




the tree  
the sky  
the sun

**A Pathway Towards  
Malaysia's Carbon-Neutral Future**



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# Prologue: The origins of *The Tree, The Sky, The Sun*

The COVID-19 pandemic is a crisis occurring in the midst of another global challenge – climate change. For many people throughout the world, health and economic recovery are the top priorities now. But while the serious challenge of climate change seems less urgent, it is just as important in the long run. For those who think creatively about the future, responding to both these challenges together raises opportunities to imagine how economies could develop in sustainable ways and how green technologies could help encourage economic resilience and result in a better life for all.

The stretch goal of the Paris Agreement – to hold the increase in global average temperature to 1.5°C above pre-industrial levels – is an ambitious one. To achieve this goal, the Agreement calls for a “balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the second half of the century”. This balance is what is meant by “net-zero emissions” (NZE) or “carbon-neutral”.

In 2018, Shell published the Sky scenario, which showed a technically and economically possible route forward to reduce global energy-system emissions and hold the global average temperature rise to well below 2°C. In 2021, Shell published Sky 1.5, which maps an extremely challenging pathway society would need to take to meet the stretched goal of the Paris Agreement – this pathway requires the entire world in aggregate to reach net-zero CO<sub>2</sub> emissions sometime before 2060. Different countries and sectors may move at different speeds, but all need to move as quickly as possible.

In 2019, the Shell scenarios team, with consultation and input from a diverse group of Malaysian stakeholders, developed an aspirational scenario – a story, not a forecast or a set of policy recommendations – of how Malaysia could reach the **sky** (net-zero emissions) by as early as 2065 with its unique advantages of **tree** and **sun**. This story uses data and analysis based on Shell’s World Energy Model (WEM) and Shell’s Sky scenario (2018), that was validated through stakeholder consultation workshops and engagements.

As you read this story of ***The Tree, The Sky, The Sun***, imagine yourself going through a journey into the future, from today to 2065, recognising and understanding the important levers that would enable Malaysia to achieve a net-zero emissions future. While this story of the future was developed before the onset of the pandemic, the only effect of the pandemic on the journey it describes is to make it more urgent than ever that the world, including Malaysia, begin to take steps now to reach the stretch goal of the Paris Agreement, for the sake of all.





the tree





The **Merbau** tree, an indigenous hardwood species, is announced as Malaysia's national tree. The Prime Minister said Merbau was chosen as a symbol of national pride and to show the government's commitment towards sustainability.

Malay Mail, 23 Aug 2019

# The journey from today to 2025

## From BAU to Merbau

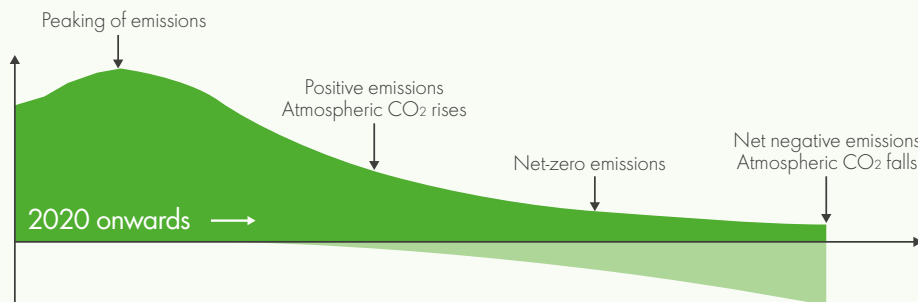
In **The Tree, The Sky, The Sun** scenario, business as usual – BAU – is transformed. This transformation is possible because of the commitment of the Malaysian people; the policies of the Malaysian government; and the wise use of resources.

During this period, Malaysia shifts from aspiring to be a leading sustainable country to *having the confidence* that this goal can be achieved. It has so much to build on:

- Malaysia is free from the natural disasters that many other countries suffer;
  - Malaysia has land available for development;
  - Malaysia has a steady GDP growth, good foreign investments, a conducive investment climate, and a tech-driven economy;
  - Malaysia has an educated, multilingual population;
- Malaysia is situated in the middle of ASEAN, occupying a strategic location for trade;
  - and Malaysia has good infrastructure, although with room for improvement.

The first step on the journey is a **communication campaign** and extensive discourse throughout the country to encourage a *consensus for commitment* to work together to achieve the ambitious goal of net-zero emissions by 2065. This campaign helps Malaysians understand that in relation to this goal, all parties must act together, just as the nations of the world did in creating the original Paris Agreement. For this purpose, *Malaysia must be one tree, even though it has many diverse branches.*

### The journey towards net-zero emissions



The Intergovernmental Panel on Climate Change (IPCC) identifies net-zero emissions by 2070 as consistent with keeping global average temperature increase to well below 2°C

■ Greenhouse gas emissions      ■ CO2 absorbed by emissions sinks

Source: Hone D. (2017). *Putting the genie back - solving the climate and energy dilemma*



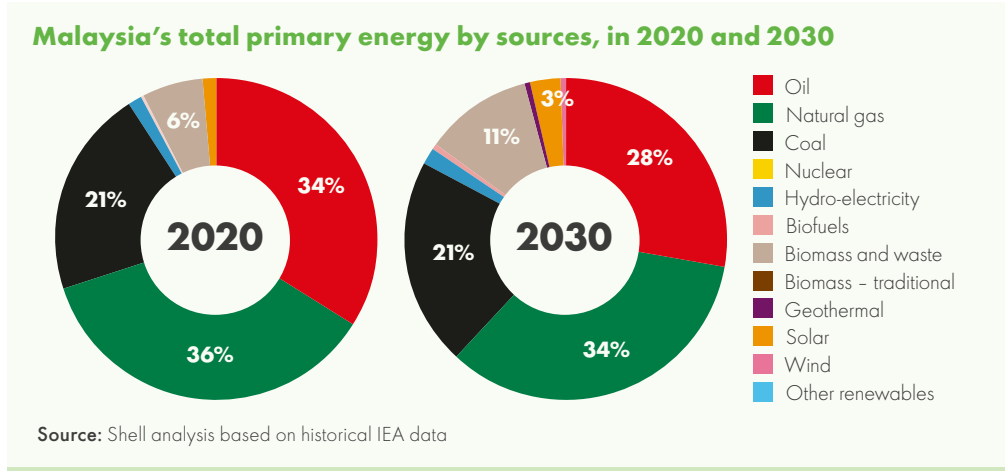


# The journey from 2025 to 2030

## Flourishing forests

Malaysia already enjoys the advantage of having shifted from an oil-dependent economy to one based on a diversified mix of oil, gas, coal, and hydro. But while natural gas provides a significant portion of primary energy supply in Malaysia and generates

about 35% of the electricity, greater portions of the primary energy are still supplied by oil and coal – significant contributors to the production of greenhouse gases, especially as Malaysia moves into a more electrified economy.



The transition to a more **renewable economy** must start early and aggressively, as the transition takes time. And during that time, carbon emissions must be offset. Here, Malaysia is blessed with a natural carbon sink – trees. Early in the journey to a carbon-neutral economy, forest preservation and reclamation is a top-level priority. Malaysia made a public commitment at the 1992 Rio Earth Summit to maintain at least 50% of its land mass under forest cover. In order to protect 50% of Malaysia’s forest areas, by 2025, all states must institute a public consultation process before any deforestation project. In addition, for every tree cut, another tree must replace it – and the replacement must happen first. A plan is in place for 100% protection by 2045 – including rehabilitating those parts of the forests that have been degraded over time, and providing an additional 19,000 square kilometres of **reforestation** before 2065.





## Shifting the market

In tandem with other markets, Malaysia will also **de-regulate** its fuel market. While fuel subsidies are phased out, a **price on carbon** or the **external cost** will be phased in for all forms of carbon emissions beginning from 2026, starting with the energy and transport sectors. The funds saved (from fuel subsidies) and raised (from carbon pricing) are specifically set aside to support the transition pathway towards more renewable, energy-efficient and green technologies. Some funds, for example, are used to help states save their forested land. Others are used to support the fuel needs of low-income families through lower-carbon fuel options. As the economy becomes more developed, the total amount of subsidies to poor families lessens.

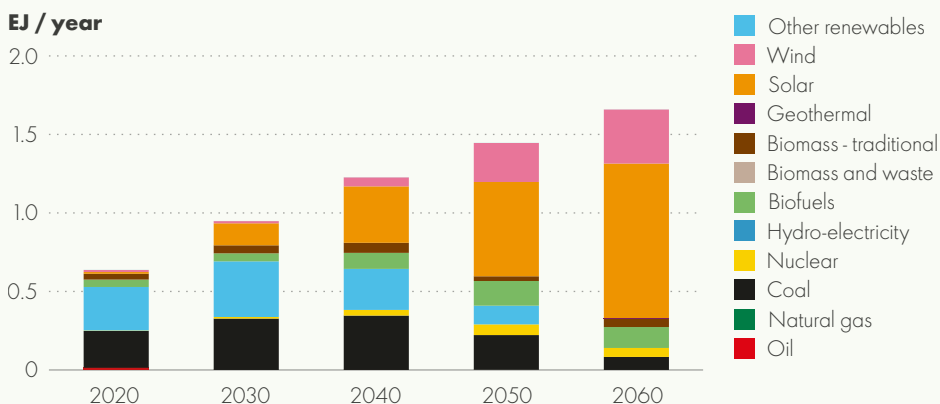
While the fuel market is no longer distorted by subsidies, it is increasingly shaped by the

financial market, with its preferential interest rates for energy-efficient houses, cars, and appliances. All these measures help push electricity generation away from coal and into natural gas and renewables. By 2030, Malaysia's greenhouse gas (GHG) emissions intensity, in relation to gross domestic product (GDP), has been reduced from 2005 levels by 45%.

## Shifting the culture

With more emphasis on energy sources and a robust **sustainability curriculum** in education, young people become more environmentally inclined. Not only do they influence their parents, but they also become champions of the environment. As they become working adults, they have louder voices and more influence on the nation's economic agenda, favouring government policies and actions that move Malaysia towards a carbon-neutral future.

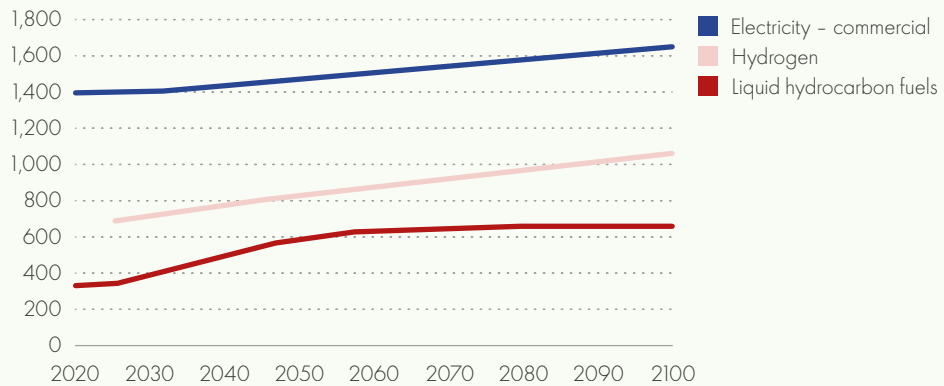
### The decline of coal in Malaysia's total final consumption, from 2020 to 2060



Source: Shell analysis based on historical IEA data

## Energy (fuel) efficiency for passenger road transport

### Vehicle km per GJ (input)



Source: Shell analysis based on historical IEA data

Where this circle of influence is seen most dramatically is in passenger transportation. More people prefer **electric vehicles** (EVs) over internal combustion engine (ICE) vehicles, and early adopters form EV owners' clubs to advocate and share information on enabling policies, the air quality of cities, EV lifestyles, recharging locations, EV purchase incentives, and the latest news. As more Malaysians enter the middle class and buy cars, this preference makes a difference in the market – a preference that is given a push from aggressive fuel efficiency and emissions standards for vehicles, and air quality standards for cities.

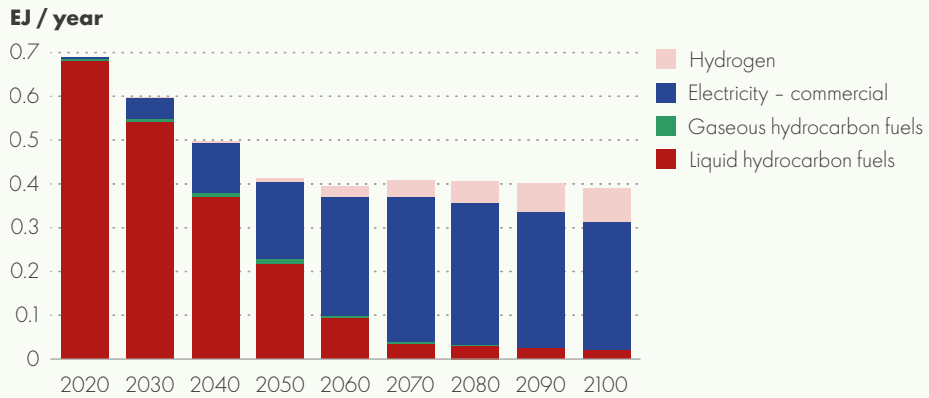
Also enabling the faster-than-expected shift in transportation is the relatively lower cost of EV ownership due to its higher energy efficiency. Having reached price parity with ICE vehicles of similar classes in 2025, EVs quickly become even more affordable. Beyond 2030, in many regions, EVs make up 100% of new car sales. And Malaysians have a great deal of national pride in the extremely popular EVs manufactured by Malaysian car companies.

## Transparency and engagement

At the beginning of the push for a carbon-neutral Malaysia, an ambitious public engagement campaign is launched, especially as carbon pricing is introduced in 2026 at the start of the 13th Malaysia Plan, and as subsidies go down. Web-based **dashboards** with key goals and progress towards those goals give every citizen a picture of what is going on and whether milestones along the pathway are being met. Dashboards bring the long-term into the now and give Malaysians a sense of the meaning behind some of the short-term challenges they are tackling, such as unsubsidised petrol prices. A number of the dashboards are managed by schools and colleges as part of students' computer, ICT, and blockchain programmes, with statistics and oversight provided by the Ministry overseeing climate change matters. Additional information, such as green or energy ratings for buildings, vehicles, products, equipment, and appliances, is also reported on the dashboards.



## Malaysia's electrification of passenger road transport

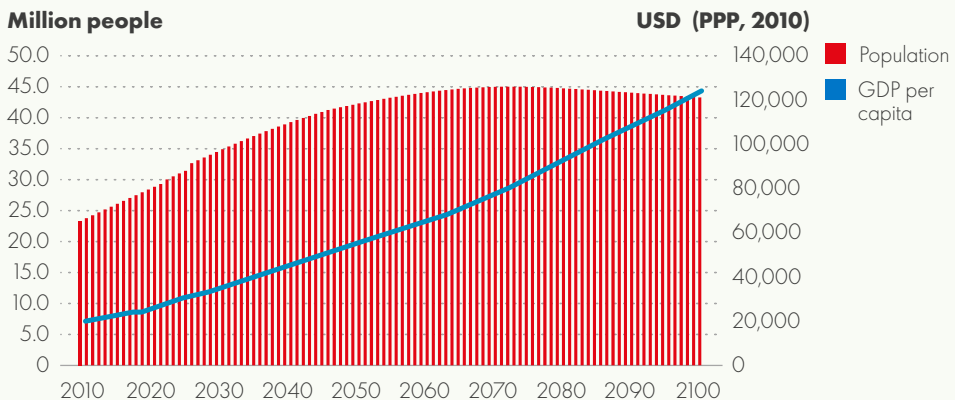


Source: Shell analysis based on historical IEA data





## Malaysia's rising prosperity: GDP and population growth



**Source:** Shell analysis based on historical IEA data

**Note:** PPP - purchasing power parity, is used to compare the income levels or GDPs in different countries.

While policy objectives remain the same, certain aspects are changed slightly in response both to new information and to public input. For example, in addition to reforestation, there is a big push to green the cities as well, leveraging the progress of **green buildings**. Public discussions are often followed by additional objectives and measurements on the sustainability dashboards.

One of the most effective aspects of the **public engagement and transparency campaign** is that carbon prices are paid directly into

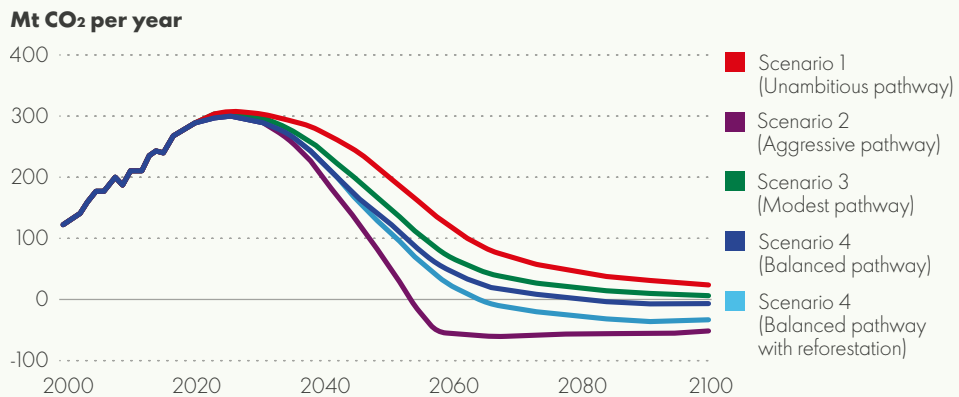
the government's climate change fund rather than into general (consolidated) funds in order to support the transition to a low-carbon economy. Through the public climate-change fund dashboard, the public can see the carbon price, the amount collected and where funds are distributed. Feedback mechanisms allow participatory budgeting for renewable and green technology programmes or initiatives that the public feels should be a priority.

The use of social media continues to be important and contributes to adjustments made

on the dashboards. Young people, especially, are a growing voice for sustainable policies. In 2030, targets along the road to more sustainable palm oil plantations are added to the dashboard website. By the early 2030s, it's clear that carbon emissions have peaked, and this milestone is cause for celebration, and a renewed commitment to even faster movement along the pathway towards a carbon-neutral future.

There is also a public understanding that while carbon emissions have peaked, reaching net-zero is still challenging because of the healthy growth that Malaysia has experienced during the decade – and this growth looks to continue, along with an increased demand for energy. After this carbon emissions peak milestone has been reached, managing growth for the benefit of all and the environment becomes a major focus of Malaysia's sustainability policy.

### Peak of carbon emissions for Malaysia under various scenarios



**Source:** Shell analysis based on historical IEA data

**Note:** The appendix "Behind the Scenes" explains how these scenarios were developed.







the sky



We are the first generation that can end poverty, the last that can end climate change.

UN Secretary-General Ban Ki-moon

# The journey from 2030 to 2050

## The five “increase levers”

By 2030, the government has been working for close to a decade turning goals into policies and demonstrating that green growth is a clear priority for Malaysia. Two “increase levers” have already begun to make a difference in the greening of Malaysia: the increase in **forest acreage and density** and the gradual increase in the **carbon price** (accompanied by the removal of fuel subsidies). In 2035, ASEAN adopts a regional carbon pricing and trading mechanism under Malaysian leadership.

In 2035, Malaysian leaders announce a **refreshed focus** on three other levers of increase: renewed emphasis on **energy efficiency**; a greater push for electrification; and a more widespread use of **renewables**, especially solar.

## Efficiency and electrification

In the decade beginning in 2030, policies which were introduced in the early 2020s to promote energy efficiency are having an effect in every sector of the economy. Regulations coupled with incentives for high-

efficiency motors and appliances, energy-efficient buildings, and industrial processes have produced significant results over time, as regular energy audits show. In many areas, creative coupling of energy efficiency goals and social welfare goals increases public support for the measures necessary to actually

### Malaysia’s rising energy consumption but with increased efficiency

GJ per capita



Source: Shell analysis based on historical IEA data





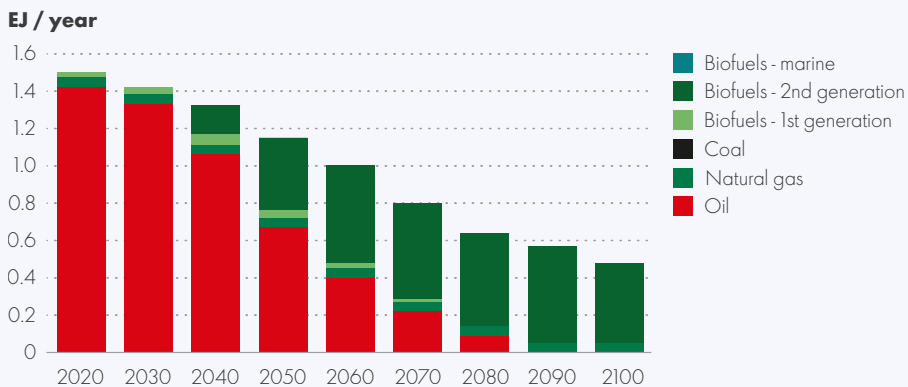
Solar PV installation in a songket motif design on rooftop of Suria KLCC by Petronas

accomplish this greater efficiency. For example, energy-efficient houses are coupled with policies promoting affordable housing.

Palm oil is produced much more efficiently and sustainably, too, along with more efficient production of **biofuels**. During the decade, biofuels form a greater percentage of the liquid fuel mix, even in air transport, road freight, and shipping.

**Digitalisation**, with its capacity to use big data to increase efficiency, plays a key role in the electrification of the energy system. It not only allows electricity to flow efficiently throughout the grid, and self-driving cars to operate within heavily populated areas, but it also allows enterprising consumers to becoming *prosumers* – producers of energy, who sell excess energy back to the grid, enabling a smarter grid system operation.

### Biofuels displacing oil as the preferred liquid fuel for transportation



Source: Shell analysis based on historical IEA data



## Disciplined policy-making – the Iron Triangle

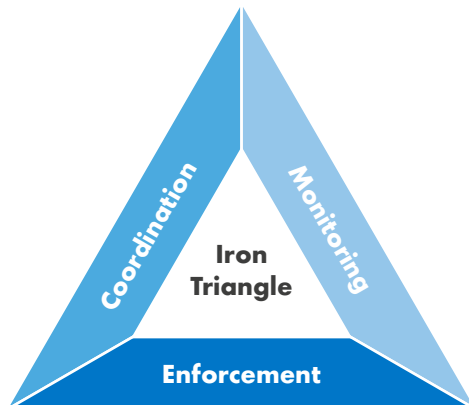
By 2040, Malaysia has made notable progress in achieving its sustainable development goals, building on solid data and power system studies. One reason for this progress is the application of the “**Iron Triangle**” of coordination, monitoring, and enforcement.

Success rests on **coordination** of stakeholders and policies – and the alignment of policies over time, no matter who is in power in government. Malaysia has also made progress in coordination among agencies for effective implementation. For example, the transformation of transportation is the result of inter-agency policy coordination in order to remove fuel subsidies, impose a carbon price and sustainability incentives, support the electrification of transport, and build a much more robust public transport infrastructure.

The second leg of the Iron Triangle is a clear regulatory framework with results that are measured and performance that is **monitored**. Third, regulations are **enforced** fairly and

consistently. And when these regulations are no longer useful, or distort a market that has changed, they are removed.

The Iron Triangle of disciplined policymaking that is coupled to public engagement and transparency and openness of communication yields successes in spite of difficulties and challenges. The public has a new sense of shared responsibility. And policy inconsistencies or flipflops are fewer when the policies themselves are clear to the public, and when there is ongoing transparency as to implementation.





## Reaching for the sky – Malaysia in 2050

By 2050, coal has almost completely disappeared, and the transport sector is almost 50% electrified, in part because of significant improvements in battery technology along with a steep decrease in battery cost. Even heavy industry, the last sector to electrify, is using mainly electricity as its primary energy source.

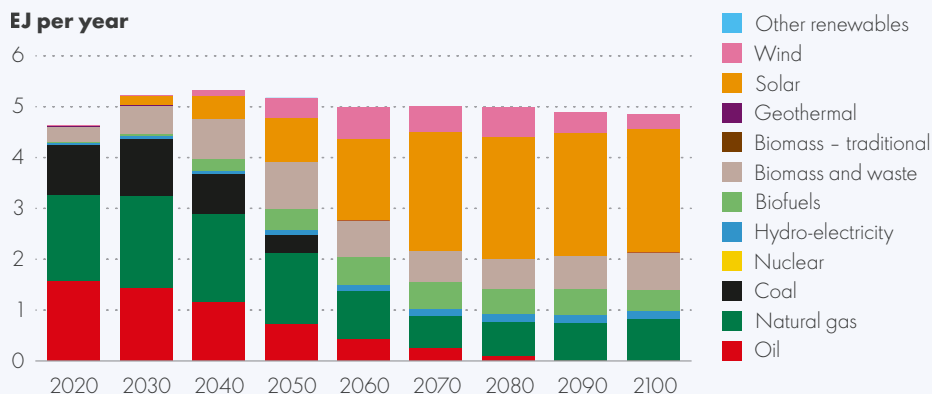
Because rail transport and last-mile public transport has become so efficient, many Malaysians in and near urban areas seldom drive their cars during the workweek.

A highly coordinated ASEAN grid and free trade area is bringing ASEAN countries ever closer together. ASEAN countries share not only connected electricity grid and gas pipelines, but also coordinated transportation systems and an electrified rail and EV recharging network.

A look at the web-based dashboards show that in 2050:

- Malaysia has about 44 million total population.
- Malaysia's GDP is USD57,000 per capita (based on 2010 purchasing power parity).
- Malaysian total final energy consumption is 77 Giga-Joules per capita.
- The carbon price, which was introduced in 2026, has steadily increased to USD100 per tonne carbon over the 25-year period, and Malaysians embrace carbon pricing as the fundamental lever to shift towards a decarbonised nation.
- The electrification rate is at 43% of total final consumption, where solar generates more than 50% of electricity, and the rest is mostly from low-carbon technologies.
- 50% of total primary energy is from renewable energy with natural gas contributing up to 27%.
- Malaysia's reforestation programme is ramping up rapidly, moving beyond 55% of forest cover over Malaysia's total land area.

### Malaysia's total primary energy by source, from 2020 to 2100



Source: Shell analysis based on historical IEA data



the sun





The sun – that power plant in the sky – bathes Earth in ample energy to fulfil all the world’s power needs many times over. It doesn’t give off carbon dioxide emissions. It won’t run out. And it’s free.

**Susannah Locke, Scientific American**



## The pathway of the sun

From 2005 to 2018, Malaysia's installed capacity in solar power had gone up from 1 MW to 1,000 MW, while the system and installation cost had gone down from MYR30 million to 5 million per MW, in large part as a result of a government programme that incentivised rooftop solar. In addition, by the mid 2010s, Malaysia had become the third largest manufacturer of photovoltaics equipment, behind only China and Taiwan. And yet, at the same time, less than 1% of Malaysia's own energy was generated by solar.

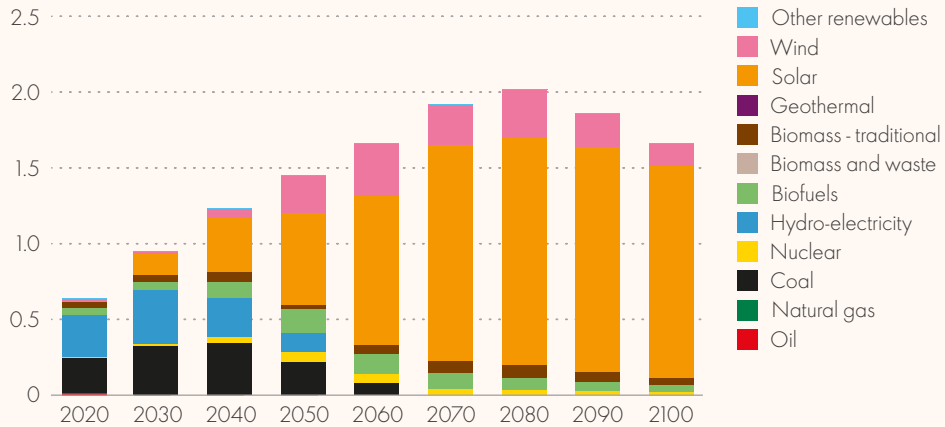
In early 2020s, the Malaysian government begins to formulate a pathway for removing some of the upfront obstacles to solar as a long-term solution. Beside the large-scale solar programmes, the widespread public-private partnership initiatives provide platforms for developers to build **solar townships**, and attractive loans to homeowners to purchase and install rooftop solar panels, with the

loan repayments to be deducted from savings on electricity bills. It incentivizes the installation of solar-battery home systems, and supports the smart grid infrastructure that enhances prosumers to sell power to the grid. Beyond 2040, the percentage of Malaysia's energy that is generated by solar increases to more than 20%.



## The growth of solar power in Malaysia

EJ per year



Source: Shell analysis based on historical IEA data

# The journey from 2050 to 2065

## The sun shines on Malaysia

Many large apartment buildings begin to create circular energy systems, generating solar energy by day and storing it in the newly efficient and capacious batteries for use when needed. Some buildings feature solar photovoltaics as integrated cladding, as part of the building's envelope and architecture, further growing the popularity of building integrated photovoltaics (BIPVs).

By 2065, solar energy has become so affordable that almost all homes are powered by solar-battery-grid systems all

across Malaysia's **green cities and green townships**. Most Malaysians drive EVs powered by solar energy, rather than ICE vehicles - although a growing number don't drive at all but use public transport. Even heavy-duty road transport is mainly hybrid with biofuels and hydrogen "greening" the fuel to a greater and greater extent.

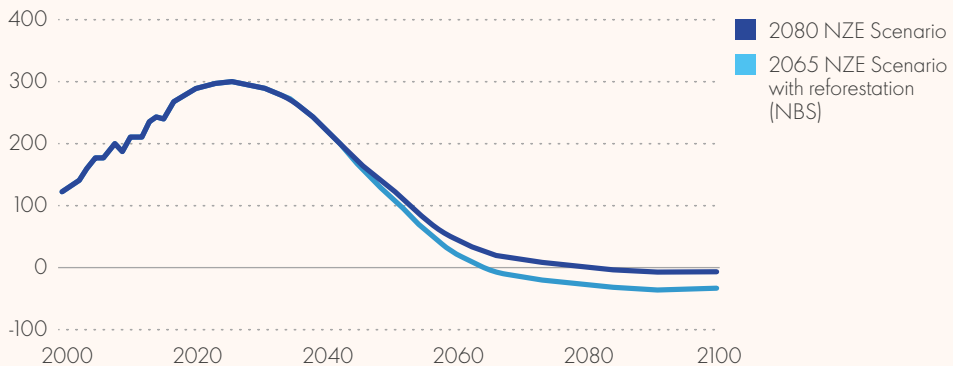
## Eco-tourism

In 2065, 56% of Malaysia's land mass is covered with forest, including an additional 19,000 square kilometres of reforested areas, while degraded areas have been managed back into health. The emphasis on the health of Malaysian forests and biodiversity, particularly the rainforest and the mangrove, has continued to spur the **eco-tourism**

industries. In a number of places, eco-tourism creates so many attractive investment and employment opportunities, especially for local and native communities, that it begins to replace palm oil agriculture. And the booming eco-tourism business means that many more people are able to experience Malaysia's leadership in sustainable development.

### Malaysia's pathway towards net-zero emissions

#### Mt CO<sub>2</sub> per year



Source: Shell analysis based on historical IEA data

Note: NZE stands for net-zero emissions; NBS stands for nature-based solutions.

By 2065, the **sun** provides 50% of Malaysia's total primary energy, as well as allowing the carbon sinks of Malaysia's **trees** to flourish. Having achieved its **sky** goal of net-zero emissions, Malaysia is among those who are recognised for its sustainability efforts - a *fully developed, prosperous, and green home*. And this is the Malaysian story of **the tree, the sky, the sun**.





a fully developed,  
prosperous, and  
green home.

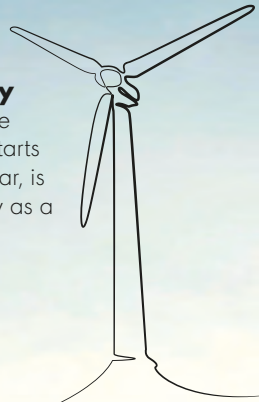


# Our path towards a carbon-neutral future



## People

Our journey begins with a public engagement campaign which encourages commitment from all parties to work together to achieve net-zero emissions.



## Renewable energy

The transition to a more renewable economy starts early. Solar, in particular, is promoted aggressively as a long-term solution.

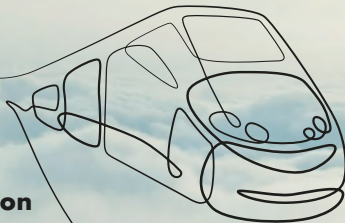
## Energy efficiency

Regulations and incentives successfully promote energy efficiency across all sectors, coupled creatively with social welfare goals.



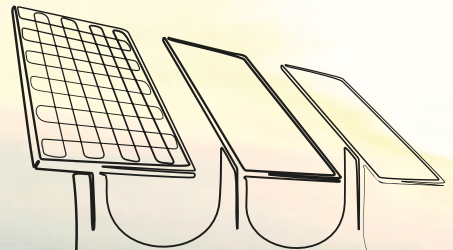
## Electrification

Greater electrification is enabled by digitalisation and a smarter grid system.



## Public transportation

By 2050, public transport has become so efficient that many urban Malaysians seldom drive their cars.



## Solar

By 2065, the sun provides 50% of Malaysia's total primary energy and almost all homes are powered by solar-battery-grid systems.



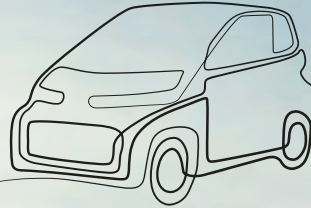
### Price on carbon

Fuel subsidies are phased out while a price on carbon is phased in for all forms of carbon emissions beginning 2026.



### Public dashboard

Web-based dashboards allow Malaysians to track the country's progress against key goals and milestones.



### Electric Vehicles

EVs gain in popularity, supported by aggressive fuel efficiency and air quality standards, reaching price parity with comparable ICEs in 2025.



### NZE achieved

Having achieved its *sky* goal of net-zero emissions, Malaysia has become a fully developed, prosperous and green home.



### Reforestation

An additional 5.8% of Malaysia's land mass has been reforested allowing eco-tourism to thrive.

## Acknowledgements

1. Ministry of Energy, Science, Technology, Environment & Climate Change Malaysia (MESTECC)
2. Malaysian Green Technology Corporation (MGTC)
3. Shell Scenarios Team, Royal Dutch Shell plc
4. All the participants and representatives from various government ministries, agencies, departments, government linked companies, industry players, corporate bodies, public and private institutions, industry associations, non-governmental organisations, and individuals who participated and contributed throughout the stakeholders consultation workshops and the various public forums in 2019.

The scenario and pathway towards Malaysia's net-zero emissions (NZE) future was jointly developed by Shell and MGTC in accordance with the Memorandum of Understanding, signed and exchanged on 9th October 2019 in the presence of the Minister of Energy, Science, Technology, Environment & Climate Change. The scenarios were modelled from Shell's Sky scenario (2018), adapted to the Malaysian context through Shell's World Energy Model (WEM) and analysis, and validated through stakeholders' consultations workshops and engagements.

## Resources

1. GDP projection: The World in 2050 (PwC); Malaysia Third National Communication and Second Biennial Update Report.
2. Population projection: Department of Statistics Malaysia.
3. Summary of Mitigation Actions: Malaysia's Third National Communication and Second Biennial Update Report (Chapter 3 - Mitigation Assessment).
4. Energy Infrastructure: Peninsular Malaysia Electricity Supply Outlook 2017 (ST); Sabah Electricity Supply Industry Outlook 2015; Sarawak Annual Energy Report 2017.
5. Primary Energy Supply (historical data): Malaysia Energy Information Hub (MEIH - ST).
6. Carbon taxation in Malaysia: Insights from the enhanced PAGE09 integrated assessment model (by Kum Yeen Wong, Joon Huang Chuah, Chris Hope)
7. Malaysia's RE Target: Achieving 20% Renewable Energy (RE) Capacity Mix by 2025 (SEDA).

## Further Reading

- Shell's scenarios: [www.shell.com/scenarios](http://www.shell.com/scenarios)
- Shell's Energy Transformation Scenarios: [www.shell.com/transformationsscenarios](http://www.shell.com/transformationsscenarios)
- Shell's Sky scenario: [www.shell.com/skyscenario](http://www.shell.com/skyscenario)





## Behind the Scenes: **How the 2065 scenario was created**





**Step 1.** The Shell Scenarios team first created a reference scenario for Malaysia, based on Shell's Sky scenario (2018) and by using Shell's World Energy Model (WEM). This initial reference scenario established a baseline for Malaysia to achieve net-zero emissions (NZE). Subsequently, through discussions, feedback, and consultations with MGTC and stakeholders, various parameters were adjusted and adapted based on preferences, trends and policy directions, to suit the Malaysian local conditions, opportunities and limitations, in order to produce more accurate pathways for Malaysia to achieve NZE.

Ultimately, five different scenarios were deduced (see Step 4):

- a. Scenario 1: Unambitious Pathway;
- b. Scenario 2: Aggressive Pathway;
- c. Scenario 3: Modest Pathway;
- d. Scenario 4: Balanced Pathway;
- e. Scenario 4a: Balanced Pathway with Reforestation.

**Step 2.** Based on the initial reference scenario, the NZE pathway development process began by identifying key parameters that would have significant contributions to Malaysia's carbon emissions. To facilitate the modelling and stakeholder discussions, the situation in the year 2050 was used as the reference point for the following key parameters:

- a. Carbon price (in USD/tonne CO<sub>2</sub>);
- b. Carbon Capture & Sequestration (CCS) volume (in million tCO<sub>2</sub>/year);
- c. Electrification rate (in % of total fuel consumption);
- d. Natural gas mix (in % of total primary energy by source);
- e. Nuclear energy mix (either yes or no).

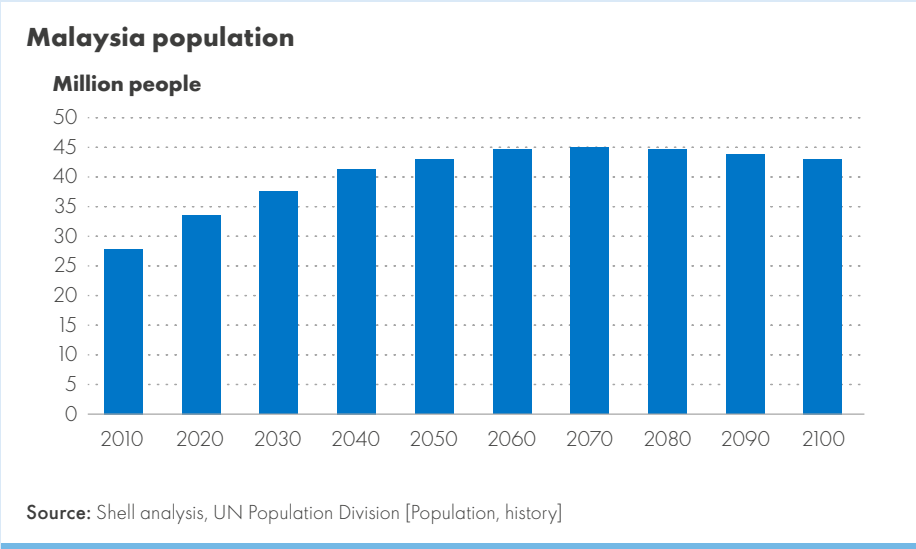
Based on discussions and feedback from MGTC, two additional parameters were significantly emphasised for Malaysia:

- f. Renewable energy mix (in % of total primary energy by source);
- g. Carbon sequestration from forestry via nature-based solutions (in million tCO<sub>2</sub>/year).

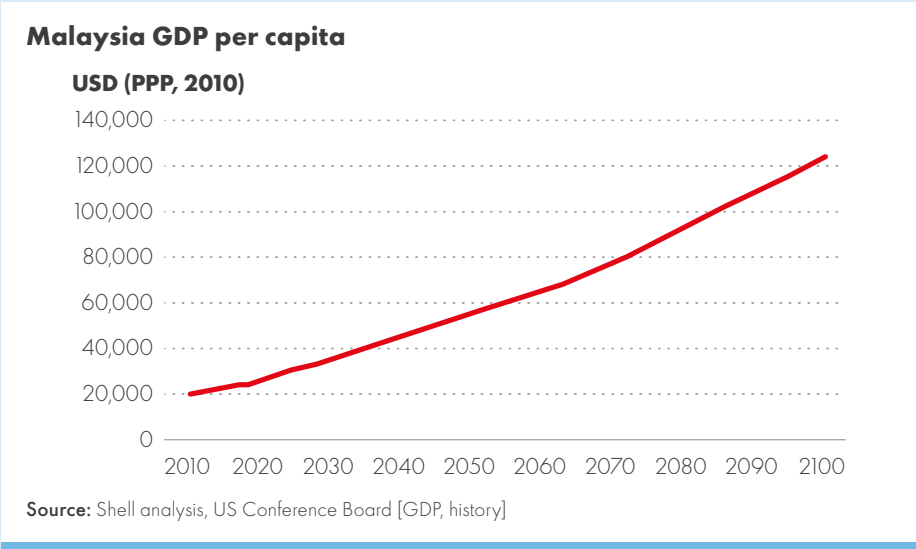
**Note:** Nature-based solutions (NBS) refers to actions to protect, sustainably manage, and restore, including reforestation and natural and modified land eco-systems.

**Step 3.** Several assumptions were applied for the pathway development, based on referred resources and information, as follows:

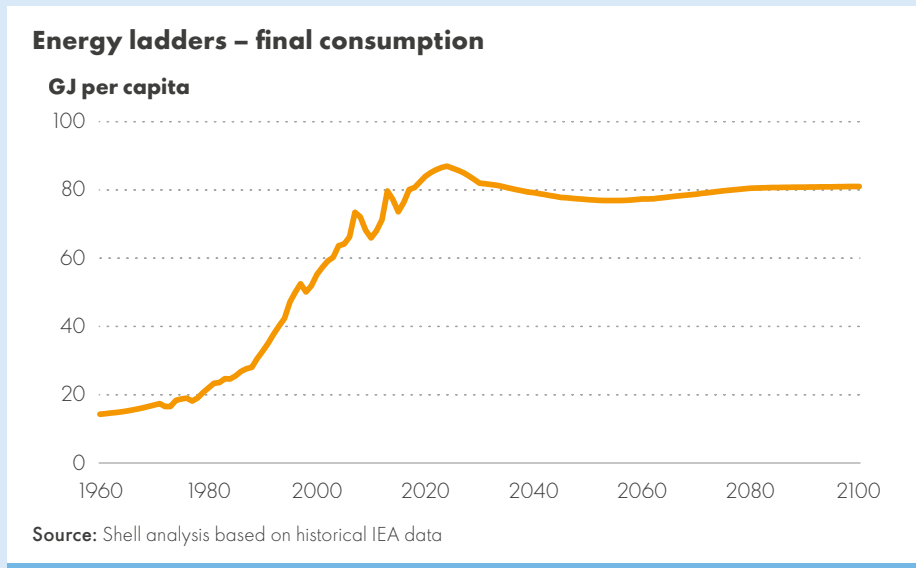
a. Malaysia’s population growth:



b. Malaysia’s GDP growth:



- c. Global prices in year 2050 for major energy resources:
  - i. Oil: 43 USD/bbl;
  - ii. Natural Gas: 5.1 USD/mmbtu;
  - iii. Coal: 44.6 USD/tonne;
  - iv. Biofuels: 1.32 USD/litre-ethanol;
  - v. Biomass: 74.7 USD/tonne.
- d. Global annual inflation rate (2030 to 2100): 2%.
- e. Malaysia's energy ladders (final energy consumption):



**Step 4.** Initially, four different NZE pathways were developed for Malaysia by adjusting the values of six key parameters, namely carbon price, CCS volume, electrification rate, natural gas mix, nuclear energy mix, and renewable energy mix (see tables below – the year 2050 is used as the reference year for discussion purposes).

From these four pathways, Scenario 4 (Balanced Pathway) was chosen by the stakeholders as the most realistic pathway for Malaysia, whereby the NZE would be achieved by year 2080. The Scenarios team then incorporated into this Scenario 4 pathway the critical role of reforestation as a natural carbon sink. A study conducted by The Nature Conservancy identified that Malaysia could potentially reforest a maximum land area of 19,000 square kilometres, which could then remove up to 29 million tCO<sub>2</sub>/year from the atmosphere. This reforestation would increase Malaysia's forest cover by 5.8%, which would bring forward NZE by up to 15 years due to the additional carbon sequestration. This scenario with reforestation is defined as **Scenario 4a (Balanced Pathway with Reforestation)** that would enable Malaysia to reach NZE by the year **2065 – the basis of The Tree, The Sky, The Sun.**



a. Scenario 1: Unambitious pathway

Carbon price in 2050	CCS volume in 2050	Electrification rate in 2050	Natural gas mix in 2050	Nuclear energy mix in 2050	Renewable energy mix in 2050	Year to achieve NZE
0 USD/tCO <sub>2</sub>	0 mil tCO <sub>2</sub> /year	30% of total final consumption	25% of total primary energy by source	Yes	30% of total primary energy by source	>2100

b. Scenario 2: Aggressive pathway

Carbon price in 2050	CCS volume in 2050	Electrification rate in 2050	Natural gas mix in 2050	Nuclear energy mix in 2050	Renewable energy mix in 2050	Year to achieve NZE
140 USD/tCO <sub>2</sub>	54 mil tCO <sub>2</sub> /year	50% of total final consumption	45% of total primary energy by source	No	50% of total primary energy by source	2054

c. Scenario 3: Modest pathway

Carbon price in 2050	CCS volume in 2050	Electrification rate in 2050	Natural gas mix in 2050	Nuclear energy mix in 2050	Renewable energy mix in 2050	Year to achieve NZE
50 USD/tCO <sub>2</sub>	27 mil tCO <sub>2</sub> /year	40% of total final consumption	35% of total primary energy by source	No	40% of total primary energy by source	2099

d. Scenario 4: Balanced pathway

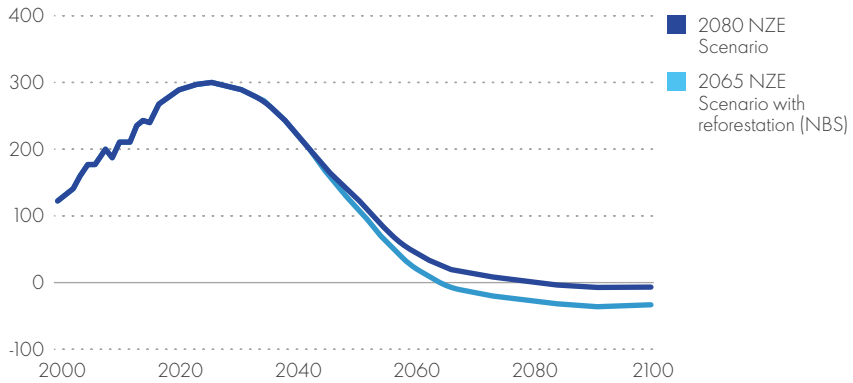
Carbon price in 2050	CCS volume in 2050	Electrification rate in 2050	Natural gas mix in 2050	Nuclear energy mix in 2050	Renewable energy mix in 2050	Year to achieve NZE
100 USD/tCO <sub>2</sub>	5 mil tCO <sub>2</sub> /year	43% of total final consumption	27% of total primary energy by source	No	50% of total primary energy by source	2080

e. Scenario 4: Balanced pathway with reforestation

Carbon price in 2050	CCS volume in 2050	Electrification rate in 2050	Natural gas mix in 2050	Nuclear energy mix in 2050	Renewable energy mix in 2050	Nature-Based Solution (NBS)	Year to achieve NZE
100 USD/tCO <sub>2</sub>	5 mil tCO <sub>2</sub> /year	43% of total final consumption	27% of total primary energy by source	No	50% of total primary energy by source	19,000 km <sup>2</sup> of reforestation by 2065	2065

## Malaysia's pathway towards net-zero emissions

MT CO<sub>2</sub> per year



Source: Shell analysis based on historical IEA data

**Note:** Reference values (in year 2018):

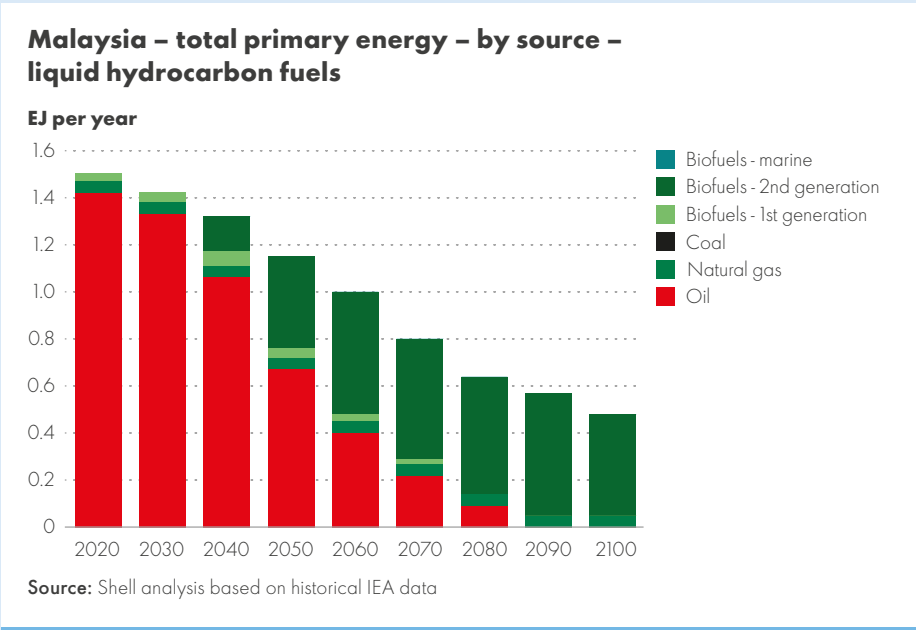
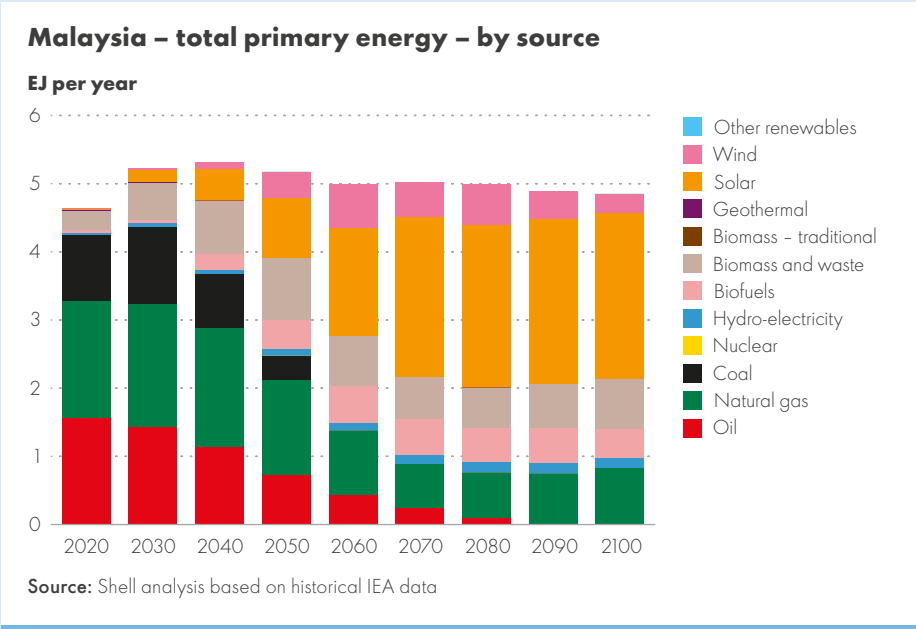
	Carbon price	CCS volume	Electrification rate	Natural gas mix	Nuclear energy mix	Renewable energy mix
<b>Malaysia's Value (2018)</b>	0 USD/tCO <sub>2</sub>	0 mil tCO <sub>2</sub> /year	21% of total final consumption	40% of total primary energy by source	No	5% of total primary energy by source
<b>Global Value (2018)</b>	N/a	≈40 mil tCO <sub>2</sub> /year	19% of total final consumption	20% of total primary energy by source	5% of total global primary energy by source	9% of total primary energy by source

**Step 5.** Based on stakeholder consultations and engagements, Scenario 4a (Balanced Pathway with Reforestation) was identified as the most realistic and probable pathway for Malaysia to achieve net-zero emissions (carbon-neutral) by year 2065, based on the following levers:

- a. Carbon price to be introduced in the mid-2020s, gradually increasing to USD100/tCO<sub>2</sub> by 2050 but plateauing at USD140/tCO<sub>2</sub>.
- b. CCS technologies are deployed to store a modest 5 million tCO<sub>2</sub>/year by 2050.
- c. Additional reforestation of 19,000 square kilometres by 2065, sequesters up to 29 million tCO<sub>2</sub>/year. Any shortage of carbon sinks from forestry will need to be substituted by CCS or other carbon absorption technologies.
- d. Electrification rate to increase to 43% of TFC by 2050.
- e. Natural gas mix to decrease to 27% of TPE by 2050.
- f. Renewable energy mix to increase to 50% of TPE by 2050.
- g. Nuclear is not needed in the energy mix, whereby the impact of nuclear to NZE is insignificant.

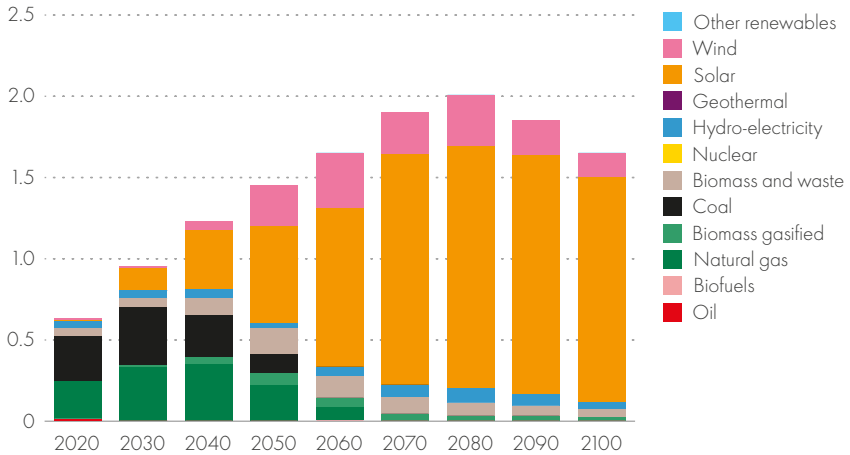


**Step 6.** Based on Scenario 4a, selected details of Malaysia’s energy scenarios, as modelled by Shell’s World Energy Model (WEM), were produced as follows:



## Malaysia – total final consumption – by source – total electricity

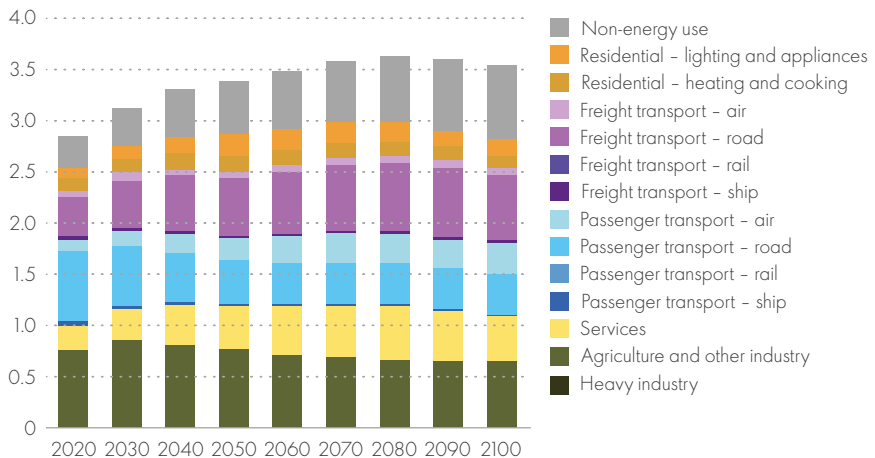
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by sector

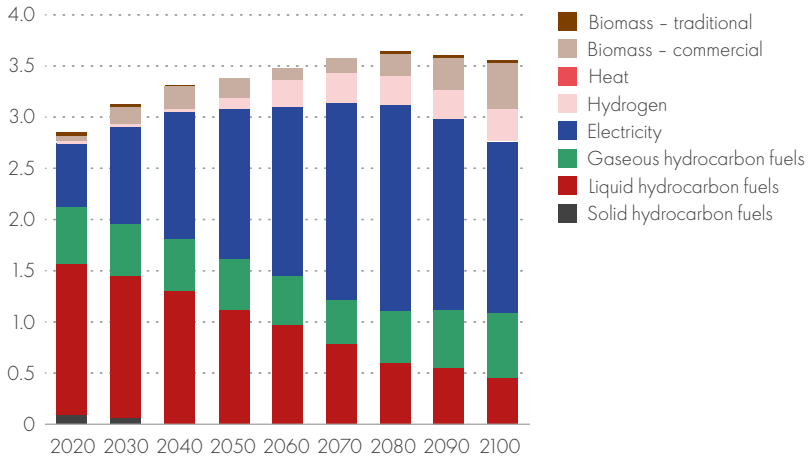
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier

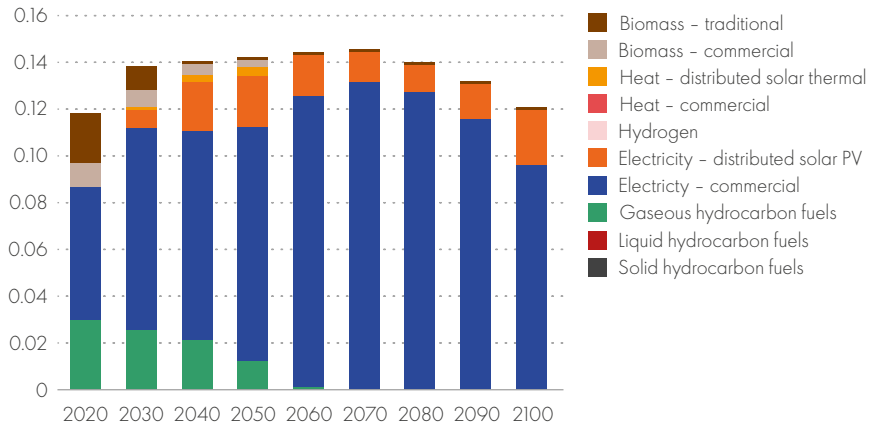
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – residential – heating and cooking

EJ per year

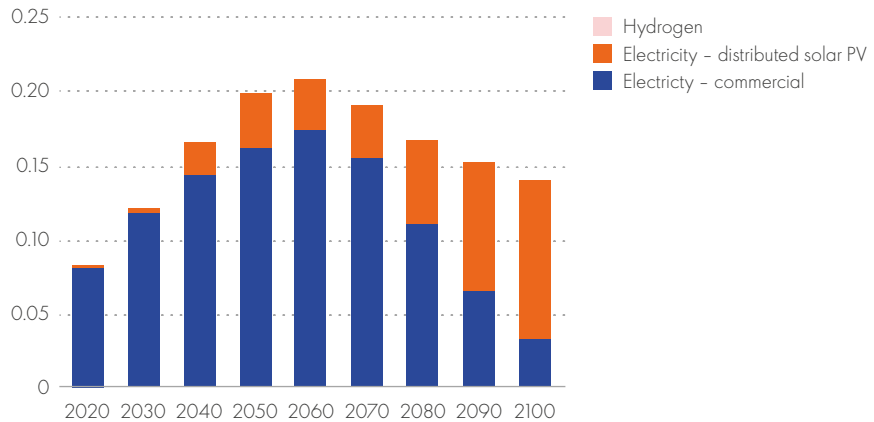


Source: Shell analysis based on historical IEA data



## Malaysia – total final consumption – by carrier – residential – lighting and appliances

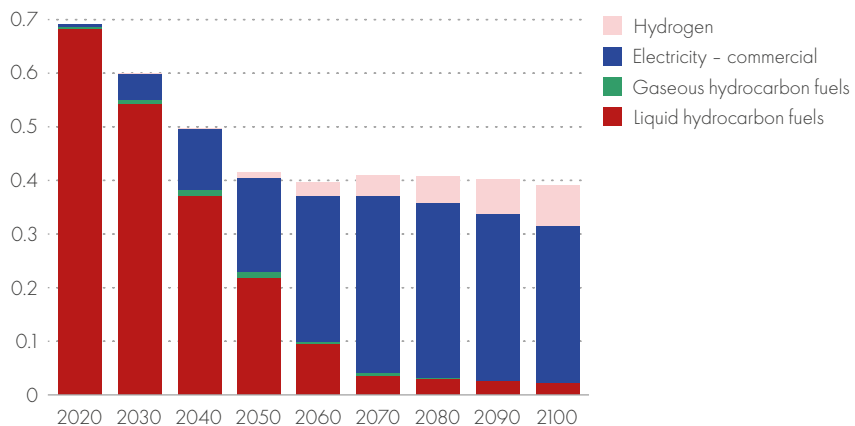
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – passenger transport – road

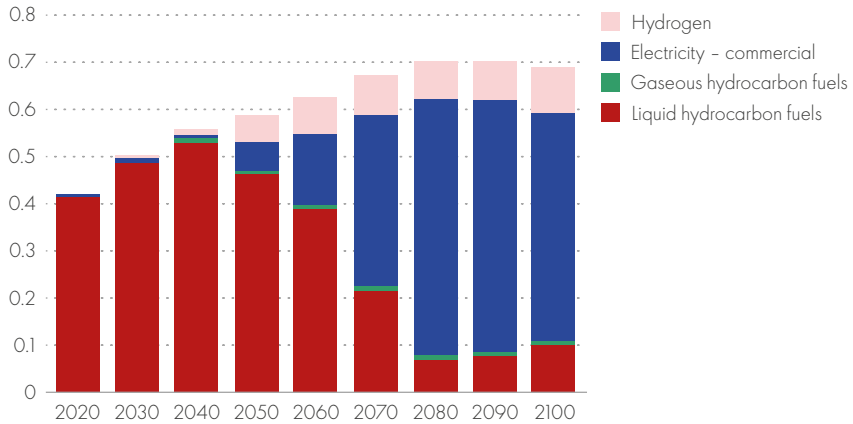
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – freight transport – road

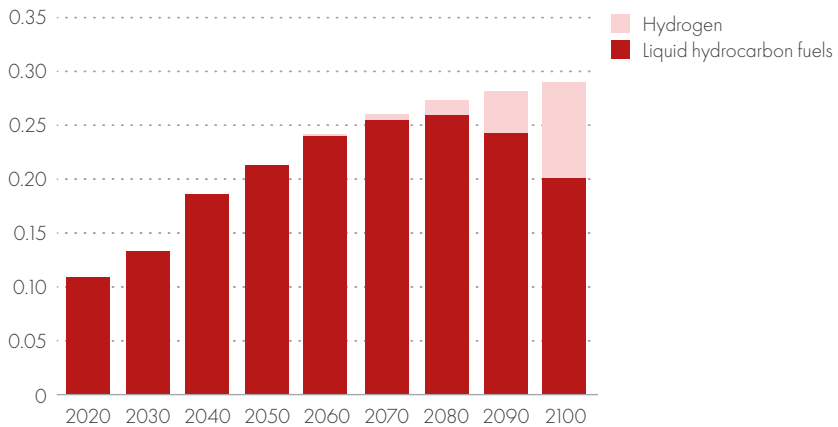
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – passenger transport – air

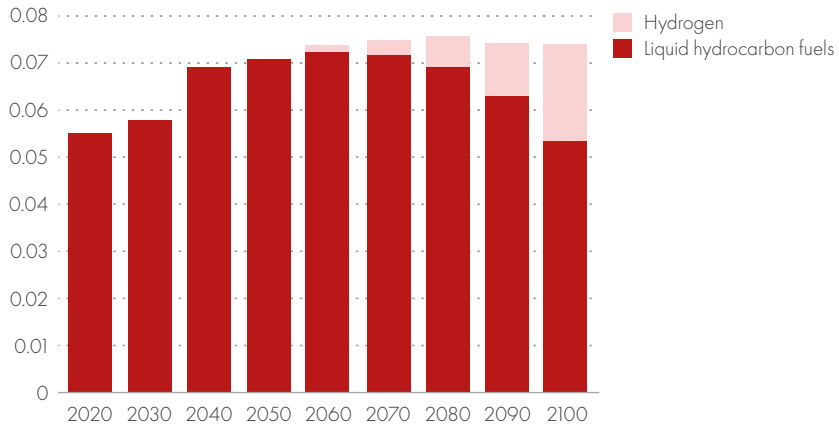
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – freight transport – air

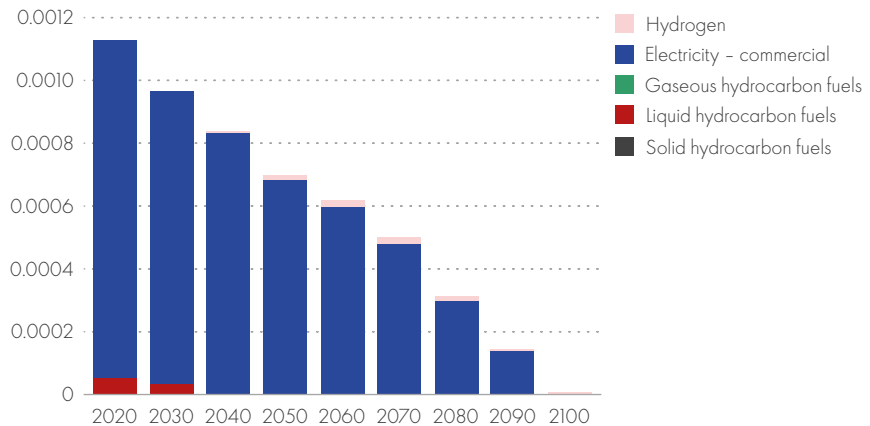
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – passenger transport – rail

EJ per year

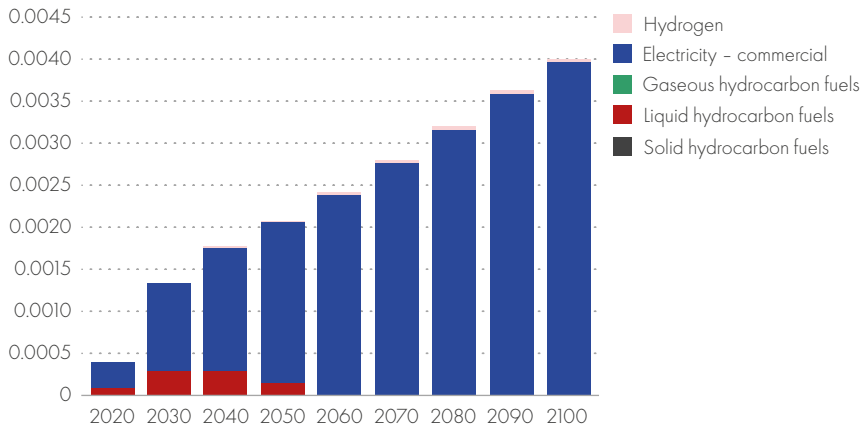


Source: Shell analysis based on historical IEA data



## Malaysia – total final consumption – by carrier – freight transport – rail

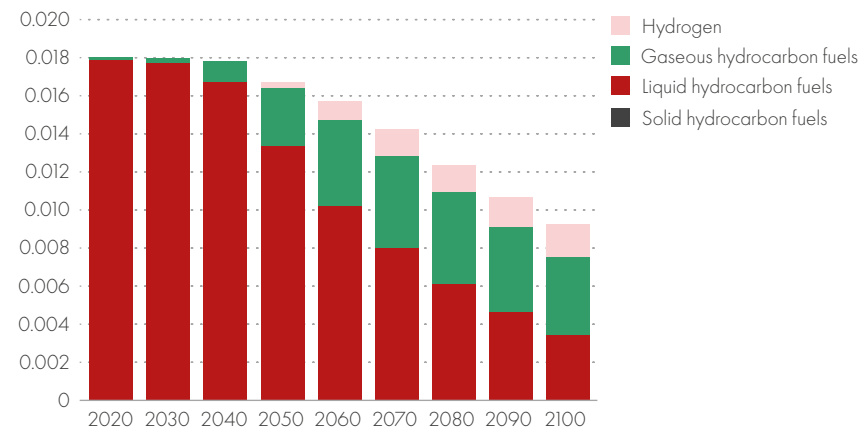
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – passenger transport – ship

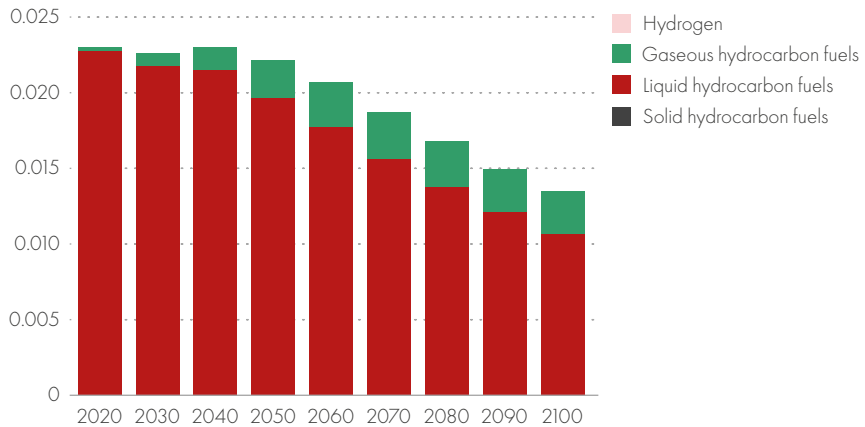
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – total final consumption – by carrier – freight transport – ship

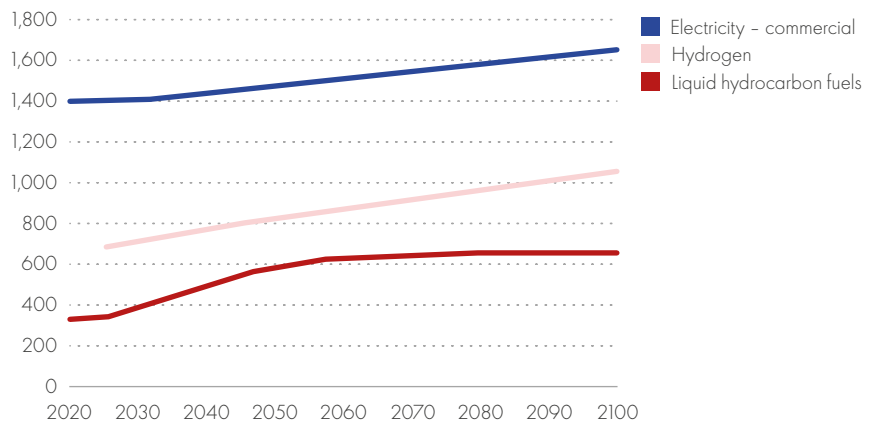
EJ per year



Source: Shell analysis based on historical IEA data

## Malaysia – energy service efficiency – by carrier – passenger transport – road

Vehicle km / GJ (input)



Source: Shell analysis based on historical IEA data

**Step 7.** All these assumptions, modelling, analysis, and results were presented and discussed with invited stakeholders, and finalised in November 2019.

# Disclaimer

Scenarios describe possible future worlds to help stretch how we all think about and plan for the future – so we can make better decisions today. This scenario starts with data from Shell's Sky scenario and uses additional data from Shell's World Energy Model. We assumed the Malaysia energy system reaches net-zero emissions by 2065 and then worked back to see how this could occur. While there are other possible paths for Malaysia to achieve a net-zero emissions energy system, we believe this scenario is technically and economically possible. Nevertheless, it will be highly challenging and action must begin immediately. Our scenarios are not predictions, Shell strategy or business plans. Our scenarios present possible pathways for society to meet the goals of the Paris Agreement. Accordingly, when developing Shell's strategy, our scenarios are one variable among many that we consider. Ultimately, whether society meets the goals of Paris, is not within Shell's control. While we intend to travel this journey in step with society, only governments can create the framework for success.

Shell's operating plan, outlook and budgets are forecasted for a ten-year period and are updated every year. They reflect the current economic environment and what we can reasonably expect to see over the next ten years. Accordingly, Shell's operating plans, outlooks, budgets and pricing assumptions do not reflect our net-zero emissions target. In the future, as society moves towards net-zero emissions, we expect Shell's operating plans, outlooks, budgets and pricing assumptions to reflect this movement.

This report contains forward-looking statements (within the meaning of the U.S. Private Securities Litigation Reform Act of 1995) concerning the financial condition, results of operations and businesses of Royal Dutch Shell. All statements other than statements of historical fact are, or may be deemed to be, forward-looking statements. Forward-looking statements are statements of future expectations that are based on management's current expectations and assumptions and involve known and unknown risks and uncertainties that could cause actual results, performance or events to differ materially from those expressed or implied in these statements. Forward-looking statements include, among other things, statements concerning the potential exposure of Royal Dutch Shell to market risks and statements expressing management's expectations, beliefs, estimates, forecasts, projections and assumptions. These forward-looking statements are identified by their use of terms and phrases such as "aim", "ambition", "anticipate", "believe", "could", "estimate", "expect", "goals", "intend", "may", "objectives", "outlook", "plan", "probably", "project", "risks", "schedule", "seek", "should", "target", "will" and similar terms and phrases. There are a number of factors that could affect the future operations of Royal Dutch

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