative, under which the upgraded electricity connector between Malaysia and Singapore now facilitates bi-directional electricity flows of 1 000 MW (Malaysia MoNRECC, 2023). In response to the rising demand for clean energy, Malaysia has also launched the Energy Exchange Malaysia, enabling it to engage in green electricity trade with neighbouring countries since 2024 (ADB, 2024).

Human capital and skill gaps

Workers with the specialised expertise required by renewable energy industries are in short supply in Malaysia, which needs 62 000 skilled workers to reach its renewable energy generation targets by 2050 (MIDA, 2024). Advancing the energy transition will involve re-skilling workers from carbon-intensive industries and ensuring skill development matches the needs of emerging green sectors such as solar engineering, energy management, battery technology and grid modernisation (IRENA, 2023a). Labour representatives in Malaysia note that many workers "continue to prioritise economic concerns over sustainability" and show limited understanding of how the energy transition will shape the job market (Eco-Business, 2025). Meeting the future demand of a green economy will require Malaysia's technical and vocational education and training system to integrate green skills into its curricula.

Malaysia is actively working to close the workforce skill gap through a human capital development initiative that supports a rakyat-centric energy transition[6] and focuses on four dimensions – workforce planning, green skilling, community resilience and energy literacy. The government aims to establish a green skills taxonomy that defines the skills needed for a just transition and helps align skill demand and supply. Green skilling programmes are being introduced through new curricula and upskilling or re-skilling initiatives, particularly targeting those affected by the job shifts of the energy transition. Community resilience measures support individuals and communities impacted by the transition. Such measures include re-deployment programmes for displaced workers.

Harnessing the benefits of renewable energy deployment is tied to economic development. A more productive economy generates higher output, raising the need for energy. This in turn creates demand for cleaner energy sources as well as the financial means to invest in them. A cyclical relationship results wherein economic growth is not only driven by the development of the renewable energy sector but serves as a pre-requisite for advancing renewable energy ambitions. Despite the challenges, the energy transition in Malaysia could present great opportunities, which are discussed in the next chapter.

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[6] *Rakyat translates to "people" in the Malay language. A rakyat-centric energy transition refers to an energy transition centred on the needs and well-being of the people.*

CHAPTER 3
THE ENERGY TRANSITION AND ITS SOCIO-ECONOMIC IMPACTS

This chapter provides a succinct overview of the energy transition roadmap as outlined in IRENA's *Malaysia energy transition outlook* (IRENA, 2023a). In addition to being a technological change, Malaysia's energy transition offers an opportunity for development. Drawing on IRENA's 1.5°C Scenario pathway, the analysis will capture how energy system transformations can influence economic growth and employment evolution in Malaysia. For this, the 1.5°C Scenario (accelerated deployment of renewable, energy efficiency and electrification measures) is compared against the PES, which reflects current policies and commitments.

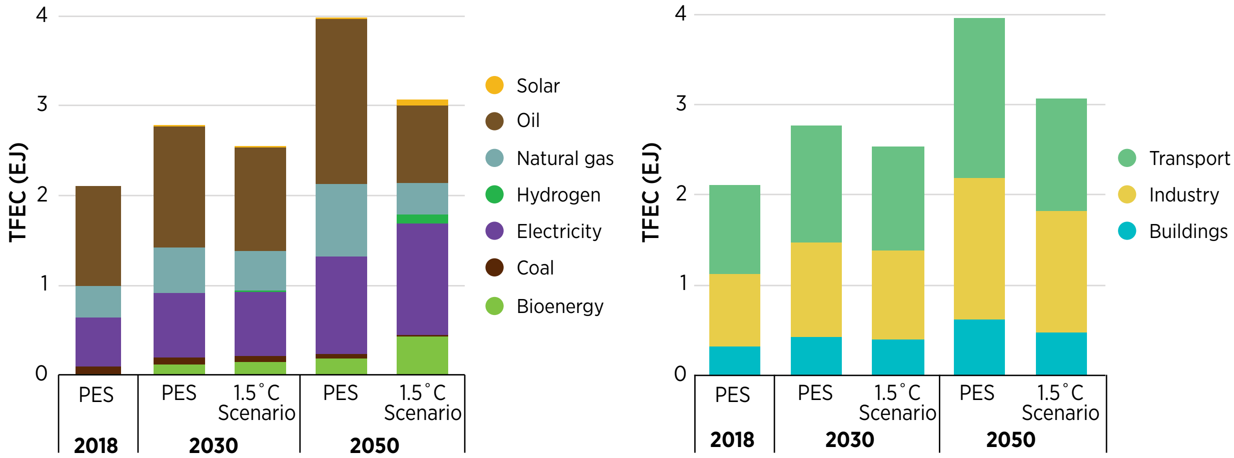
3.1 IRENA'S MALAYSIA ENERGY TRANSITION OUTLOOK

As of 2018,[7] Malaysia's primary energy supply stood at 4.1 exajoules (EJ), and renewables contributed only 3% to the mix. Renewables' share would reach up to 40% under the 1.5°C Scenario by 2050. This constitutes energy savings of 21% relative to the PES (IRENA, 2023a).

Malaysia's TFEC was 2.49 terajoules (TJ) in 2022. Oil products led contributions at 1.07 TJ (43%), followed by natural gas at 0.76 TJ (31%) and electricity at 0.59 TJ (23.7%) of this TFEC. Bioenergy played only a marginal role, with a share of 1.4%. Under the PES, Malaysia's TFEC is expected to increase 2% annually on average, to 4.0 EJ by 2050 from 2.1 EJ in 2018. But despite a continued increase in electricity consumption, fossil fuels will still constitute 68% of TFEC in 2030 and 77% in 2050 under the PES. In both timelines, they would remain crucial for transport and industry. Under the 1.5°C Scenario, where all sectors have a renewables presence, aggressive energy efficiency measures and electrification, TFEC grows at an annual average rate of 1.2% reaching 3.1 EJ by 2050, which is a decline by 23% relative to the PES. By 2050, under the 1.5°C Scenario, there is a fundamental transformation in the energy mix of the TFEC and a shift towards a sustainable, low-carbon energy system. Electrification and the consumption of renewable energy sources, including biofuels and hydrogen, show a remarkable increase, whereas conventional fossil fuels are phased out progressively. There is a larger trend towards electrification (29% share), and the increased use of biomass in industry and transport in the form of biofuels (20%). Hydrogen also plays an emerging role, contributing up to 5% of TFEC by 2050 under the 1.5°C Scenario (IRENA, 2023a) (Figure 11).

[7] *These were the latest data available during the preparation of IRENA's Malaysia Energy Transition Outlook (IRENA, 2023a). More recent data, for 2022, suggest that Malaysia's total energy supply was 4.17 TJ. Natural gas accounted for the largest share at 47%, followed by oil at 25.2% and coal at 23.6% (IEA, 2022c).*

Figure 11 Malaysia's total final energy consumption (EJ) under the PES and the 1.5°C Scenario, by energy carrier (left) and by sector (right), 2018-2050

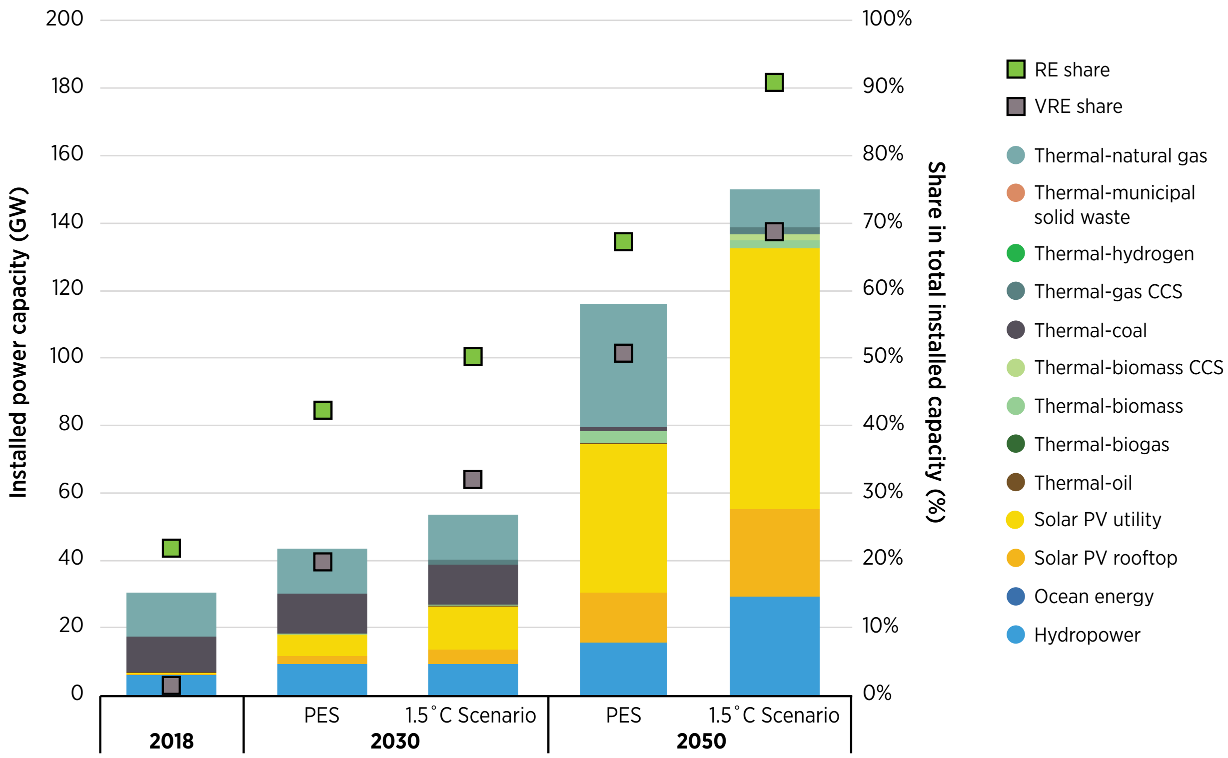


Source: (IRENA, 2023a).

Notes: EJ = exajoule; TFEC = total final energy consumption; PES = Planned Energy Scenario.

Under the PES, the power sector is on a trajectory towards decarbonisation by 2060, in line with national plans, while more ambitious renewable pathways are being explored under the 1.5°C Scenario, demonstrating how higher shares of solar PV and sustainable dispatchable power can help mitigate the expansion of coal capacity in the long run. Solar PV is a key technology, and given its modularity and low costs, and Malaysia's rich industrial potential, it plays a key role regardless of ambition level. There is also a clear role for sustainable dispatchable power and grid flexibilities of various forms (hydropower, bioenergy, fossil fuel generation with carbon capture and storage, and battery storage), which help mitigate the diurnal and seasonal variability of solar resources (Figure 12).

Figure 12 Installed power capacity mix (GW) under the PES and the 1.5°C Scenario, by technology, 2018-2050

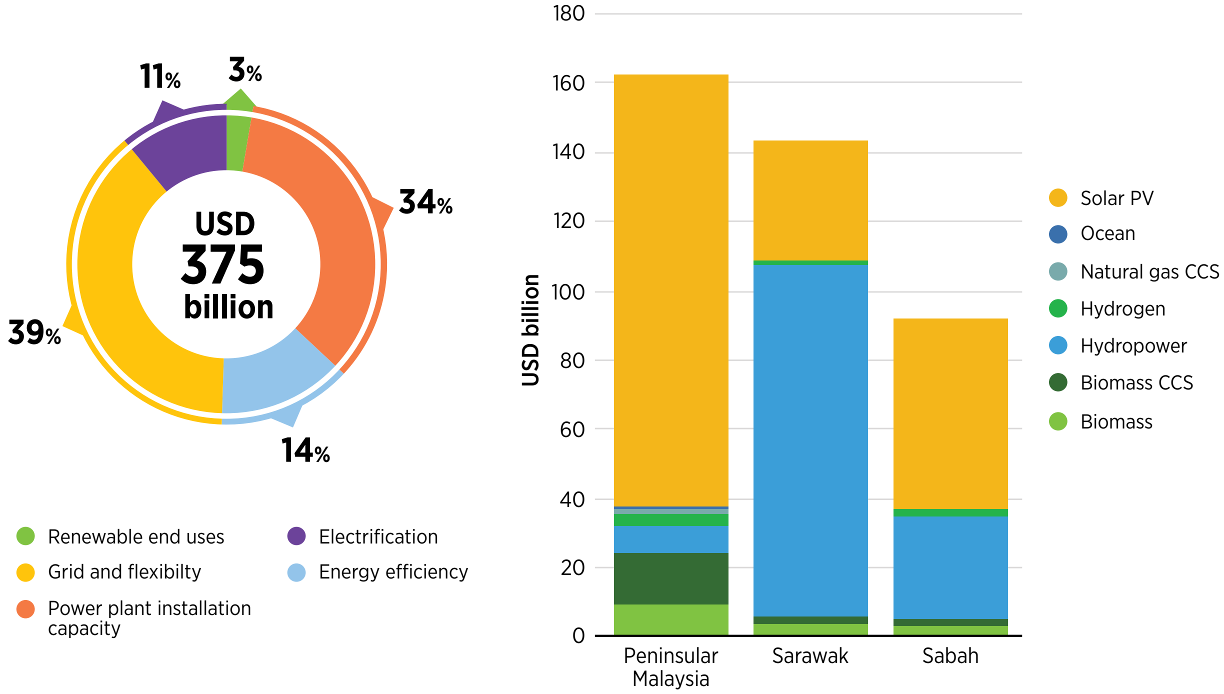


Source: (IRENA, 2023a).

Notes: RE = renewable energy; VRE = variable renewable energy.

In the years leading to 2030, an accelerated energy transition under the 1.5°C Scenario will require investments in decarbonising the power sector and in EV infrastructure. Malaysia also needs substantial investments for expanding renewable energy installation capacity in the country – especially for solar PV (Figure 13). Under the 1.5˚C Scenario, an estimated USD 47 billion would need to be invested in clean and renewable energy by 2030, with about USD 27 billion going towards expanding the grid's power capacity and energy storage (IRENA, 2023a).

Figure 13 Total cumulative investment needed between 2018 and 2050 by sector (left); and total clean and renewable energy investment required in Peninsular Malaysia, Sarawak and Sabah up to 2050 under the 1.5°C Scenario (right)



Source: (IRENA, 2023a).
Notes: CCS = carbon capture and storage; PV = photovoltaic; USD = US dollar.

Under the 1.5°C Scenario, USD 375 billion needs to be invested between 2018 and 2050. This is 2.5 times more investment than under the PES, or an additional USD 8 billion per year (IRENA, 2023a). Annual energy investments in Malaysia would need to be roughly 4% of its total GDP by 2050. IRENA's analysis shows that three-quarters of the investment under the 1.5°C Scenario goes to power and grids and storage infrastructure, while the rest goes to energy efficiency and electrification in end-use sectors (Figure 13). Under the 1.5°C Scenario, the country is projected to save roughly USD 9 billion annually in total energy system costs relative to the PES by 2050. Despite extra spending in low-carbon infrastructure, costs savings under the 1.5˚C Scenario are realised through lower fuel costs (IRENA, 2023a).

3.2 SOCIO-ECONOMIC IMPACTS OF THE ENERGY TRANSITION

This section examines the key socio-economic implications of the transition. It highlights:

- Overall GDP and employment impacts and growth trends,
- The underlying drivers of economic and employment trends, and
- Insights into the IRENA Energy Transition Welfare Index (ETWI).

The findings outlined above delineate the differences between the 1.5°C Scenario and the PES. The analysis in this section builds on these insights by identifying the key drivers (investment, trade, household consumption and government spending) and provides an evidence-based foundation for policy makers to leverage the transition's socio-economic benefits while anticipating and managing its associated risks.

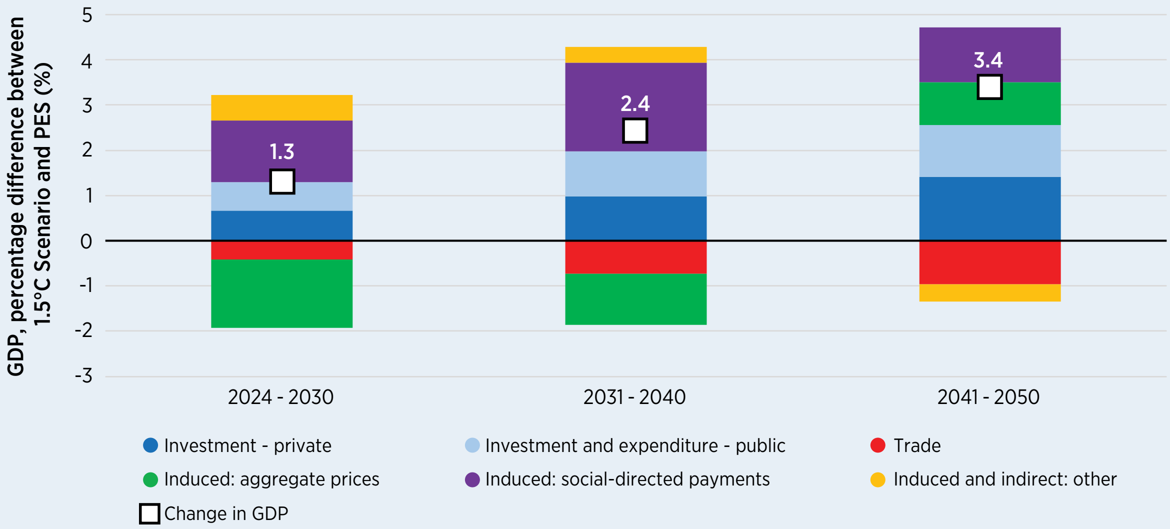
3.2.1 Economic impacts

Between 2005 and 2023, Malaysia's economy experienced consistent growth. Real GDP grew steadily, from MYR 730 billion to over MYR 1.6 trillion, at an average of 4.4%. Under IRENA's scenarios, Malaysia's economy is expected to grow steadily between 2024 and 2050. Under the 1.5°C scenario, GDP shows a promising outlook for Malaysia's economy relative to the PES. GDP performance improves by an annual average of 2.4% between 2024 and 2050, relative to the PES (Box 1). Throughout 2024-2050, Malaysia's GDP is expected to improve, by roughly USD 533.3 billion[8], between the two scenarios, due to investment.

Box 1 Drivers of GDP growth

Under the 1.5°C Scenario, Malaysia is projected to add an additional USD 533.3 billion[9] to the GDP already anticipated under the Planned Energy Scenario (PES) over 2024-2050. GDP continues to grow steadily, and the between-scenario difference in GDP is projected to increase annually by 1.3% between 2024 and 2030, followed by an annual 2.4% rise in the second decade of the transition (*i.e.* 2031-2040), and a 3.4% annual increase in the last decade (2041-2050) compared with the PES (Figure 14).

Figure 14 Percentage difference in GDP (%) between the 1.5°C Scenario and PES, 2024-2050



Notes: GDP = gross domestic product; PES = Planned Energy Scenario.

Investment, indirect and induced effects, and trade to a lesser extent, are the main macroeconomic factors influencing GDP differences. The relative importance of these factors varies depending on the period analysed.

Investment, which has two components (private investment, and public investment and expenditure), has the most impact on the GDP difference between the 1.5˚C Scenario and the PES throughout the transition period (*i.e.* 2024-2050). The between-scenario difference in impact is expected to be higher for public investment and expenditure, by 0.5%, in 2024, with the difference rising to 1.2% in 2050, mostly due to transition-related investments (renewables, grids and energy flexibility) and government social spending. Under the 1.5°C Scenario, government social spending, which is allocated to essential public services like healthcare, education and administration that enable inclusive growth and greater human well-being, still gets a significant boost. The government expends an additional USD 2.2 billion in social spending relative to the PES in 2050. Government spending represents a cumulative

[8] *In 2021 USD.*
[9] *In 2021 USD.*

USD 41.5 billion throughout the transition period (*i.e.* 2024-2050), supported by international climate co-operation flows. Private investment is also among the key drivers of the GDP difference between the 1.5˚C Scenario and the PES throughout the transition period. Private investment is significantly higher under the 1.5°C Scenario than the PES. This results in a difference of more than USD 16.4 billion, which represents a 1.5% increase in the GDP difference by 2050. The positive impact of transition-related investments (mainly in renewables, energy efficiency, grids and energy flexibility) would increase and would offset the negative impact from the loss of investment in fossil fuel supply and the effect of investment in the power sector crowding out investment in other sectors.

Indirect and induced effects positively impact Malaysia's economy over the transition period, mainly driven by spending due to social-directed payments. The induced social-directed payments driver, which addresses issues with domestic distribution (*i.e.* provision of support to the lower-quintile population), has a positive influence in driving the overall GDP difference throughout the transition period.

Under the 1.5˚C Scenario, the government's balance after revenue recycling[10] is projected to see a surplus compared with the PES. This is mainly due to the revenues realised through transport fuel and carbon taxes, public energy-related investments and receipts from international climate co-operation funds. The government would begin reaping fiscal benefits through implementing carbon taxes and reducing fossil fuel subsidies. By 2030, the government is expected to achieve a net fiscal gain of over USD 1.2 billion by cutting down fossil fuel subsidy payments under the 1.5°C Scenario (Box 2). With fossil fuel subsidies fully phased out from 2040, the net fiscal gain is expected to reach over USD 2.3 billion in 2040 and USD 1.9 billion in 2050. The introduction of carbon taxes[11] would contribute an additional USD 764 million to the government balance in 2030 under the 1.5˚C Scenario. This nearly doubles the potential government revenue in 2026 under the PES. Throughout the transition period, carbon taxes could generate substantial additional revenues of around USD 15.9 billion to the government balances between the scenarios.

The evolution of the country's fiscal balances would influence social-directed payments to low-income households. The fiscal balances would limit this driver due to equilibrated revenue and spending in the transition's last decade (*i.e.* 2041-2050). Social-directed payments are expected to increase annually by over USD 10.8 billion on average under the 1.5°C Scenario relative to the PES throughout the transition period. Additionally, the impact of the domestic response to changes in carbon prices, technology costs, power sector capacity, fossil fuel subsidies and investment expenditure, which is reflected under the induced aggregate prices driver, would be negative in the first two decades due to increasing carbon taxes. However, the impact would wear off and be positive in the last decade due to the swift adoption of renewables, which would lower electricity prices.

On the other hand, household consumption would benefit from the ripple effects of the investment stimulus and international climate co-operation flows, which provide financial support to low-income households in the first two decades. This explains the positive impact of the induced and indirect effects (other) throughout the transition's first two decades under the 1.5˚C Scenario, driven by consumer expenditure.

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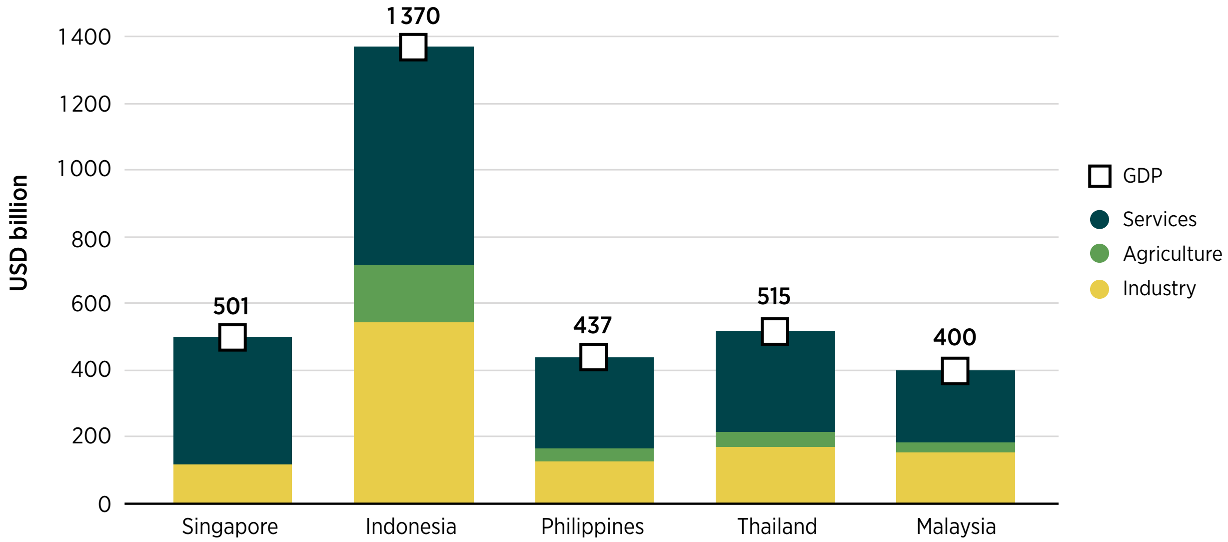
[10] *From a modelling perspective, revenue recycling is not only a policy instrument for addressing distributional issues in the context of scenarios, but it is also a way to avoid assuming that in the case where large investments must be made to finance the transition, governments would increase borrowing without any quantified impact on the economy and society.*

[11] *Under the 1.5˚C Scenario, carbon prices are higher for high-income countries than for low-income countries. For example, Malaysia's carbon price for 2030 (in 2021 USD) was set at around USD 105 /tonne of carbon dioxide (tCO_2), while ASEAN's was around USD 74 /tCO_2. The carbon price for 2030 was set at around USD 150 /tCO_2 for high-income economies and USD 30 /tCO_2 for low-income countries.*

The impacts of trade on GDP are shaped by changes in fuel trade and responses to trade in other commodities. Both negatively impact Malaysia's economy, given that lower global consumption of manufactured fuels drives down fuel export revenues under the 1.5°C Scenario. The 1.5°C Scenario also affects non-fuel trade; changes in non-fuel trade are expected to be negative throughout the forecast period. This could be explained by the increase in imports of engineering and transport equipment to satisfy the increasing domestic demand in Malaysia.

Figure 15 GDP (USD billion), by sector, 2024



Source: (Malaysia MoE, 2025c).
Notes: GDP = gross domestic product; USD = US dollar.

Sector impacts

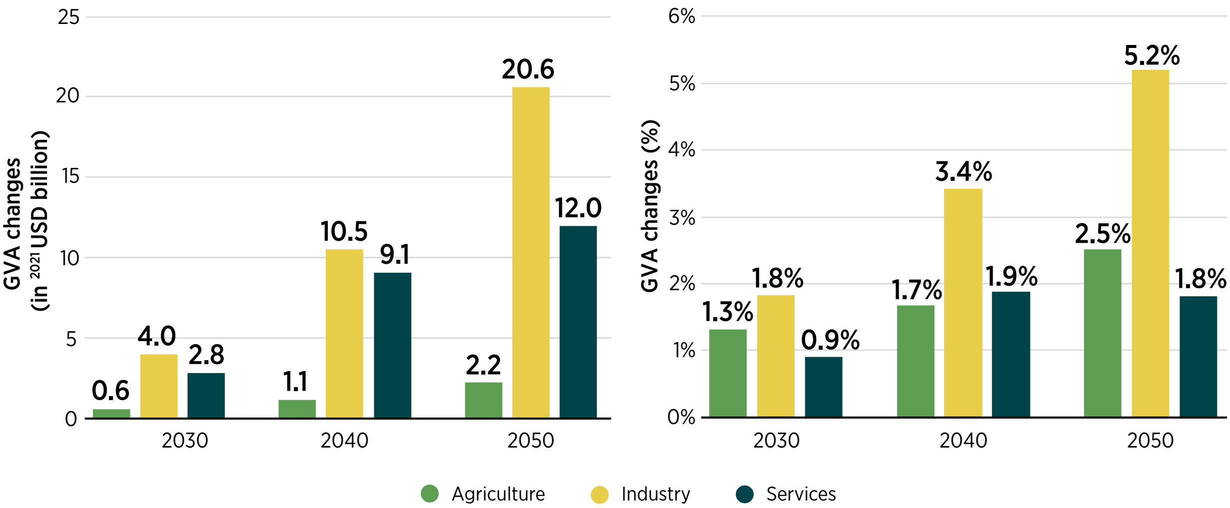
At the sector level, over the past few decades, Malaysia's economy has diversified towards a services-dominated structure, while the manufacturing sector has also developed strongly. In 2024, the services sector accounted for 59.4% of GDP, and manufacturing, agriculture and mining contributed 23.2%, 6.2% and 6.1%, respectively (Figure 15).

The agriculture, industry and service sectors are expected to grow persistently under the 1.5°C Scenario. They will cumulatively add around USD 471.5 billion[12] to Malaysia's gross value added (GVA)[13] between 2024 and 2050. Compared with the PES, industry GVA is expected to be higher under the 1.5°C Scenario – by 1.8% in 2030, 3.4% in 2040 and 5.2% in 2050. This growth can be attributed to private sector investment in energy efficiency and electrification, increased global demand and an improved trade position. The agriculture sector is expected to see higher GVA, by 1.3% in 2030, 1.7% in 2040 and 2.5% in 2050, under the 1.5°C Scenario relative to the PES. This will mainly be due to rising investment in biofuel supply. The services sector follows a similar upward trend, with GVA gains of 0.7% in 2030, 1.3% in 2040 and 1.4% in 2050 under the 1.5°C Scenario relative to the PES (Figure 16), highlighting the economic benefits of the transition.

12 *In 2021 USD.*

13 *GVA is the result of subtracting intermediate consumption (at purchaser prices) from output (at basic prices). It measures the contribution of producers, industries or sectors to an economy (Eurostat, n.d.).*

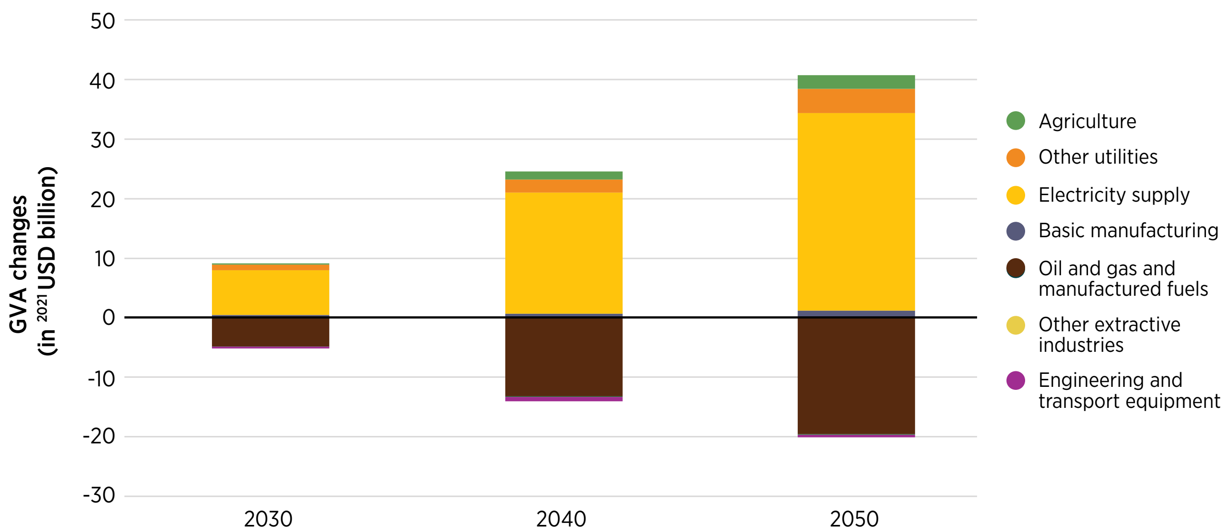
Figure 16 Changes in gross value added between the 1.5˚C Scenario and PES in USD billion (left) and in % (right), by sector, 2030-2050



Notes: GVA = gross value added; USD = US dollar.

The breakdown of GVA changes in industry (Figure 17) illustrates a sharp decline in GVA, by roughly 29.3%, in oil, gas and manufactured fuels in 2050 under the 1.5°C Scenario relative to the PES. This decline can be attributed to the reduced dependence of industry on fossil fuels and a strategic shift towards sustainable energy sources. This would be consistent with a surge in the growth of electricity supply and the utilities sector in Malaysia (respectively, 166% and 118%)[14] in 2050 relative to the PES. Advancements in both sectors are due to a sustainable energy transition and the provision of high-quality national infrastructure, especially in expanding electricity coverage in rural Malaysia. The construction sector would see a positive shift, with a gain of around 4% relative to the PES. Basic manufacturing would also expand, but moderately, by 1.0% in 2050, compared with the PES.

Figure 17 Changes in gross value added (USD billion) in industry, 2030-2050



Notes: GVA = gross value added; USD = US dollar.

[14] *"Other utilities" refers to and encompasses sectors related to gas, steam, air conditioning, water supply, waste management, etc. (excluding electricity supply) (UNSD, 2008).*

Box 2 Fuel subsidy reform in Malaysia

While there is growing international consensus to phase out fossil fuel subsidies, specifically to mitigate the risks of climate change and increase energy independence, the global energy crisis has hindered progress in making energy affordable and accessible and in transitioning to cleaner energy sources.

Fossil fuel subsidies and their rationalisation represent a long-standing topic in Malaysia. While fuel and electricity price regulation through subsidies shields the country from volatile international energy prices, it comes at substantial costs. Monetary allocation for energy-related subsidies, with fuel subsidies far exceeding that of its regional peers and costing USD 478 per capita in 2022 (OECD, 2024), has significantly strained the government budget. In 2022, when crude oil prices hit USD 100 per barrel under a post-pandemic demand boom and dwindling oil supply, fuel subsidies surged to MYR 52 billion in Malaysia. The growing bill not only imposed fiscal costs but also limited the capacity to support sustainable public spending and fund a just transition. The subsidised energy prices have distorted market signals, reducing incentives to shift towards renewables and undermining the country's decarbonisation efforts. The rationalisation[15] of fuel subsidies exerts pass-through effects on the economy, considering that higher fuel prices translate into higher transport and business operating costs, and increases inflation, compelling governments to expand social transfers to vulnerable groups. For countries like Malaysia, where fossil fuels remain the dominant energy source and the renewables sector is still at an early stage of development, rationalisation of subsidies also heightens the economy's exposure to fluctuations in global energy markets. From a societal perspective, universal subsidies are regressive, disproportionately benefiting higher-income households.

In June 2024, Malaysia's government – as a first step – removed diesel subsidies in Peninsular Malaysia. Diesel prices increased from MYR 2.15 to MYR 3.35 per litre, a 56% rise. Yet, fiscal savings of around USD 135 million (MYR 600 million) per month were recorded after rationalisation (Nurginias Ibrahim and Zazreen Zainudin, 2025b). Meanwhile, targeted measures, including fleet cards for commercial vehicles and cash transfers to low-income households, helped contain the inflationary impact on the economy. Headline consumer price inflation averaged 1.8% in 2024, down from 2.5% in 2023. The muted inflationary effect is attributable to several factors: global oil prices were on a downward trend, the weight of transport in the consumer price index basket had been reduced and compensatory mechanisms effectively shielded lower-income groups. Building on this experience, the government plans to extend targeted pricing to RON95 petrol in 2025, which is expected to yield potential fiscal savings of over USD 1.8 billion (MYR 8 billion) annually while ensuring that roughly 85% of households continue to benefit from subsidised fuel (Nurginias Ibrahim *et al.*, 2025b).

Fuel subsidy rationalisation in Malaysia reveals the complexity of aligning environmental objectives with fiscal, economic, political and social considerations. The International Monetary Fund highlights that further rationalisation of fuel subsidies and targeted social transfers are key components of achieving fiscal sustainability while reducing socio-economic inequality under national decarbonisation targets (IMF, 2025). Meanwhile, as highlighted in the scenario analysis, Malaysia's growing renewable energy capacity presents a positive signal from the government. Projected revenues from the energy transition between 2030 and 2050 are expected to increase fiscal flexibility, in turn creating opportunities for greater social spending and energy-transition-related investments for a just and inclusive energy transition.

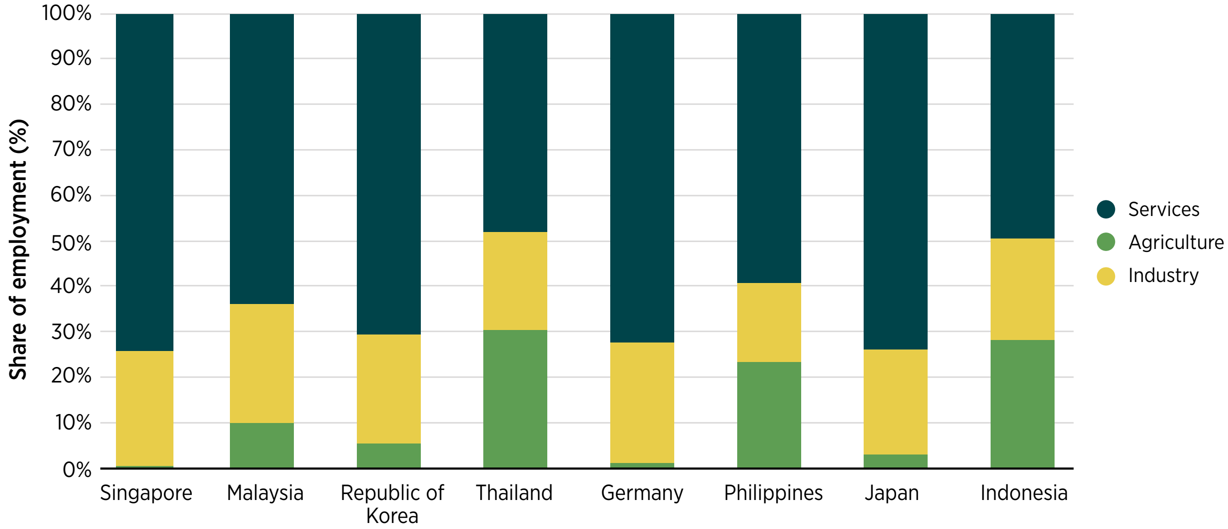
15 *Subsidy rationalisation is the reform of subsidies, which typically involves reducing or removing universal subsidies and replacing them with more targeted measures.*

3.2.2 Employment

Economy-wide employment

Strong domestic demand and a continued recovery in external markets have led to improved market conditions in Malaysia. By the end of 2024, total employment in Malaysia was estimated to have reached a record 16.3 million, with a substantial 8.3% year-on-year growth, while the unemployment rate was expected to have declined to 3.1%. The services (65.7%) and manufacturing (16.4%) sectors continued to be the main sources of employment opportunities in 2024, particularly in the wholesale retail, trade, and electrical and electronics industries (Figure 18). Overall, employment prospects stay positive, and total employment is anticipated to rise by a further 2.1% to 16.6 million by 2025 (Malaysia MoF, 2025). At the same time, labour productivity was expected to have improved, by 2.3%, reaching MYR 100 000 in 2024. The efficiency improvement is due to advancements in technology, expanded research and development efforts, and talent development (Malaysia MoF, 2025).

Figure 18 Share of employment (%) by sector across different countries, 2024



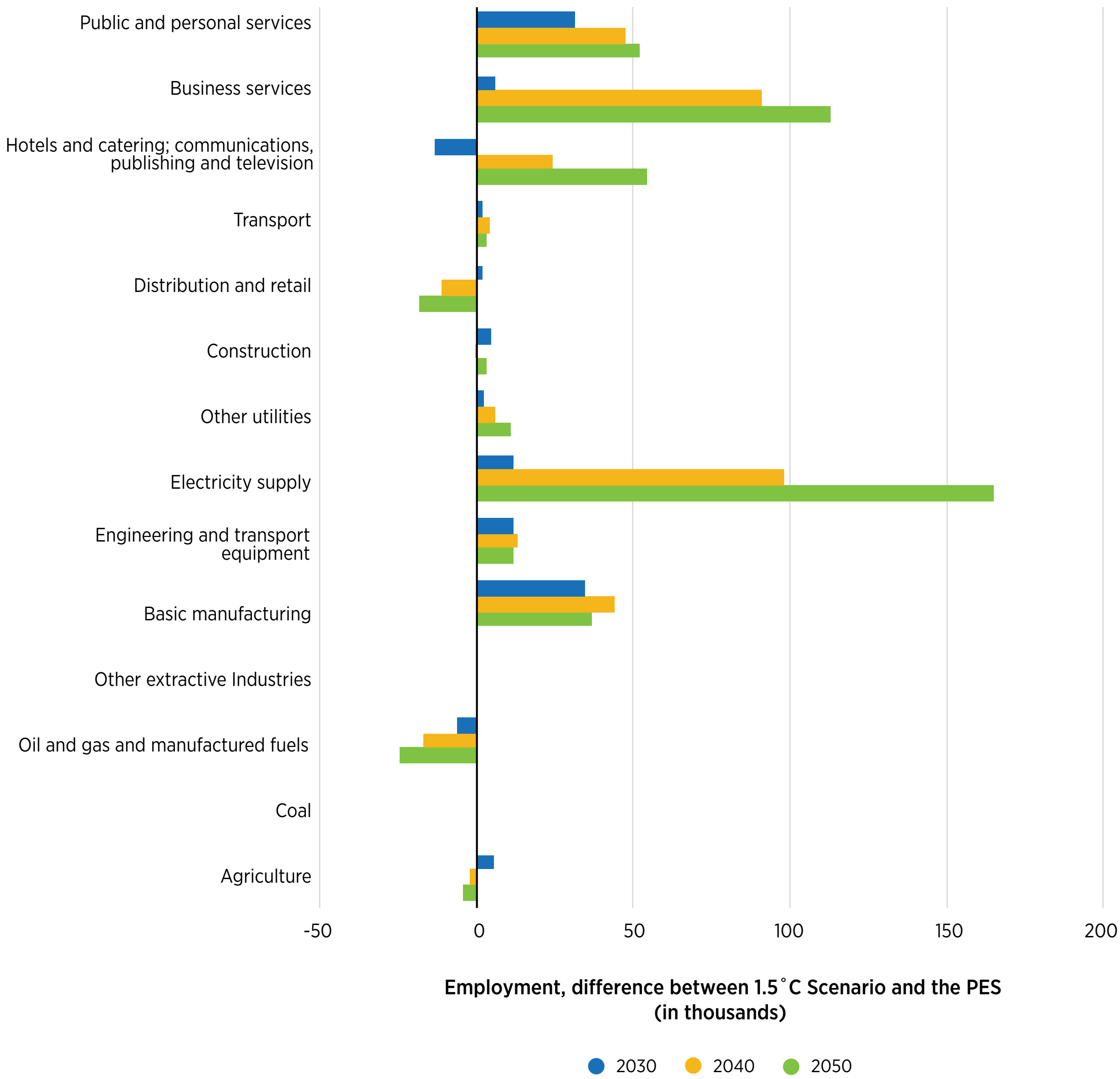
Source: (Malaysia MoE, 2025a).

Malaysia's labour market has shown resilient development amid substantial industrial transformation. Its labour structure reveals distinct characteristics: employment is concentrated in the services and industrial sectors. Compared with other countries of the Association of Southeast Asian Nations, 63.9% of Malaysia's workforce was employed in the services sector – a significantly higher share than that of Indonesia (49.6%) and Thailand (47.9%). About 10.0% of Malaysia's labour force is engaged in agriculture, which is less than in Indonesia (28.2%) and Thailand (30.2%). The share of jobs in industry is comparable with that in other countries, at 26.1% of employment. The service-oriented labour structure reflects Malaysia's more advanced stage of industrial transformation (Malaysia MoE, 2025a).

Malaysia's labour market continues to grapple with persistent structural challenges. The prevalence of the low-cost production model discourages the productivity boom and depresses wages. High dependence on foreign workers should be noted, with further negative impacts on local market wages. Additionally, the labour market faces a widening gap between high-skilled and high-paid job opportunities and a booming graduate pool, which has worsened post-pandemic. In 2021-2022, fewer than half of new graduates (266 000 persons) were able to secure high-skilled jobs (105 000 jobs) (Central Bank of Malaysia, 2023b). This imbalance raises concerns about underemployment among the youth and a risk of brain drain. Nevertheless, quality investments in high-value-added industries, especially in the energy transition, might create better-paying, high-skilled employment opportunities, serving as a long-term remedy for Malaysia's labour market challenges.

Under the 1.5°C Scenario, employment is, on an annual average, 1.4% higher than under the PES over 2024-2050 (Box 3). In 2050, there would be an additional 420 000 jobs under the 1.5°C Scenario compared with the PES, due to the development of electricity supply and of utilities, services and basic manufacturing (Figure 19). This rapid expansion is primarily due to energy transition-related investments in quality infrastructure, in line with Malaysia's national policy. However, the construction, transport and engineering sectors would experience modest growth (Figure 19).

Figure 19 Employment difference (in thousands) between the 1.5°C Scenario and PES, by sector, 2030-2050



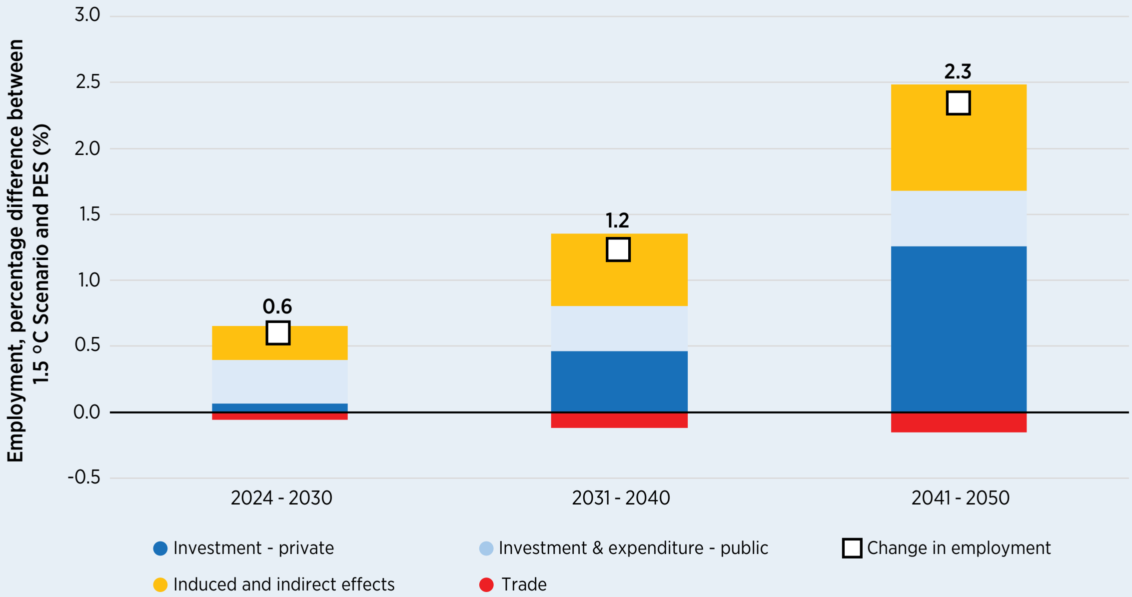
Notes: "Other utilities" refers to and encompasses sectors related to gas, steam, air conditioning, water supply, waste management, etc. (UNSD, 2008) PES = Planned Energy Scenario.

These trends signify a shift in employment patterns, with decreased reliance on manufactured gas and fuels, and growing importance placed on sectors associated with renewable energy, services and manufacturing. Notably, the oil, gas and manufactured fuels sectors are anticipated to see substantial job reductions, of 6.1% in 2030, 16.2% in 2040 and 22.0% in 2050, between the 1.5˚C Scenario and the PES. Other service sectors are expected to create jobs due to indirect and induced effects.

Box 3 Drivers of economy-wide employment growth

The 1.5˚C Scenario would see increasingly positive impacts on economy-wide employment in Malaysia. Under this scenario, employment is projected to increase by an annual average of 1.4% (which translates to an annual average of around 250 000 additional jobs each year), during the transition period (2024-2050) relative to the Planned Energy Scenario (PES). The employment difference is 0.6% in the first decade (2024-2030), 1.2% in the second decade (2031-2040) and then peaks, at 2.3%, by 2041-2050. This trend is mainly driven by investment, and the indirect and induced effects between 2024 and 2050 (Figure 20).

Figure 20 Percentage difference in employment (%) between the 1.5°C Scenario and PES, 2024-2050



Note: PES = Planned Energy Scenario.

As in the analysis of GDP, **investment** (including private investment, and public investment and expenditure) is driving the majority of the employment difference between the 1.5˚C Scenario and the PES. The 1.5˚C Scenario adds more than 4.6 million jobs between 2024 and 2050. Private investment has an increasing positive impact on the economy-wide employment difference over the transition period, largely due to private energy-transition-related investments, mainly in the power sector. The jobs created due to transition-related investments (*i.e.* in grids and energy flexibility, energy efficiency, renewables, hydrogen and biofuel supply) would surpass the expected negative impacts of job displacement in fossil fuel extraction activities. Public investment in transition-related technologies and sectors, as well as greater social spending, would also lead to additional employment across the country relative to the PES. Under the 1.5˚C Scenario, more service-oriented sectors would benefit from government investments, and the positive effect of social spending would be strongly influenced by social-directed payments to low-income households financed by international climate co-operation flows. As can be seen in Box 1, the government is expected to expend roughly an additional USD 2.2 billion in social spending in 2050 under the 1.5˚C Scenario relative to the PES.

Indirect and induced effects also have a net positive impact on the between-scenario employment difference. In the years leading up to 2035, wage effects have the dominant positive role, before being overtaken by consumer expenditure. Growth of lump-sum payments would reduce the tax burden on employment wages, as can be seen in Box 1, and this will positively impact the expansion of labour supply in the years leading up to 2035; the employment difference between the 1.5˚C Scenario and the

PES peaks in the years up to 2030. Consumer expenditure creates more jobs throughout the transition period, and is more dominant after 2035, due to a shift in consumption pattern from fossil fuels to basic manufacturing, hotels and catering, communications, business services, and public and personal services.

Trade has a marginal but negative impact on job creation (around -0.1% per year on average between 2024 and 2050) under the 1.5°C Scenario. This is due to reduced fuel export revenues from lower consumption of manufactured fuels under the 1.5°C Scenario and changes in non-energy trade due to higher imports of goods because of increased consumer expenditure.

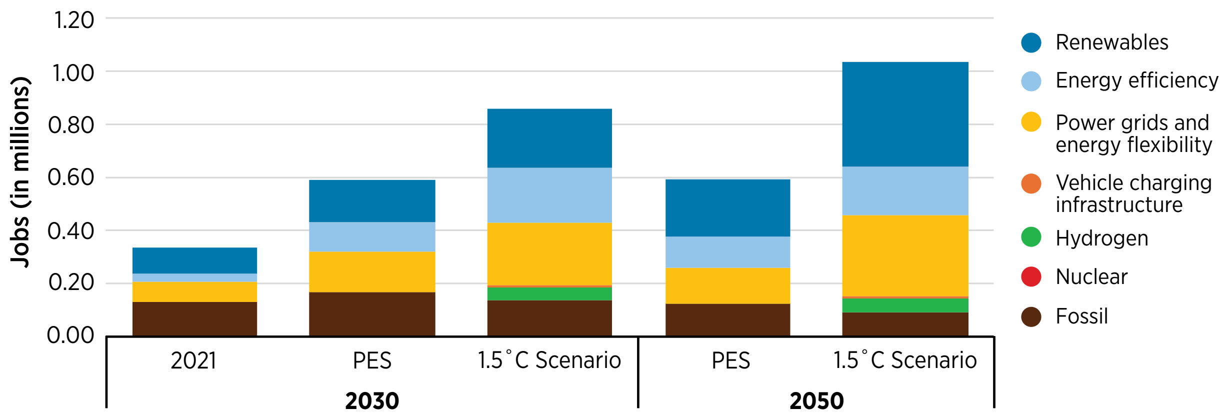
Energy sector jobs

By 2030, the energy sector is anticipated to have roughly 0.9 million jobs under the 1.5°C Scenario, which is 2.6 times greater than the 2021 figure (approximately 0.3 million) (Figure 21). The loss of over 32 000 jobs in conventional energy (*i.e.* fossil) is more than offset by jobs created in renewables (roughly 64 120 additional jobs) and in other transition-related sectors such as energy efficiency, power grids and flexibility, vehicle charging infrastructure and hydrogen (over 237 000 additional jobs), between the 1.5˚C Scenario and the PES by 2030.

Looking ahead to 2050, energy sector jobs increase to over 1.0 million under the 1.5°C Scenario, almost double the expected figure of roughly 0.6 million under the PES. The sustained growth in job creation between 2030 and 2050 is mainly due to renewables and other transition-related technologies (*e.g.* power grids and energy flexibility), which offsets the continuing job losses in the fossil fuel sectors.

Under the 1.5˚C Scenario, the share of renewables in total energy sector jobs would reach roughly 38.2% (equivalent to around 396 000 jobs) in 2050, whereas the share of fossil-fuel-related jobs would decline to around 8.8% (which is around 91 000 jobs) (Figure 21). On the other hand, employment in energy efficiency, and power grids and energy flexibility, would grow rapidly, by around six times and four times, respectively, to reach roughly 182 300 and 305 520 jobs.

Figure 21 Overview of energy sector jobs (in millions) in Malaysia under the 1.5°C Scenario and PES, by sector, 2021-2050



Note: PES = Planned Energy Scenario.

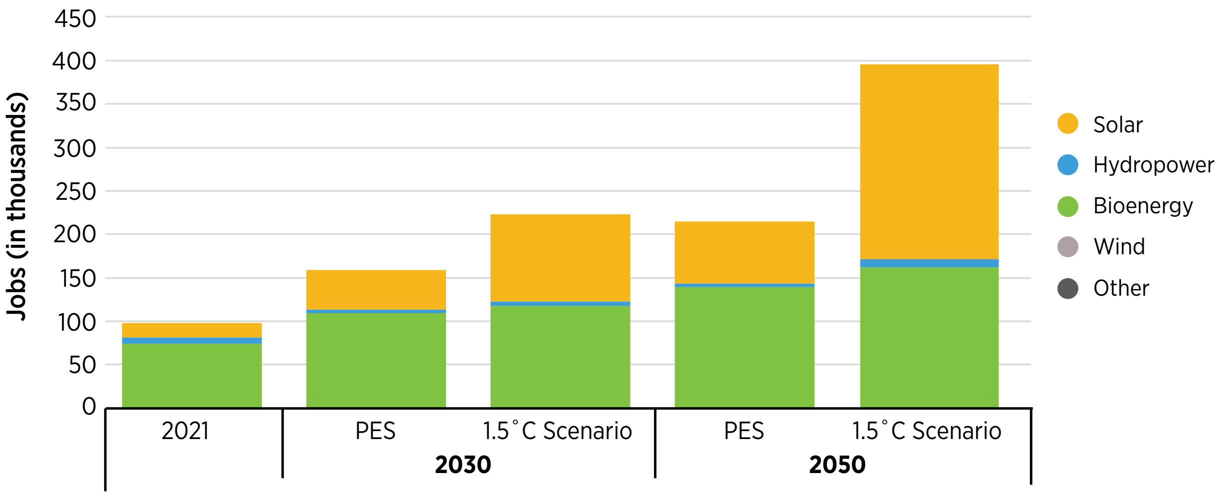
Renewable energy jobs

Employment in renewable energy would increase substantially. From approximately 98 000 renewable energy jobs in 2021, employment would grow to 159 000 in 2030 and 214 000 in 2050 under the PES. The job growth would be more pronounced under the 1.5°C Scenario and would exceed projections under the PES. Renewable energy jobs will reach 223 000 in 2030 and 396 000 in 2050 under the 1.5°C Scenario (Figure 22).

Solar and bioenergy would have the most renewable energy jobs in Malaysia under the 1.5°C Scenario. Rapid growth is forecast for bioenergy, which would generate roughly 118 000 jobs in 2030, further rising to over 162 000 by 2050. The solar sector plays a key role in Malaysia, which is a leading solar PV manufacturer. Solar PV will have around 90 000 and 224 000 jobs in 2030 and 2050, respectively. Solar would represent roughly 56.6% of all renewable energy jobs by 2050, followed by bioenergy, which will have a roughly 40.9% share. In addition, hydropower is expected to contribute with nearly 10 000 jobs in 2050, supported by a 35% growth relative to 2021.

Overall, these figures highlight the substantial growth potential and the increasing significance of renewable energy in Malaysia's energy system, particularly under the 1.5°C Scenario, where solar technologies and bioenergy play pivotal roles in the energy transition.

Figure 22 Renewable energy jobs (in thousands) in Malaysia under the PES and 1.5°C Scenario, 2021-2050

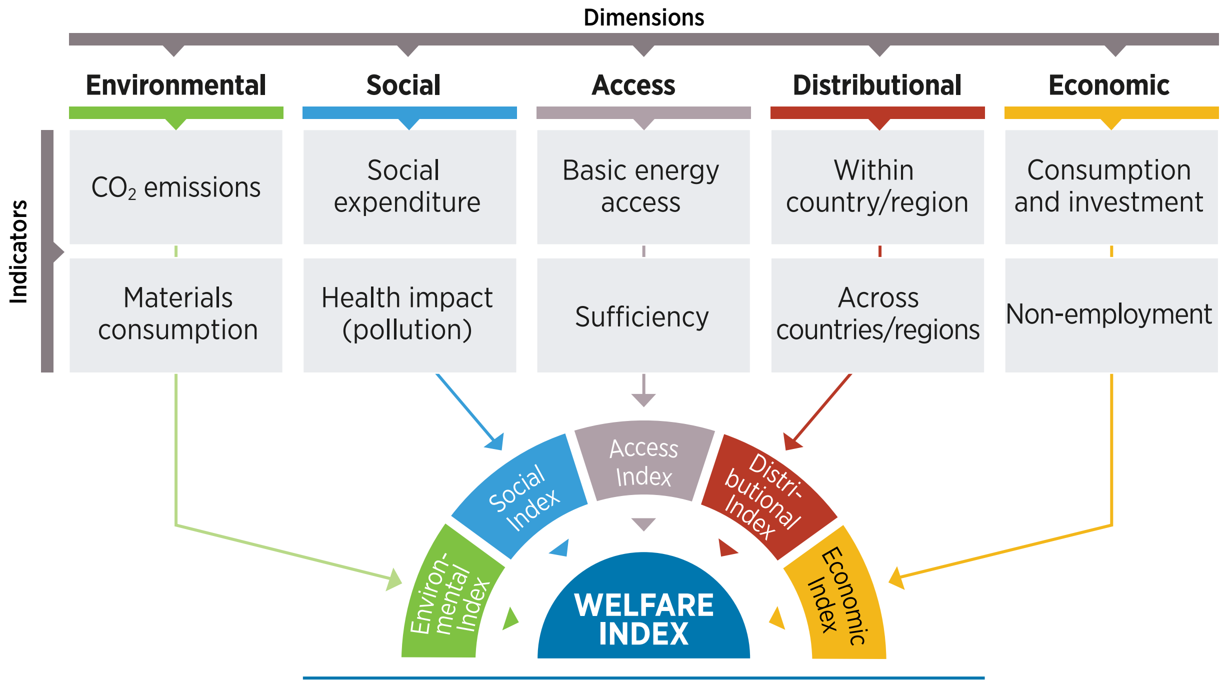


Notes: Other = tidal/marine and geothermal; PES = Planned Energy Scenario.

3.2.3 IRENA Energy Transition Welfare Index

GDP is the standard measure of economic output, but it does not capture factors beyond the market, such as human health, job fulfilment and environment quality. Climate change impacts GDP, but it also affects societies, nature and economies in ways that GDP cannot reflect. Conventional indicators like GDP are thus incomplete and potentially misleading. To better reflect social well-being in the context of the energy transition, IRENA has developed and refined its Energy Transition Welfare Index (ETWI) (IRENA, 2016, 2019a, 2019b, 2020, 2021, 2022, 2023b, 2024) for an extended impact analyses. The IRENA ETWI is a statistical composite index that provides a comprehensive framework to assess the impacts of this transition across five dimensions: Economic, Social, Environmental, Distributional and Access. Each dimension incorporates two indicators (Figure 23).

Figure 23 Structure of the IRENA Energy Transition Welfare Index



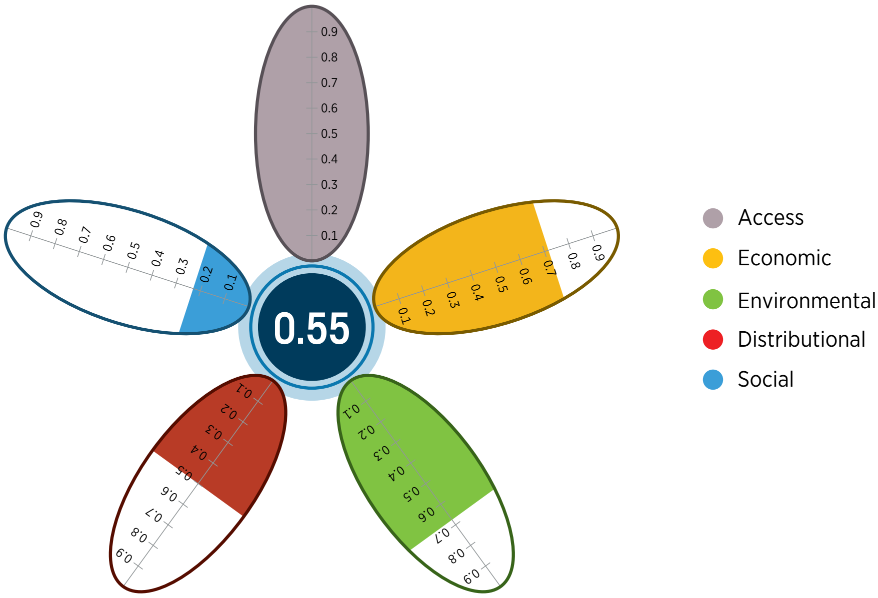
Source: (IRENA, 2021)
Note: CO_2 = carbon dioxide.

To maximise human welfare benefits, a decarbonised energy system must be supported by policies that distribute economic and environmental dividends equitably and bolster sustainable development.

The methodological framework of the IRENA ETWI allows direct comparison between scenarios, revealing potential challenges for policy makers. The five dimensions, which the framework defines, are measured based on ten indicators (Figure 23) (IRENA, 2021). Essentially, once indicators are normalised, they are aggregated through an equally weighted geometric mean to generate the dimension indices, which are in turn summed in the overall welfare index using logarithmic shares. Other international and multilateral organisations use similar methodological frameworks for their respective indices. For example, the United Nations Industrial Development Organization's Competitive Industrial Performance Index and the African Development Bank's Africa Industrialisation Index measure industrial performance and competitiveness based on 8 and 19 indicators, respectively (AfDB *et al.*, 2022; UNIDO, 2013).

The ETWI's five dimensions are evaluated on a scale from 0 (low performance) to 1 (high performance). Figure 24 presents the overall Welfare Index and its five dimensions for Malaysia by 2050 under the 1.5°C Scenario. The overall ETWI score is projected to be 0.55 under the 1.5°C Scenario, which is an improvement compared to 0.29 under the PES. Nonetheless, Malaysia's overall ETWI is slightly lower than the global average (0.56). Separate indices for each dimension shed light on the driving factors.

Figure 24 IRENA's Welfare Index and dimensional welfare indices for the 1.5°C Scenario by 2050



Note: The five petals are on a scale from 0 (low performance) to 1 (high performance) and represent the absolute values of the five dimensions of the Welfare Index. The number in the centre is also on a scale from 0 to 1 and represents the absolute value of the overall Welfare Index.

Environmental dimension

The environmental dimension is informed by two indicators: cumulative GHG emissions and resource use as measured by per capita material consumption. Malaysia ranked 24th in the world as a GHG emitter and was responsible for 0.77% of global emissions in 2022, releasing 387.45 $MtCO_2eq$. Consistent with the country's economic structure, the energy sector leads the country's GHG emissions, with a 69% share that same year (WRI, 2022). The ND-GAIN index,[16] which assesses countries' vulnerability to climate challenges and their readiness to improve resilience, ranked Malaysia 50th in resilience in the world and 3rd in the ASEAN region, behind Singapore and Brunei Darussalam, in 2023 (University of Notre Dame, n.d.).

Malaysia is actively working to reduce its GHG footprint and support the transition to a low-carbon economy. It is developing instruments for climate action, in line with its latest NDC. Under the 12th Malaysia Plan (2021-2025), the country plans to promote resilient cities and township, expand green mobility and increase the consumption of low-carbon energy (Malaysia MoE, 2021), among other actions. Malaysia spent USD 0.7 billion (MYR 3.1 billion) on environmental protection, which is 4.8% growth in 2021 compared to 2020, most of which was allocated to pollution and waste management and environmental assessment. The manufacturing sector contributed USD 562.7 million, equivalent to MYR 2 487 million (79.8% of the total expenditure), followed by the services sector, which contributed USD 87.3 million, equivalent to MYR 386 million (12.4% of total expenditure) (Malaysia MoE DoSM, 2023).

The environmental dimension is driving significant welfare improvement under the 1.5°C Scenario over the PES in Malaysia by 2050 (right panel in Figure 24). The 1.5˚C Scenario has significantly lower global cumulative CO_2 emissions, and this is solely responsible for the added improvements in the environmental dimension. Meanwhile, domestic material consumption, the other indicator of the environmental dimension, continues to grow under the PES as well as the 1.5° C Scenario, slightly dragging down the environmental dimension.

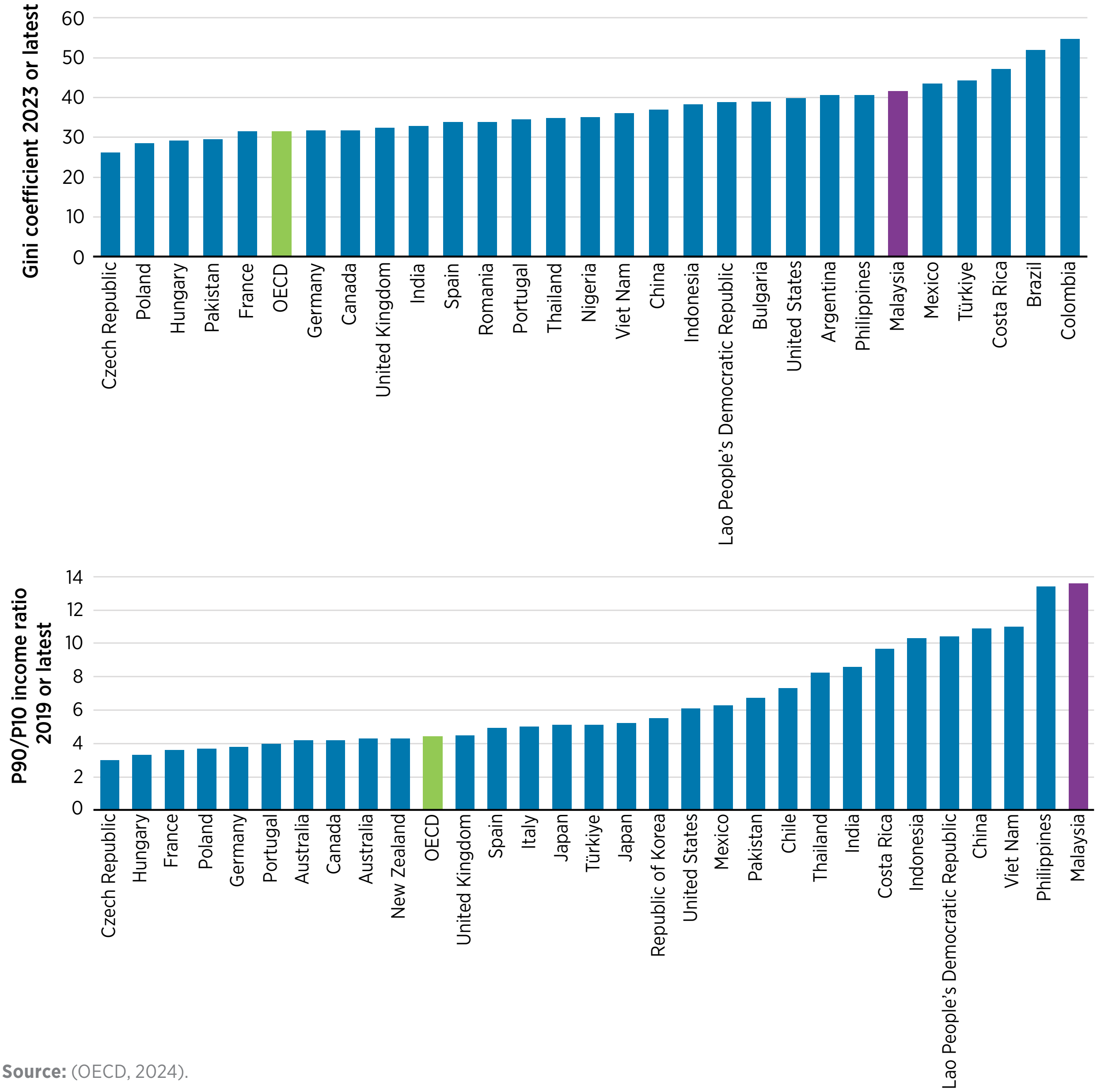
[16] *The ND-GAIN (Notre Dame Global Adaptation Initiative) Index measures a country's readiness to adapt to climate change by integrating two critical dimensions: vulnerability and readiness. It gauges a country's exposure, sensitivity and capacity to adapt to climate change across sectors such as food, water, health and infrastructure. Readiness addresses the country's economic, governance and social capacity to undertake adaptation actions. The ND-GAIN index is a normalised difference between readiness and vulnerability, such that a higher value represents greater preparedness for and resilience to the impacts of climate change.*

The slight decline in the environmental dimension underscores a need for reducing domestic material consumption in Malaysia in the future. For this, the country needs a more circular and resource-efficient economy, which can decouple material consumption from economic growth. This involves lessening dependence on natural resource extraction, reducing material intensity and fostering innovation in priority value chains. Malaysia will also need to strengthen policies that promote and support circularity, including sustainable public procurement, eco-design standardisation and recycling infrastructure. Consistent with IRENA's findings (IRENA, 2025b), the development of low-carbon and resource-resilient supply chains will not only help address environmental pressures, but it will also reinforce Malaysia's competitiveness, industrial resilience and long-term socio-economic prosperity in line with its net-zero aspiration.

Distributional dimension

The distributional dimension of the IRENA ETWI measures income and wealth inequalities within and across regions and countries. Malaysia has seen significant gains in poverty reduction and income convergence over the past two decades, but such advancements have not eradicated the structural disparities that remain between regions and social groups. Malaysia continues to have higher income inequality than recently transitioned as well as long-established high-income countries, as can be seen in Figure 25 (OECD, 2024). Inequality in the country exceeds the average of the Organisation for Economic Co-operation and Development (OECD) countries as well as that of other comparable economies (such as the Philippines, Argentina and Thailand), when measured by the Gini coefficient and the P90/P10 income ratio. The P90/P10 income ratio highlights even worse indicators. In 2022, Malaysia's median national monthly gross household income was MYR 6 338, while the mean was MYR 8 479, indicating that average incomes were pulled upwards by higher earners. Such income differences mirror disparities among states. Selangor, Kuala Lumpur, and Putrajaya lead as the highest-earning regions, whereas Kelantan and Kedah remain the lowest-income states.

Figure 25 Gini coefficient (top) and P90/P10 income ratio[17] (bottom) in selected regions



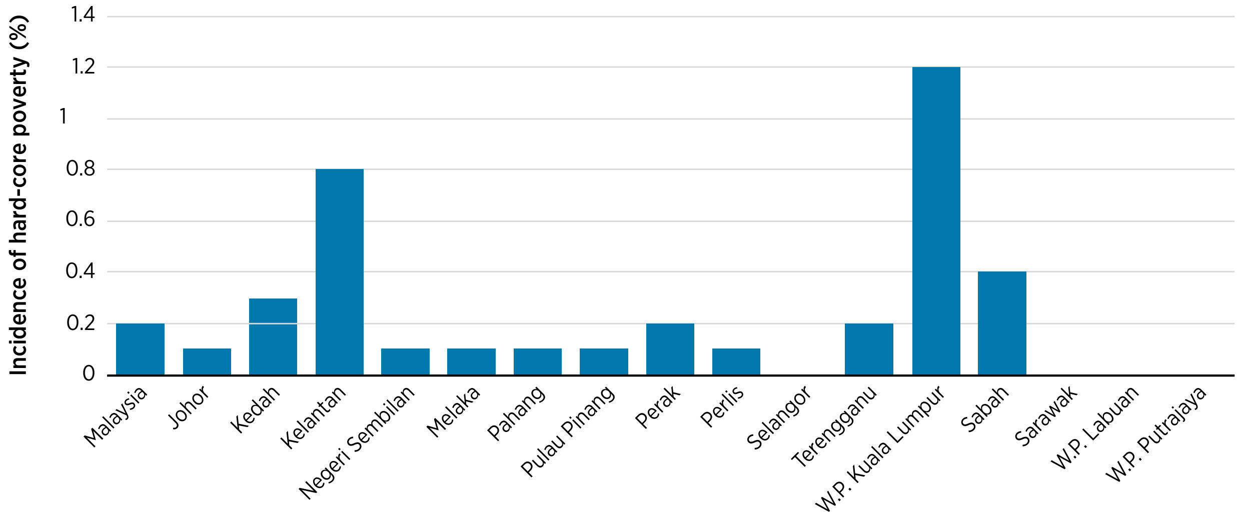
Source: (OECD, 2024).

Regional patterns suggest that economic activity is concentrated in regions such as Putrajaya, Kuala Lumpur and Selangor, forming a high-income corridor. Other regions, including Kelantan, Kedah and Sabah, trail in comparison with Selangor. This is also reflected in the incidence of extreme poverty,[18] which is 0% in the most-developed regions and significantly higher in the less-developed states (*e.g.* reaching 1.2% in Sabah) (Figure 26).

[15] *The P90/P10 income ratio is a measure of income inequality. It specifically compares the income of the 90th percentile of a population (i.e. the 10% of people with the highest income) to that of the 10th percentile. It thus compares the gap between the richest and the poorest.*

[18] *Extreme poverty: A household is considered to be under extreme poverty if its gross monthly income is below the Food Poverty Line Income (Food PLI). This indicates that this household's income is not sufficient for meeting the basic calorie requirements.*

Figure 26 Incidence of extreme poverty in Malaysia, by state, 2022



Source: (Malaysia MoE DoSM, n.d.).

The analysis of the distributional dimension reveals positive impacts on welfare when comparing the 1.5°C Scenario and PES. Under the 1.5°C Scenario, increased fiscal capacity and the inflow of international climate collaboration funding result in income distribution improving substantially. Public expenditure (such as subsidies to support the transition and public transition-related investment) has increased as a result. By 2050, the absolute distributional index will reach 0.50 under the 1.5°C Scenario, compared with 0.43 under the PES, indicating some progress but also highlighting scope for further improvement. Reducing structural distributional inequalities would require more action from Malaysia in addition to the measures in the climate policy basket under the 1.5°C Scenario, which directly targets the improvement of income distributions within the country and relative to other countries in the global context.

Social dimension

The social dimension consists of two indicators: per capita social public expenditure, which targets increase of social value, and per capita health impacts from pollution. Social public spending in Malaysia has grown steadily. Government expenditure on subsidies and social assistance increased from USD 4.48 billion (*i.e.* MYR 19 793 million) in 2020 to USD 16.3 billion (*i.e.* MYR 71 873 million) in 2023. This represents an expanded share of social public spending in overall operational government expenditure, from 8.8% of in 2020 to 23.1% in 2023 (Malaysia MoE, 2024). However, social spending at a country level remains relatively lower in Malaysia than other upper-middle-income countries, raising concerns about its fiscal capacity to address forthcoming challenges. In 2022, social spending in Malaysia stood at 5.5% of GDP, only about a quarter of the OECD average, highlighting the potential need for more public social spending (OECD, 2024).

In 2021, Malaysia's health expenditure amounted to 4.4% of GDP, which was slightly below the roughly 5% average of East Asia and the Pacific (excluding the high-income countries) and the roughly 5.8% average of upper-middle-income countries (WHO, n.d.). Since 2024, the government has prioritised universal access to quality healthcare services, pledging to allocate 5% of GDP to healthcare spending, as stipulated in the Health White Paper (Malaysia MoF, 2024).

Under the 1.5°C Scenario, the social dimension registers the lowest gain among all dimensions in Malaysia by 2050. Clean air yields important improved public health outcomes and reduces health damages. This also has a positive impact on the social dimension of the ETWI. Malaysia can realise larger welfare benefits by increasing and expanding social investments that can build resilience to climate risks and also strengthen social protection, education and healthcare.

International collaboration could also play a crucial role in strengthening the social dimension for Malaysia. International collaboration funds could be allocated specifically to support government investment in social infrastructure, such as energy access, healthcare and education. However, Malaysia's experience highlights the fact that increased public spending alone does not guarantee improved social outcomes. Socio-economic factors, including gender equality and equitable treatment of marginalised groups, profoundly influence access to higher education and improved health outcomes. Persistent gender and regional disparities often impede potential gains in health, education and social infrastructure, though they present development opportunities. To maximise impact, government spending must be integrated within a holistic policy approach that addresses underlying socio-economic inequalities.

Energy access dimension

By 2019, electricity constituted roughly 20% of Malaysia's total TFEC, with over 80% of residential and commercial buildings dependent on it (IRENA, 2023a). While Malaysia reported nearly universal electricity access, at 99.7% in 2022 (Malaysia MoF, 2025), urban-rural disparities remained. Remote areas, especially in East Malaysia (Sabah and Sarawak) and parts of the northern peninsula, were persistently struggling to access energy. Rural Sabah recorded the lowest electrification rate at 88.7%, compared with 96.1% in Sarawak and 99.5% in Peninsular Malaysia. Geographic isolation, challenging terrain and outdated infrastructure have driven up grid expansion costs and frequent brownouts in rural areas (Kearney, 2021).

In response, the government implemented targeted programmes, including the Rural Electricity Supply Programme (Bekalan Elektrik Luar Bandar, BELB), which provided electricity to 49 415 rural houses until 2020. The programme will continue to provide electricity to an additional 28 000 houses and facilitate progress towards the 99% rural electricity coverage target. The Sabah Renewable Energy Rural Electrification Roadmap (RE2), supported by the UK Partnering for Accelerated Climate Transitions (UK PACT), was initiated in 2023 to deploy renewable energy mini-grids for at least half of the unelectrified villages in remote Sabah by 2027 (UK PACT, n.d.). The 13th Malaysia Plan (2026-2030) prioritises the expansion of infrastructure and essential services (clean water, electricity, broadband) in rural areas to improve social mobility (Malaysia MoE, 2025b). Together, these measures highlight Malaysia's recognition of energy access as a socio-economic equity issue and its efforts to ensure reliable and affordable energy access in remote areas. For Malaysia, expanding rural electricity coverage, through off-grid and hybrid solutions, and scaling up renewable energy capacity could be emerging solutions to bridge the urban-rural accessibility gaps.

Under the PES, basic energy access in Malaysia would reach an index value of 0.99 by 2050. It improves significantly under the 1.5°C Scenario, with the country achieving universal energy access by 2029 – two decades in advance of the PES. Under both scenarios, Malaysia's energy consumption reaches the sufficiency level,[19] defined as 20 kilowatt hours per capita per day in the literature (Millward-Hopkins *et al.*, 2020).[20] This indicates that the energy accessed is not only basic but also meets the sufficiency requirements for a decent standard of living in Malaysia.

[19] *This indicator is defined as the required level of energy consumption for decent living, but no more.*

[20] *The authors estimated the sufficiency level to be between 11.6 kWh and 30.4 kWh/capita/day across all 119 countries in the Global Trade Analysis Project (www.gtap.agecon.purdue.edu/databases/regions.aspx?version=9.211).*

Economic dimension

The economic dimension is composed of two indicators: one measuring consumption and investment per capita and the other measuring non-employment as the ratio of the share of the working-age population (aged 15-64 years) that is neither employed nor in education and the share of youth (aged 14-24)[21] that is neither employed nor in education. Malaysia's consumption and investment dynamics continue to strongly support domestic demand. Private spending acts as the main driver. Rising private investment is expected to further stimulate economic growth in the coming years. The labour market demonstrated resilience in recovering from the pandemic. Labour force participation showed an upward trend, total employment grew consistently, and the unemployment rate remained low at around 3.5% (Malaysia MoF, 2024).

As with the environmental and energy access dimensions, the economic dimension sees notable improvement under the 1.5°C Scenario, reaching an index value of 0.71 by 2050 (Figure 24). Both consumption and investment per capita, as well as the non-employment indicator, contribute positively to the improvement of the economic dimension.

[21] *Non-employment is used instead of unemployment or employment metrics because non-employment gauges the social implications of paid work more comprehensively, which is the main goal of a welfare index.*

CHAPTER 4
CONCLUSION

Economic growth in Malaysia has slowed, but the economy remains resilient despite recent global uncertainties, including slowing global growth, geopolitical tensions and the impact of climate change. Between 2010 and 2024, Malaysia's economy grew at an annual rate of approximately 4%, recovering steadily from the COVID-19 pandemic (World Bank, n.d.).

Looking ahead to 2050, Malaysia's economic outlook appears promising. Under the PES, its economy is expected to grow steadily, with real GDP expected to increase at a compound annual growth rate of around 3.5% per year between 2023 and 2030. This growth rate is anticipated to rise to 4.1% per year during the subsequent period (2031-2040) and then moderate to 2.9% in the final decade of the transition (2041 and 2050). Under the 1.5°C Scenario, Malaysia is projected to add an additional USD 533.3 billion to its GDP, building on the growth already anticipated under the PES from 2024 to 2050. Investment (private, and public investment and spending), induced social-directed payments from revenue recycling, domestic responses to carbon price shifts, technology prices, power sector capacity, fossil fuel subsidies and trade to a lesser extent, are the main macroeconomic drivers influencing the GDP differences between the scenarios throughout the transition (*i.e.* from 2024 to 2050).

Employment in Malaysia is projected to increase by an annual average of 1.4% (which translates to approximately 250 000 additional jobs each year) during the transition period under the 1.5°C Scenario, compared with the PES. The employment difference between scenarios is 0.6% in the first decade of the transition (*i.e.* 2024-2030), increases to 1.2% in the second decade (*i.e.* 2031-2040) and peaks at 2.3% in 2041-2050. This trend is due to a shift in employment patterns; reliance on mining and manufactured fuels is less, and sectors associated with manufacturing, electricity supply and utilities, services and renewable energy are given increasing importance. Notably, substantial job growth is anticipated in the electricity sector throughout the transition period. The loss of jobs in conventional energy (*i.e.* fossil fuels) under the 1.5˚C Scenario is more than offset by the jobs created in renewable energy and other transition-related sectors, including energy efficiency, power grids and flexibility, vehicle charging infrastructure and hydrogen.

Renewable energy employment in Malaysia is projected to quadruple between 2021-2050 under the 1.5°C Scenario. Growth is led mainly by solar and bioenergy. As a major global solar PV manufacturer, Malaysia is well placed to leverage this global shift. Employment in solar is expected to reach around 90 000 jobs by 2030 and 224 000 by 2050, accounting for more than half of total renewable energy jobs. Bioenergy follows closely, with a share of 40.9%. These trends underscore the significance of the sector in Malaysia's energy transition and suggest potential opportunities in terms of socio-economic benefits.

Welfare improves significantly under the 1.5°C Scenario compared with the PES. This improvement is driven by progress in the environmental, economic and energy access dimensions. But more needs to be done to unleash yet higher increases in welfare in Malaysia. The detailed results provide clear indications of where to focus policy action to improve welfare. The greatest room for improvement occurs in the social dimension, where the government might look to introducing measures to increase social spending. International climate collaboration could play a crucial role in improving this social dimension. Revenues received from these collaborations could be earmarked specifically for the government contribution to social infrastructure spending, including healthcare and education. Furthermore, there is significant room for improvement in the distributional dimension. Policies to improve wealth distribution and enhance fiscal space should be given priority as means of further strengthening both economic and distributional performance.

The energy transition is a challenging process, and an inclusive just transition implies there should be alignment between energy policies with broader economic and development priorities. Socio-economic disparities should be addressed with the help of comprehensive policies. The following are some key points for policy makers to consider moving forward:

a. Malaysia is economically exposed to climate change, limited fiscal space while experiencing growing socio-economic inequality. The energy transition provides a pathway through which to tackle these challenges. Climate-related damages can be mitigated with proactive and adaptive measures.

b. The energy transition can stimulate investments in high value-added industries and drive research and development for sustainable technology. Increased financial and knowledge resources not only can enable local transitions but may also position Malaysia as a major player in the international market.

c. The transition can uplift the local workforce by promoting skills development, and lead to reduce unemployment and improve social equity. Investing in targeted training programmes, especially for women and youth, as well as vulnerable groups within the population will be essential to ensure a more equitable distribution of the benefits generated from new clean energy value chains.

d. Reinforcing international collaboration to strengthen fiscal support, notably through climate and social funds that support a just transition. Such support could close infrastructure and financing gaps while also potentially revitalising high value-added manufacturing sectors currently in decline.

e. Redirecting public finance could also contribute to ensuring that fiscal policy aligns with equity considerations within national decarbonisation pathways, for instance, through the phasing out of fossil fuel subsidies in support of redirecting public expenditures in favour of social protection.

f. Scaling of facilities like the National Energy Transition Facility into a broader blended finance platform may potentially synchronise concessional capital and private investment. This would be especially relevant for energy transition projects at small-scale and early-stages.

g. Measurement of participatory governance and social equity indicators in national energy and industrial plans, so that policy design and investment decisions reflect all segments of the population.

h. In the energy sector, renewable energy technologies can support universal access to energy in rural and remote areas. Malaysia has great potential to capitalize on its abundant resources for a green and sustainable energy transition. Yet unlocking this potential will require to tackle complex challenges through collaboration and co-ordination, on both technological, economic, regulatory and social fronts.

i. In line with IRENA's framework for just transition, there is a need to expand the roll out of modern energy services, notably in underserved rural areas. An increasing number of decentralised renewable energy options offer the potential to improve living standards, reduce household energy spending and provide new opportunities for economic gain.

Although Malaysia faces economy-wide challenges, the long-term perspective offers real opportunities for economic prosperity and employment transformation, with a focus on the renewable energy sector. The priority remains a well-functioning, inclusive and low-carbon economy. Supporting the social along the distributional dimensions may result in improvements of overall welfare when people can access equitable socio-economic opportunities. As the energy transition advances, the world is starting to see the benefits of relying on renewables for future energy supplies and by reducing energy demand through more efficient use. Malaysia stands to gain significantly from the energy transition, bolstered by international co-operation along with supportive policy measures.

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