# UK – Brunei Green Economy Framework

British
High Commission
Bandar Seri Begawan

ARUP

# ACKNOWLEDGEMENTS

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**Public sector:**
- Ministry of Finance and Economy
- Brunei Climate Change Secretariat
- Department of Energy, Prime Minister's Office
- Ministry of Foreign Affairs, Department of Europe and Americas
- Forestry Department, Ministry of Primary Resources and Tourism
- Transport Policy Division, Ministry of Transport and Infocommunications
- Brunei Economic Development Board
- Manpower Planning Employment Council

**Private sector:**
- Brunei Shell Petroleum
- Brunei LNG Sdn Bhd
- Brunei Fertilizer Industries
- Brunei Methanol Company
- Hengyi Industries Sdn Bhd
- Polygel Organometallic (Brunei) Sdn Bhd
- Brunei Darussalam Central Bank (BDCB)
- Standard Chartered Brunei
- Baiduri Bank
- Bank Islam Brunei Darussalam

**Academia:**
- Universiti Brunei Darussalam
- Universiti Teknologi Brunei
- Institute of Brunei Technical Education

# NOTICE

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# 1 Introduction

# FOREWORD

This year, 2024, the United Kingdom and Brunei Darussalam are celebrating 40 years of diplomatic relations. Over those four decades – and for many years before – both our nations have prospered thanks, in part, to our abundant and cheap energy resources. Yet we are now facing radical structural change in the global economy including a global energy transition away from fossil fuels – structural changes which are also affecting our domestic economies.

Both our nations are rising to this challenge. In the UK, we are investing in the industries of the future. We have reduced our greenhouse gas emissions by 48% since 1990 while growing our economy by 65%. In Brunei, economic diversification efforts under Wawasan 2035 (Vision 2035) have seen rapid growth in the non-oil and gas sector. His Majesty The Sultan, in his recent titah (speech) to the 20th Legislative Council, stressed the need to develop new industries in a way which both meets the nation's need for growth and jobs, and also protects the environment.

From an economic growth perspective, seizing opportunities in a changing world is the key to a sustainable and prosperous economy. According to the International Renewable Energy Agency (IRENA), investing in energy transition technologies creates jobs in areas such as academia and research, testing, manufacturing, and the installation, operation and maintenance of renewable energy technologies. In the UK, 80,000 new jobs have been created, or are in the pipeline, since 2020 as a result of government green growth policies.

Conversely, business-as-usual is not an option. As the world moves through the energy transition, the demand for fossil fuels will decrease. The cost of renewable energy is falling fast and is already cheaper, in most places, than fossil fuels. We are seeing investors increasingly reluctant to invest in old industries, as well as trade measures such as Carbon Border Adjustment Mechanism (which is being introduced by the EU and considered by others including the UK) which imposes a price on carbon-intensive imports, to encourage cleaner industrial production. Developments such as these underline the urgent need to build a diverse and sustainable industrial base.

In my four years in Brunei, I have prioritised climate change and energy transition as a key pillar of the relationship between the UK and Brunei. Brunei's commitment to preserve its rainforest and biodiversity, whilst developing its economic prosperity, is commendable. So, too, are the ambitious commitments Brunei made at COP26: to work towards Net Zero carbon emissions by 2050, to continue to protect its forests, and to phase out the use of coal.

The UK has made good progress towards our own Net Zero target and is committed to support Brunei achieve its climate change and biodiversity targets. We also recognise the vital importance of Brunei's economic growth and diversification priorities. This is why we are pleased to support the UK-Brunei Green Economy Framework project, which brings together the urgency of economic diversification with the opportunities of decarbonisation.

It is therefore my pleasure to introduce this UK – Brunei Green Economy Report, in partnership with Yang Berhormat Dato Seri Setia Dr Haji Mohd Amin Liew Abdullah, Minister at the Prime Minister's Office and Minister of Finance and Economy II.

Based on a detailed analysis of Brunei's economy and global trends, the report explores how Brunei can achieve economic growth in a key industrial growth sector, in a way which is consistent with its Net Zero commitment. Success in economic and industrial policy requires careful planning, drawing on deep expertise and in consultation with a wide variety of stakeholders. This is the approach taken by the report's authors and I hope it will be a helpful contribution to the Government of Brunei's own strategic planning efforts.

As a close partner, the UK is strongly committed to supporting Brunei to continue to prosper into the future. With this report, and the wider Brunei Green Economy Framework project, I have the greatest optimism that Brunei will continue to grow towards a prosperous, sustainable economy.

**His Excellency Mr John Virgoe**
*British High Commissioner to Brunei Darussalam*

# FOREWORD

بسم الله الرحمن الرحيم

The launch of the UK – Brunei Green Economy Report marks a pivotal step in identifying green economic opportunities towards meeting the country's 2030 Nationally Determined Contribution (NDC) target and Net-Zero Emissions goal by 2050, while keeping our Wawasan 2035 National Vision in sight, particularly our economic goals.

As Brunei Darussalam stands at the crossroads of economic transformation and environmental responsibility, we are dedicated to forging a path towards a sustainable future. The Economic Blueprint for Brunei Darussalam charts our path forward, highlighting five priority sectors to enhance economic resilience and reduce dependency on oil and gas. Brunei Darussalam has made significant strides in economic diversification, with the non-oil and gas sector contributing 53% to the Gross Domestic Product (GDP) in 2023. At the same time, preserving Brunei Darussalam's natural environment is paramount. Our commitment to environmentally friendly initiatives and the protection of our natural heritage is integral to our green economy strategy.

In alignment with global efforts to tackle climate change, Brunei Darussalam is strategically investing in the future. This is underpinned by the Brunei National Climate Change Policy that outlines the key strategies that not only paves the way for a low carbon and climate resilient Brunei Darussalam, but also identifies economic opportunities within this energy transition.

The UK – Brunei Green Economy Report offers a comprehensive view of climate change's impact on our economy. It emphasises green opportunities, particularly in the downstream energy sector, and highlights key enablers in our Green Economy pursuits. A focus on equipping our workforce with relevant skills and fostering innovation is vital for our regional and global competitiveness. It will enable the country to attract quality investment and compete effectively on the international stage to deliver our national goals.

Aligned with Brunei Darussalam's key principle of pursuing national priorities through a Whole-of-Nation approach, this report also appreciates collaboration and collective action with internal and external partners towards a resilient and sustainable future. The UK – Brunei Green Economy Report underscores our nation's commitment to harnessing the potential of the global green economy while achieving our net-zero ambitions in collaboration with the United Kingdom (UK). This report is the result of collaborative efforts involving the Ministry of Finance and Economy, the Brunei Climate Change Office at the Prime Minister's Office, the British High Commission in Brunei Darussalam, ARUP Singapore, the Brunei Green Economy Framework Taskforce and various stakeholders.

It serves as a catalyst for dialogue, engagement, and action, uniting government officials, industry representatives, academics, and the wider community in advancing the green economy agenda.

Together, these efforts represent a concerted and holistic approach to address climate change and advance the economy in a viable manner. It is my own hope that this report sparks much-needed conversations that are solutions-focused, and encourages readers to consider ways to contribute positively to our shared future.

**Yang Berhormat Dato Seri Setia Dr. Awang Haji Mohd. Amin Liew bin Abdullah**
*Minister at the Prime Minister's Office and Minister of Finance and Economy II*
*Co-Chair of the Brunei National Council on Climate Change*

# EXECUTIVE SUMMARY

This report covers four opportunities related to O&G and its downstream sectors that can lay the foundation for the green economy by driving decarbonisation and bringing economic value for Brunei.

The urgency of climate action has accelerated as world leaders were called to action at the 28th meeting of the Conference of Parties, COP28, from November to December 2023. The conference set a global agenda to 'transition away' from fossil fuels and many nations, including Brunei, are committed to achieving emissions reduction targets. During COP26, Brunei Darussalam submitted its Nationally Determined Contribution (NDC) to reduce greenhouse gas emissions by 20% by 2030 and made a national statement on its ambition towards net zero by 2050.

Brunei, a small and wealthy nation located in Borneo, has relied on its oil and gas reserves to drive economic growth since the first oil discovery in 1899. Up to 2018, Brunei's oil and gas exports made up 90% of the total export value, serving as the nation's economic backbone. In recent years, the challenge towards economic diversification has borne some successes. Notably, the downstream hydrocarbon and petrochemical sectors made up 40% of the total export value in 2022 and led to a 90% increase in export values since 2018.

However, this has come at a price, with a ~1 million tonne per annum (MTPA) or ~7.7% increase in greenhouse gas emissions from 2018-21. Emissions and the oil and gas reliant GDP of the nation are inextricably linked, and Brunei remains financially dependent on the oil and gas sector. The non-oil and gas sector achieved a moderate 4.5% growth in 2023.

As a commodity-based economy, Brunei is vulnerable to several factors ranging from external shocks to constrained resources. At present, two significant aspects are causing material impact to Brunei's economic resilience and growth story. Firstly, exposure to O&G price volatility can affect and weaken Brunei's financial reserves, especially in cases of prolonged global economic downturns. This is further exacerbated by the finite nature of hydrocarbon reserves in the country. Secondly, climate change has emerged as the single most significant trend shaping the future of our planet, with far-reaching consequences for economies, societies, and ecosystems. This has fueled a global green transition through technological change, national climate action commitments, policy and investment shifts. This global green transition will result in a fossil fuel phase-out and a shift towards greener activities, posing a range of threats to Brunei's current economic sectors, while increasing benefits of refocusing to new sectors.

As the world responds to the climate emergency and as countries seize the momentum of green growth, Brunei's economy will need to adapt to stay competitive.

*"In reality, we can no longer depend solely on the oil and gas industry because there are factors beyond our control, such as the decline in oil and gas production and the unpredictable oil and gas prices in the global market. Efforts need to be made to diversify the economy by focusing on industries that have potential to be successful. At the same time, issues such as environmental and climate change must not be neglected"*

by **His Majesty Sultan Haji Hassanal Bolkiah** during 20th Legislative Council Session

# EXECUTIVE SUMMARY

## A green economy can only be achieved by addressing decarbonisation, developing green commercial drivers and urgently advancing economic diversification, which Brunei must start now

This report undertook an estimation of what climate inaction could look like in the context of Brunei – this could mean losing up to 58% of its GDP under a 1.5-degree Celsius scenario. This broadly quantifies the magnitude of the challenge that Brunei needs to overcome.

As such, transitioning Brunei towards a green economy is urgent and needs to address its activities in the O&G and related sectors to minimize economic risk and capture the widest range of opportunities that are available to future proof the economy. Overall, green economy for Brunei relies on three pillars: 1) decarbonisation of existing downstream O&G sector, 2) develop new green economic opportunities in the upstream and downstream O&G sector, and 3) develop other non-O&G sectors for economic diversification.

With a focus on O&G and related sectors, this report identifies four high potential opportunities to green the economy and lay the foundation for further green economy development and economic diversification. These are – **1) transition to renewable energy; 2) carbon capture storage services; 3) clean hydrogen export hub; and, 4) commercial and industrial waste recycling**.

This report provides in-depth analysis of each of these opportunities, discussing their rationale and impact in terms of direct GVA and jobs created. It discusses the challenges that these opportunities face in the context of Brunei and identifies potential actions and a clear and concise roadmap that can enable relevant public and private sector actors to drive implementation and a sustainable transition pathway.

Aggregating the four green economic opportunities, the **direct additional annual GVA to Brunei by 2050 is ~BND 1.0 Bn**, 7.8% increase from Brunei's 2022 GDP. **Job creation is in the range of 10,000 to 16,000 and emission reduction at 3.8 to 6.2 MTPA CO2e by 2050**. Furthermore, additional indirect value-add created in adjacent sectors and related activities can boost the estimated GVA addition.

These opportunities represent a significant step towards green economy development in Brunei. Moving now to secure these promising green economy opportunities from the downstream O&G sector alone could create up to 16% of the GDP and jobs that could be lost from a declining O&G sector during the global energy transition. The select four opportunities could potentially lead to ~6 MTPA $CO_2e$, cumulatively contributing up to a ~45% decrease in national carbon emissions relative to Brunei's 2022 GHG emissions. This represents a considerable first step to guide Brunei towards it's near zero pledge in 2050. Moreover, these opportunities serve as a catalyst for foreign investments that are increasingly driven by environment, social and governance (ESG) factors, help develop human capital and nurture essential green skills while laying the foundation for Brunei's other strategic sectors such as food, ICT, services and tourism to develop in alignment with sustainability and green growth.

To deploy the four opportunities, Brunei must address its existing policy and regulatory environment, infrastructure readiness, funding gaps, partnership opportunities, and skills gaps. A green economy can only be achieved by addressing decarbonisation, developing green commercial drivers and urgently advancing economic diversification, which Brunei must start now. As immediate next steps, four key actions emerge:

- Renew strategy and policies to address energy transition and climate action
- Engage outside-in expertise on key development areas to support capacity building and collaboration
- Establish a dedicated, empowered organisation to drive and implement green transition
- Communicate and educate the public on the need for transition and future plans.

# INTRODUCTION TO BRUNEI

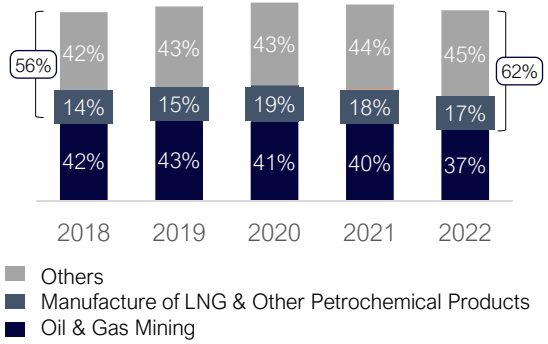
Brunei's growth has been attributed to upstream oil and gas (O&G) exports. Some success in economic diversification via downstream petrochemicals production boosted non-oil GVA share from 56% to 62% from 2018 to 2022[1]

## A PETROSTATE IN SOUTHEAST ASIA

Brunei Darussalam is an independent Islamic Sultanate occupying 5,765 km$^2$ of land with a population of 445,400 people.[1] Although small, Brunei is a highly wealthy nation (GDP per capita of BND 51,645).[1] Brunei's GDP has grown at a CAGR of 1.7% from BND 18.7 Bn in 2010 to BND 23 Bn in 2022.[1]

Brunei has significant O&G reserves, which have served as its economic backbone since its discovery in 1899. From 2018 to 2022, the upstream and downstream O&G sectors combined comprise over 50% of the nation's gross value added (GVA).[1]

*Proportion of contribution of sub-sectors, 2018 – 2022 (% share of GVA)[1]*



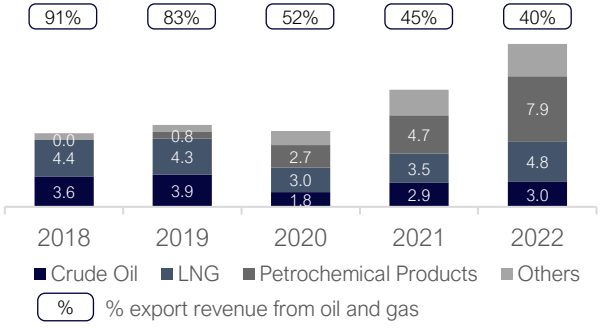

Today, Brunei is the third-largest oil producer and 4th biggest LNG producer in Southeast Asia.[2]

## EVOLUTION TO DOWNSTREAM OIL & GAS

While the O&G sector has contributed between 38-51% to Brunei's national GDP in the past 10 years and 91% of the country's export revenue in 2018,[1] the export revenue from O&G products (crude oil and LNG) has declined from 91% to 40% as of 2022 as seen below.

In the same period, revenue from downstream O&G's exports rose from 0.06% in 2018 to 40% in 2022. This has been critical to supporting Brunei's economic diversification away from upstream exports but remains interdependent. The entry of petrochemical giant Hengyi Industries contributed over a total of ~ BND 4.5 Bn to Brunei's GDP between 2019 to 2022,[3] ~4% of Brunei's GDP in the same period.

*Upstream and downstream O&G export revenue, 2018 – 2022 (BND Bn)[1]*




Brunei faces multiple challenges. It is export-dependent on O&G activities but dependent on most other sectors with little self-sufficiency despite reduced export revenues. To achieve long-term economic stability, the country is pursuing diversification strategies beyond hydrocarbon resources.

Central to this effort is "Wawasan Brunei 2035", a roadmap that identifies five priority sectors. Within this policy, the focus is placed on growth-enhancing reforms including reskilling the labour force, seeking open trade policies, and promoting a conducive business environment. As mentioned, some diversification success is seen due to downstream O&G, however, other non-oil and gas sectors have seen limited growth. The unemployment rate stood at 5.2% in 2022. Additionally, the largest share of Brunei's unemployed population was held by those who had completed secondary school, comprising 53.4%.[4] There is still more required for Brunei to meet its Wawasan Brunei 2035 goal.

1 Ministry of Finance and Economy Brunei
2 East Asia Forum, 2023
3 The Star, 2023
4 Department of Economic Planning and Statistics, 2020

# INTRODUCTION TO BRUNEI

While Brunei has goals for sustainability and economic diversification, the nation's high dependency on O&G poses a significant challenge that necessitates immediate action to fully realise economic transition potential

## BRUNEI'S SUSTAINABILITY TARGETS

In 2020, Brunei submitted its Nationally Determined Contribution (NDC) to reduce greenhouse gas emissions by 20% by 2030.[1] During COP26, Brunei reaffirmed commitments and announced its ambition towards net zero by 2050.[2] Realising these ambitions necessitates urgent implementation of whole-of-nation plans to reduce emissions.

As of 2022, Brunei produced 127,000 barrels per day of oil and 243,000 barrels per day equivalent of natural gas.[3] Brunei ranked 3rd globally in terms of $CO_2$ emissions per capita as of 2021.[4] 86% of its GHG emissions in 2022 came from its extractive and power industries, which Brunei's economy is highly reliant on.[5] Combined, the industries constitute 54% of GDP in 2022.[6] In 2019, emissions spiked in power generation due to the coal power plant on Pulau Muara Besar (developed by Hengyi Industries) coming online.

In 2018, 0.05% of Brunei's electricity was derived from renewable energy sources, the remaining 99.95% came from fossil fuels.[4] Reducing emissions in line with national ambitions is contingent on scaling up the share of clean energy mix in the national grid.

Confronted with the climate change imperative, Brunei will need to reduce its emissions and diversify its economy to reduce its high dependency on carbon-intensive activities.

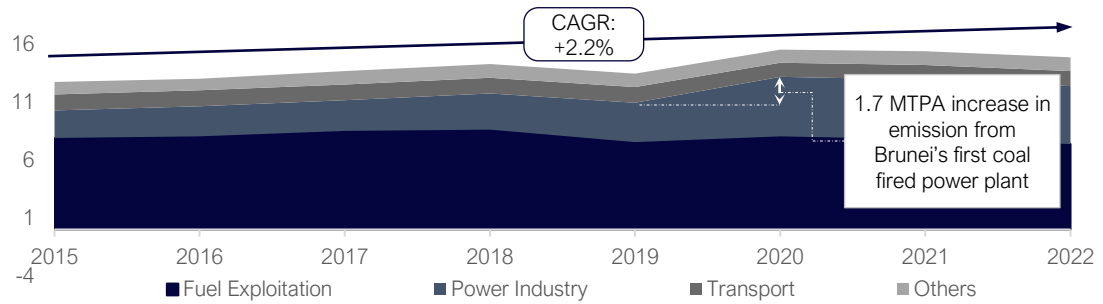
Brunei has already implemented climate initiatives. The Brunei Climate Change Secretariat (BCCS) was formed in 2018, along with it, the Brunei National Climate Change Policy (BNCCP) that details a climate change strategy up to 2035. It has been successful in creating awareness around addressing climate change within public ministries and yielding further studies. In collaboration with the World Economic Forum, Brunei Shell Petroleum (BSP) produced a study on industrial decarbonisation, System Value Analysis. Arising from that, BSP is also leading the formation of a unified industrial cluster to drive net-zero objectives.

Diversification is another key agenda for Brunei. In the recent 20th Legislative Council, His Majesty Sultan Haji Hassanal Bolkiah set a clear direction on the need for economic diversification, "*In reality, we can no longer depend solely on the oil and gas industry because there are factors beyond our control, such as the decline in oil and gas production and unpredictable oil and gas prices in the global market*".

Although multiple climate initiatives have been rolled out, the urgency of adoption has been low. Brunei's policy framework should be further optimised for climate transition. This report aims to provide an independent perspective on how a green economy transition strategy can foster both sustainability and economic prosperity for Brunei.

**Brunei greenhouse gas emissions by sector, 2015 to 2022**

MTPA $CO_2e$[5]




1 UNFCCC, 2022
2 UNFCCC, 2021
3 ASEAN Briefing, 2022
4 International Energy Agency, 2021
5 The Emissions Database for Global Atmospheric Research, 2022
6 Ministry of Finance and Economy Brunei

# 2 A case for change

# NAVIGATING A SHIFTING LANDSCAPE

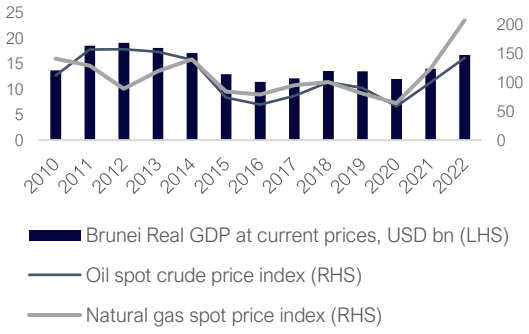
Brunei's economy needs to build resilience to global O&G volatility and begin moving towards a green economy to prevent exposure to vulnerabilities

Brunei strives for continued and sustainable economic growth. However, as a commodity-based economy, it is vulnerable to several factors ranging from external shocks to constrained resources. At present, two significant aspects are causing material impact to Brunei's economic resilience and growth story.

### 1 Exposure to global O&G price volatility

Brunei's GDP is highly sensitive to changes in global crude oil and natural gas prices. Exposure to volatility can affect and weaken Brunei's financial reserves, especially in cases of prolonged global economic downturns.

*Brunei's real GDP in relation to global oil and natural gas (indexed prices), 2010 – 2022*[1,2]




This was evident during the Covid-19 pandemic when Brunei experienced fiscal deficits and instability due to drops in global O&G prices. The pandemic triggered a crash in global prices – the OPEC basket fell to USD 12.22, and West Texas Crude (WTI) traded briefly at a negative price (USD -37.63 per barrel),[3] leading to losses of Brunei's real GDP.

Brunei also faces the threat of depletion of its O&G reserves. Brunei has been reliant on its onshore Seria oil field, and offshore fields Southwest Ampa, Champion, Magpie, and Rasau for its hydrocarbon resources. Brunei is expected to run out of oil in 27 years (by 2048), according to BP's Statistical Review of World Energy published in 2021.[4]

Brunei's economy would benefit from diversification and growth of new sectors, to achieve greater economic resilience and to reduce its reliance on the price volatile O&G market.

### 2 The global shift towards a green economy

Future exogenous influences will continue to reshape the global economy and expose Brunei to vulnerabilities if the nation is not prepared. Among the various trends shaping the world's future, climate change stands out as a major factor with the potential to significantly impact everything from economies, societies to ecosystems. A response to this trend has seen the rise of green finance, rapid technological advancements, post-Covid Green New Deals, and more ambitious COP targets which in turn have accelerated the development of the global green economy.

Economies not moving apace with this transition could face job displacement and increased unemployment in the event of poor or slow workforce retraining, as well as high upfront costs for adopting sustainable infrastructure and technologies.

While many perceive the green transition to be a cost, the green economy also presents a substantial opportunity, with the potential of adding USD 10.3 Tn to the global economy by 2050.[5] Other studies estimate that the transition can generate 30 million new clean energy jobs by 2030.[6] The green transition has also led to the development of cleaner markets, including products such as clean hydrogen and CCS which can bring large economic value.

As the world moves towards the global green economy, Brunei must prepare itself for the shifting landscape, find its opportunities, and avoid missing out on economic benefits.

1 International Monetary Fund, 2022
2 S&P, 2023
3 FactSet Research Systems Inc, 2020
4 BP, 2021
5 Arup, 2023
6 International Energy Agency, 2023

# NAVIGATING A SHIFTING LANDSCAPE

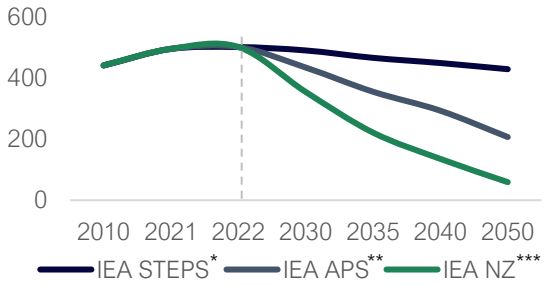
The global energy transition will result in a fossil fuel phase-out and a shift towards greener activities, posing a range of threats to Brunei's current economic sectors, while increasing the benefits of refocusing on new sectors

## SHIFT IN DEMAND AWAY FROM FOSSIL FUEL

Global demand for fossil fuels is expected to fall by 80% in IEA's net zero scenario due to the rapid adoption of renewable energy.

The shift to renewables has accelerated due to increased cost competitiveness as adoption reaches scale. By 2030, the Asia Pacific region is expected to see the renewable levelised cost of energy (LCOE) drop 23% below the LCOE of fossil fuel projects.[1] As a result, **Brunei's O&G exports will become less attractive and cost-competitive** in the region. The difference in LCOE may also **threaten the effectiveness of Brunei's energy subsidies**, which comprise 6% of the national GDP as of 2022, equivalent to USD 0.9 Bn.[2]

**Fossil fuel demand across IEA's scenarios**[3]
*/ EJ*



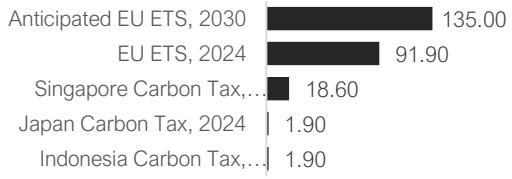

## INCREASING COST OF TRADE

Over 40 countries have adopted carbon pricing mechanisms; carbon taxation or cap and trade, etc, which could further increase costs of export and import trade for Brunei.

Most recently, the European Union's (EU) Carbon Border Adjustment Mechanism (CBAM), the first of its kind carbon border tax, was implemented. CBAM applies a carbon tax on selected goods entering the EU. Though not felt by Southeast Asia yet, the rise of carbon pricing mechanisms and climate urgency could result in added costs to exporters.

Regionally, countries have started imposing carbon pricing, and given the climate urgency, **Brunei must be prepared for regional carbon import tariffs to be imposed.**

**Selected carbon pricing mechanisms globally**
*/ USD*

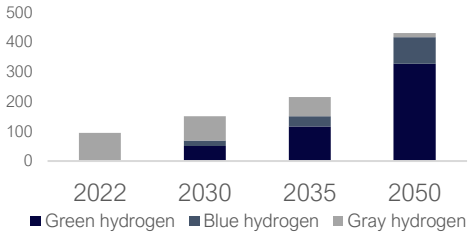



## INCREASED DEMAND FOR CLEANER INDUSTRIAL PRODUCTS

The rise in demand for cleaner products globally is anticipated to **threaten demand for Brunei's emissions-intensive upstream and downstream O&G production.** Under the IEA's Net Zero Emissions Scenario, demand for low to zero-carbon industrial products such as urea, ammonia, and methanol is expected to skyrocket by 2050. Furthermore, products such as blue and green hydrogen will enjoy strong demand to support global energy transition and low-carbon products.

This shift towards alternative cleaner products will likely disrupt Brunei's existing traditional petrochemical exports but also signal an opportunity to move production towards cleaner products.

**Hydrogen demand in IEA NZE Scenario**[3]
*/ Mt $H_2$*




1 Wood Mackenzie, 2024
2 International Monetary Fund, 2023
3 International Energy Agency, 2023

*STEPS: Stated Policies Scenario
**APS: Announced Pledges Scenario
***NZ: Net Zero Emissions by 2050 Scenario

# NAVIGATING A SHIFTING LANDSCAPE

The global energy transition will result in a fossil fuel phase-out and a shift towards greener activities, posing a range of threats to Brunei's current economic sectors, while increasing benefits of refocusing to new sectors

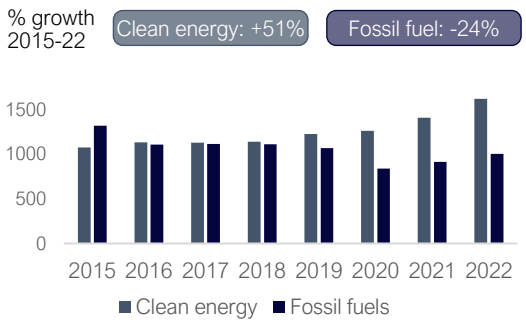
## REDUCED SUPPORT FOR NON-GREEN ACTIVITIES

Failure to align with international efforts to transition away from fossil fuels could lead to decreased investment and financing support for Brunei, as well as increased exposure to reputational risks.

Inaction in renewable energy development could affect regional cooperation as well as efforts towards achieving regional energy security.

Financial institutions (FIs) globally are increasingly divesting from fossil fuels and advancing green investment, which may lead to challenges in securing investment and financing for O&G projects for Brunei. Clean energy investment has been advancing over fossil fuels yearly from 2017 to 2022, according to IEA (see Global Clean Energy Investment chart). Globally, banks such as SMBC, Mizuho, and MUFG have pledged to cease funding of new coal power projects.[1] Similarly, the Glasgow Financial Alliance for Net Zero sees Financial Institutions such as ANZ, Barclays, Citi, CIMB, and DBS rebalancing investment portfolios away from fossil fuels.[2] Securing financing for future developments from these institutions could be a challenge if Brunei continues to be seen only as a petrostate.

*Global Clean Energy Investment, 2015–22*[3]
*/ USD Bn*




## TRANSITION IN SKILLS SET

Globally, according to the IEA, 30 million new clean energy jobs are anticipated to be created[4] while 5 million jobs in the fossil fuel sector are expected to be rendered obsolete by 2030. Brunei is not exempt from these opportunities. Energy transition is expected to cause job displacement in Brunei's O&G sector, which could result in rising national unemployment. This job loss has already been seen in the U.S., where petroleum jobs declined by 6.4% in 2021, equivalent to a loss of 31,000 jobs.[5] At the same time, the O&G workforce has some advantages with transferable skills and an existing knowledge base that makes them well-positioned for jobs linked to green transition areas such as Hydrogen and CCUS. Brunei will need to continue upskilling efforts for its workforce beyond hydrocarbons. A curated approach will be required in retraining and equipping the workforce with new and green skills. Without careful planning and government policy support, only 2% of fossil fuel workers globally are likely to transition to green jobs by 2030.[6] Massive job loss in Brunei over the next decade could pose threats to the economic and social vulnerability of the nation.

These five external global influences are further elaborated within the Appendix spread across eight key trends that explore the range of mounting challenges that come with transitioning to a green economy:

- Technology Advancements;
- Profitability and Cost;
- Policy Commitments and Targets;
- Green Skills Development;
- Regional Partnerships and Strategies;
- Geopolitics and Global Trade Dynamics
- Climate Financing; and,
- Emerging Industries and Opportunities.

Each trend highlights the key economic and social risks and losses Brunei could face as a result of inaction, as well as the opportunities that a green transition presents to Brunei.

1 Eco-Business, 2024
2 Glasgow Financial Alliance for Net Zero, 2021
3 International Energy Agency, 2023
4 International Energy Agency, 2024
5 U.S. Department of Energy, 2022
6 Fast Company, 2023

# POTENTIAL IMPACT ON BRUNEI'S ECONOMY

As the world responds to the climate emergency and as countries commit to recent COP decisions seizing momentum of green growth, Brunei's economy will need to adapt to stay competitive. Inaction could cause up to 58% GDP reduction

## PATHWAYS FOR THE ECONOMY

There is a high cost of inaction for economies that are slow to shift towards greening their economy, in line with global trends. This section presents Brunei's GDP projections up to 2050, in the event of 3 scenario pathways. The forecast relies on O&G demand forecasts averaged across 6 sources (IEA, Wood Mackenzie, Rystad, BP, Lukoil and Shell).[1]

- **Base case:** This theoretical scenario assumes a world where there is no global green transition. The only factor impacting Brunei's growth here is its depletion of resources with no further discovery of O&G fields. Here, the total energy production is expected to drop to 10 Mtoe by 2050.[2]
- **2 Degree:** The world is progressing towards this scenario, which assumes a pathway where climate actions are adopted globally to maintain warming at 2-degree Celsius. In this scenario, global oil demand averages 64 million barrels per day.[1 3]
- **1.5 Degree**: This is an ambitious scenario that the world aspires to reach, in which net-zero $CO_2$ emissions targets are met by 2050 and global warming is limited to a peak of 1.5-degree Celsius. Oil demand is expected to drop to 40 million barrels per day[2] as the shift towards cleaner fuel is adopted globally (e.g. high uptake of electric vehicles, 60% primary energy from renewables, etc.)

1 Forecast is averaged from 6 sources (listed above)
2 Asia-Pacific Economic Cooperation. 2022
3 W.K. Associates, 2022
4 International Energy Agency, 2021
5 Carbon Tracker Initiative, 2021
6 Combination of sources (Brunei Statistical Yearbook 2022, Energy Information Administration, BP, etc.)

## THE IMPACT

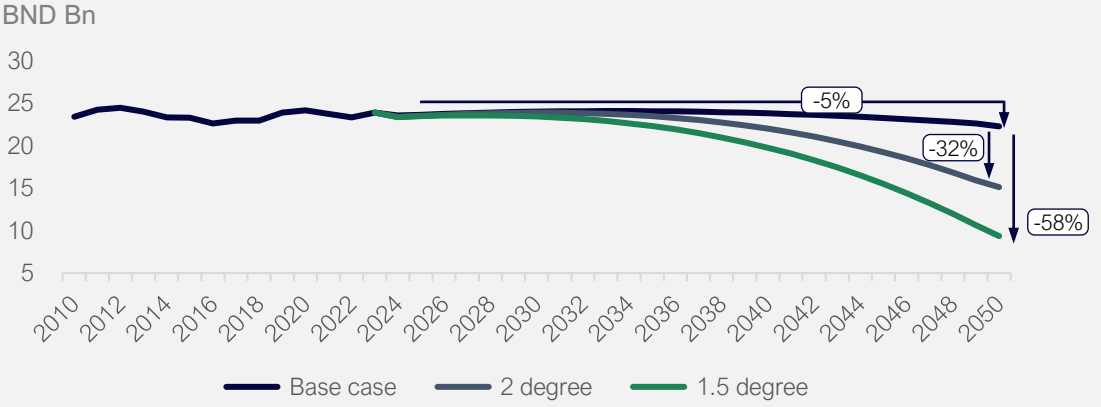
The global momentum toward green economic growth is promising – if all commitments made at COP26 were fulfilled, the world could steer to a 1.8-degree Celsius trajectory by 2100.[4] As the world edges closer towards 1.5-degree to 2-degree Celsius scenarios, **any climate inaction for Brunei could mean losing 58% of its GDP** under a 1.5-degree Celsius scenario. A study by Carbon Tracker Initiative reinforces this, reporting that 61% of Brunei's O&G revenue is at risk by 2040 in a low-carbon or 1.5-degree scenario.[5]

Even the base case scenario presents a serious picture — Brunei's GDP due to just its resource constraints is expected to drop by 5% highlighting a need for a step change in its economic model for growth.

The global sentiment on the future of oil and gas demand is mixed. Fossil fuel promoters are relatively optimistic that O&G will continue to dominate global demand while climate activists believe otherwise. It is challenging to predict exactly what the demand for fossil fuels will be by 2050. However, the global competition for fossil fuel products will intensify as countries impose regulations on emissions and other oil-producing nations compete for the remaining demand. Furthermore, the cost of exploration of oil & gas fields is also expected to rise, as deposits become harder to reach.

As such, **climate action can safeguard Brunei's economy from a significant GDP risk and loss of competitiveness.**

### BRUNEI GDP FORECAST TO 2050[6]



# POTENTIAL IMPACT ON BRUNEI'S GREENHOUSE GAS EMISSIONS

Brunei's GHG emission is strongly tied to its O&G sector GVA. To reach Brunei's net zero ambitions, its climate actions will need to address the decarbonisation of this hard-to-abate sector, supported by economic diversification

## GREENHOUSE GAS EMISSIONS PATHWAYS

Brunei's O&G and power sectors are the biggest contributors to the nation's GHG emissions. **Brunei's GHG emissions hold strong statistical relation to its O&G sector GVA**, which the GHG emissions pathways are modelled after. This section presents Brunei's GHG emissions projections up to 2050, following the same three scenario pathways described in the previous page. These pathways also consider the impact of the scenario if Hengyi Industries' Phase 2 utilises coal as its primary energy source, resulting in a 5 MTPA $CO_2e$ spike observed in 2028.

## THE IMPACT

In the theoretical base case scenario, GHG emissions are expected to rise by 32% over 2022 emissions to ~20.2 MTPA $CO_2e$ by 2050. This increase is partially attributed to the potential impact of Hengyi's Industries should they proceed with coal as its primary energy source in Phase 2.

In the realistic 2-degree and 1.5-degree scenarios, the global green transition is expected to gain momentum and as such O&G demand will fall, hence resulting in the decline of emissions to 13.7 MTPA $CO_2e$ and 8.5 MTPA $CO_2e$ in the 2-degree and 1.5-degree pathways respectively. It is noted that Brunei has existing natural carbon sinks of ~4 MTPA $CO_2e$ from its 72% forest cover.[1] While the 1.5-degree scenario seemingly demonstrates a smaller gap towards net zero of approximately 4.5 MPTA, this comes at the cost of 58% GDP reduction if climate action is not proactively pursued.

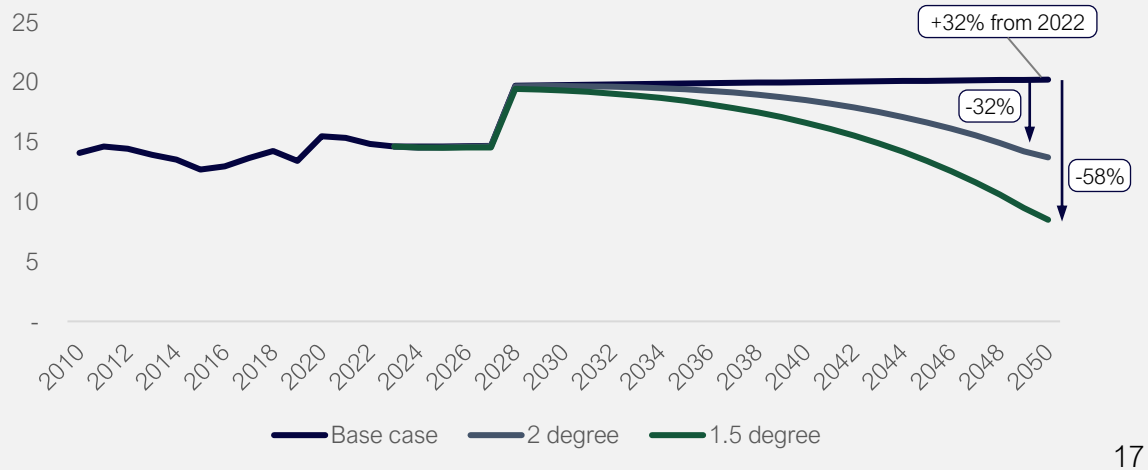
## THE CONUNDRUM

Brunei's O&G sector GVA and its GHG emissions are inextricably linked – which makes the decoupling of economic growth and environmental emissions a huge challenge for Brunei to overcome. Any action related to Brunei's decarbonisation will need to address activities in its O&G and related sectors and will need to be implemented now to minimize economic risk and capture the widest range of opportunities that are available to future-proof itself. The following actions can serve to address this conundrum (further elaboration on next page):

- Emissions reduction from its hard-to-abate O&G sector
- Creation of new O&G products that are clean and green by nature
- Decrease in reliance on the O&G sector, through economic diversification

**BRUNEI GREENHOUSE GAS EMISSION FORECAST TO 2050[2]**

Million Tonnes Per Annum (MTPA) $CO_2e$




1 Department of Energy Brunei
2 Combination of sources including Emissions Database for Global Atmospheric Research, public announcements, etc.

# TRANSITIONING TO A PROSPEROUS GREEN ECONOMY

To create a green economy, Brunei must start by greening existing sectors, develop new green economic drivers and new non-O&G sectors

## A PROSPEROUS GREEN ECONOMY

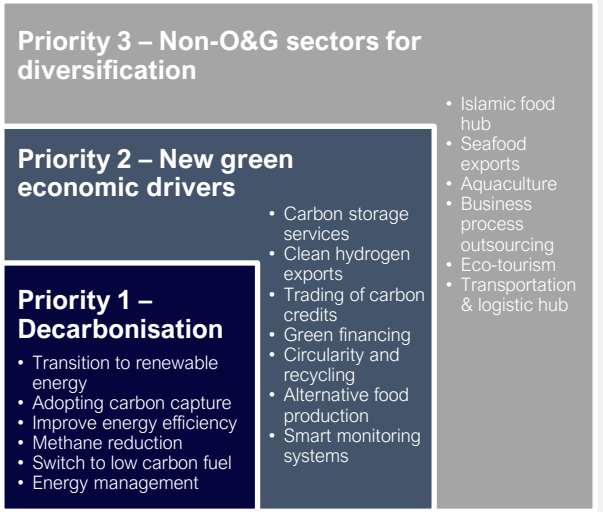
A prosperous transition towards net-zero, where economic growth is in tandem with greenhouse gas decline, means decarbonising existing industries while progressively diversifying from highly polluting industries to greener or green economic sectors. Thus, it is critical for Brunei to create a green economy that delivers the capacity to adapt to climate change, develop new drivers, and provide economic and social benefits to the nation. To do so, three key pillars will drive Brunei's green economic transition strategy.

## THREE PILLARS OF TRANSITION STRATEGY

The three pillars of the transition strategy are 1) decarbonisation of the existing downstream O&G sector, 2) developing new green economic opportunities in the upstream and downstream O&G sectors, and 3) developing other non-O&G sectors for economic diversification.

- **Decarbonisation of existing downstream O&G sector as a key priority:** Brunei's upstream and downstream O&G sectors are the backbone of its economy and account for more than 80% of its total greenhouse gas emissions. Driving down emissions from its core sector is the natural first step towards building a green economy. Broadly, this translates to adopting renewable energy improving energy efficiency, adopting carbon capture, etc. With the accelerated growth of the petrochemical sector in recent years, the deployment of renewable energy is a key priority.
- **Develop new green economic drivers in the O&G sector:** The global transition towards net-zero has uncovered new drivers of downstream O&G products and services that are considered green. Brunei is in the position to start developing these new drivers provided it acts early to establish competitive advantage. Examples are carbon capture storage as a service, clean hydrogen exports, circular economy, etc.
- **Develop non-O&G sectors to diversify the economy:** Diversification beyond the O&G sector is critical to reduce dependency on a volatile and emission-intensive industry and build economic resiliency. Growth of other sectors is key and this growth essentially needs to align with sustainability and green best practices. For example, sustainable aquaculture has the potential to reduce harmful environmental impact and build food security.

## ILLUSTRATION OF TRANSITION STRATEGY PRIORITY (non-exhaustive)




### Decarbonisation vs green economic opportunities

In addition to decarbonisation and emissions reduction opportunities, there are green economic opportunities that potentially impact all aspects of sustainability, be it environmental (waste reduction, climate adaptation, natural asset preservation), as well as economic and social factors. As such, green economic opportunities here refer to opportunities that encompass environmental, economic, and social objectives.

# 3 Identify green economy opportunities

# METHODOLOGY

To identify priority opportunities for Brunei, a long list of opportunities was formulated and put through a multi-criteria selection process

## CONTEXT AND SCOPE

Building a green economy requires deploying multiple levers ranging from renewable energy, energy efficiencies, methane reduction measures, bio-based fuel, circularity, transport electrification, and more. All these measures must be deployed together for Brunei to strive towards net zero by 2050. Amongst them, the study has identified four opportunities that have the potential to lay the foundation for a green economy. A screening methodology is adopted to select these four opportunities.

## APPROACH

The selection process utilises Arup's green economy expertise, tailored criteria, and stakeholder feedback. An existing list of economic opportunities is identified using Arup's proprietary global green economy database.[1] A multi-criteria selection process that considers impact, Brunei's unique position, and the three pillars of transition strategy was then designed to shortlist four green economic levers that:

1. **Have potential for decarbonisation**, a key component of a green economy is the capacity to reduce emissions and meet Brunei's near-zero targets. As such, opportunities that rank highly for their potential to decarbonise naturally stand out.
2. **Driving direct economic growth and long-term market demand** – opportunities should be able to contribute sizeable GVA to Brunei's GDP, create substantial jobs and export opportunities. Furthermore, it should lay the foundation for Brunei to create future market demand opportunities (indirect impact).
3. **Leverage Brunei's position and strengths,** such as its natural resources, labour, physical location, local skills, and capacity. By doing so, there is also a significant opportunity for Brunei to capture and potentially lead activities regionally.

While excelling in only one criterion (either decarbonisation potential, economic potential, or relevance to Brunei) is not in itself enough, success does not require an activity to excel in all three criteria to emerge as a priority opportunity. Most of the activities with the highest scores ranked medium or low in one or more variables.

For example, Brunei may be limited in its production of electricity from renewable sources due to lower availability of natural resources, hence ranking medium in the "relevance to Brunei" variable; yet, the opportunity scores high in every other variable, increasing its importance for Brunei.

**Four green economic opportunities for Brunei are identified,** along with several other non-O&G opportunities that have the potential to drive diversification, green the economy, and bring sustainable growth.

Multiple stakeholder's feedback was obtained during the study which reinforced the finalisation of these opportunities. A summary is shown on the following page.

1 Arup, 2023

# METHODOLOGY

Stakeholder engagements carried out during the course of this study

## STAKEHOLDER ENGAGEMENT APPROACH

Part of the screening methodology to identify and finalise the key green economic opportunities is our stakeholder engagement approach, which involved consultations with a range of experts across government, academia, and industry (see below). These engagements were critical to validating our opportunity identification approach.

**GOVERNMENT**

- جابتن تناك DEPARTMENT OF ENERGY PRIME MINISTER'S OFFICE | BRUNEI DARUSSALAM
- قجابت ڤراوبهن اقليم نكارا بروني دارالسلام BRUNEI CLIMATE CHANGE OFFICE
- MPEC مجليس ڤرايخن تناك مانپي دان ڤكرجاءن Manpower Planning & Employment Council
- BEDB BRUNEI DARUSSALAM

**INDUSTRY**

- بروني BRUNEI
- BMC BRUNEI METHANOL
- BRUNEI FERTILIZER INDUSTRIES
- BIBD
- CIC
- HENGYI
- بروني BRUNEI LNG
- Standard Chartered
- BAIDURI BANK

**ACADEMIA**

- يونيرسيتي بروني دارالسلام UNIVERSITI BRUNEI DARUSSALAM
- اونيورسيتي تيكنولوكي بروني UNIVERSITI TEKNOLOGI BRUNEI
- LCB Laksamana College Of Business
- IBTE Institute of Brunei Technical Education

# METHODOLOGY

The figure below summarises the selection process and its outcome. This involved a combined scoring to identify a short list of activities for Brunei to capture

## GREEN ACTIVITIES

## CRITERIA

### Decarbonisation Potential

Can the opportunity bring long-term emissions reductions and help Brunei achieve its near-zero targets?

### Economic Potential

Is the opportunity attractive enough for Brunei to reap economic benefits?

### Relevance To Brunei

Does Brunei have the right strengths and position to capture this opportunity?

## VARIABLES

- Emissions reductions (emissions that can be avoided)
- Independence from Oil & Gas (reliance on O&G resources)
- Longevity (ability to be sustainable in the long-term)

- GVA potential (Impact on Brunei's GDP)
- Jobs creation potential
- Export potential
- Long term market demand

- Resource availability (based on natural resources, labour, physical location)
- Brunei's strength (based on past track records, local skills and capacity, government support, partnerships)
- Alignment to Wawasan Brunei 2035 goals

## MULTI-CRITERIA ANALYSIS

| | DECARB. POTENTIAL | | | ECONOMIC POTENTIAL | | | | RELEVANCE TO BRUNEI | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Green Activities | Emissions reduction | Independence from O&G | Longevity | GVA | Jobs | Exports | Global Market Size | Resource Availability | Brunei Strength | Wawasan Alignment |
| Forestry conservation, forestation and rehabilitation | Low | High | High | Low | Low | Low | Low | Low | Medium | Medium |
| Landscaping and maintenance of natural environmer | Low | High | Medium | Low | Low | Low | Low | Low | Medium | Medium |
| Supporting freshwater and marine ecosystems | Low | High | High | Low | Low | Low | Medium | Low | Medium | High |
| Sustainable agricultural processes | Medium | High | Medium | Low | Low | Low | High | Low | Medium | High |
| Green Buildings Construction | Medium | Medium | High | High | High | Low | High | Low | Low | Low |
| Green infrastructure projects | Medium | Medium | High | High | High | Medium | High | Medium | Low | Low |
| Sustainable building renovation activities | Low | Medium | Medium | High | High | Low | Low | Medium | Low | Low |
| Efficient electricity transmission and distribution activi | High | Medium | High | Medium | Medium | Low | Medium | Medium | High | Medium |
| Efficient heating and cooling | High | Medium | High | Medium | Low | Low | Medium | Medium | Medium | Medium |
| Hydrogen Fuel for Energy Production | High | Medium | High | High | High | High | High | High | High | High |
| Ammonia Production as Hydrogen Carrier | High | Medium | High | High | Medium | High | High | High | High | High |
| Production of electricity from natural gas | Low | Low | Low | Medium | Medium | High | High | High | High | Medium |
| Production of electricity from renewable sources | High | High | High | High | High | High | High | Medium | Medium | High |
| Brokering and trading | Low | High | High | Medium | High | Medium | Medium | Medium | Medium | High |
| Green finance | High | High | High | Medium | High | Medium | High | Low | Medium | High |
| Green fuel | Medium | Medium | High | High | High | High | High | High | High | High |
| Greening of industrial products | Medium | Medium | High | High | Medium | Medium | High | High | Medium | High |
| Greening of electronics | Medium | High | Medium | Low | Low | Medium | Medium | Low | Low | Medium |
| Greening of raw materials and metals | High | High | High | Medium | Medium | High | Medium | Low | Medium | Medium |
| Greening plastics and plastic product manufacturing | High | High | High | High | High | High | High | High | High | High |
| Manufacture of low carbon and environmentally-frien | High | High | High | Medium | Low | Medium | High | High | Medium | Medium |
| Production of new and alternative foods | Medium | High | Medium | Low | Low | Medium | Medium | Low | Low | High |
| Cities design and engineering consultancy | Low | High | Medium | Low | Medium | Medium | Medium | Low | Medium | High |
| Enabling ICT and Digital Infrastructure | Medium | High | High | Medium | High | Low | Medium | Medium | High | High |
| Environmental Education/Training | Medium | Medium | High | Low | High | Low | Medium | Low | High | High |
| Smart Environmental Monitoring & Modeling | High | High | Medium | Medium | Medium | High | Medium | Medium | High | High |
| Air transport greening activities | Medium | High | High | Medium | Medium | Medium | Medium | Low | Low | Low |
| Personal vehicles greening activities | Medium | High | High | High | High | High | High | Medium | Medium | Low |
| Public transport greening activities | High | High | High | Medium | High | Low | Low | Medium | Medium | Low |
| Road and rail freight greening activities | Medium | High | Medium | Low | Medium | Low | High | Low | Low | Low |
| Sea transport greening activities | Medium | High | Medium | Low | Medium | Low | High | Low | Low | Low |
| Carbon capture, transport and storage | High | High | High | High | High | High | High | Medium | High | High |
| Collection and management of biological waste | High | High | High | Medium | High | Low | Medium | High | High | Medium |
| Hazardous waste management and decontamination | High | Medium | High | Medium | Medium | Low | Medium | High | High | Medium |
| Landfill services | Medium | Medium | Medium | Low | Medium | Low | Low | High | High | Medium |
| Material collection & recovery from non-hazardous w | Medium | High | Medium | High | High | High | Medium | High | High | Medium |
| Pollution Detection and Reduction | High | Medium | High | Medium | Medium | Low | Low | Medium | High | High |
| Recycling | High | Medium | High | High | High | High | High | High | High | High |
| Sewage services | Low | High | High | Medium | High | High | Medium | Medium | High | High |
| Water desalination | Medium | Medium | High | High | Medium | Medium | High | High | Medium | Medium |
| Flood defences | Low | High | High | Low | Low | Low | Medium | Medium | Medium | Medium |
| Water infrastructure | Low | Medium | High | Low | Low | Low | Medium | Medium | Medium | Medium |
| Water storage | Low | Medium | High | Low | Low | Low | Medium | Medium | Medium | Medium |
| Water treatment | Low | High | High | Low | Low | Medium | Medium | High | Medium | Medium |

Shortlisted targeted opportunities in the downstream O&G sector

- **Transition to Renewable Energy**
- **Carbon Capture and Storage**
- **Clean Hydrogen**
- **Consumer & Industrial Waste Recycling**

# METHODOLOGY

Four green economic opportunities have been identified as priorities for Brunei's journey towards net zero by 2050

Four downstream O&G opportunities were selected as key priorities for Brunei to capture. A brief justification for why each opportunity was chosen, in line with the selection criteria, is as follows:

### Transition to Renewable Energy

Brunei can scale-up its renewable energy capacity to support Brunei's transition away from natural gas and coal-fired plants to clean energy. Specific potential in solar, waste-to-energy and hydropower.

**Decarbonisation Potential:** Reduced reliance on O&G for power generation, reduction in carbon emissions.
**Economic Potential:** Renewables LCOE will become lower than fossil fuel LCOE bringing better cost savings, more job creation, and contribution to GVA.
**Relevance to Brunei:** Abundant solar resources of 2.3 GW, alignment to Wawasan Brunei 2035's low carbon sustainability targets.

### Carbon Capture and Storage

There is an opportunity to build or retrofit plants with CCS technologies to ease decarbonisation.

**Decarbonisation Potential:** Removal of emissions, can retrofit existing coal-fired or natural gas-fired power plants and hard-to-abate sectors.
**Economic Potential:** GVA contribution, jobs creation, can help produce clean industrial products.
**Relevance to Brunei:** 9.5 trillion cubic feet of existing natural gas reserves and mature oil fields could be used for $CO_2$ storage. Brunei can leverage partnerships with CCS experts (Shell plc, etc). CCS will also support Wawasan 2035 priorities.

### Clean Hydrogen Export Hub

This opportunity involves building a strong industrial cluster in Brunei for clean hydrogen production.

**Decarbonisation Potential:** Blue hydrogen reduces GHG emissions 5-36% more than grey.
**Economic Potential:** Contribution to GVA, job creation, high O&G job and skills transferability, high investment interest in clean energy.
**Relevance to Brunei:** Brunei-Japan pilot project successful in supplying the world's first foreign-origin hydrogen. Good location to transport to the Asian market. Alignment to Wawasan 2035 priority for development of clean industrial products.

### Consumer & Industrial Waste Recycling

There is an opportunity for Brunei to establish an rPET plant, using flyash for production, and enforcing cleaner industrial waste management – including via Anson's decommissioning yard.

**Decarbonisation Potential:** Reducing oil dependence for plastics production will reduce waste and emissions. Flyash use also helps reduce the carbon content of cement/concrete.
**Economic potential:** Recycled PET (rPET) and flyash are growing in demand and can contribute to Brunei's GVA.
**Relevance to Brunei:** Brunei's large waste output (1.4kg/capita) can be recycled and repurposed.

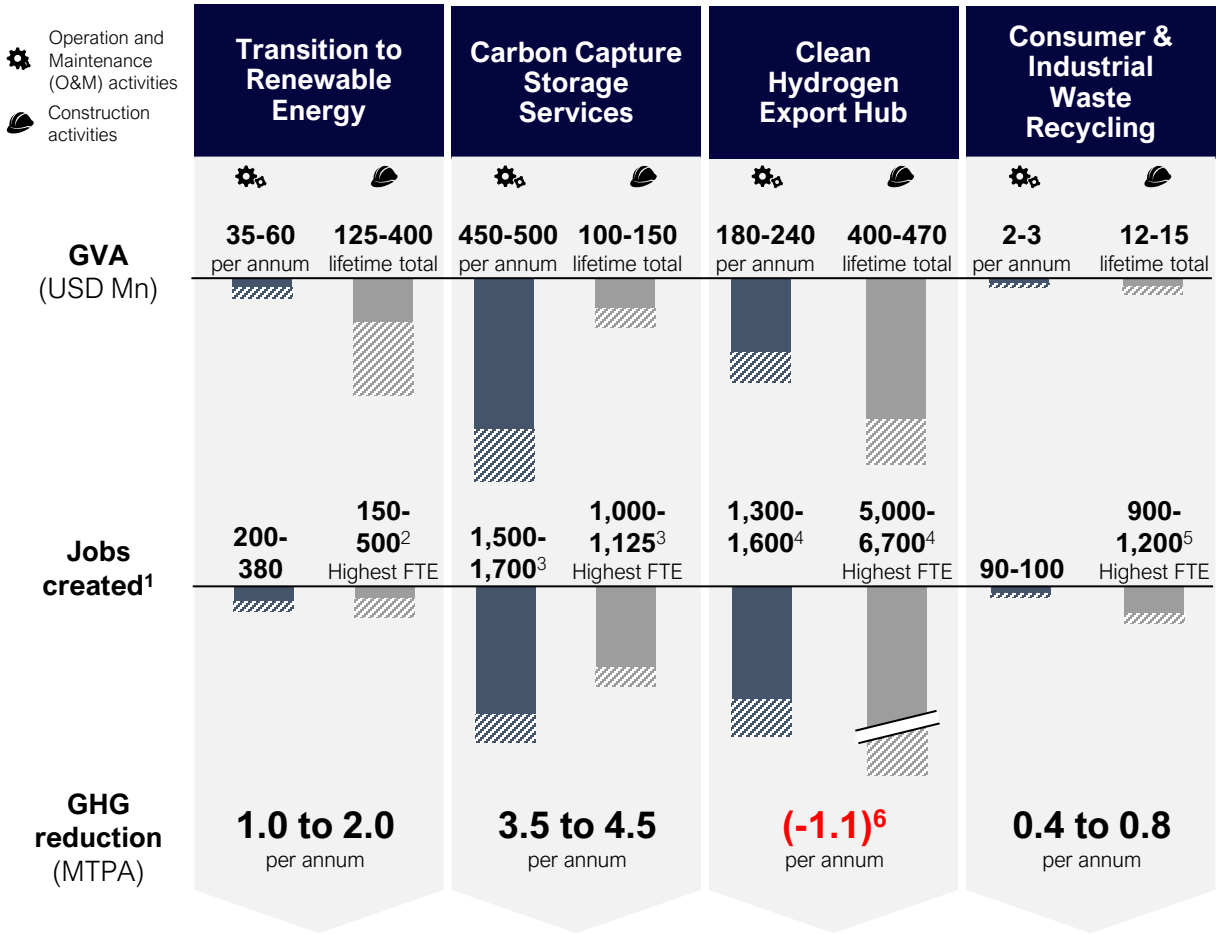
As discussed previously, this report intends to cover the four key green economic opportunities within the downstream oil and gas space that have economic potential and can lay a foundation to create long-term green economic growth. Other green opportunities are not covered for various reasons including 1) there is little scope as it is in the process of implementation, and 2) lack of feasibility to develop in Brunei.

For example, methane emissions reduction and energy efficiency measures are also critical levers for a petrostate to consider. However, initial investigation found that most players have started implementing similar measures in their 5-year strategic plans. Therefore, these have not been selected as major levers to feature in this report.

Similarly, switching to bio-based fuels is a well-acknowledged solution to decarbonisation. However, production could be challenging due to limited waste volume in Brunei, increasing competition, and regulation for waste importation in the region. In this case, bio-based fuel could be better produced in other ASEAN regions.

# THE IMPACT OF GREEN ECONOMY

Select green opportunities could add ~USD 670-800 Mn annual GVA and ~USD 690-1090 Mn construction GVA to Brunei's economy, creating 10,000-16,000 jobs[1] and reducing emissions by 3.8-6.2 MTPA $CO_2$e up to 2050




The collective implementation of initiatives in renewable energy, CCS, the hydrogen economy and recycling hub are anticipated to generate USD 660 to 800 Mn in annual GVA and USD 690 to 1,000 Mn cumulative construction GVA directly to Brunei's economy. Job creation is in the range of 10,000 to 16,000 and emission reduction at 3.8 to 6.2 MTPA $CO_2$e by 2050. This additional GVA (opportunity implementation + construction) represents a potential 7.8% increase from Brunei's 2022 GDP and a potential 6% increase in employment from 2022 reports.[7]

It will also be important to consider indirect value add- economic activity from adjacent sectors such as manufacturing, services, education, and research will also be stimulated, which will contribute to further GVA growth and job opportunities in Brunei. These direct and indirect jobs will also, while increasing awareness of green technologies, grow a more dynamic and skilled labour market.

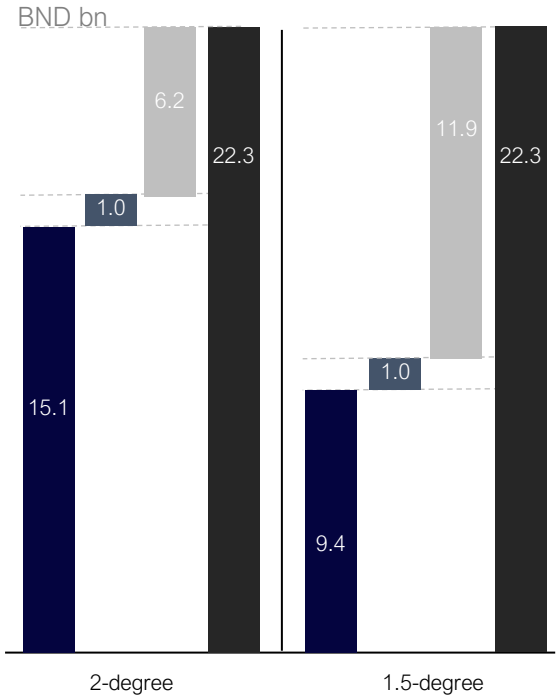
Each opportunity carries its weight in GHG reduction, cumulatively contributing to a ~45% decrease in national carbon emissions relative to Brunei's 2022 GHG emissions. Most critically, the transition to renewable energy and the deployment of CCS technologies will address the carbon footprint of the energy sector.

1 Jobs creation does not account for jobs replacement from O&G sector
2 Solar will create 5,342 construction jobs in total from now till 2050
3 CCS will create 6,750 construction jobs in total from now till 2050
4 Inclusive of jobs for floating solar PV construction and operations
5 The circular economy will create 925 construction jobs in total from now till 2050
6 Blue hydrogen facility will increase carbon emission as carbon capture rate is not 100%. There is potential for indirect emission reduction from industrial players but insufficient inputs to quantify.
7 Department of Economic Planning and Statistics Brunei, 2022

# BENEFITS TO THE ECONOMY

The direct value-added impact of the four green economic opportunities creates a sizable proportion of the GDP that could be lost from a declining O&G sector while also laying the foundation for economic diversification

**GDP gap in 2050** (with green economic drivers)




[1] Note: This excludes total construction GVA of BND 793 Mn up to 2050

## SIGNIFICANT GAP BETWEEN 1.5 AND 2-DEGREE SCENARIO TO BASE CASE

Aggregating the four green economic opportunities, the direct additional annual GVA to Brunei by 2050 is ~BND 1.0 Bn, 4.5% of base case GDP in 2050. Benchmarking this to global estimates, the global green economy opportunity is worth USD 10.3 Tn by 2050. This is equivalent to 5.2% of global 2050 GDP,[2] a similar ballpark. Furthermore, additional indirect value-add created in adjacent sectors and related activities can boost the estimated GVA addition.

While there is still a gap of BND11.9 and 6.2 bn from the 1.5 and 2-degree scenario to the GDP base case projected (see page 16), these opportunities represent a significant step towards green economy development in Brunei. Moving now to secure these promising green economy opportunities from the downstream O&G sector alone could create up to 16% of the GDP and jobs that could be lost from a declining O&G sector during the global energy transition. This argues for expanded scope to examine the economic potential of diversification to reduce O&G sectoral mix in the overall economy.

## TOWARDS NET-ZERO PLEDGE

The select four opportunities could potentially lead to ~6 MTPA $CO_2$e, or 30% reduction from 2050 base case (see page 17). This is a considerable first step to guide Brunei towards it's near zero pledge in 2050.

## A CATALYST TO ATTRACT FOREIGN INVESTMENTS

Another huge indirect benefit of building a green economy is catalysing investments. An LSE study shows that 85% of investors and banks now consider environment, social and governance (ESG) factors when making investment decisions.[3] In addition, discussions with stakeholders have revealed that the ESG-related impact of projects is increasingly affecting investors' decision-making processes. One stakeholder shared that interest in a solar PV project appeared to be hampered by current tariffs and subsidies that seem to disincentivise a clean energy transition.

## DEVELOPMENT OF HUMAN CAPITAL

The four green opportunities are also expected to create up to 16,000 new jobs by 2050; an important part of the solution to Brunei's current 5.2% unemployment rate.[4]

## FOUNDATION FOR ECONOMIC DIVERSIFICATION

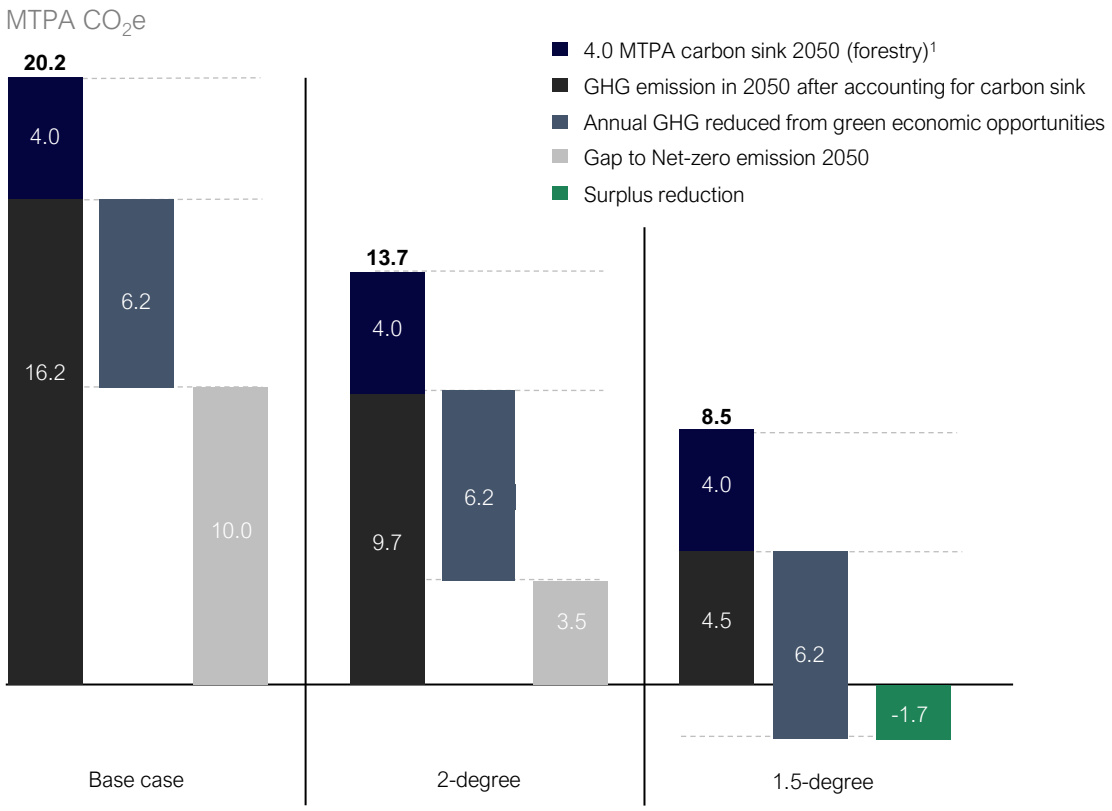
These opportunities are a stepping stone towards an economic diversification that aligns with sustainability best practices. Brunei's other sectors (food, ICT, services and tourism) are well within global sustainability interests and will be facilitated from the ecosystem benefits created by these opportunities.

1 GVA from construction is excluded, as construction for the selected opportunities would have been completed by 2050
2 Arup & Oxford Economics, 2023
3 London School of Economics, 2023
4 Department of Economic Planning and Statistics, 2022

# TOWARDS NET-ZERO BY 2050

Green economy can deliver substantial emissions reductions but not enough to meet 2050 net-zero target. An achievable scenario requires significant scale down of its O&G sector – potentially detrimental to current economy

**GHG emission gap in 2050** (with green economic drivers)




## NET ZERO POTENTIALLY ACHIEVABLE WITH DRASTIC SHIFT FROM O&G

Estimates show that the select four green economic opportunities can help Brunei meet its 2050 near-zero emissions in the 1.5-degree Celsius scenario. However, achieving this ambitious scenario requires a whole-of-nation approach to prioritise and accelerate decarbonisation and climate action.

In a relatively less ambitious 2-degree scenario a gap of 3.5 MTPA CO2e remains. This suggests that net zero achievement could be realistic post-2050 and dependent on other factors like technological advancement and further decline in solutions costs.

2050 net-zero is a tall order with a continued oil & gas sector. Beyond the four select green opportunities, Brunei must pursue other green initiatives to boost commercial and residential energy and water efficiency, and transport efficiency, to move towards net-zero.

1 Department of Energy Brunei

# 01 – TRANSITION TO RENEWABLE ENERGY

Gas and coal make up 99% of Brunei's existing power generation and contribute to 33% of total greenhouse gas emissions. The availability of renewable energy sources makes it a viable option to drive Brunei's transition to clean energy

## FOSSIL FUEL DRIVEN POWER SYSTEM

Brunei's 671 MW[1] peak power demand is supplied by natural gas and coal, at 81% and 18% of total power capacity respectively.[2] The 220 MW coal-fired power plant by Hengyi Industries is an off-grid plant, developed in 2019 for its own petrochemical and refinery consumption. As a result, carbon emissions from the power sector have increased from ~3.4 to 5.1 $MTCO_2$ between 2019-20.[3] As the power sector contributes ~33% of GHG emissions,[2] renewable energy is a natural key driver for decarbonisation especially given its availability. Stakeholder interviews conducted during the project have also confirmed that the availability of renewable energy is a key investment consideration for investors.

## THEORETICAL POTENTIAL FOR SOLAR, WASTE-TO-ENERGY, AND HYDROPOWER

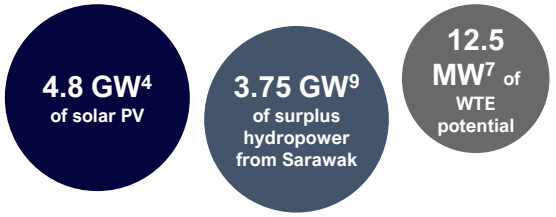
Due to its location, Brunei receives solar irradiance of 1,750 to 1,850 kWh per square metre annually[4] or an average of 19% capacity factor.[4] Slightly higher than Singapore's 1,580 kWh/m2/p.a, solar PV is a viable option for Brunei. An existing study by the World Economic Forum has identified 4.8 GW[5] of ground-mounted, floating, and rooftop solar theoretical potential for Brunei. High power consumption in the residential, commercial, and governmental sectors indicates the viability of rooftop solar PV.

With more than 300,000 tonnes per annum[6] of municipal solid waste generated, Brunei has 12.5 MW[7] of waste-to-energy (WTE) theoretical potential.

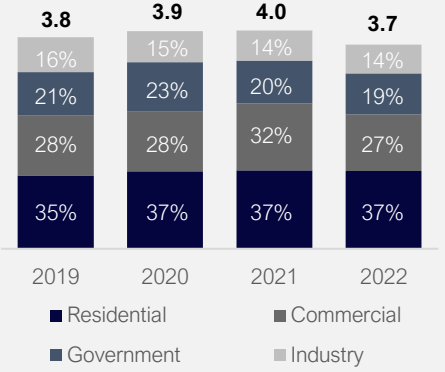
Given its location, wind power in Brunei is limited. Onshore mean wind speeds are below 4 m/s[7] and offshore is 4-6 m/s.[8] Studies have shown potential for offshore wind resources via low-speed turbines. However, the impact of wind power is low and not a realistic option.

Importing hydropower could be a viable option given its proximity to Sarawak. Sarawak has ~1.5 GW[9] hydropower surplus and plans to export further (e.g. to Singapore and Sabah). 3.75 GW surplus is expected if Sarawak increases hydropower capacity to 9.5 GW.[9] The average hydropower cost in Sarawak is lower than Brunei's grid tariff, making it a financially viable option (USD 0.046 per kWh vs USD 0.069).

## BRUNEI'S RENEWABLE ENERGY POTENTIAL

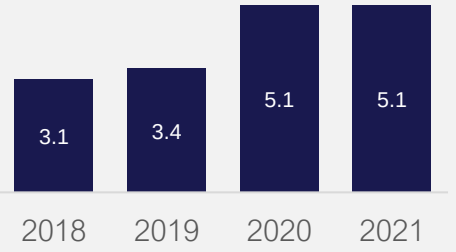



## BRUNEI POWER CONSUMPTION, 2019-22 TWh




## GHG EMISSION FROM POWER SECTOR[3], 2018-22, MTPA $CO_2e$

~50% increase in emissions between 2019-2020 due to the start of a 220 MW coal power plant




1 Department of Economic Planning and Statistics, Brunei Darussalam Statistical Yearbook, 2022
2 Department of Energy Brunei
3 The Emissions Database for Global Atmospheric Research, 2022
4 Economic Research Institute for ASEAN and East Asia, 2023
5 World Economic Forum, 2022 (System Value Analysis)
6 CIC Environmental Services
7 Arup analysis
8 IRENA, 2023
9 Malay Mail, 2023

# 01 – TRANSITION TO RENEWABLE ENERGY

Transitioning to renewable energy has benefits beyond decarbonisation. It enables the development of other green economic opportunities, creating energy optionality and will attract investments to Brunei

## RENEWABLE ENERGY – AN ENABLER FOR OTHER GREEN ECONOMIC OPPORTUNITIES

Increasing renewable energy adoption can support Brunei's green economy development. The global net zero-scenario transition is expected to shift demand away from existing oil and gas products toward low-carbon ones. This requires renewable energy sources. Furthermore, the demand for renewable energy under the net-zero scenario will drive investment to Brunei as in other countries.

### Enabling green hydrogen

Under the IEA net-zero scenario, global demand for clean hydrogen-based fuel is expected to increase more than 6 times[1] by 2050, to fill the gaps where electricity is not accessible, e.g. hydrogen-based fuel ships. Green hydrogen could be a potential option for both domestic consumption and exports in Brunei. However, this requires the availability of renewable energy.

In recent years, Brunei received interest from foreign investors to begin green hydrogen production.[2] Ultimately, the investor withdrew interest due to the unavailability of readily available renewable power. It is imperative Brunei does not miss further investment opportunities that instead will go to regional competitors.

### Free-up natural gas

Transitioning to renewable energy will free up natural gas for existing power generation. A World Economic Forum study has shown that 31% solar penetration in the grid would free up 25%[3] of natural gas. The savings in natural gas can potentially be directed to other uses.

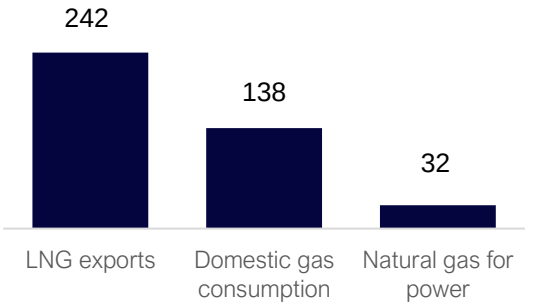
This natural gas could be channelled toward blue hydrogen production, for either domestic or export markets. Freeing up natural gas through renewable power creates flexibility for Brunei. Currently, an estimated 32 million MMBTU of natural gas is used for power generation in Brunei. An estimated 30% natural gas savings from power generation could yield ~USD 145 Mn per annum* in additional LNG exports.

### Attracting downstream O&G, manufacturing, and logistics investment

With growing requirements for ESG compliance, the availability of renewable energy resources has become an important criterion in selecting sites for investments, especially for hard-to-abate sectors industries such as downstream O&G, manufacturing, and logistics sectors.

**BRUNEI LNG EXPORT AND GAS CONSUMPTION, 2022**

million MMBTU




Global companies such as Taiwan Semiconductor Manufacturing Company[4] for example, have set renewable energy as a criterion when identifying new investments. Greening its energy supply will position Brunei to attract foreign investments.

* Based on 2022 LNG price of USD 14.40 per MMBTU

1 International Energy Agency, 2023
2 Stakeholder interviews
3 World Economic Forum, 2022 (System Value Analysis)
4 Taiwan Semiconductor Manufacturing Company, 2023

# 01 – TRANSITION TO RENEWABLE ENERGY

Brunei could replace 60% of its power supply from 2 key renewable sources; solar PV and hydropower imports. This could create more than USD 120 Mn in annual GVA, >5,000 jobs, and reduce 13% of GHG emissions

**Impact of transitioning to 60% renewable energy* by 2050**

| | | | | |
|---|---|---|---|---|
| **2.7 GW**** [1] of solar PV** | **USD 35-60** Mn annual O&M GVA** [2] | **200-380** O&M Jobs** [2] | **0.5-1.0** MTPA GHG reduced** [2] | **USD 2.0-2.3** Bn total cumulative investment[2] |
| | **USD 125-400** Mn construction GVA** [2] | **4,500-5,000** construction Jobs** [2] | | |
| **30% hydro-power from Sarawak** | **USD 15-20** Mn construction GVA*** [2] | **900-1,000** construction Jobs*** | **0.5-1.0** MTPA GHG reduced[2] | **USD 85-95** Mn total cumulative investment[2] |

### RENEWABLE ENERGY OPTIONS

This study assumes the potential for 60% of Brunei's power from two renewable sources by 2050; Solar PV and Hydropower import.

30% of power generation from Solar PV is established based on an existing study and benchmark of national targets. The study proposes the possibility of 30% on-grid solar PV penetration[1]. This is further substantiated by benchmarks of nations globally. IEA estimates that solar PV could make up 31% of India's energy mix by 2040. The USA has a target for 30% solar in its power mix by 2030[3]. Morocco has pledged to increase renewables in its electricity mix by 52%[4] by 2030, of which 40% are from intermittent renewable energy.

Based on existing studies, Brunei could deploy 900 MW on-grid solar PV (250 MW utility-scale, 500 MW floating on-grid, 150 MW rooftop) and 1.8 GW off-grid floating solar PV (for green hydrogen production)[1].

30% hydropower import potential (~1.3 TWh) was established based on its availability (from Sarawak) and a high-level estimate of the response time for Brunei's gas power plant to close the power gap in the scenario that import becomes unavailable. Assuming a 10-minute dispatch requirement, an average 25 MW/min ramp-up rate of a gas power plant, and 671 MW peak demand, 30% import of hydropower may be possible. However, further studies will be required to determine technical feasibility.

Hydropower is one of the few non-intermittent clean energy sources that are not readily available to most nations. When utilised properly it is a dependable power source with lower resource consumption (as compared to battery storage), to support high solar PV integration. Given the accessibility to it and potentially economical options (see next slide on cost of hydropower in Malaysia), it should be actively explored.

As discussed previously, Brunei has sufficient municipal waste for ~12.5 MW of Waste-to-Energy (WtE) power plant. The economic and emissions impact are covered under commercial and industrial waste recycling opportunities.

### IMPACT

Assuming a 60% power from solar PV and hydropower import by 2050, Brunei can achieve up to 2 MTPA reduction in emissions, equivalent to 13% of emissions in 2022. Cumulative GVA of USD 140-420 Mn can be achieved from the construction of solar PV plants and transmissions (for hydropower). Annual GVA of USD 35-60 Mn can be achieved from the operation and maintenance of these assets. Job creation is in the range of 2,300-5,000 jobs by 2050.

1 World Economic Forum, 2022 (System Value Analysis)
2 Arup analysis
3 Solar Energy Industries Association, 2019
4 BBC, 2021

* Considers only renewable energy from 30% power from solar PV and 30% from hydroelectric power import from Sarawak. WTE is separately covered.
** Does not include investment for grid upgrade. Considers 31% grid penetration as proposed by System Value Analysis report published by the World Economic Forum. Considers GHG reduction from replacement of grid-connected power. GHG avoidance from off-grid floating solar PV not included.
*** GVA estimated based on construction of 40-55 km of 275 KV overhead AC transmission line, switch station and balance of plant on both ends of transmission

# 01 – TRANSITION TO RENEWABLE ENERGY

Brunei has difficulty in meeting its 300 MW solar PV target by 2035. Economic feasibility is a big challenge as the electricity tariff is far below solar PV cost

## KEY CHALLENGES TO SET UP SOLAR PV

Under the Brunei Darussalam National Climate Change Policy published on 25 July 2020, Brunei has targeted deploying 200 MW of solar PV capacity by 2025 and 100 MW of additional capacity by 2035. Currently, only 60 MW is on track for completion by 2024, which is far from Brunei's 2025 target. In recent years, Brunei banks and BEDB received interest[1] from foreign investors to set up a solar PV plant in Brunei. It was found during this study that land sites have been earmarked for solar PV development, but existing challenges have prevented the advancement of these projects.

### Lack of economic feasibility

The feasibility of a solar PV project is one of the key reasons stopping investors and bankers from investing.[1] Due to government subsidies, Brunei's grid power tariffs are approximately 70% lower than solar PV costs. The average electricity cost in Brunei is USD 0.069 vs USD 0.118[2] for solar PV. An appropriate tariff model for Brunei that promotes the economic viability of solar PV investment is required. This could mean re-channelling existing subsidies, developing a suitable tariff model, or both.

### Space is still a constraint

To meet its near-zero target by 2050, forestry will play an important role. To maintain 72% of its forest cover as a natural carbon sink, there is a limited amount of land available for scaling up utility-scale solar PV plants. Potential water bodies have been identified for floating solar PV. However, this option could still be limited due to the high current costs of floating solar PV. A detailed technical study will be required to ascertain a feasible area for floating solar PV.

### A need to upgrade the grid infrastructure

Brunei's connectable solar PV capacity is 334 MW[3], equivalent to ~10% of its power generation. Accommodating 30% solar PV generation will require significant upgrades to Brunei's existing grid infrastructure.

### Lack of a clear energy transition plan

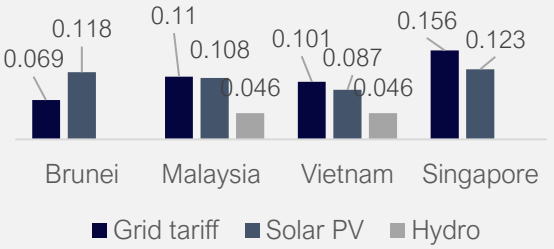
A successful clean energy transition must consider national energy security and resource requirements. Especially for a fossil-fuel-reliant nation, defining the condition for a 'just energy transition' is imperative. The absence of a national strategy with clear goals and an execution plan is a significant hurdle when mobilising key stakeholders.

## KEY CHALLENGES TO HYDROPOWER IMPORT

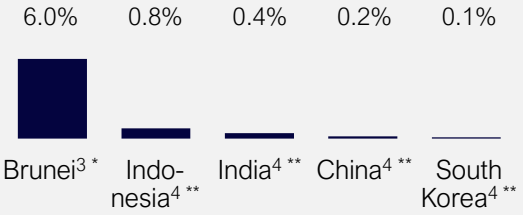
Key challenges for importing hydropower from Sarawak are maintaining energy security, establishing mutually beneficial agreements, and availability of cross-border infrastructure. Fostering a strong relationship with the right commercial agreements is important.

1 Insight from stakeholder interviews
2 Economic Research Institute for ASEAN and East Asia, 2024
3 International Monetary Fund, 2023
4 Climate Transparency, 2023

**Cost of electricity[2] across selected SEA nations, 2020, USD / kWh**

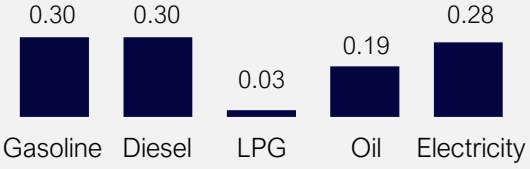



**Fossil fuel subsidies of selected Asian countries, % of GDP**




* 2022 data – Brunei's fossil fuel subsidy in 2018 was ~4% of its GDP
** 2017 data

**Brunei's fossil fuel subsidies by fuel[3], 2022, USD Bn**



# 01 – TRANSITION TO RENEWABLE ENERGY

To achieve 60% power from renewable energy by 2050, initiatives must be put in place via policies, tariffs, infrastructure, partnerships, and skills development. Setting a national energy transition plan is an immediate first step

## RIGHT CONDITIONS FOR BRUNEI

Meeting 60% of power generation from solar PV and hydropower imports will require Brunei to address existing challenges. This could mean developing a national strategy across its electricity policies, infrastructure, partnerships, and skills development.

### National strategy and targets

As mentioned previously, developing an ambitious and transparent national clean energy transition plan is a critical first step, more so for a fossil fuel-reliant nation. Neighbouring ASEAN nations Malaysia and Singapore have published national energy plans. Clear goals and roadmaps allow for close monitoring, review, and periodic updating of clean energy strategy to meet targets and attract investments.

### Clear renewable energy policies and regulation

Clean energy policies must be developed across Brunei's energy value chain. Key components include policy guidelines to regulate solar PV tariffs and rooftop solar installation, grid upgrades for variable renewable energy integration, policies for importing hydropower, etc.

### Mechanism to support solar PV investments

Due to subsidies, grid tariff prices do not encourage solar PV investment. It is unlikely that Brunei will meet its current Solar PV targets of 300 MW by 2035. A whole of system approach will be required to develop the right tariff mechanism for solar PV installation. In the medium to long term, a swap strategy could be used to progressively redirect existing gas subsidies to deploy a tariff mechanism for solar PV as Brunei progressively frees up its gas supply. Denmark is a notable success case of undergoing fossil fuel subsidy reform to drive wind power adoption.[1] India and Indonesia are two Asian countries that took concrete actions to reform fossil fuel subsidies and increase the renewable energy share.[2]

### Infrastructure readiness

For Brunei, two important requirements for large-scale solar PV are space and grid infrastructure. Effective spatial planning translates to the efficient deployment of solar PV systems on land, water, and rooftops. With proper planning, Singapore can utilise public housing and town council rooftops to develop 366 MW of rooftop solar PV capacity.

As discussed previously, Brunei needs to upgrade its existing grid to increase solar penetration from 10% to 30%.

To address intermittency, Brunei could explore utilising its existing gas-fired plant for frequency regulation in the medium term. Large-scale battery storage may have to be considered in the longer term and potentially targeted at industrial clusters.

Brunei must also accelerate the construction of a 275kV interconnector between Sarawak and Brunei to accommodate proposed hydropower imports.

### Partnerships, commercials and skills development

Beyond policies and physical infrastructure, Brunei needs to establish the right commercial 'software' to drive renewable energy adoption. Availability of loans, solar PV supply chains and incentives programmes are important to attract investors to Brunei, particularly given the competition for renewables within the ASEAN region.

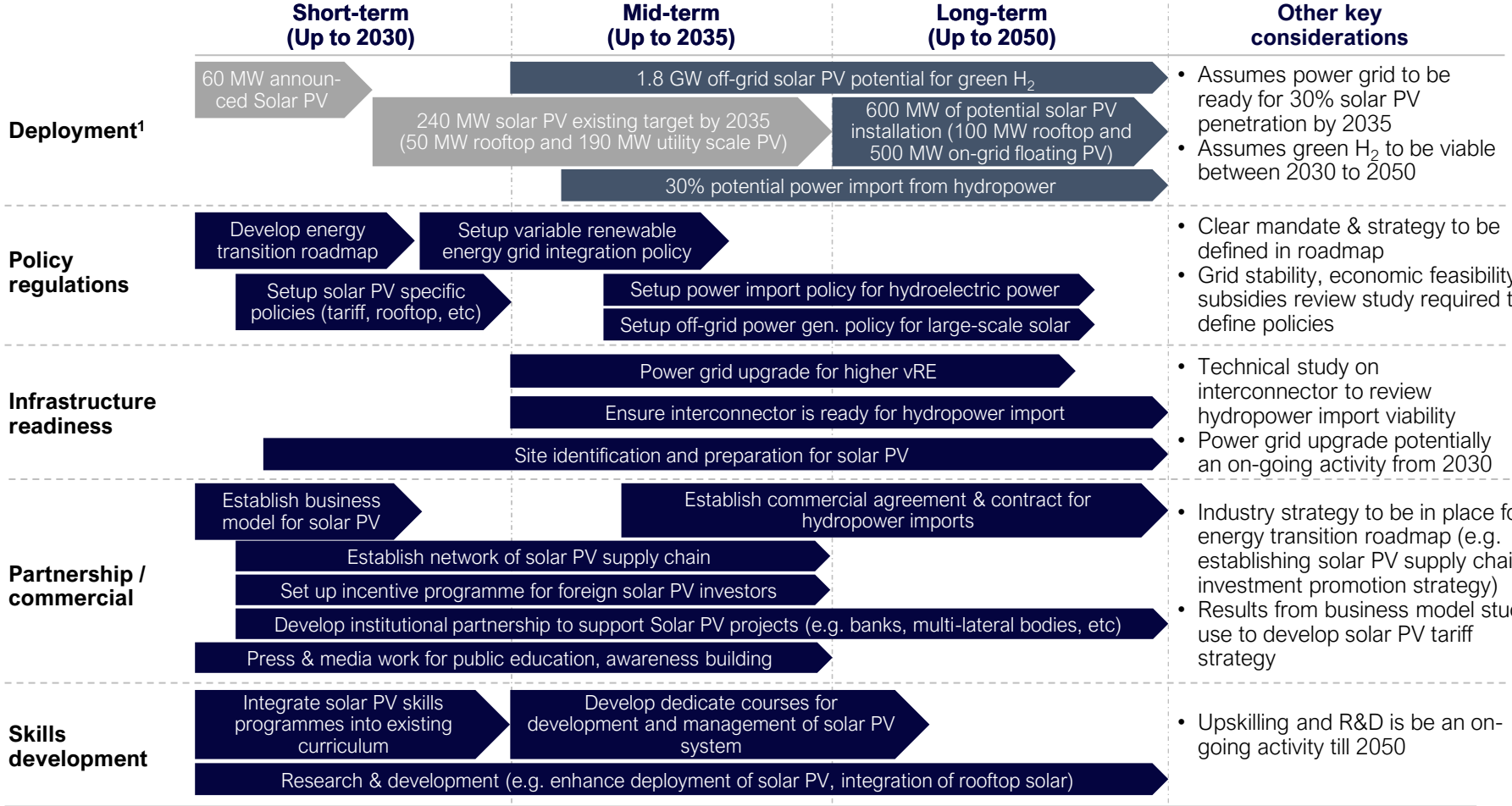
The availability of talent and skilled workers is important in attracting solar PV investments and development. Brunei must work together with institutions like Universiti Brunei Darussalam, Universiti Teknologi Brunei, and Institute of Brunei Technical Education to ensure the right level of capacity.

1 Nordic Council of Ministers, 2017
2 State of Green, 2019

Announced and existing target
Potential capacity deployment
Enablers

# 01 – TRANSITION TO RENEWABLE ENERGY

The potential roadmap must consider developing an appropriate plan and policies soon for successful implementation. Key policies around solar PV tariffs and rooftop regulation should be developed in the short term




1 Solar PV capacity deployment is developed based on capacity proposed in system value analysis report published by World Economic Forum, 2022

# 02 – CARBON CAPTURE STORAGE SERVICES

Southeast Asia has a huge potential to explore CCS as an economic opportunity, within which Brunei is strategically equipped to play a key role in

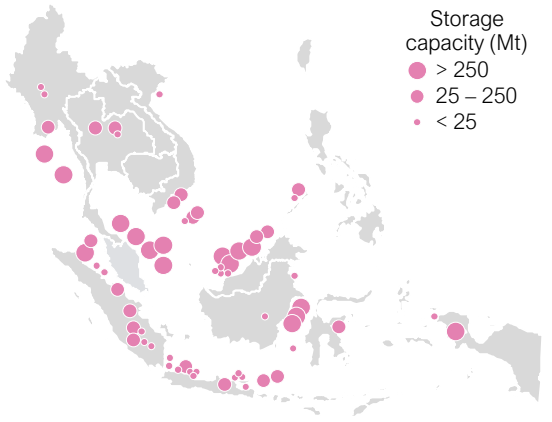
## CCS IN SOUTHEAST ASIA

The global CCS market is expected to reach USD 3.5 Bn by 2025[1], with Asia-Pacific potentially accounting for 55% of global CCUS share by 2050.

As fossil fuel demand in the Southeast Asian (SEA) region grows to more than 800 Mtoe in 2040[2], CCS' strategic value lies in its ability to retrofit existing assets and hard-to-abate sectors. CCS can contribute to emissions reductions in many parts of the region's energy systems. The deployment of CCS can enable recently built industrial plants and facilities to continue to operate with substantially reduced emissions while adhering to broader sustainability commitments. In line with sustainability development scenarios aligned to the 2015 Paris Agreement, the region will need to exceed 200 Mt of $CO_2$ capture by 2050.

**SEA has great potential to capture the CCS opportunity** with large numbers of basins suitable for geological $CO_2$ storage. In a global study by Kearns and others, about 170 Gigaton (Gt) of potential storage capacity is estimated in SEA[3], though less will be economically and technically viable. Due to the compact geographical area in SEA and the existence of oil/gas infrastructure close to suitable geological sites, the region is well-positioned to build a CCS hub-and-cluster network delivering economies of scale.

**Estimated storage capacity in SEA region[3]**




Organisations like the Asia CCUS Network – whose primary members are national energy ministries from Indonesia, Japan, and Malaysia among others – see a role for an international $CO_2$ trade from CCS projects in Japan, South Korea, and Singapore, which lack storage capacity.

The November 2020 Association of Southeast Asian Nations (ASEAN) Plan of Action for Energy Cooperation (APAEC), in recognizing a role for CCS in SEA, particularly to reduce emissions from coal-fired power plants, has further fuelled discussions in the region.

## SHIFT TOWARDS CARBON PRICING MECHANISMS ACROSS ASIA-PACIFIC

Regional governments have enacted proactive policy shifts and strategic investments. CCS is being facilitated with such carbon regulations and pricing mechanisms.

**Singapore** has started implementing a carbon tax that applies to facilities emitting at least 25,000 $tCO_2e$ annually.[4] Singapore is also interested in developing an offshore CCS value chain. In 2024, ExxonMobil and Shell formed an S-Hub consortium for this purpose.[5]

*"We are keen to work with like-minded partners (countries in the region with geological potential for $CO_2$ storage) on pathfinder projects to catalyse the development of such regional hubs"*
- Senior Minister Teo Chee Hean, Singapore[6]

On top of developing its storage capabilities, **Japan** contributes actively to the Asia CCUS Network, setting common standards for the region. Nippon Steel, and Mitsubishi, have also started joint ventures with ExxonMobil[7] for CCS research and potential implementation in Asia.

**Thailand** has introduced a voluntary carbon credit exchange (FTIX)[8], enabling private companies and government agencies to trade carbon credits. It is also developing a voluntary emissions trading scheme, indicating interest in carbon pricing mechanisms.

1 MarketsandMarkets, 2024
2 International Energy Agency
3 Li, 2022
4 National Climate Change Secretariat Singapore
5 Exxonmobil, 2024
6 The Straits Times, 2024
7 Nippon Steel Corporation
8 The Business Times, 2024

# 02 – CARBON CAPTURE STORAGE SERVICES

Brunei is well-placed to become a key hub for CCS, which will represent both a decarbonisation and new economic opportunity for the nation

## BRUNEI'S STORAGE POTENTIAL

Brunei is well-poised to capture this regional opportunity.

### Potential geological resources

Brunei's 16.8 trillion cubic feet of existing natural gas reserves and mature oil fields[1] are reaching depletion, which provides the potential for large-scale commercial $CO_2$ storage. A deeper technical study should also be conducted to explore the possible existence of saline aquifers in Brunei, which have higher capture capacities and higher exploration costs.

### Build on professional expertise within Upstream Oil & Gas

Brunei has long-standing partnerships with international companies like Royal Dutch/Shell Group, a key stakeholder in Brunei Shell Petroleum (BSP). With existing CCS facilities in operation, development, and study stage, these companies have tested and effective cutting - edge $CO_2$ capture technologies that can streamline knowledge transfer and deployment processes. Complementing this, Brunei's academic institutions like Universiti Brunei Darussalam (UBD) and Institute of Brunei Technical Education (IBTE) impart essential skills in geology and engineering, creating a workforce with transferrable skills.

CCS can also support opportunities for low-carbon industrial and petrochemical products through Carbon, Capture and Utilisation (CCU). Brunei's downstream oil and gas sector – with facilities producing LNG, and methanol – has been a key driver of growth since 2020 and is predicted to grow by 5.4% in 2023.[2] With industrial players already located close to Sungai Liang Industrial Park (SPARK), there is potential to leverage on existing industrial clusters to produce new products (e.g. blue ammonia, methanol). The industrial cluster committee led by Brunei Shell Petroleum could be an ideal platform to advance this discussion.

### Regional partnerships

Brunei can leverage its partnerships within the SEA region to develop cross-border CCS agreements. Brunei has developed regional influence through various partnerships, such as its Memoranda of Understanding with Singapore to deepen economic cooperation in sectors including energy and the green economy, being a founding member of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP), as well as working towards establishing ASEAN Centre for Climate Change. These engagements provide Brunei with levers for negotiation to align its CCS objectives with regional sustainable development goals.

## THE OPPORTUNITY FOR BRUNEI

The CCS potential for Brunei is hence twofold, as a tool for decarbonisation and as a new green economic opportunity.

1. **As a decarbonisation solution for 'hard-to-abate' industries:** More than 75% of Brunei's emissions come from 'hard-to-abate' upstream and downstream oil & gas sectors.[3] With 90% of emissions captured with the best CCS systems,[4] this technology will be highly effective and critical to helping Brunei reduce its emissions to reach its decarbonisation goals when deployed across these sectors.
2. **As a "new green" economic opportunity:** Moreover, the rising regional demand for carbon storage offers Brunei a new source of revenue. Strategically positioned, Brunei's depleted oil and gas fields present a prime opportunity for repurposing as carbon storage sites. Nations like Japan, South Korea, and Singapore, which face storage constraints due to geographical limitations, could become key partners. This not only promises to diversify Brunei's economy but also cements its role in the regional transition to sustainable energy practices.

1 Seasia.co, 2023
2 Centre for Strategic and Policy Studies Brunei, 2023
3 World Economic Forum, 2022 (System Value Analysis)
4 MIT Climate Portal, 2021

# 02 – CARBON CAPTURE STORAGE SERVICES

CCS as a service can generate a GVA of USD 450-500 Mn and USD 100-150 Mn for operation and construction processes respectively

## Scaling up to CCS facilities of 15 MTPA* capacity by 2050

| | | | | |
|---|---|---|---|---|
| **Operation** | **USD 450-500** Mn GVA** | **1,500-1,700** Jobs*** | **3.50-4.50** MTPA GHG reduced | **USD 3.0-3.5** bn total cumulative investment **** |
| **Construction** Till 2046 | **USD 100-150** Mn GVA*** | **6,500-7,000** jobs*** | | |

### IMPACT

A facility of 15 MTPA was estimated through a thorough analysis of global benchmarks of planned and deployed facilities, taking more ambitious capacity beyond Northern Lights[1] example occurring at cold temperatures and deep waters, with reference to the availability of Brunei's existing depleted oil and gas fields.

Establishing a 15 MTPA* CCS facility can generate USD 450-500 Mn GVA in operations and USD 100-150 Mn GVA in construction. By 2050, it is expected to generate up to 9,000 jobs. Assuming 31% storage for domestic use can reduce GHG emissions by 3.50-4.50 MTPA.

In the 15 MTPA CCS facility, it is assumed that 31% will be from domestic sources and 69% imported from regional sources of carbon.** For domestic sources, hard-to-abate industrial sectors are the best capture sources. This blends CCS as both a decarbonisation and new green economic opportunity.

Beyond the construction and operation of CCS facilities, jobs are also created in the supply chain[2] associated with the supply of new materials and professional services such as design consulting and engineering for CCS/CCUS integrated plants.

* Actual capacity will require further technical analysis of resource availability, demand, costs etc.
** GVA is split up by domestic and imported sources of carbon, where assumed median carbon pricing of 48 USD / T from Singapore benchmark is only taken for imported carbon. Percentage of domestic to imported carbon studied from global benchmark in SVA report. Middle carbon price of 30 USD / T taken for domestic after 2040. Costs in GVA calculation only includes costs of transport, storage, does not include capital costs.
*** Jobs taking an estimate from global benchmarks for capture, storage, transport and construction jobs. Construction GVA derived from value added per worker in Brunei construction industry (2022) in relation to jobs forecasted and scaled proportionally to CAPEX over the years.
**** CAPEX estimates were gathered from a range of benchmarks, scaled up to 15 MTPA with internal methodology by Arup experts.

1 World Economic Forum, 2022 (System Value Analysis)
2 Upstream Online, 2020
3 The Sydney Morning Herald, 2021
4 NS Energy
5 Viking CCS
6 PGJ, 2023

### KEY GLOBAL CCS FACILITY BENCHMARKS

The **Northern Lights**, a collaboration between Equinor, Shell, and TotalEnergies, is part of the broader Longship initiative to develop a full-scale CCS value chain in Norway by 2024. In 2022, it secured the world-first commercial agreement for cross-border $CO_2$ transport and storage with Yara International. The project is expected to store 1.5 MTPA in Phase 1 (with investment costs of USD 1.63 Bn)[2], to be increased to 5 MTPA.

Other **global** benchmarks include:

| Facility | Country | Capacity (MTPA) | Investment (USD Bn) |
|---|---|---|---|
| **Gorgon** | Aus | 3.4-4.0 | 3.1[3] |
| **Moomba** | Aus | 20 | 0.0165/ 1.7 Mtpa[4] |
| **Viking** | UK | 15 | 3.21[5] |
| **Smeaheia** | Norway | 20 | 3.17[6] |

# 02 – CARBON CAPTURE STORAGE SERVICES

Brunei will need to overcome challenges to successfully deploy CCS with high investment cost the biggest hurdle for the Bruneian authorities

### LACK OF NATIONAL STRATEGY FOR ENERGY TRANSITION

Brunei is limited by the lack of a definitive national strategy for energy transition, including targeted regulations and enabling policies.

Specifically, Brunei does not have proper and comprehensive CCS regulations or legal frameworks[1] to underpin the safe and effective development of CCUS and to provide certainty for investors. These regulations should cover key issues such as site selection and permitting requirements, long-term ownership and liability for stored $CO_2$, and property rights. They can be adapted from existing laws related to environmental protection and resource management (e.g. Brunei's Environmental Protection and Management Act (EPMA), Oil and Gas Act) or international standards for $CO_2$ transport and storage such as ISO/TC 265 and ISO 27914.

There is also a lack of targeted policy measures to support CCS commercially, including carbon pricing tools, grant support, operational subsidies, or tax incentives. As the market develops, subsidies can be gradually removed, and carbon pricing/emission caps can help sustain the opportunity. Defining a competitive carbon price is important to sustain the rollout of this opportunity, even with two different prices for domestic and imported carbon.

### SUBSTANTIAL INVESTMENT REQUIRED FOR CCS INFRASTRUCTURE

CCS requires significant capital investment impacting commercial viability, as global projects currently in development require billions of dollars of capital to unlock economies of scale from retrofitting capture technologies, pipeline networks, or transport to downstream industries for utilisation or storage.[2] Given the high capital costs and risks associated with CCS, government funding could be an important lever to enable market development and industrial clusters could be leveraged to create shared infrastructure to drive down costs.

Accompanying strong government leadership, support from international finance entities specialised in development and climate finance – such as the ADB and the Green Climate Fund – alongside sustainable debt and transition financing will be essential.

### GAP IN TECHNICAL DEPLOYMENT

The SEA region has limited technical experience in operating reservoirs with subsurface $CO_2$ storage with few pilot and operational-project proof points to demonstrate technological readiness[2] (such as $CO_2$ separation and capture) and key technical de-risking (such as the ability to reuse existing wells without compromising integrity). Technical capacity will therefore need to be built up for large-scale CCS development. More widely, the technology and its associated risks are poorly understood, including carbon leakage concerns and advancements to boost CCS efficiency rates. This is a risk to be managed for potential gains from this emerging technology.

Brunei will have to focus on offering specialised courses, training, and industrial capacity building to ensure existing process, mechanical and chemical engineering skillsets are upskilled and prepared for CCS opportunities.

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **CCS specific domestic policies** | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✗ |
| **CCS projects proposed** | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ |
| **CCS regulatory & legal frameworks** | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ |

Brunei is lagging in defining clear CCS frameworks[3]

1 Stakeholder interviews
2 International Energy Agency
3 Global CCS Institute, 2023

# 02 – CARBON CAPTURE STORAGE SERVICES

There are several key considerations Brunei should integrate into its CCS roadmap, particularly across enablers in policy, infrastructure, partnerships and skills

## RIGHT CONDITIONS FOR BRUNEI

Brunei needs to address its existing challenges to successfully deploy CCS. A timeline should be gradually scaled up from pilot project to small-scale deployment by 1-1.5 MTPA per year before reaching maximum capacity. This can be done in several ways, including establishing frameworks, developing skills, and setting incentive schemes in place.

### Clear CCS framework

Developing legal and regulatory frameworks for risk monitoring is necessary (see right). There is a need to establish carbon pricing policies and mechanisms.

### Robust business model

There is a need for a clear commercial model coordinating efforts among all stakeholders. Models usually fall into two types: full or partial chain model. The majority of projects in operation adopts the full chain model, whereby the captured $CO_2$ is transported from one capture facility to one injection site. Investment and financing structures and risk management tools should also be considered.

### Skills development

There is a need for workforce upskilling and equipping skills in future industry professionals in process, chemical, and mechanical engineering.

## LEGAL AND REGULATORY FRAMEWORKS

The below issues must be addressed for successful CCS implementation, requiring both adapting existing laws and creating new regulations.

1. **Regulatory and Property Rights:** Solidify the legal framework defining $CO_2$ and establish clear property rights for subsurface storage, ensuring it harmonises with existing mineral rights.
2. **Carbon Management Regulations:** Ratify the London Protocol to comply with regulations of carbon storage at sea, and ensure exclusion of stored carbon from national emissions inventory.
3. **Operational and Environmental Standards:** Enforce comprehensive environmental assessments, strict operational protocols, underpinned by targeted health and safety regulations.
4. **Financial Assurance and Liability:** Develop financial security guidelines and liability assignments to address CCS site closure and long-term stewardship.
5. **Global Compliance and EOR Policies:** Craft transboundary $CO_2$ policies in line with global standards and integrate $CO_2$-EOR practices within the existing oil sector framework.
6. **Investment Attraction and Technological Advancement:** Offer clear legal incentives to attract investment, regulatory support for CCS innovation, and alignment with carbon markets.

## INCENTIVISING CCS

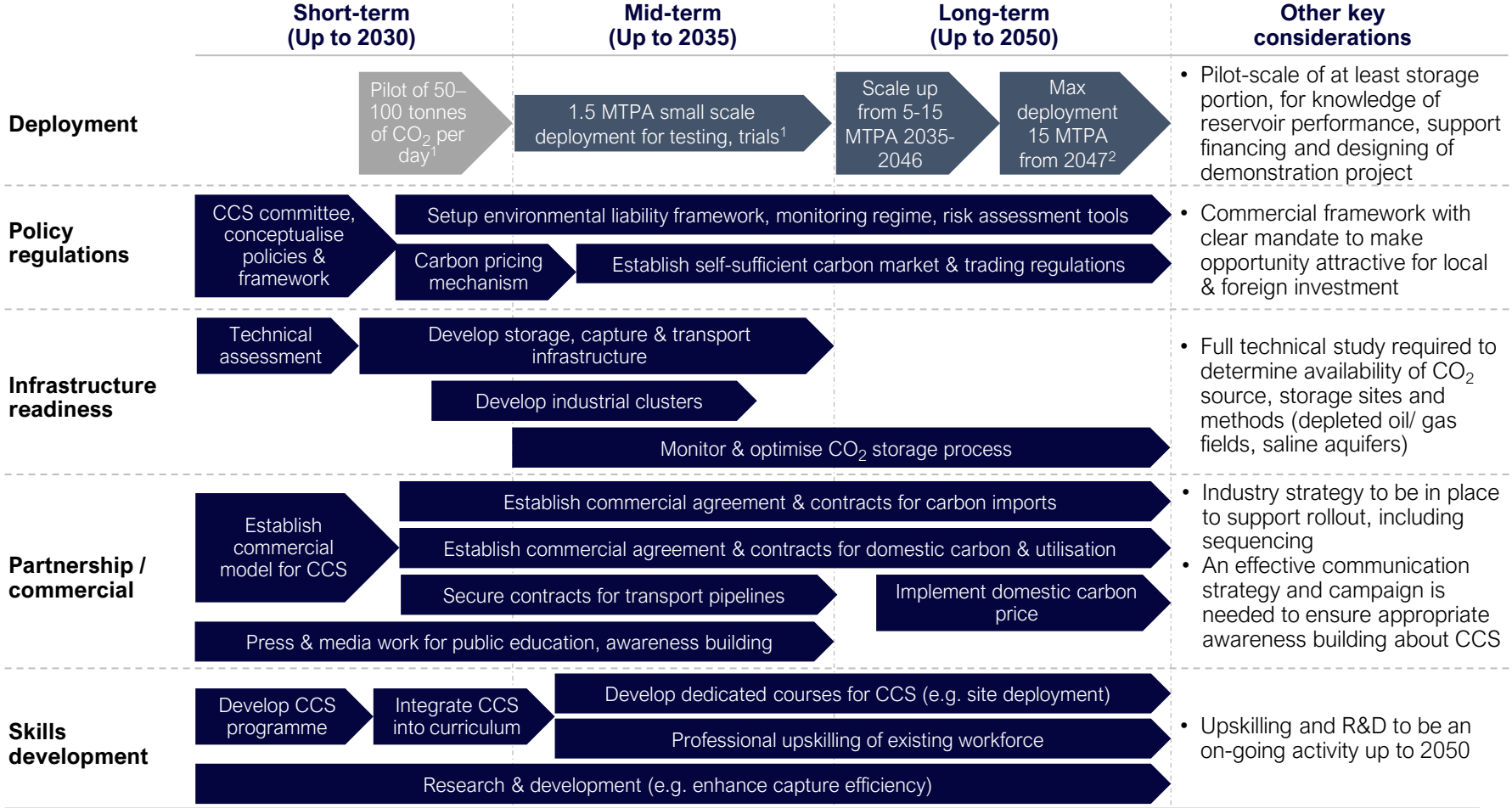
There are various policy and funding instruments to incentivise CCS. Specialised international financing for climate transition can also be explored.

| Instrument | Mechanism | Examples |
|---|---|---|
| **Grant Support & Financial Participation** | Capital funding to mitigate upfront costs (e.g. preferential government loans), third-party investments for de-risking | UK CCS Infrastructure Fund co-funding capital expenses, UK Industrial Energy Transformation Fund (IETF) for capital expenditure on on-site ICC projects EU Innovation Fund for low carbon technologies |
| **Revenue Support** | Operations subsidy, tax credits, CfD mechanisms | US 45Q and 48A tax credits, Netherlands' SDE++ scheme, UK power sector CfD |
| **Carbon Pricing** | Taxes, ETS, and credit trading systems | Carbon taxes in Singapore, Norway, ETS in Europe, potential in Asia, Canada's federal output-based pricing, Australia's Emissions Reduction Fund |
| **Demand-side Measures** | Procurement standards and border adjustments | Canada and the Netherlands' rules for low-$CO_2$ materials, countries purchasing $CO_2$-cured concrete |
| **Regulatory Standards** | Emission mandates and standards | Australia's Gorgon project CCS standards, Canada's low-$CO_2$ intensity- coal, natural gas generation |

Pilot and testing
Potential capacity deployment
Enablers

# 02 – CARBON CAPTURE STORAGE SERVICES

The potential roadmap must consider establishing appropriate plans for successful CCS implementation, including infrastructure assessments and commercial modelling in the short term




1 Global CCS Institute
2 15 MTPA assumed from global benchmarks

# 02 – CARBON CAPTURE STORAGE SERVICES

Case study of an effective, sustainable CCUS roadmap balancing costs, environmental impact and various stakeholder interests

## UK'S CCUS ROADMAP

Carbon Capture, Usage and Storage (CCUS) has been envisioned as a key enabler for the UK's energy transition. With the capacity to store up to 78 bn tonnes of $CO_2$ under the North Sea – one of the largest such capacities in the world – the government has invested £20 bn to establishing a CCUS sector that will help the UK support up to 50,000 jobs, reach net zero and boost its economy by up to £5 bn per year by 2050.[1]

- **Market creation** 20 - 30 MTPA CO2 by 2030 — Track-1 & 2 sector development with projects spanning multiple cluster sectors: "anchor" & "buildout" phase. Regulatory frameworks for CCUS market defined.
- **Market transition** 50 MTPA by 2030s-2040 — Gradual expansion & commercial & competitive market emergence: CCUS sector increase amount by 6 MTPA per year from 2031. Define sector decarbonisation routes.

…

- **Self-sustaining CCUS market from 2050**

## LESSONS FOR BRUNEI

Firstly, the design of a comprehensive commercial framework is critical in the "market creation" phase for CCS rollout. These frameworks should target industrial clusters to support economies of scale and kick-start CCS deployment. A hub approach can enable $CO_2$ capture from multiple industrial and power facilities and promote greater efficiencies in the planning and construction of capital-intensive transport and storage infrastructure. It is also important to form proper governance accompanied by business models like the UK's Industrial Carbon Capture (ICC) and waste, Dispatchable Power Agreement (DPA).

Subsequently, it is also important to implement policies to develop a commercial and competitive CCS market in a "market transition" phase, as the opportunity scales.

The government can play a critical role in facilitating the creation of the CCUS market in Brunei, through the provision of large infrastructure support. As this opportunity scales, the private sector will benefit and leverage this opportunity.

**Key enablers**

1. Consultation for competitive allocation process for capture contracts
2. Strategic frameworks for $CO_2$ transport networks collaboratively defined with stakeholders
3. Regulatory review that third-party access to infrastructure aligns with CCUS goals
4. Policy development for subsurface storage capacity
5. Explore commercial framework supporting international imports
6. Explore commercial framework supporting international market
7. Engagement with industry to define CCU's role
8. Publication of Green Jobs Plan outlining workforce development policies
9. Establishment of industry working group to identify cost reduction opportunities
10. £960 mn in the Green Industries Growth Accelerator for clean energy supply chains

**UK's CCUS market transition frameworks**

The government will launch a consultation in 2024 on future market frameworks for CCUS. Alongside a consultation on allocating capture contracts, a process for the future allocation of transport and storage economic licenses is being considered, the ability to grant licenses transferred to Ofgem at the appropriate time, as provided for in the Energy Act 2023[2].

To be consistent with a Carbon Budget 6 timeline, a process for applications for new economic licenses for transport and storage is being considered for 2025/6 so that $CO_2$ transport networks can be sufficiently designed to run an allocation round for prospective capture projects.

1 GOV.UK, 2023
2 Energy Act, 2023

# 02 – CARBON CAPTURE STORAGE SERVICES

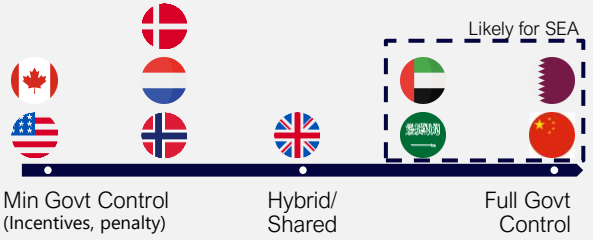
Brunei will have to compete against other strong players for the regional CCS opportunity, many of whom have already secured investors

## INCREASING COMPETITION

In Southeast Asia, at least seven large-scale CCUS projects have been identified and are in early planning stages in Indonesia, Malaysia, Singapore and Timor-Leste,[1] including several linked to natural gas processing with offshore storage. Singapore and Indonesia have established CCUS research programmes, including the Institut Teknologi Bandung (ITB) Centre of Excellence for CCU and CCS.[2] Countries have increasingly started to explore the feasibility of various CCS solutions through:

- Developing understanding of $CO_2$ storage resources with technical assessments
- Defining legal, and regulatory frameworks
- Exploring targeted policies and international financial support for CCS deployment.*

Governments worldwide have adopted different approaches to establishing a CCS market through contributing capital and sharing costs and risks. Most projects in Asia will skew towards heavier government control.




## KEY COMPETITORS FOR CCS

**Indonesia** has been proactively investing in CCS as part of its wider climate strategy and hopes to become a CCS hub in the region. The country has initiated 15 projects due to be operational by 2030[3], driven by partnerships with international energy firms from Japan, South Korea for CCS development and between ExxonMobil and Pertamina for blue hydrogen production.

The country has also prepared a regulatory framework facilitating the integration of CCS into existing and new Production Sharing Contracts, including monetisation strategies for stored $CO_2$. The framework allows for designated CCS operations, supported by incentives and a tender process for exploration and long-term operational permits.

**Malaysia** via national oil company Petronas is positioning itself as a key player in the CCS landscape, underpinned by significant projects and international agreements. The nation has formalised an agreement with Japan commencing 2028 to import $CO_2$ for underground storage,[4] pioneering the operationalisation of CCS at scale.

At the heart of Malaysia's CCS initiatives is the Kasawari gas field project, poised to become the world's largest offshore CCS venture. Scheduled to start operations by 2025, this project is set to capture and store 3.3 MTPA per year. Petronas is also developing a comprehensive CCS value chain, leveraging Malaysia's offshore capabilities to emerge as an international storage hub.

Beyond SEA

**Oman** has embarked on a significant journey to advance its CCS initiatives as part of a broader strategy to achieve net-zero emissions by 2050.[5]

The Sultanate's Ministry of Energy and Minerals, alongside Petroleum Development Oman (PDO), is actively developing a legal and regulatory framework to support the deployment of CCS technology. PDO and Oman Shell are also conducting technical studies to assess the potential for $CO_2$ reinjection and storage across the country. This partnership is a part of Oman's broader effort to kickstart the CCUS industry within its borders and foster a low-carbon hydrogen value chain, aligning with Oman Vision 2040 and national 2050 net-zero commitments.

1 International Energy Agency
2 International Energy Agency
3 Upstream Online, 2023
4 The Japan Times, 2023
5 Oman Observer, 2023

* Topic is further explored in the following chapter on Enablers

# 03 – ESTABLISH A CLEAN HYDROGEN EXPORT HUB

The global green $H_2$ market is expected to reach USD1.4 Tn per year by 2050 with APAC estimated to capture over half the demand by 2030

## THE GLOBAL OPPORTUNITY

Hydrogen is a versatile energy carrier, already widely used in petroleum refining, producing fertilisers and processing foods, for example. This energy, however, is considered "grey." As the globe pushes towards climate action, clean hydrogen ($H_2$) becomes a very useful commodity to decarbonise hard-to-abate sectors such as long-haul land transportation, the maritime and shipping industry, chemical production and iron and steel. $H_2$ can be made "greener" in a variety of ways. The focus of this report will be on blue hydrogen (conventional hydrogen with carbon capture and storage), as well as green hydrogen (produced with renewable energy via electrolysis of water).

The global market value of clean hydrogen is expected to reach USD1.4 Tn per year by 2050 and will support up to 2 million jobs between 2030 and 2050. APAC is expected to capture approximately 55% of the market in 2030.[1] Realising this full potential, however, will require over USD 9 Tn of cumulative investments across the supply chain, based on global net-zero targets by 2050.[1] Establishing robust interregional trade networks will also be essential to unlock the opportunity.

## CLEAN HYDROGEN IN APAC

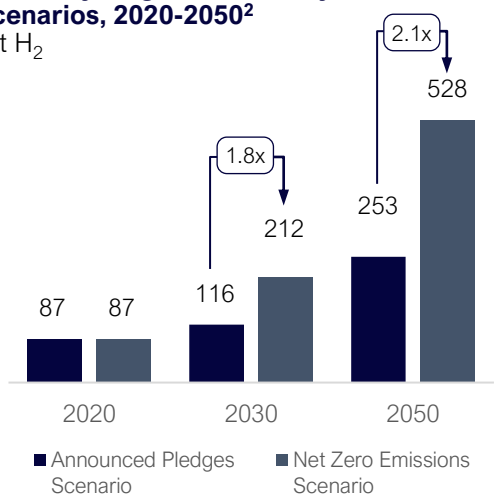
In the region, markets are progressing at vastly different paces depending on the robustness of policy, technology advancements and investment into clean hydrogen projects. Australia, China, India, Indonesia, Japan and Korea are driving the clean $H_2$ transformation in the region. Almost half of the projects in Asia-Pacific are export-focussed and currently struggling to progress to construction as firmer offtake agreements are required to proceed.

## THE POTENTIAL FOR BRUNEI

With nearly 40% of global demand generated in APAC, Brunei is well-positioned to produce and export clean $H_2$ via regional supply chains

**Global hydrogen demand by IEA scenarios, 2020-2050[2]**

Mt $H_2$




## REGIONAL HYDROGEN STRATEGIES

Countries across APAC are developing strategies that will foster demand generation of clean hydrogen among industries to move towards net-zero futures.

Low carbon $H_2$ including derivatives is a key component of **Singapore's** pathway[3] to decarbonising the domestic power sector, as well as maritime and aviation fuel. The country is seeking to work with partners to develop a hydrogen supply chain in Asia. The country is focused on R&D, exploring technology advancement and deploying pilot projects (e.g. ammonia for marine bunkering), among other initiatives.

**Indonesia's** Hydrogen strategy[4] estimates substantial demand for low-carbon $H_2$ from 2031 – 2060, driven by transport, energy and industrial sectors. The Ministry of Energy & Mineral Resources is establishing regulations, technical standards and safety measures to drive investment. Based on Net-Zero Modelling, the demand for low-carbon $H_2$ is projected to increase from 0.2 PJ in 2031 to 609 PJ in 2060.

**South Korea** has rolled out a Hydrogen Roadmap[5] to 2040, aiming to raise demand in transport, power & industrial use for both blue and green hydrogen. Aspirations are to establish large-scale domestic and overseas production bases. South Korean chemical producer Lotte Fine Chemical announced plans to import 50,000t of blue ammonia from Saudi Arabia in 2022.

1 Deloitte, 2023
2 International Energy Agency, 2023
3 Energy Market Authority Singapore, 2022
4 Indonesia Business Post, 2023
5 Argus Media, 2022

# 03 – ESTABLISH A CLEAN HYDROGEN EXPORT HUB

Brunei has an opportunity to produce 1.04 MTPA of clean hydrogen for export between 2030 and 2050, capitalising on growing demand across APAC

APAC will require the development of a 78 $MtH_2eq$ clean $H_2$ market.[1] In addition, clean $H_2$ can easily be used to green domestic industry.

In recent years, Brunei has received interest from investors to set up blue and green hydrogen plants for export, confirming regional demand for clean hydrogen, and Brunei as a strategic location.

## IMPACT

Brunei's total hydrogen production potential stands at 1.28 MTPA by 2035, where 8% is derived through renewable sources and is, therefore, green. This assumes that 1.8GW of the nation's solar capacity can be leveraged for green hydrogen production.

Additionally, Brunei has 9.5 trillion cubic feet of natural gas reserves.[2] 77% of the total projected hydrogen capacity comes from natural gas, a "grey" product. With the use of CCS in conventional grey hydrogen plants, this product can be made "blue." If renewable energy were to take off and assuming increase in clean $H_2$ demand, surplus natural gas could also be channelled to blue $H_2$ production while waiting for green $H_2$ to be economical.

As such, Brunei has the **opportunity to produce 1.04 MT of clean hydrogen per year,** 0.06 MT of which is green, and 0.98 of which is blue.

Together, operating green and blue $H_2$ has the potential to generate USD 180-240 Mn in GVA per annum and sustain 1,300-1,600 jobs. Assuming a 2-year construction period for both, USD 250-300 Mn in GVA can be added to the Brunei economy, as well as 5,000-6,700 jobs. This includes the jobs generated by floating solar used for green $H_2$. Beyond the construction and operations of facilities, there are wider benefits across the associated value chain; design, storage, transportation, planning and engineering.

## THE BENEFIT TO BRUNEI

A clean hydrogen ecosystem will result in economic and environmental benefits.

**Export opportunity to the region:** Asia is predicted to capture 55% of the green hydrogen market driven by rapid demand in China, India, Indonesia, and Japan.[1] The Brunei-Japan pilot project was a success in transporting hydrogen, signalling more opportunities for regional exports.

**Enables meeting decarbonisation goals:** Green $H_2$ has near-zero carbon intensity and is an option to decarbonise downstream activities (e.g. ammonia & methanol production, maritime & land-transport fuels) if not exported. In the near term, blue $H_2$ could be a transition.

**Brunei Clean Hydrogen Opportunity of 1.04 MTPA* capacity by 2050 [3] [4]**

| | | | |
|---|---|---|---|
| **Operation** Until 2050 | **USD 180-240** Mn GVA** | **1,300-1,600** jobs | **USD 20-25** Mn OPEX yearly |
| **Construction** 2-year period, per annum | **USD 250-300** Mn GVA** | **5,000-6,700** jobs* | **USD 2.5-3.0** Bn CAPEX |

**GHG Emissions Profile**

| | |
|---|---|
| **- 0.4** MTPA $CO_2e$ | 0.06 MTPA OF Green Hydrogen will result in a 0.4 MTPA reduction in GHG emissions |
| **+ 1.47** MTPA $CO_2e$ | **8.37 MTPA of $CO_2$ emissions reduction** achieved by using blue $H_2$. Blue $H_2$ facility is a net emitter but can bring about indirect reduction from domestic industrial players |
| **Net emissions for $H_2$** **+ 1.07** MTPA $CO_2e$ | While net emissions are positive, developing an SMR $H_2$ facility with CCS has huge potential for carbon savings. Without CCS, a grey $H_2$ facility of the same size would emit 9.8 $CO_2$ MTPA. In the near term, Blue $H_2$ can provide huge potential for decarbonising sectors like heavy industry or maritime, before Green $H_2$ becomes more widely available. |

1 Deloitte, 2023
2 BP, 2018
3 Ministry of Finance and Economy Brunei, 2022
4 World Economic Forum, 2022 (System Value Analysis)

*Blue $H_2$ Capacity: 0.2 MTPA (initial), 0.98 MTPA (final). Green $H_2$ Capacity: 0.06 MPTA, requiring 1.8GW of solar
** Impact derived from internal Arup methodology and global benchmarks
***GVA/worker: USD 0.02 Mn / worker (construction), USD 0.18 mn / worker (operations)
****Carbon capture rate: 85% for blue hydrogen

# 03 – ESTABLISH A CLEAN HYDROGEN EXPORT HUB

Clean hydrogen can help Brunei move towards a net-zero future and capture new economic opportunities due to burgeoning demand – this comes with a variety of challenges to consider over the coming decade

**Opportunity to be an early mover:** APAC has great potential for clean hydrogen production with many countries just starting to invest in the necessary infrastructure. Few countries have operational facilities (e.g. China's Ningxia Baofeng Energy Group)[1] with other projects emerging across the region (China, Japan, Korea, New Zealand and Australia). With immediate action to set up an enabling environment, Brunei can position itself as a first mover in the region and capture this emerging demand.

## CHALLENGES TO DEPLOYMENT

While blue and green hydrogen are promising solutions, there are a set of challenges that need to be addressed, particularly around the cost of development, technological advancements required and safety.

### Cost of Production

Currently, the cost of producing green hydrogen is four times more expensive than grey hydrogen and more than twice as high as blue hydrogen, ranging from USD 5.5/kg up to USD 9.5/kg.[2] The biggest determinants of cost are purchasing a water electrolyser (ranges from USD 500/kW to 5600/kW) as well as renewable energy input. Global consensus from market and industry experts expects costs to drop significantly by the 2030s.

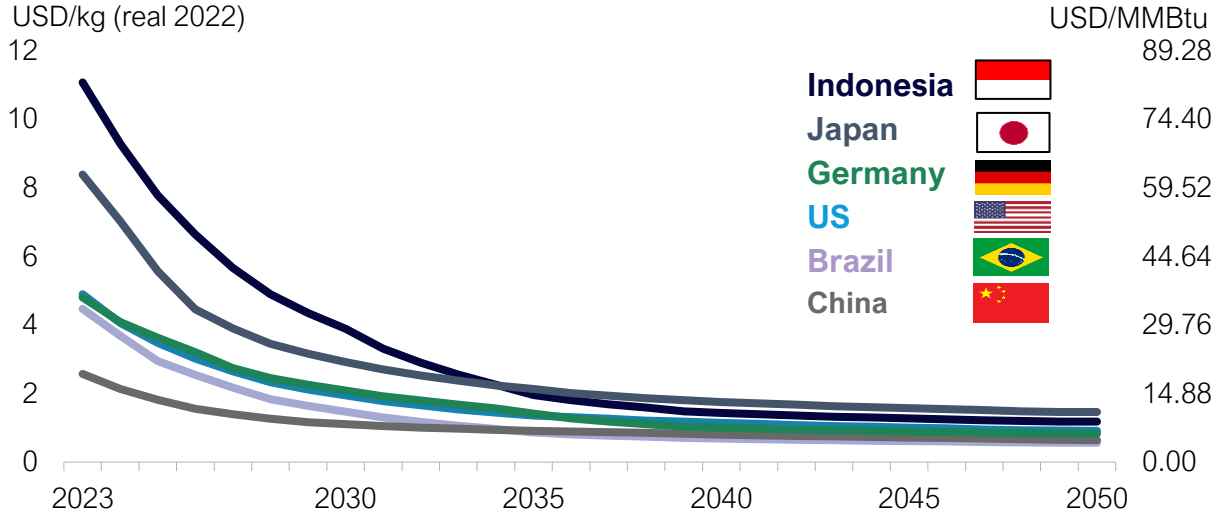
In recent years, the cost of renewable energy inputs has decreased by 60-88% since 2010 to approximately USD 48/MWh for solar power. This dramatic decline bodes well for the burgeoning clean hydrogen industry. The viability of green hydrogen will be dependent on driving down the cost of electrolysers.

### Cost of Conversion, Transport & Storage

Additionally, the cost to compress, liquefy or convert to ammonia, as well as transportation, will raise the cost to the end user.

Transportation costs can be mitigated by using pipelines which require substantial investment into pipelines (millions of USD per kilometre). Natural gas pipelines can be converted to do so. In addition to local planning and investment, it is important that Brunei identifies markets that are investing in the enabling infrastructure to support the importing and usage of hydrogen.

**Cheaper Renewables and Electrolysers will cut cost of Green $H_2$**[3]




*Source: BloombergNEF*

1 China Daily, 2023
2 100re-map, 2023
3 BloombergNEF, 2023

# 03 – ESTABLISH A CLEAN HYDROGEN EXPORT HUB

Key challenges to enable clean hydrogen are around cost, safety and establishing demand

### Immature Value / Supply Chains

As clean hydrogen is not widely traded, the larger value chain is yet to be established with a lack of clarity on off-takers. When setting up a blue or green hydrogen facility it is essential to have specific off-takers lined up to guarantee demand before construction. Access to a wider hydrogen network may be beneficial e.g. industrial clusters.

### Safety Protocols and Standard Setting

Hydrogen is a colourless, odourless, and explosive substance with a pale flame. Due to its low viscosity and small molecule size, hydrogen can leak more easily than other gases from pipelines or other structures. As such, it is essential to set stringent safety protocols during the project development phase to ensure pipelines are made hydrogen-ready (e.g. leak detectors, additional layers) and storage and transportation methods are built with the right materials (e.g. stainless steel).[1] Regulatory frameworks and standards should be in place to ensure safety in production, transportation and storage.

In addition, there is a lack of international technical standards that govern the green hydrogen market. Standards around production and usage need to be developed and agreed upon for use regionally and internationally. Protocols for verification of clean hydrogen need to be put in place. This may involve a certification and tracking process that states the $CO_2$ content of hydrogen. Many countries and off-takers will have regulations that stipulate the maximum $CO_2$ content of hydrogen to be considered clean (e.g. UK Low Carbon Hydrogen Standard).

### Competing Uses for Renewable Energy

Green hydrogen relies on a constant supply of renewable energy. In the case of Brunei, 1.8GW of solar needs to be dedicated to the hydrogen economy by 2050, which can take away from other possible uses.

### Stranded Asset Risk

Blue hydrogen facilities possess a significant white elephant risk as their cost-competitiveness is currently questioned with policy and market forces focused on enabling and generating demand for green hydrogen.[2]

### Public Acceptance

There are a variety of concerns held by the general public on the relative safety of hydrogen as an energy source due to its flammability. Efforts to educate the public on the benefits and safety protocols will need to be made over the years to overcome this issue.

1 Draeger, 2021
2 S&P Global, 2022
3 U.S. Department of Energy, 2023

## CASE STUDY
## USA CLEAN HYDROGEN ROADMAP

Clean hydrogen production for domestic demand has the potential to scale from <1 MTPA to ~10 MTPA by 2030.[3] USA demand for clean hydrogen will stem from transitioning existing end-uses away from current grey hydrogen production. The overall opportunity for clean hydrogen in the USA, according to the Department of Energy's National Clean Hydrogen Strategy and Roadmap, is 50 MTPA by 2050.[3]

***Implementation Plan***

- **Market transition:** Increase from ~0 MTPA today to 10 MTPA of clean hydrogen by 2030[3]
- **Market scaling**: 20 MTPA of clean hydrogen by 2040[3]
- **Self-sustaining clean hydrogen market from 2035 onwards:** 50 MTPA by 2050[3]

Production will be incentivised by a tax credit for clean hydrogen launched in 2023 ranging from USD 0.60 – USD 3 per kilogram of hydrogen, depending on whole lifecycle emissions produced.[3] These will last 10 years.

Overall, there is an expectation that 100,000 direct and indirect jobs will be created for the construction of clean hydrogen infrastructure and that the sector will result in ~10% economy - wide emissions reduction by 2050.[3]

# 03 – ESTABLISH A CLEAN HYDROGEN EXPORT HUB

Developing a 1.04 MTPA clean hydrogen capacity ecosystem will require the right policies, standards and enabling infrastructure to be successful

## RIGHT CONDITIONS FOR BRUNEI

In order to develop a successful green and blue hydrogen export hub, it is essential that the right enabling environment is established. This may be through policy and regulation, physical infrastructure investment, as well as leveraging partnerships to address key roadblocks.

### National strategy and targets

Deployment of clean hydrogen is complex due to the cost and its multiple use cases (e.g. energy use, transportation fuel, steel production) across the economy. A dedicated strategy with clear use case prioritisation (whether domestic or export) is required to ensure long-term commercial deployment. China, France, Japan, and South Korea, who are serious about their hydrogen implementation, have announced national hydrogen strategies and roadmaps.

### Policies to drive hydrogen development

Formulating supportive policies such as investment incentives, tax breaks, and regulatory frameworks to encourage private sector involvement, research, and development in clean hydrogen technologies will foster development, as clean hydrogen is still relatively nascent and requires de-risking for the private sector to engage and invest in.

### Standard Setting & Safety Protocols

Prior to the construction of blue and green hydrogen facilities, studies must be conducted on standards and safety concerns. Implementing rigorous safety protocols and regulations to mitigate potential hazards associated with hydrogen production, storage, transportation, and utilisation, thereby ensuring public and environmental safety.

### Infrastructure readiness

A successful blue hydrogen plant is dependent on Brunei's ability to outfit grey plants with sufficient CCS technology allowing a carbon capture rate of >85%. A green hydrogen plant will require 1.8GW of floating solar to be developed first and earmarked for green hydrogen production.

Moreover, hydrogen storage and liquefication technologies and solutions need to be readied by 2030 and 2035 for blue and green hydrogen, as well as any such infrastructure for their derivatives (e.g. low-carbon ammonia and methanol).

### Partnerships

To develop the 'right conditions for Brunei' to implement a clean hydrogen ecosystem, Brunei can leverage partners who may have appropriate expertise or a vested interest in the field. For example, convening industry associations, fuel producers, potential off-takers and grey hydrogen producers can provide a platform to tackle standards-setting and develop the right safety protocols. Establishing partnerships to test-bed green hydrogen solutions through pilot projects can catalyse more widespread development.

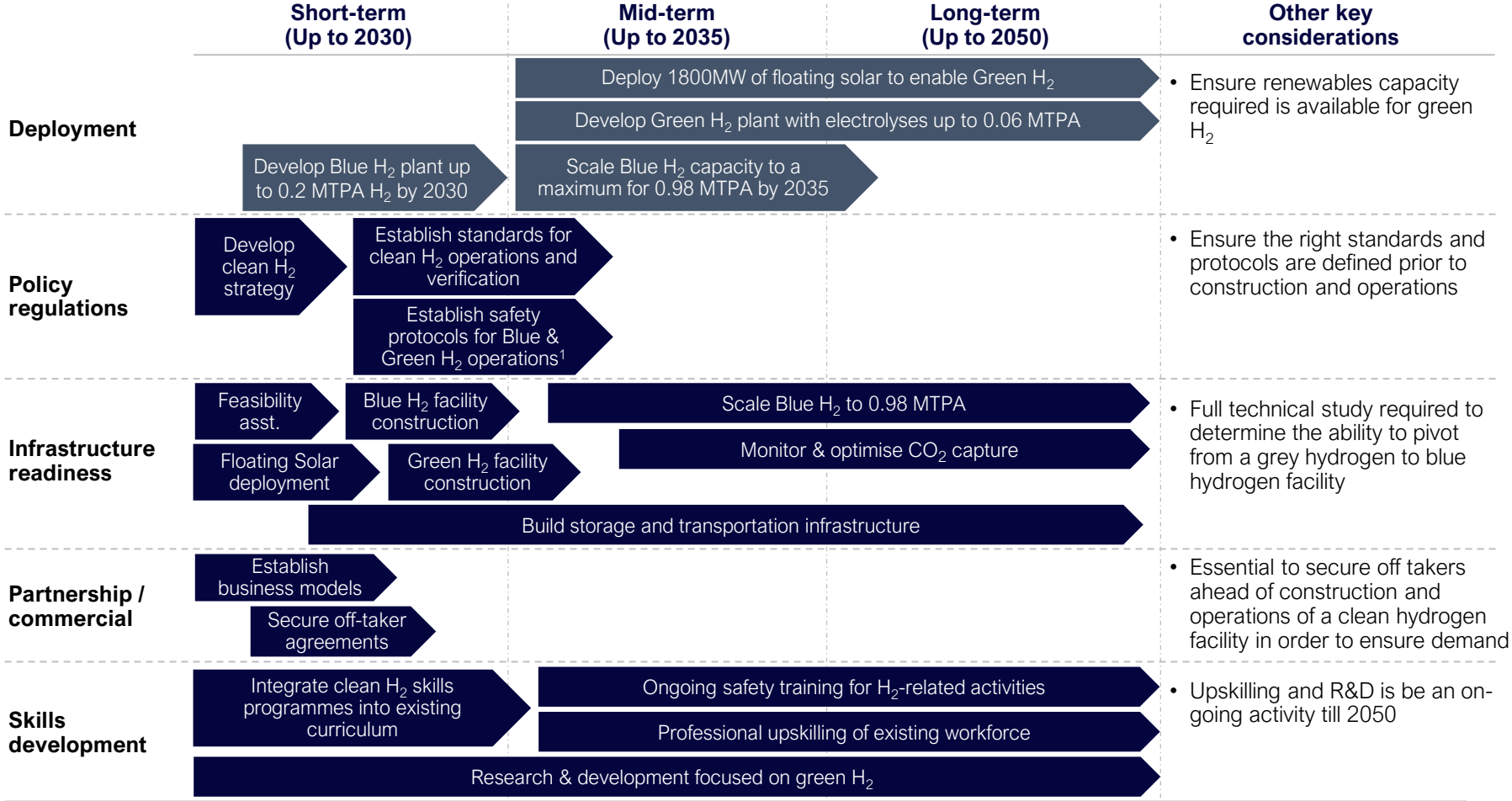
### Skills Development

Finally, the availability of talent and skilled workers who can effectively design, construct and operate these facilities is essential. This will require the design of new courses through institutions such as Universiti Brunei Darussalam, Universiti Teknologi Brunei and Institute of Brunei Technical Education to ensure a steady stream of talent that can support the industry in the long term. In the near term, inviting experts from the global community to help develop capacity-building efforts may be a useful tool.

Pilot and testing
Potential capacity deployment
Enablers

# 03 – ESTABLISH A CLEAN HYDROGEN EXPORT HUB

The roadmap for clean hydrogen deployment must consider sequential scale up from blue to green $H_2$ to capture near-term clean hydrogen opportunities




1 Draeger, Hydrogen Safety Challenges, 2021

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING

Brunei has an opportunity to instill a circular economic approach to future opportunities via a comprehensive recycling ecosystem that can underpin further economic opportunities

### Developing a circular economy

Developing cross-cutting recycling goes beyond managing unsightly waste but is also a valuable tool in reducing emissions and developing a circular economy. Globally, each year the 'Seventh Resource' (recyclables) saves over 700 Mn $tCO_2e$ - projected to increase to 1 $tCO_2e$ by 2030.[1]

1. **Consumer waste** is predominantly landfilled, with key landfill Sungai Paku reaching capacity by 2030. Recycling and waste separation will be a key government initiative in assigning sustainable waste management – particularly for non-biodegradable waste ie. plastics. Recycled plastic material is a growing market that also brings GHG savings. Remaining municipal solid waste (MSW), particularly biowaste, is best suited for waste-to-energy (WtE) conversion, of which Brunei has already chosen to adopt an incinerator WtE plant. The current tariff regime in Brunei may preclude commercial WtE options, with a plant likely to be self-sustaining and used to eliminate waste. Both initiatives require the pre-sorting of MSW.
2. **Industrial waste** management can also be mandated – i.e. responsible disposal of flyash from Hengyi Industries' coal power plant and decommissioning of oil and gas assets. Flyash is increasingly in demand demand and can be used by producers of cement and bricks as non-virgin feedstock to reduce product carbon footprints.

**Decommissioning assets** have already been taken up via Anson International's decommissioning yard. As the yard is under construction it has not been included in the final economic model but the potential of expanding beyond phase 1 (3 topsides) is detailed in the following section.

**Long-term benefits:** Establishing the foundations and responsibility around industrial and residential waste management will have emissions savings benefits that can be expanded to other areas including electronic waste. Except for decommissioning, the remaining initiatives present small but self-financing options to reduce waste and emissions and produce low carbon materials.

1 Global Recycling Day

### Brunei Recycling Hub – rPET, Flyash and WtE Opportunities to 2050

| | | | |
|---|---|---|---|
| **Operations** | **USD 2-3** Mn GVA | **60-97** Jobs | **0.4-0.8** MT GHG reduced |
| **Construction** 2-year period | **USD 12-15** Mn GVA* | **900-1,200** jobs | **USD 2.8-3.5** Mn total CAPEX |

*GVA here refers to profit

**ASSUMPTIONS**

- **Recycled Plastics (rPET)**
  - Assuming construction (2 years) from 2024-26, with operations commencing 2026 with a plant processing PET plastic and producing rPET pellets
- **Flyash**
  - Assuming no construction, with processed ash used by existing cement/brick manufacturer
- **Waste-To-Energy (WtE)**
  - Under current electricity tariffs, a plant would not be economically viable but could be a self-financing option for biowaste processing

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: DECOMMISSIONING AND RESTORATION

Global best practice has moved beyond a rigs-to-reefs approach as decommissioning and restoration costs fall worldwide and new technology opens repurposing potential which Brunei is already capitalising on

## DECOMMISSIONING – LED BY NORTH SEA OPERATORS

Despite International Maritime Organisation guidelines and standards that provide for the removal of installations on a continental shelf or special economic zone there has been a reluctance to pursue decommissioning activities, mainly due to prohibitive cost, lack of national legislation, and lack of enforcement. With costs falling some 35%, North Sea decommissioning and restoration (DnR) efforts are supposed to reach GBP 15 bn by 2030 and create thousands of direct and indirect jobs.[1] GHG savings and ecological benefits are rig-specific, with no standard savings available.

## ASEAN PRACTICE

Regional Decommissioning Guidelines were first published in 2012 by the ASEAN Council on Petroleum ('ASCOPE'). This sought to clarify issues and approaches and has prompted members to move toward legislation. Brunei's 2009 and 2017 National Exploration & Production Guidelines have been supplemented since. Traditionally offshore decommissioning efforts centred around reefing or removal (including scrapping). Current international norms have moved further driven by new technologies and more stringent emissions regulations beyond reefing.

As yet there is no stand-out leader in Southeast Asia's decommissioning space. Brunei has extensive rules in place around legislation, guidance and technical know-how.

## ENABLING A GREEN OPPORTUNITY

Brunei has over 1,000 ageing oil wells and 200 offshore structures.[2] Since 1988, 13 rigs-to-reefs projects have been completed in line with local laws. Anson's 16-hectare Decommissioning Yard (DY) includes solar PV modules, a re-circular waste-water system, composting for food waste in addition to the recycling of materials resulting in a green rating. Phase 1 capacity is for 3 topsides at one time. The DY taps into a BND 30 Bn market (over the next 20 years) and 4000 direct and indirect jobs.

Should the DY handle all of Brunei's decommissioning projects the potential revenue is an estimated USD 11 Mn per annum and at 1,500 direct and indirect jobs per annum up to 2050.

## EXPANDING THE OPPORTUNITY

Southeast Asia has more than 7000 wells and 1500 platforms projected to need decommissioning by 2030. This market offers a credible growth option for Brunei's decommissioning yard feeding into wider recycling efforts – steel scrapping, etc.

1 Oil and Gas UK, 2019
2 The Scoop 2021

## REGIONAL DECOMMISSIONING HIGHLIGHTS

**Indonesia:** regulator SKK Migas' recent roadmap positions decommissioning and low carbon initiatives as its 6th strategic pillar. Within that, there are the following DNR projects:

1. Rig-to-reef: Commonly accepted practice
2. Rig-to-fish farm: closed-loop energy self-sufficient farms
3. Rig-to-CCS: State oil company Pertamina has signed a Joint Study Agreement with Korea National Oil Company
4. Rig-to-LNG terminal
5. Rig–to–wind farm
6. Rig-to-solar power
7. Recycling

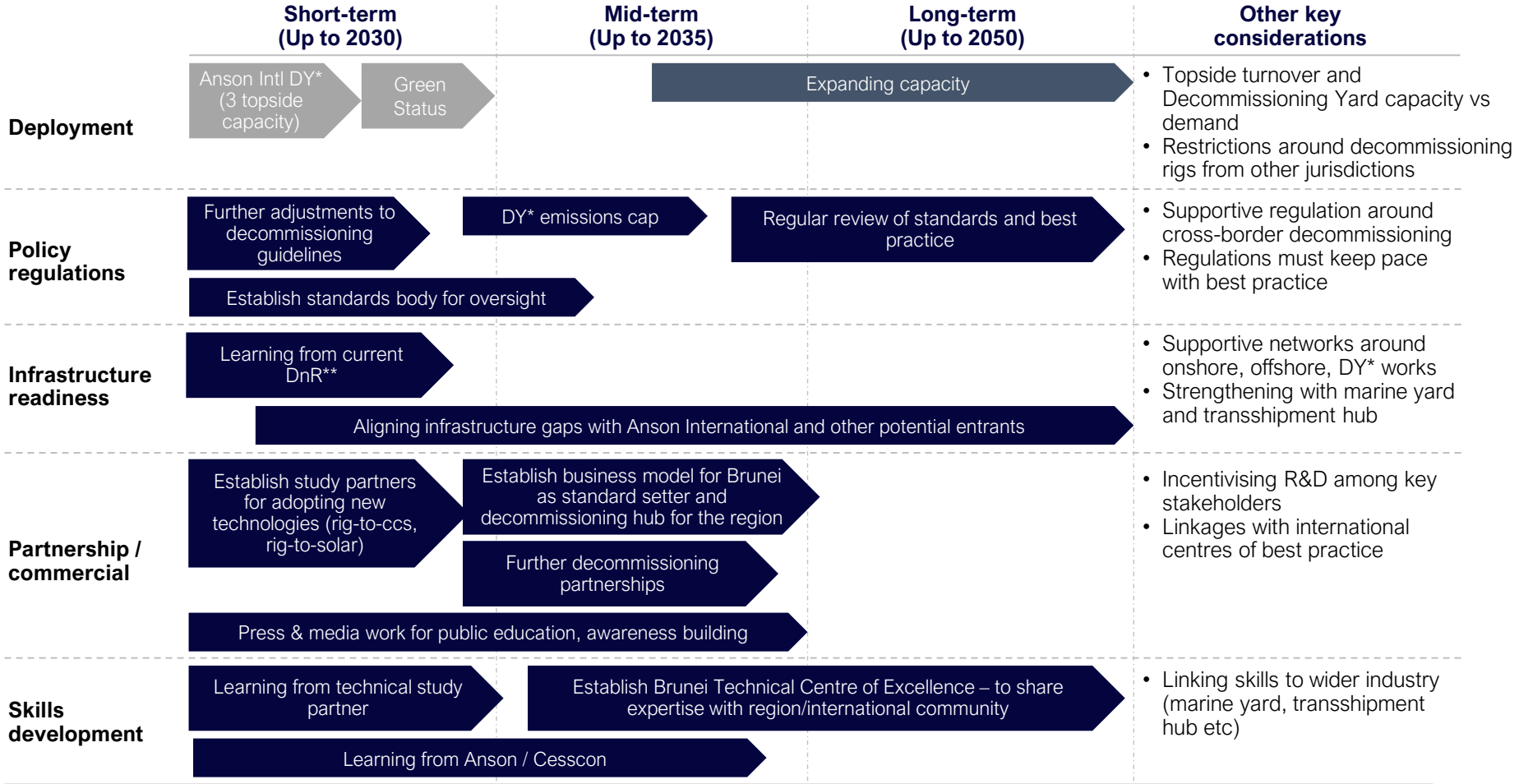
Prior to this, Indonesia introduced Regulation No. 15 (2018) concerning post-operation activities imposing abandonment and site restoration (ASR) obligations (including the creation of an ASR fund). Legal challenges are expected around the retrospective application of this law.

**Malaysia**, Under United Nations Convention on the Law of the Sea, there is an obligation to decommission assets. Between 2003-2017 of the 7 decommissioned assets 4 underwent total removal and 3 were converted to reefs. Since 2018 the 3 decommissioned assets were repurposed marking a shift in Petronas' practice.

Announced and existing target
Potential capacity deployment
Enablers

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: DECOMMISSIONING AND RESTORATION

The potential roadmap must consider developing an appropriate plan and policies soon for successful implementation




* DY refers to Decommissioning Yard
** DnR refers to Decommissioning and Restoration

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: DEVELOPING A CIRCULAR ECONOMY

Various forms of recycling can be considered for Brunei to integrate into a whole-of-nation approach to emissions reduction and economic growth

## BACKGROUND

Brunei has a relatively large waste per capita output (1.4kg), of which non-degradable plastics account for up to 20%.[1] The bulk of Brunei's municipal solid waste (MSW) goes to landfills posing problems of groundwater contamination, dissemination of microplastics and marine waste. Whilst not large of itself, plastics as non-biodegradable should be separated from biodegradable waste.

Polyethylene terephthalate, or PET plastic has a life cycle carbon emissions of 100%, mostly due to the oil feedstock used in production, or between 1.5-3.6kg $CO_2$e per kg of PET.[2]

Mechanical recycling is the end-of-life option with the lowest GHG emissions. It avoids the emissions derived from the production of virgin polymer, the most polluting process across the plastics life cycle. Incineration of plastic waste presents the highest recycling emissions overall. The proposed waste-to-energy plant (WtE) will require separated waste to avoid excessive emissions. Similarly, separated waste will boost the potential of other recycling options including recycled plastics (rPET)- an increasingly demanded product.

## BENEFITS OF RECYCLING

1. **Waste Reduction:** On average only 9%[3] of global plastic waste is recycled. The bulk goes to ever-expanding and unmanageable landfills, which can be solved by recycling.
2. **Reduced Oil Dependence:** Current plastics rely heavily on oil inputs, under BAU this will represent 20% of global oil consumption by 2050.
3. **Emissions Reduction:** By 2050, plastics will account for 15% of GHGs, recycling 90% of PET bottles represents a 14% GHG reduction under the current state[4] while landfills account for 5% of emissions.[5]
4. **Circular Economy:** Achieving circularity relies on sustainable waste management that involves consumers, industrial sectors, and government intervention.

## KEY CHALLENGES

1. **Supply:** Waste tonnage is not comparable to neighbours which limits commercial opportunities both for resource inputs as well as export potential.
2. **Regulations:** Current waste is not separated. This will be crucial for both recycling and WtE, as will be expanding national waste collection.
3. **Restrictions:** Expanding the hub may require importing waste - not seen as a desirable option or in line with government commitments (Basel Convention).

## OPPORTUNITIES FOR BRUNEI

Recycling serves as a whole-of-nation **decarbonisation** pathway. It is also interlinked with national policies to reduce oil dependence for plastics production as well as offering waste and emissions reduction. Due to the limited volume of waste, a WtE plant may not be commercially viable but can provide self-sustaining reduction to landfill, waste and GHG emissions.

rPET has a stronger commercial outlook for Brunei. The global rPET market is now worth USD 8.9 Bn (2021) and expected to reach USD 21 Bn by 2026.[6] Supporting local F&B producers with rPET bottles, textiles and packaging options provides **green growth** options for local and export markets in line. This could also be an opportunity for Brunei to reform its **waste regulatory monitoring** and **enforcement** around pollution by adopting a 'polluter pays' principle whilst creating value by recycling and reusing materials.

1 Department of Environment, Parks and Recreation Brunei
2 Plastic Energy, 2023
3 UN Environmental Programme, 2019
4 Meys et al., 2021
5 Zhang et al., 2019
6 Research & Markets, 2021

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: rPET & WASTE-TO-ENERGY

Significant potential carbon savings of up to 50,000 TPA until 2050 and potential profit between of 30%. Limited job creation but foundational to developing a strong green and circular economy

## POTENTIAL rPET INDUSTRY

With the majority of Brunei's current plastics waste going to landfill there is a small-scale emissions savings and repurposing potential within the domestic market that can strengthen overall movements towards net zero. Currently, Brunei's annual life cycle plastic waste emissions are around **80,000 tonnes** ($CO_2$e). Under a medium recovery (55% via a mechanical recycling plant) this could be almost halved. Under a high recovery scenario (90%) emissions would be reduced to **31,000 tonnes** annually. In addition to GHG savings, a small rPET hub would deliver an average profit of **USD 5.6 Mn** from selling rPET pellets[1] – to be taken up by Brunei's F&B manufacturers for use in packaging and film or exported.

## POTENTIAL WASTE-TO-ENERGY (WtE)

The remaining bulk of MSW (200,000 tonnes) can also be integrated with a self-sufficient WtE plant. Brunei has plans to install a small plant (15MW). This could reduce emissions by **90%** compared to landfill. Displacing fossil fuel GHGs from MSW would require importing waste. Incinerated waste must be pre-sorted for biogenic non-atmospheric emissions. The plant would allow Brunei to move towards a **zero-landfill** scenario and create 350 construction jobs a year (2-year period) and 50 operational jobs annually. Construction costs are estimated at some USD 300,000.[2]

## KEY ENABLERS

- **Waste Separation Policies:** There will be a need for consumer and industry incentives to separate plastic waste from other solid wastes as well as a national policy to prohibit single-use virgin plastics and robust waste management and value chain. The separation will also reduce the $CO_2$ emissions of a WtE plant by removing paper and plastics from MSW.
- **Aggregation of supply:** Existing plastic waste can be recycled on a small scale (1 plant), increasing production would rely on importing used PET from neighbours or using sea buckets. The WtE is an important landfill reduction intervention.
- **Downstream Market:** Either a domestic or export rPET market needs to be targeted prior to operations. Target exports could include countries with supply constraints (US), major F&B manufacturers looking for rPET bottles and packaging (Nestle, Danone, Ghanim), as well as textiles and carpet manufacturers (Indorama). In addition, both plants could be suitable for inclusion in a carbon market, creating and providing for credits and swaps, and may be eligible for external financing and investment. An incinerator WtE plant would likely utilise all generated electricity. Other potential WtE solution includes gasification from landfills to avoid incineration.

### Opportunities From rPET and WtE Plants to 2050

| | | | |
|---|---|---|---|
| **Operations** Until 2050 | **USD 1.9-2.0**** Mn* GVA | **70-90** Jobs | **310,000-335,000***** T GHG reduced |
| **Construction** 2-year period | **USD 11-12*** Mn GVA | **900-930** jobs | **rPET: USD 0.8-1** Mn CAPEX<br>**WtE: USD 2-2.5** Mn CAPEX |

* GVA from jobs alone
** WTE GVA calculated from jobs over project lifetime with the average profit from rPET plant
*** Average over project timeline

1 Chemanalyst, 2023
2 Asian Development Bank

# 04 – CASE STUDY: rPET ROADMAP

Countries and corporations globally have committed to plastic waste recycling; the UK has targeted to recycle 90% of plastic bottles by 2029 while Coca-Cola has committed to recycling all of its PET bottles by 2030

## RISING DEMAND

Globally PET is the most used plastic, mechanical recycling is the cheapest and most common, but regional differences in plastics sorting and collection impact the potential of an rPET plant

- **Scale & production volume:** In Southeast Asia demand for rPET for F&B packaging is expected to increase 10 to 15 fold by 2030[1] the region aims to recycle 35% of PET.
- **Investment:** Cost depends on price, technology involved, and the level of sorting that the producer must undertake.

## UK ACTIONS

The UK has progressively committed to plastic waste reduction. Since 2022 all plastic bottles made in the UK are made with rPET, 57% of the UK's 13bn plastic bottles are recycled with a 2029 target of 90%. Many initiatives are driven by brands' sustainability commitments. Demand for food-grade rPET is expected to outpace supply by 2030. As a circular economy approach to waste management becomes the global norm governments are increasingly legislating the sorting of plastic waste at the household level to improve recycling recovery rates and reduce pressure on landfills and micro-plastic leaching.

## COCA-COLA-INDORAMA, PHILIPPINES [2]

As part of Coca-Cola's 2030 commitment to recycle all its PET bottles Coca-Cola Philippines partnered with Indorama Ventures – a technology leader in recycling plastics for food packaging and textiles. The JV commits over USD 40 Mn to opening a bottle-to-bottle recycling plant.

1. **Timeline:** PETValue, the Philippines' first food-grade bottle-to-bottle recycling plant answers Coca-Cola's 2030 recycling goal.
2. **Value-added:** Aims to improve national recycling rates, prevent leakage into waterways and support post-consumer waste management. All repurposed plastics will be used by Coca-Cola.
3. **Key Partnerships:** Partnership with IVL brings technological expertise. Coca-Cola has engaged suppliers of PET from community and NGO plastics sorting and collecting, including sponsoring 800 collection points.
4. **Opportunities:** PETValue will recycle up to 2 bn (30,000 tonnes) bottles into rPET flake/resin (32,000 tonnes) and create 200 jobs during phase 1 (2022-25). By partnering with Coca-Cola IVL has successfully tapped into SE Asia's food grade rPET demand – expected to reach around 400,000 tonnes per annum by 2030.

1 Rabobank, 2021
2 Coca Cola Philippines, 2022

## IMPLEMENTATION OF PETVALUE PLANT, PHILIPPINES

EVERY BOTTLE MATTERS
PETVALUE
A JOINT VENTURE OF INDORAMA AND Coca-Cola Beverages Philippines, Inc.

**March 2020:** Indorama Ventures (IVL) and Coca-Cola sign a JV agreement to invest in a PHP2.28 bn state-of-the-art rPET recycling plant – PETValue

**2021:** The Philippine Board of Investment grants PETValue pioneer status owing to its use of new technologies – used PET bottles to undergo 8 step green tech process

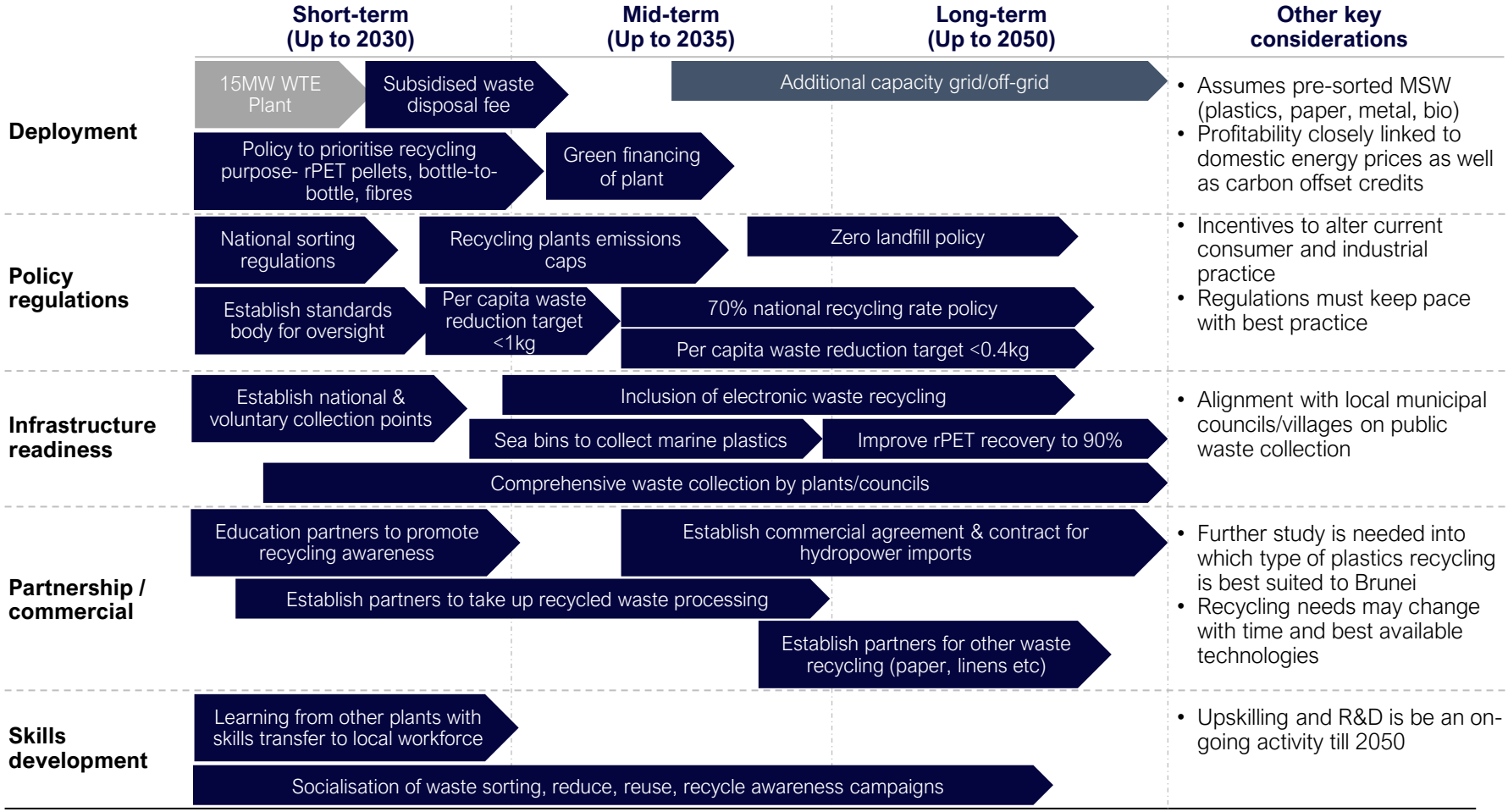
**2022:** Coca-Cola partners Plastic Bank (targets collecting 100,000kg of plastics), and initiated 30 solid waste management community projects to source plastics for PETValue

**October 2022:** 'PETValue' plant is officially operational

Announced and existing target
Potential capacity deployment
Enablers

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: rPET & WASTE-TO-ENERGY

The potential roadmap must consider developing an appropriate plan and policies soon for successful implementation



# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: FLYASH

As global energy demand rises, so too does the production of flyash. A by-product of coal-fired power plants, it is used in a variety of construction applications: cement, concrete, bricks, ceramics and land reclamation

## INTERNATIONAL PRACTICE

Rapid urbanisation in China and India has been driving demand and supply (coal power) for flyash while the UK and Europe have been experiencing shortages – offering export opportunities for EN450-certified flyash. For example, the Netherlands, France and Italy utilise 100% of flyash.[1] With its suitability for tropical climates, processing flyash for domestic use (bricks, ceramics) offers a closed-loop supply of construction materials.

Brunei's 220MW coal-fired power plant, operated by Hengyi Industries, is likely to produce an average of ~1 MTPA of flyash when compared to international benchmarks. Whilst globally, flyash has traditionally been deposited in ash ponds or stockpiled there is now a trend to repurpose flyash to avoid leaching and air pollution and create safe industrial waste processing techniques.

Repurposing flyash for construction material is a potential option for Brunei. Existing and smaller coal plants in the region have created on-site flyash brick-making facilities for domestic use. For example, Indonesia's PLN uses its flyash for bricks for residential construction and cement for national road projects.

## KEY ENABLERS

1. **Waste Reduction:** potential mismanagement of flyash could have negative impacts on public health and the environment. [2]
2. **Safety:** Previous use of ponds to collect and store flyash has the potential to poison the surrounding environment & wildlife as well as the potential to leak, leach & collapse.
3. **Emissions Reduction:** Employing methods to collect and remove both flyash and bottom ash for repurposing could remove **240,000TC02e** in Brunei annually.
4. **Circular Economy:** Repurposing of flyash waste further lowers the carbon content of cement, concrete and bricks.

## KEY CHALLENGES

1. **Standards:** avoiding health risks requires close monitoring and standards in the application of flyash to building materials. Potential export of flyash requires harmonisation with EU/UK/US standards.
2. **Regulations:** further processing of flyash may require the government to mandate Hengyi Industries to report the quantity of flyash and bottom ash production and capture and processing techniques.
3. **Quality:** Low sulfur coal results in slightly different capture and processing techniques. Bottom ash (more coarse) may require further processing, Combustion conditions, ash collection technology and maintaining a stable combustion load also affects quality and downstream repurposing.

## OVERALL BENEFITS FOR BRUNEI

Flyash recycling is a **pollution control solution** for Hengyi Industries. Untreated flyash contains arsenic, barium, cadmium, nickel, lead and other harmful chemicals thought to lead to a range of health and respiratory problems if left to leach into the surrounding environment.

Flyash offers a **decarbonisation** pathway for cement/brick manufacturers. The use of flyash negates the use of coal in brick production and lowers the carbon content of cement/concrete whilst improving strength.

It could also help to **regulate a circular economy** by enforcing sustainable waste management in industries and establishing norms for other players to replicate.

1 Petrovic et al., 2022
2 Jaiswal, 2006

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: FLYASH

Enforcing and expanding industrial waste management and economic activities can bring a range of positive economic impacts

## IMPACT OF FLYASH PROCESSING

Flyash is increasingly in demand as cement, brick and concrete manufacturers look for innovative and low-cost alternatives to virgin feedstock. Brick processing has been an affordable and implementable strategy that has created both income and jobs across the Asian region – notably in India and Indonesia, both large coal consumers with significant construction and infrastructure needs and net-zero targets.

For Brunei, the annual $CO_2e$ savings from repurposing flyash could reach **260,000 tonnes**. Whilst the GVA (assuming flyash and bottom ash brick prices remain equal) amounts to **USD 509,000** per year. This profit could be added value to an existing cement or brick manufacturer in Brunei. In addition, it negates the need for space-heavy stockpiling and ponding, which pose direct environmental and health risks.

## ENABLERS

1. **Waste Management Policy:** Mandated recovery of flyash combined with emissions regulations are necessary to impose industry to capture all ash flyash, pulverised flyash and bottom ash.
2. **Aggregation of demand:** Domestic demand for construction material and suitability of application should be considered against potential export markets, with competitors China and India set to grow flyash production. As a free by-product, potential brick manufacturers may only need to pay for the capture and transportation method.
3. **Infrastructure:** For Brunei's size, an export market may not be feasible for local flyash products. However, local demand for bricks, cement, and concrete blocks should be fostered to adopt a circular economy approach.

| | | | |
|---|---|---|---|
| **Operations** Per Annum | **USD 0.4-0.5*** Mn GVA | **15-20** Jobs | **240,000-260,000** T GHG reduced |
| **Construction** | No construction is needed assuming that flyash is processed by existing cement / brick producers. | | |

## FLYASH CONTRIBUTION

1. Frees up land
2. Reduces environmental risks
3. Reduces health and safety risks
4. Ensures responsibly industrial practice
5. Creates a value-added industry

Assuming the 220MW Hengyi coal-fired power plant remains constant at this size, coal consumption and flyash production should remain equal.


* GVA from profit of selling flyash bricks per annum

# 04 – CASE STUDY: FLYASH

Global demand will push the market to USD 20 Bn by 2030, driven by new technologies incorporating flyash as a low carbon feedstock

### UK ACTIONS

Progressive climate regulations have seen mandated reductions in coal-fired plants' emissions as well as compulsory recovery of flyash. Currently, the UK uses flyash for cement and concrete (it improves hardness) as well as land reclamation. Flyash bricks do not absorb heat making them unsuitable for a UK climate. The UK will cease all coal-fired power plants by Oct 2024 in line with net zero targets meaning a continued UK shortage of flyash is expected which will impact the cement industry's future ability to reduce $CO_2$. Western demand has seen costly investments into removing ponded flyash to be used by large cement manufacturers instead of virgin feedstock (Holcim, US).

### DEMAND

UK demand for flyash is expected to remain stable at just over 2 Mn tonnes per annum.[1]

- **Scale & production volume:** currently 100 Mn tonnes of legacy stockpile of flyash which is being considered for processing to EN450 quality as a cement feedstock. Importing of EN450 flyash is also permissible.[1]
- **Investment:** led by regulations to capture ash via BAT (ESP or baghouse methods) before sale for further processing. Use of stockpile requires some processing.

### INDONESIA NATIONAL ELECTRICITY COMPANY (PLN) – FLY ASH AND BOTTOM ASH PROCESSING (FABA)[2]

1. **Timeline:** PLN established on-site FABA brick and concrete block production to be used in public infrastructure projects within a relatively short time frame – feeding into low-tech brick, blocks, and cement facilities from 20 coal-fired power plants.
2. **Value-added:** The information centre highlights future potential products from all (private and PLN) power plants' by-waste to fulfil 3R and circular economy commitments as well as create economic value. PLN gives away its FABA for free to community producers.
3. **Key Partnerships:** PLN has linked production with community MSMEs. In addition, secured buy-in from Public Works Departments, Military, and other SOEs to buy FABA products for use in public-led government construction projects.
4. **Opportunities:** By partnering with state construction companies, local councils and the Indonesian Armed Forces PLN's initiatives have enabled successful take-up and supported the commercialisation of flyash as a feedstock in Indonesia's infrastructure development from land reclamation to roads and low-cost housing.

1 UK Quality Ash Association
2 Ekonomi.bisnis.com, 2023

### IMPLEMENTATION OF FABA, INDONESIA

**Feb 2021:** FABA is no longer classified as hazardous material – allowing 20 coal power plants to commence supplying local brick and cement makers with (free) flyash.

**June 2021:** PLN Persero launches the FABA Information Centre.

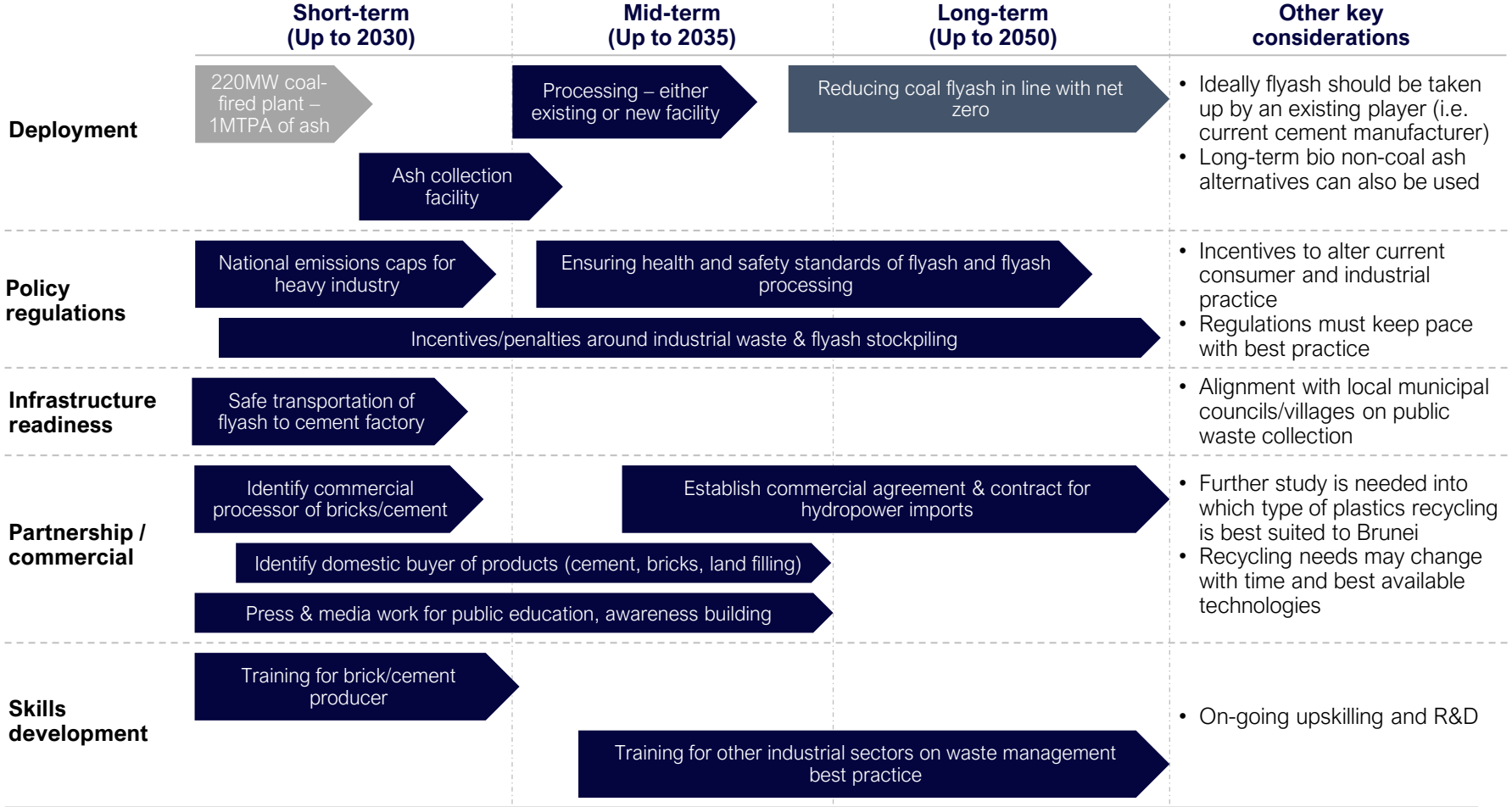
**2022:** Ongoing: Financial and network support to community owned cooperatives and micro-industries to open production value chain.

**Q1 2023:** PLN had produced 1mn cement paving units, 246,000 bricks, 2,000 tetrapods, 48km of road concrete, 34,000 tonnes land stabilisation material, 699 tonnes fertiliser material and 671,000 tonnes as cement raw material– all for domestic use – including the Lombok MotoGP circuit. PLN is also developing seismic resistant housing from FABA.

Announced and existing target
Potential capacity deployment
Enablers

# 04 – CONSUMER & INDUSTRIAL WASTE RECYCLING: FLYASH

The potential roadmap must consider developing an appropriate plan and policies soon for successful implementation



# FURTHER IMPACT OF GREEN ECONOMY OPPORTUNITIES

The green economy can also become a catalyst for further change across other industries, which will also bring further benefits to Brunei

## EXTENDED BENEFITS & IMPACT

As Brunei navigates the path towards a green economy, the implications extend far beyond the direct benefits of the four key opportunities identified within the downstream oil and gas sector. Instead, the economic, infrastructure and societal shifts generated will also lay the foundation for further economic development.

The four opportunities expanded in the chapter have the potential to drive great change in Brunei's society, including but not limited to:

- A mindset shift towards sustainable modes of economic growth, departing from the traditional oil and gas economy towards non-traditional, low-carbon industries.
- Increased funding and partnerships, collaborations in non-upstream-oil-and-gas spaces, including green financing and international partnerships.
- Expanded Foreign Domestic Investment (FDI) as the green economy becomes an attractive proposition for investors seeking opportunities aligning with sustainable and ethical practices.
- Development of green infrastructure such as renewable energy projects and sustainable urban planning.

The ripple effects of the green economy can also become a catalyst for further change across Brunei's other industries, most notably its tourism, aquaculture and Islamic food hub sectors. These three sectors are growing in global relevance, and have the potential to enjoy strong sustainable economic development:

- **Tourism:** The global tourism industry is set to grow by 50% from 2019 to 2033, reaching USD 15.5 Tn value by 2033 and accounting for 11.6% of the global economy.[1]
- **Aquaculture:** Demand for seafood is expected to double globally by 2050,[2] raising a need for its long-term sustainable growth.
- **Islamic food hub:** This is one of the fastest-growing food markets worldwide, with a CAGR of 7.5% from 2021 to 2025.[3]

## TOURISM

About two-thirds of middle-class spending power is expected to be centred in Asia by 2030[4], and Brunei is well-positioned to capture this. Its strategic location in the centre of the BIMP nexus allows for capitalisation on demand from adjacent markets in Sabah and Kalimantan. The sector has also been identified to have high potential in contributing towards the diversification of the economy[5], led by the Tourism Development Department.

**Tourism in a green economy:** The overall societal shift towards sustainability will also be a catalyst for Brunei to develop a niche in sustainable and wellness travel. The increased prioritisation of sustainable development, on top of the increased clean energy supply, will appeal to travellers who are increasingly willing to pay premiums for more natural, eco-friendly and mindful travel experiences.

### SUSTAINABLE TOURISM IN SEA

Southeast Asia has long been an attractive destination for tourists worldwide. In recent years, more travellers are seeking experiences that engage with locals and have minimal ecological impact. Since the pandemic, 57% of Asia-Pacific tourists wish to avoid contributing to over-tourism.[6] As a result, governments have been reorienting offerings to tap into this trend.

**Thailand** has obtained GSTC sustainable tourism recognition, launching the UNESCO Sustainable Travel Pledge, in which over 500 Thai hotels have pledged to invest in more sustainable practices[7]

**Malaysia**'s Taiping city was ranked 3rd most sustainable city destination in the world in 2019,[8] attributed to the city's focus on nature-related offerings of mangroves, forests etc.

1 Bloomberg, 2023
2 World Economic Forum, 2022
3 DinarStandard, 2022
4 United Nations Development Programme
5 Wawasan Brunei 2035
6 Lombard Odier, 2023
7 United Nations Thailand, 2022
8 NST, 2019

# FURTHER IMPACT OF GREEN ECONOMY OPPORTUNITIES

Other opportunities that stand to gain from the green economy include the aquaculture sector as well as the development of an Islamic food hub

## AQUACULTURE

The aquaculture industry in Brunei has further commercial potential and can further support export targets. Brunei's Department of Fisheries has already implemented initiatives such as providing basic infrastructure facilities for new sites, developing and upgrading facilities of existing industrial sites and introducing new sea prawn species for cultivation.[1] The department has also implemented training programmes and seminars for entrepreneurs, as well as other related programmes such as Brunei Good Aquaculture Practices Certification (BGAqP).

**Aquaculture in a green economy:** The global shift towards more sustainable modes of food production means that aquaculture practices in Brunei can leverage clean energy and green standards locally to adhere to the highest environmental standards. This includes leveraging renewable energy sources for operations, utilising eco-friendly feed, and implementing closed-loop water systems to minimise waste and prevent pollution. Additionally, the increased profile of Brunei as a green, low-carbon society can bring increased financing, partnerships, investments for knowledge exchange and technology development in sustainable feed technology, breeding programmes, and disease control.

## ISLAMIC FOOD HUB

The Asia-Pacific region is forecasted to be home to approximately 53% of the global Muslim population by 2050[2]. Brunei, situated in the heart of Southeast Asia, is well-positioned to tap into this growing market. This will also complement current halal credentials and efforts to develop halal food, beverages, cosmetics and pharmaceuticals[3], particularly in ASEAN and BIMP-EAGA (Brunei, Indonesia, Malaysia and the Philippines) East ASEAN Growth Area. Linking this to aquaculture growth can serve as a catalyst.

**Islamic food hub in a green economy:** Brunei's commitment to sustainability can attract FDI and collaboration with large food players (e.g. Nestle) interested in ethical and sustainable food production, which will be a key enabler for the scale-up of manufacturing and processing activities. Additionally, the shift towards green practices can allow for the opportunity to develop sustainability, including embracing low-carbon and energy-efficient standards in facilities, as well as the implementation of eco-labelling for halal products. These initiatives can further help Brunei differentiate itself from its competitors.

## A SUSTAINABLE SLANT IN FOOD & AQUACULTURE

Norway serves as a case study to understand how sustainability and economic growth can be complementary in aquaculture.

**Norway,** a leader in global aquaculture, especially in salmon farming, and has pioneered an approach integrating economic viability and protection of traditional livelihoods with environmental stewardship and social responsibility. This includes:

- Regulations: The Norwegian Aquaculture Act, one of the world's most rigorous frameworks, enforces strict controls over operations, mandating sustainability in every facet, from water quality, fish health and feed usage to waste management and ecosystem impact.
- Feed innovation: Norwegian companies have incorporated ingredients like algae and trimmings from sustainable fisheries to develop sustainable feed, reducing reliance on wild fish stocks.
- Technology: Norway has invested heavily in technology, including closed-containment systems that prevent escapement and interaction with wild fish populations, and advanced monitoring systems that ensure optimal conditions for fish health and growth.
- Spatial planning: Norway has adopted marine spatial planning to minimise conflicts with other marine activities and environmental impacts.

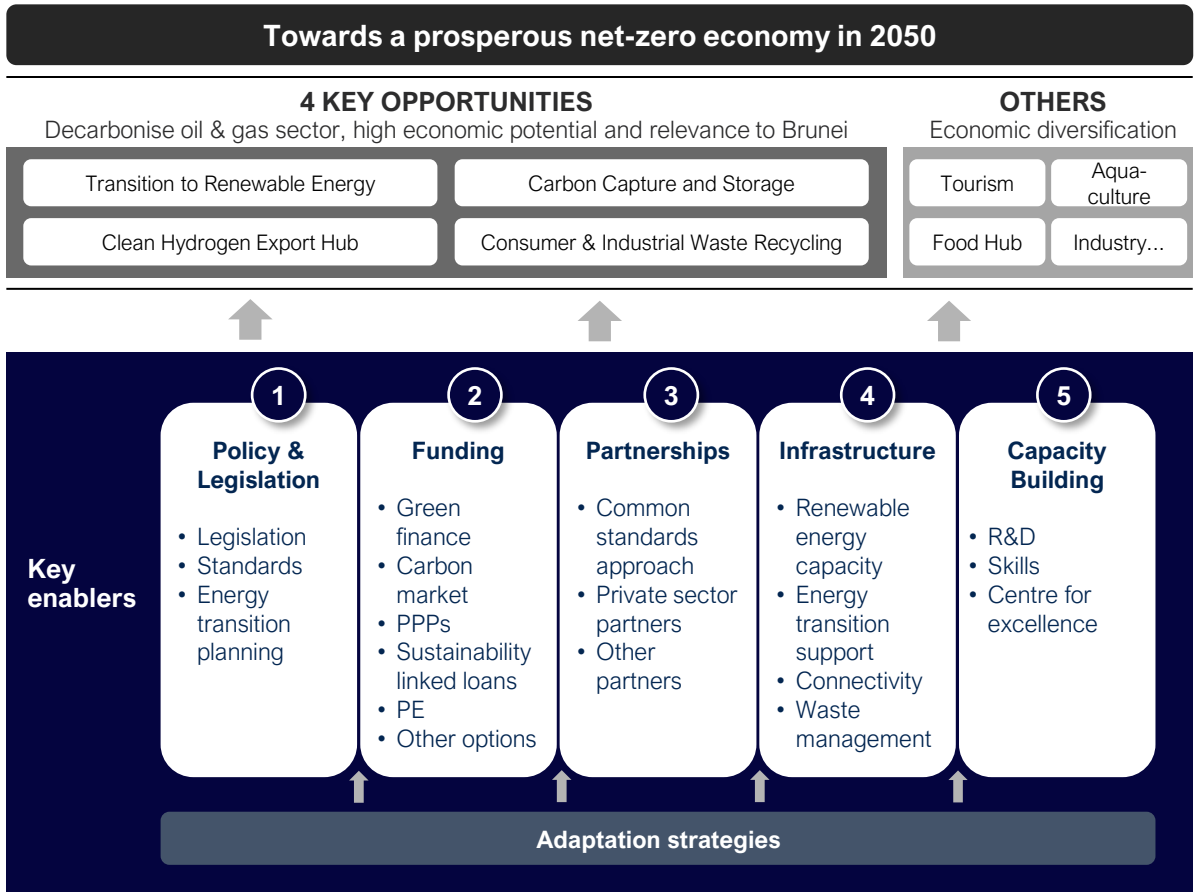
1 Borneo Bulletin Handbook, 2023
2 Pew Research Centre, 2015
3 Borneo Bulletin Handbook, 2023

# 4 Develop key enablers

# THE FIVE KEY ENABLERS

Brunei now needs to catch up to capitalise on green opportunities. As a first step, immediate efforts should be made to start building capacity across the following five categories of enablers

The opportunities explored in the previous chapter lay out an ambitious growth trajectory toward a carbon-neutral economy for Brunei. Capturing these opportunities will require deliberate and strategic action across interdependent key enablers. The identified enablers have been selected to facilitate both short-, mid- and long-term implementation and returns.




The following have been identified to capitalise on Brunei's current position and avoid opportunity loss:

1. **Policy and Legislation:** The current policy framework is not robust enough to support green transition. Transparent transition policies committing both the public and private sectors is critical for success.
2. **Funding:** The mobilisation of financial resources is vital with investment required in technology, infrastructure and continued capacity building. Market-based financing options can attract various investors.
3. **Partnerships:** Partnerships will be critical in ensuring timely and successful policy implementation. A common standards approach ensures compatibility across sectors and jurisdictions.
4. **Infrastructure:** The current physical infrastructure does not support implementation or scaling up green opportunities including EV take-up.
5. **Capacity Building:** Human capital and research capacity are key components to enable new economies. The ability to build the right capacity will attract investments and deliver efficient and quality output.

**Adaptation Strategies:** Pre-emptive climate adaption policies integrated into infrastructure planning, ecosystem management, and wider policies will also allow Brunei to ensure continued sustainable growth amidst climate variability.

# ENABLER 1 – POLICY & LEGISLATION

Countries opting to legislate green pathways are better placed to regulate, monitor and enforce a shift away from a business-as-usual approach within a defined timeframe

## LEGISLATION

Legislation allows to impose duties and confer rights for environmental governance, such as:

- **Polluter Pays Principle:** Also known as extended producer responsibility to enable enforcement and penalties. Requires fixed permissible levels of pollution (air, soil, water, noise, waste, GHG emissions, biodiversity).
- **Climate Change Act:** Common legislation to drive national reductions, and establish clear definitions and industry-specific targets. An act is often used to formalise an MRV system e.g. monitor pollution or enforce penalties.
- **Green Tech Approval:** Maturing and mass industrialisation of green or negative emissions tech (i.e. CCUS) require approval bodies equipped to make timely safety assessments to meet investor expectations.[1]
- **Financial Regulations:** Oversight functions within relevant agencies for green bonds and sukuk to enable external financing of RE projects[2] to boost investor confidence and capitalise on current demand.
- **CCUS Legal Framework:** To develop early to attract investors. Covers $CO_2$ classification, exclusions and prohibitions, establishment of property rights, and exploration rights.
- **Energy Trading:** Ensuring the correct legal framework is in place to allow for energy imports and downstream distribution.

1 UNCTAD, 2023
2 UNDP, 2022

## STANDARDS

Standards delineate industry expectations and boost public and investor confidence. This could include:

- **Carbon Pricing Policy:** For new or sector-specific industries in line with regional players. Sets foundations for a carbon credit market aimed at international buyers.

  **MRV System:** Currently under formulation by BCCS, crucial to drive action and support legislation.
- **Environmental Impact Assessment Regime:** Transparent rules for both national-level adaptation strategies and project assessments and investor due diligence.
- **$CO_2$ Storage Certification:** To allow international organisations to offset via certified credits and/or storage space.

## ENERGY TRANSITION PLANNING

For Brunei to meet or exceed its RE target of 30% by 2035 the following will be required:

- **Roadmap:** Specific timeline of milestones to ensure energy resilience, achieve targets, and compete for investment.
- **Pricing:** Rationalisation of domestic prices to scale up RE mix and attract investment.
- **Tax Incentives:** For RE producers which can be fed to consumers and companies looking to invest in RE tech.
- **EVs:** With one of the highest per capita car ownerships globally switching to EVs will maintain stable transport energy prices but will need supportive infrastructure.
- **Public Advocacy:** Ensure clarity of timeline to support industry partners' green projects.

## INDONESIA CCS-CCUS LEGISLATION

The first Asian legislation via Indonesia's Regulation on the Implementation of CCS & CCUS in Upstream Oil and Gas Business Activities was enacted in March 2023. The primary objective of legislation is to meet national emissions reduction commitments. The enactment legislates for $CO_2$ measurement, an MRV system, financing, monetising, insuring and closure of CCS/CCUS projects.

The Regulation requires that carbon emissions be captured from upstream oil and gas business activities via CCS or CCUS. In addition, $CO_2$ from the atmosphere or carbon derived from other industrial processes and sectors can be used for CCS or CCUS activities.

**Responsibilities:**

1. **Contractor:** to submit implementation and feasibility plan. to include information on geology, geophysics, reservoirs, transport, storage, injection and operations for CCUS projects, in addition to information on economic efficiency, engineering, safety and environment, project evaluation and risk mitigation and submit an annual MRV.
2. **Permissible Activities:** to inject and store $CO_2$ emissions in other Contractors' Work Areas and to inject and store $CO_2$ emissions generated by third parties.
3. **Unclear:** The beneficiary of carbon credits has yet to be clarified.

# ENABLER 1 – CASE STUDY: MONTENEGRO

With a similar population size to Brunei (600,000) and heavily reliant on one sector (tourism), Montenegro has been supported by the EU to develop the legal foundations towards sustainable growth

## MONTENEGRO LEGISLATION[1]

Montenegro aligned its legal framework with the EU's Regulation on Taxonomy which identifies and groups sustainable activities as well as prioritises and enables financing.

**December 2019:** the "Law on Protection from the Negative Impacts of Climate Change" (Climate Law) entered into force. It mandates the development of a GHG inventory, a low-carbon development strategy, and a national MRV system. This provided the legal basis for the national emissions trading scheme (ETS).

**2020:** Adopted "Decree on Activities for which a GHG Permit is Issued". It included provisions for banking allowances, a minimum reserve price of €24 (USD 25), and a linear reduction factor for the emissions cap of 1.5% annually in the period 2020-2030. Auction revenues go to the country's Environmental Protection Fund to finance climate innovation, renewable energy, and environmental protection.

Industries that must participate in the ETS include power plants, oil refineries, coke production, the production or processing of iron and steel, non-ferrous metals, cement clinker, glass, ceramic products, and paper (pulp), power plants with a capacity in excess of 20 MW.

## AN EU-INCENTIVISED CARBON MARKET

ETS was implemented in 2020 to increase the speed of reductions, but a longer timeline is needed to measure success. Initially, it applied to 3 installations: the Pljevlja coal plant, KAP aluminium plant and Tosčelik steel mill. They received 100% of their allowances for free in 2020 and 2021 (60% of total allowances). The first auction was in January 2023. Due to the very small size of the Montenegro ETS there is no participation of intermediaries or a secondary market. Allocation and auctioning are organised by the government but inter-trade is allowed between covered entities.

**Learnings:** The practical application of caps to key plants can be replicated in Brunei's carbon reference price implementation and developed into a credit system.

## TRANSITION OPPORTUNITIES

- **Financial Resilience & Sustainability:** In 2020 Montenegro's energy matrix was almost equally reliant on **coal**, **oil** and **RE**. RE comprises hydro, wind with growing solar.[2] Montenegro's majority state-owned power utility plans to invest about €1 bn over the next five years to boost renewable energy output to 2,000 gigawatt hours (GWh) per year, and eventually become an exporter of green energy.[3]
- **Tax Incentives:** Applied to solar panels to encourage solar roofing and plants as part of a plan to add 400MW of electricity. [4]
- **EVs:** No road tax for EVs up to Dec. 2025.
- **Learnings:** Similarly reliant on fossil fuels, Montenegro has capitalised on international appetite to finance the energy transition.

## GREEN FINANCE - MONTENEGRO

**Net cumulative investment in the energy sector**[5]

The European Bank of Reconstruction and Development (EBRD) invested €222 mn from 2016-22, reducing 86,000 $TCO_2e$ p.a via smart meters and 180,000 $TCO_2e$ p.a via Krnovo wind farm. Investments include RE, waste management and water efficiency projects.

| TOTAL | 2016-2021 |
|---|---|
| €222 Mn | €48 Mn |
| €150 Mn | €19 Mn |

## OTHER INVESTMENTS INCLUDE:

- **EIB:** Montenegro has the advantage of the European Investment Bank's green financing support. The EIB also invests in green opportunities outside of Europe.
- **Investment & Development Fund Montenegro:** Since 2010 the country's fund has placed €1 bn in priority economic sectors with credit lines covering a range of activities which focus on green financing.
- **The Eco Fund:** From 2020 the fund finances sustainable and climate change initiatives from both the public and private sectors.
- **Green Climate Fund:** Country support from this international fund.

1 Climate Change Laws of the World, 2019
2 International Renewable Energy Agency, 2023
3 Reuters, 2022
4 EcoDaily, 2023
5 European Bank for Reconstruction and Development

# ENABLER 2 – FUNDING

Brunei currently has a limited green finance sector but is well placed to align economic opportunities to global finance to support some of the USD 5-5.8 Bn required for these transition opportunities

## GREEN FINANCING

Options for public and private projects include:

- **Green Bonds:** A fixed-income instrument designed specifically to support climate-related or social impact projects. RE projects form the bulk of bonds but there is demand for small bonds i.e. Cagamas' MYR 150 Mn social housing ASEAN Social SRI Sukuk (USD 32 Mn 3-year bond).[1]
- **From Green Bonds to Green Sukuk:** Sukuk has been the main driver of ESG debt issuance in the GCC, making up 80% of green and sustainability bonds sold by GCC-based issuers during the first half of 2022.[2] Green Sukuk would be a natural financing option for suitable projects in Brunei and feed into current international demand for sukuk. Indonesia, Malaysia and Saudi Arabia issued close to 80% of 2023's global green sukuk (>USD 10 bn) but the majority of holders are in the US, Ireland, Luxembourg and Malaysia.[3] Globally there is an increasing share of corporate issuance – already 73% of the Malaysian market.
- **Structured products:** traditional financing platforms to raise funds via fixed income, equities, ETFs, closed-end or wholesale funds or blended finance. Private financing for CCUS is expected to emerge when projects reach similar standards to, and offtake risks of, solar and wind projects.[4]

1 Islamic Sustainable Finance & Investment, 2022
2 London Stock Exchange Group, 2023
3 Islamic Finance Council UK, 2023
4 Global CCS Institute, 2021
5 United Nations Development Programme, 2021

## ENERGY PRICING

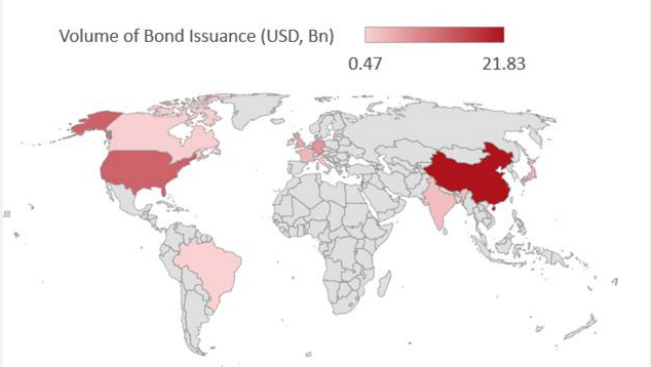
RE opportunities will require a repositioning of current domestic energy prices as countries move to decrease fuel subsidies. At over USD 650 / capita, Brunei has the highest per capita fossil fuel subsidy in Southeast Asia, followed by Malaysia at USD 90 / capita. This poses a future threat to economic stability. Attracting financing for a green energy transition will need rationalisation of prices via reduced subsidies in the near term. Subsidy rechannelling to RE providers, in the form of direct receipts to citizens or tax incentives, could be used to meet the price differential between fossil fuel and RE enabling Brunei to capture RE investment via green bonds and sukuk.

**Subsidies Snapshot:** Brunei has the advantage of transitioning at a time when RE tech and EVs are widely available unlike subsidy reforms in France, Indonesia, Chile which were challenged by lack of alternatives. Fuel taxes, when clearly communicated, can be smooth i.e. Ghana's experience.[5]

## SOURCING DEMAND

- **Credibility:** Trust is as important as returns, investors demand defined impact, strong oversight and reporting transparency.
- **Tap net-zero goals:** FIs such as Mitsubishi Bank have clear goals. The bank leads a coalition of FIs to finance low-carbon tech and zero-carbon projects.

## GREEN BONDS – TOP ISSUING MARKETS




China is the leading market by volume supported by the government's decision to build a green financial system and the 2015 publication of green bond guidelines by the People's Bank of China

Snapshot – new income via green bonds:

1. **Issuer**: Any issuer of securities –governments, companies, corporations, not-for-profit organisations.
2. **Compliance**: Generally borrowers adhere to the Green Bond Principles.
3. **Projects**: Varied but are impact focussed ie: **RE**: (wind, solar hydro, geo). **Energy efficiency**- reduce energy consumption, increase the efficiency of buildings, industries and transportation. **Conservation**: projects designed to protect wildlife and habitats. **Pollution prevention and control**: projects to prevent and reduce waste and decontaminate land. **Green infrastructure**: (urban parks, WASH, sustainable transport). **Sustainable development:** and SDG alignment. Including employment.

# ENABLER 3 – PARTNERSHIPS

Government can play a critical role in establishing new, or building on current, partnerships, with some financing and assistance options solely available to the public sector

## COMMON STANDARDS APPROACH

To integrate with global, regional sustainability benchmarks Brunei can:

- **Align with Permissible Levels:** Brunei can use commonly accepted international sectoral and product-specific standards without the need to develop a Brunei-specific regime. For example: I-REC for electricity Scope 2 reporting, or rPET food packaging can adopt the US' FDA certification for food packaging, commonly accepted low-carbon levels for green factors of production and construction (steel, cement)
- **Partner with thought leaders:** academia and think tanks that are leading in research and implementation
- **Monitor & Enforce:** Leverage on global frameworks to fast-track implementation of:
  - Testing and certification: Can be done in partnership with standards' organisations as well as linking this to skills training for local testing options.
  - Emissions Measurement: Together with local institutions with technology to measure and monitor at-point emissions.
  - In 2022 Malaysia's Green Technology & Climate Change Corporation established a real-time emissions tracking initiative for local companies. The partnership was between MGTC and Envision Digital (decarbonisation software provider)

## PRIVATE SECTOR PARTNERS

International organisations in or beyond Brunei could form technical and other partnerships

- **FDI:** Leveraging on Brunei's reputation and skills to attract further investment in energy
  - 2024: Samsung (a key regional investor and partner in green hydrogen) will open its green hydrogen and ammonia conversion plant in Sarawak (respective capacity of 150,000 tonnes per annum and 850,000 tonnes per annum)

**Industry Clusters**: Leverage on Brunei's current partners to extend decarbonisation to downstream industrial clusters ie. Strong internal coordination with current investors and government agencies

## OTHER PARTNERS

Working in partnerships to access financing, technology and speed implementation

- **MDBs:** Target CCS trust funds (ADB, World Bank), concessional loans (IFC)
- **Bilateral**: Indonesia-USAID's **USD 50 Mn** commitment to achieving FOLU sink targets. Japan **USD 10 Bn** to support energy transition in Asia. India-Australia Green Hydrogen Taskforce
- **Climate Funds & Banks:** Green Climate Fund – invested **USD 54 Mn** over 5 years in Costa Rica's forest preservation. The European Investment Bank is financing India's **€1 bn** hydrogen plans.[1]

## TRINIDAD & TOBAGO's MRV PARTNERS[2]

The largest oil and gas producer in the Caribbean with a population of 1.5 mn and a land size of 5,130 sq. km. Despite a relatively undiversified economy it has scaled up efforts towards reaching net zero with the more recently implemented MRV system:

1. Establishment of a Knowledge Management System (active as of June 2021) that submits data via a secure portal allowing for stakeholder collaboration
2. Manager: Environmental Management Authority
3. Legislation: In the process of formalising the MRV into the legal framework to support future mandatory reporting

**Countries with MRV systems can enjoy greater access to international finance. However, as with India, this is not a prerequisite.**

**Partners**: MRV rollout within 2 years made possible due to the extensive partnerships in learning, technology and funding:

- Caribbean cooperative MRV hub/ UNFCCC
- The Climate Initiative (funder)
- The British High Commission (funder)
- Greenhouse Gas Management Institute
- Ministry of Planning
- The Environmental Management Authority
- The Commonwealth Fund
- The Regional Collaboration Centre for the Caribbean
- The Windward Islands Research and Education Fund
- Initiative for Climate Action Transparency (testing partner), together with UNEP & UNOPS

1 Offshore Energy, 2023
2 Loop Trinidad & Tobago News, 2021

# ENABLER 4 – INFRASTRUCTURE

As renewable energy becomes a key priority for Brunei to embrace its near zero ambitions, it will be important to scale up green and supporting infrastructure to meet demand

## RENEWABLE ENERGY CAPACITY

Brunei's Department of Energy has committed to increasing the capacity of renewable energy by at least 300 MW by 2035, up from its current 1.2 MW of solar PV.[1] It will be critical for Brunei to capitalise on its high solar irradiance to deploy strategic investments in utility-scale solar parks and encourage rooftop solar installations on residential and commercial buildings to rapidly increase the share of renewables in the energy mix. A key development has been the development of a 30 MW solar project at Kampong Belimbing in Mukim Kota Batu through a public-private partnership (PPP) concept.[2] Brunei should continue to leverage PPPs to mobilise the capital, expertise, and innovation needed to expand renewable energy and energy storage projects. This will also facilitate the sharing of risks and rewards between the public and private sectors.

As renewable energy sources of solar and wind are intermittent, developing energy storage solutions will be essential to ensure grid stability. Energy storage, particularly long-duration energy storage technologies (LDES), is essential for maintaining grid stability, flexibility and reliability allowing for the balancing of supply and demand.

Deploying effective renewable energy infrastructure will require collaboration and decisive action from key stakeholders (including Brunei Economic Development Board (BEDB), Brunei Darussalam National Council on Climate Change (BNCCC), and financial institutions like Bank Islam Brunei Darussalam (BIBD). Existing efforts such as plans by the Department of Energy to introduce a feed-in tariff to encourage investment in renewable energy systems should be prioritised. Clear and stable policy signals can encourage long-term investments, which will be key to infrastructure development.

## GRID ENHANCEMENT

As of 2021, there is a gap in energy capacity with the national total installed energy capacity of only 1,054 MW.[3] Upgrading the grid will be essential for higher renewable energy adoption and efficient distribution of renewable energy, addressing issues such as variability.

The national grid, currently designed to distribute energy from conventional sources, requires substantial upgrades to handle the variability and decentralised nature of renewable energy. Modernisation efforts should include the adoption of a smart grid.

## GLOBAL BENCHMARKS EMBRACING RENEWABLES

**Germany's** Energiewende (Energy Transition) is a policy initiative aimed at increasing the use of renewable energy while phasing out nuclear power. Key to this is the Renewable Energy Sources Act (EEG), which introduced feed-in tariffs. To achieve its goals, investment in infrastructure has been key- the country has also undertaken extensive grid upgrades, including expansion of transmission lines from wind-rich northern regions to consumption-heavy areas in the south and west. Additionally, the country is investing in smart grid technology for management of electricity flows and enhance grid resilience. The "Stromautobahn" project, involves high-voltage direct current (HVDC) transmission lines, facilitating efficient, long-distance transport of renewable energy across the country.

**Singapore** is focused on solar power, given the country's geographic limitations. The SolarNova programme has untaken innovative deployment of solar PV systems on available spaces, including rooftops, water reservoirs, and even vertical surfaces, contributing towards the national target of 2 GWp by 2030.[4] This programme provides a co-funding grant of up to 50% of the cost of installing solar panels to eligible organizations, capped at SGD 20 Mn per project. The government also offers the Enhanced Net Energy Metering Scheme (ENEMS) to businesses and landed property owners, allowing consumers to sell excess solar power back to the grid at a higher rate.

1 Economic Research Institute for ASEAN and East Asia, 2023
2 Borneo Bulletin, 2022
3 Sinalda, 2021
4 Housing Development Board Singapore, 2022

# ENABLER 4 – INFRASTRUCTURE

Physical connectivity is also an important consideration for Brunei as it rapidly develops – including the development of sustainable modes of transport

Technologies that allow for real-time monitoring and management of the energy flow will enhance the grid's flexibility and resilience. This involves the installation of advanced metering infrastructure, grid automation, and improved forecasting tools, and can build on existing governmental efforts to replace all existing waters and electricity meters with the new Unified Smart Metering System (USMS) by 2028[1].

The development of supportive regulatory frameworks that facilitate grid upgrades and the integration of renewables is essential. This includes policies for net metering, grid access for renewable energy producers, and standards for renewable energy integration.

Brunei should also consider the establishment of interconnectors with neighbouring countries to facilitate the trade of excess energy. These open avenues for energy trade can optimise the regional energy mix and enhance energy security. These collaborations can leverage shared goals for energy security, sustainability, and economic growth. This may involve high-voltage direct current (HVDC) systems known for their efficiency over long distances. Brunei's Department of Energy plays a significant role in steering these efforts, as well as collaboration between the public and private sectors to be spearheaded by this department.

### ROOFTOP SOLAR, MALAYSIA

Malaysia's Net Energy Metering 3.0 (NEM 3.0) initiative, launched by the Sustainable Energy Development Authority (SEDA) is also a strong leader in the region. This programme is designed to encourage the uptake of solar PV systems by offering a quota of 500 MW to be allocated from 2021 to 2023. Under NEM 3.0, participants can sell excess power generated by their solar PV systems back to the grid at the system marginal price (SMP) and replace the previous feed-in tariff system for more direct incentives. This programme has optimised the infrastructure for solar energy production and consumption, facilitating a more sustainable energy landscape.

### CONNECTIVITY

The enhancement of connectivity infrastructure will also play a crucial role in enabling Brunei's green economy, encompassing the development of port facilities, the transformation of domestic transport systems, and the expansion of roads equipped for electric vehicles (EVs). The recent Memorandum of Understanding (MoU) signed between Muara Port Company Sdn Bhd (MPC) and the BIMP-EAGA Business Council (BEBC) Brunei[2] represents a significant step forward in Brunei's ambitions to become a central transshipment hub for the region. This initiative not only aims to leverage the existing infrastructure of the West Economic Corridor (WEC) and North-Western Economic Corridor (NWEC) but also presents an opportunity to integrate green economy principles into the port's operations and development.

For Muara Port to become a green transshipment hub, integrating renewable energy sources, such as exploring solar, wind and tidal energy is crucial. Building infrastructure for the supply of sustainable marine fuels, biofuels and LNG, is key. Developing dedicated facilities for biofuel handling requires significant investment in storage capacities and specialised equipment, including tanks with appropriate linings for biofuels and the integration of advanced fire suppression systems to manage the specific risks associated with these fuels. Introducing and enforcing regulations mandating the use of sustainable marine fuels, such as setting emissions standards and providing incentives for shipping companies to adopt biofuels, such as tax breaks or reduced port fees, can also accelerate the shift towards green shipping.

Separately, by prioritising investments in sustainable transport technologies and infrastructure, Brunei can significantly improve urban mobility, building on Brunei's Land Transport White Paper[3] and the strategic directions it sets forth beyond public buses.

1 Borneo Bulletin, 2023
2 BIMP-EAGA Business Council, 2023
3 Ministry of Transport and Infocommunications

# ENABLER 4 – INFRASTRUCTURE

Long-term infrastructure development for sustainable transport and waste management options will be a long-term investment, but essential to broader movements toward net-zero ambitions

Brunei can introduce a wider array of green public transport modalities, such as electric or hydrogen-powered buses, and dedicated lanes for bicycles and e-scooters, providing more eco-friendly alternatives to private car use. Financial and non-financial incentives should also be considered for individuals and businesses to adopt sustainable options, such as preferential parking for green vehicles.

Lastly, road infrastructure should also be expanded to better support EVs. Currently, Brunei has introduced its first rapid charging station by Brunei Shell Marketing Company (BSM) at the IBA Petrol Station in Lambak.[1] However, the absence of key tax rebates and vehicle purchase incentives, coupled with a relatively slow rollout of public charging infrastructure have dampened EV adoption- with EV sales remaining low and concentrated among upscale buyers. Brunei should hence consider prioritising enhanced EV charging infrastructure. This can be incentivised through PPPs, where investments from private entities like BSM and international EV service providers can expand the charging network more rapidly.

Expanding upon the Land Transport Department's ongoing pilot projects[2], specific initiatives focussed on battery swapping could evaluate the feasibility and effectiveness in Brunei's context. These projects can assess consumer acceptance, economic viability, and technical challenges, providing valuable data to inform broader implementation.

## WASTE MANAGEMENT

The strategic enhancement of waste management systems in Brunei, spearheaded by the Department of Environment, Parks and Recreation (JASTRe), is also pivotal. The introduction of a waste-to-energy (WtE) incineration plant[3], by converting waste into electricity, not only addresses the issue of landfill capacity constraints but also contributes to the nation's renewable energy mix. This WtE facility should be integrated into broader energy strategies, and requires close coordination between JASTRe, the Department of Energy, and other relevant stakeholders to ensure that electricity generated contributes to the national grid in a sustainable manner.

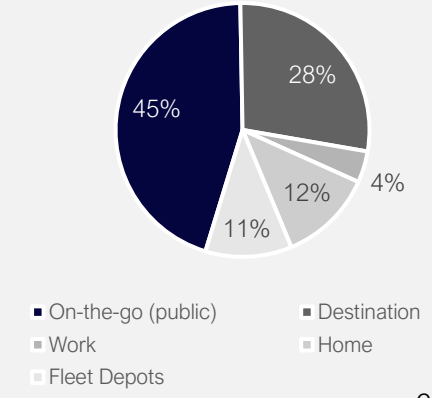
The Sungai Paku Engineered Landfill, and future landfill sites, should also incorporate advanced management practices to enable a zero-landfill scenario and mitigate environmental impacts. This includes the implementation of landfill gas capture systems, enhanced recycling and leachate treatment facilities to prevent groundwater contamination.

## NORWAY'S SUCCESS IN EV IMPLEMENTATION

In Norway, EVs account for more than 20% of passenger vehicles, over 80% of new vehicles sold are electric. Even heavy-duty vehicles are transitioning to EVs, making up about 8% of new vehicle sales.[4] On top of active incentives for EV purchases and road tolls, the government has invested heavily in charging infrastructure strategically located in urban areas, highways, and public spaces, with over 22,000 public chargers serving more than 500,000 EVs. Norway's city planning has also integrated EV infrastructure, with zoning regulations requiring new buildings to include charging stations, and urban design prioritising pedestrian-friendly streets and EV accessibility.

Most interestingly, the country derives 96% of its power supply from a reliable, low-cost yet clean source-hydropower[5], with renewable energy infrastructure supporting a stable national power system.

By 2030, public charging will make up most of the EV charging profit pools in Norway[6]
(EBITDA, USD Mn)




1 The Bruneian, 2022,
2 Ministry of Transport and Infocommunications, 2022,
3 The Star, 2023,
4 The Verge, 2024,
5 International Energy Agency
6 Business Norway, 2023

# ENABLER 5 – CAPACITY BUILDING

Capacity building, specifically through targeted R&D and skills upgrading and matching programmes, will be important to enable a future-ready workforce to fully capture green opportunities

## RESEARCH & DEVELOPMENT

R&D is pivotal for propelling Brunei Darussalam towards its green economy aspirations, with current initiatives by key institutions laying a solid foundation.

Current programmes encompass academic modules that merge classroom learning with practical industry experience, such as the Energy Policy and Management Module at UBD, which partners with key energy industry players for hands-on learning. Research projects like the Electricity Tariff Reforms Study,[1] undertaken with the support of ERIA, delve into critical policy and socio-economic considerations of energy reforms. Conferences such as the Energy Transition Solutions event[2] serve as platforms for showcasing innovative strategies in renewable energy and CCS, drawing together academia, industry, and policy-makers to discuss and shape the future of Brunei's energy landscape.

These initiatives are making commendable strides in integrating relevant content that aligns with national sustainability goals. However, there is a need to further enhance these efforts by adopting a forward-looking perspective, anticipating the future needs of the green economy and more proactively defining a stronger R&D base. This will involve dedicating more resources to test-bed and hone expertise in emerging technologies, through the establishment of research hubs and pilot programmes supporting emerging technologies like CCS, hydrogen, biofuels and renewable energy solutions. Research should also be conducted to develop expertise in climate science and long-term monitoring solutions. It will also be important to define new expertise in upcoming regional needs, such as a specialised centre of excellence in SEA for Decommissioning and Restoration (DnR).

## SKILLS

A proactive approach is required for educational institutions to develop curricula and training through close collaborations with the industry. On top of developing curriculum that prioritises relevant, practical skillsets and experiences, current efforts by institutions such as IBTE for workforce analysis and skills forecasting in collaboration with key industry players[3] should remain a priority ahead of the green economy transition. For example, constant dialogue between up, mid and downstream oil and gas players will be important to anticipate the relevance and adaptability of skillsets for new opportunities like CCS. Investing in upskilling the current workforce and fostering international skills exchanges for trainers and lecturers can further enrich the pool of expertise available within Brunei.

Additionally, a large proportion of the population are secondary school graduates. In 2022, about 53.4% of the employed population fall into this category.[4] These graduates can be enrolled in vocational institutes like IBTE to be upskilled for a green economy and seek more meaningful employment. However, this will necessitate more funding and capacity improvement to these institutes.

### CAPACITY BUILDING, SOUTH KOREA

The Green New Deal focuses on promoting a green economy through green infrastructure, renewable energy, and fostering green industries. As part of the plan, the Ministry of SMEs and Startups and the Ministry of Environment have selected 31 green start-up companies, each eligible for up to KRW3 bn by 2023.[5] This includes creating a green industrial cluster to assist with technology development, testing, production, and marketing. Another example of R&D focus is the hydrogen economy, supported through R&D subsidies, loans, and tax exemptions aimed at advancing liquefied hydrogen storage technology and reducing transportation costs. Worker transition programmes have also been incorporated to provide support for workers in traditional industries (e.g., coal mining) to acquire new skills and transition to green jobs, ensuring that no one is left without support.

1 Institute of Policy Studies, Universiti Brunei Darussalam, 2019
2 International Energy Agency
3 Stakeholder interview with Institute of Brunei Technical Education
4 4 Department of Economic Planning and Statistics, 2022
5 Korea JoongAng Daily, 2021

# INTEGRATING CLIMATE ADAPTATION

Climate adaptation strategies will equip Brunei to proactively respond to environmental shifts, allowing the nation to safeguard its developmental gains – Brunei should look outwards to formulate an effective adaptation framework

## EXISTING STRATEGIES

Across various platforms, Brunei has recognised its vulnerability as a small, low-lying nation prone to climate threats of floods, forest fires, drought, and landslides. The country has successfully formed the Adaptation and Resilience Working Group for a National Adaptation Plan in 2021 and outlined climate resilience as a key strategy in the BNCCP. However, implementation of proposed initiatives, such as the establishment of a national climate risk framework and long-term climate science research and monitoring, have been delayed resulting in a less than cohesive approach to EIA.

## THE WAY FORWARD

Brunei should continue investing in its adaptive strategies to fortify against potential disruptions. This effort should be in tandem with the wider enablers. Brunei should:

- Continue developing tools that serve as both enablers for the green economy and help progress climate adaptation (e.g., policy tools in BNCCP for risk & monitoring)
- Develop an integrated climate adaptation framework encompassing various domains such as coastal & flood protection, forestry & biodiversity, food security, public health resilience (previously discussed in Brunei's Long Term Development Plan (2007-2017))

## CANADA'S CLIMATE ADAPTATION POLICIES

Canada's Federal Adaptation Policy Framework and National Adaptation Strategy (NAS) provides a comprehensive approach to building resilient communities and a strong economy. Their emphasis on collaboration, evidence-based decision-making, and integrated policy approaches can serve as key lessons for Brunei to craft resilient and responsive strategies.

The **National Adaptation Strategy (NAS)** is the product of extensive engagement and collaboration with provincial and territorial governments, indigenous nations and organisations, the private sector, non-governmental organisations, adaptation experts, and youth. This approach ensures that a wide range of strategy is reflected for a whole-of-society movement.

Key priorities and targets identified for the framework include:

| PRIORITIES | TARGETS |
|---|---|
| **Disaster resilience** | • Identification of high-risk vulnerable areas<br>• Emergency management & disaster response plan<br>• Disaster financial assistance plan |
| **Health & well-being** | • Prevention measures for deaths from extreme heat waves<br>• Integration of climate considerations into understanding of health risks, climate-informed health policies |
| **Nature & bio-diversity** | • Conservation of land and water areas<br>• Conservation of protected land areas<br>• Establishment of new national heritage parks |
| **Economy & workers** | • Develop climate change-relevant risk management frameworks and business plans<br>• Integrate climate risk and assessment tools in associations |
| **Infra-structure** | • Integrate climate change impact into funding programmes<br>• Integrate climate adaptation in future design<br>• Integrate climate change risks into existing codes and standards (including waste management) |

The **Federal Adaptation Policy Framework** focuses on three roles for the federal government: generating and sharing knowledge, building adaptive capacity, and integrating adaptation into federal policy and planning. This is an evidence-based approach that leverages science and technology to integrate climate change considerations into all levels of government planning.

# MOVING FORWARD

Developing a green economy is a long journey which must start now. The key opportunities identified here are specific focus areas to help Brunei accelerate its green transition and economic diversification

The road to 2050 near-zero is a long and difficult journey but with clear economic rewards. A green economy can only be achieved by addressing decarbonisation, developing green commercial drivers and urgently advancing economic diversification, which Brunei must start now. To conclude this green economy report, there are three areas that Brunei must start taking action in.

### RENEW EXISTING STRATEGY, GOALS AND POLICIES

It has been 4 years since the Brunei National Climate Change Policy (BNCCP) was published. There are changes to the greenhouse gas inventory (e.g. carbon sink accounting) and practicality of the 10 key strategies identified (e.g. carbon pricing as a dependable driver). A thorough update on Brunei's climate change strategy is needed. The energy sector is a key economic driver and polluter, a transparent, clear time-sensitive energy transition plan with long-term mission and goals, must be implemented in the near term.

### ENGAGE OUTSIDE-IN EXPERTISE ON KEY DEVELOPMENT AREAS

This green economy report serves to provide an independent perspective and call-to-action on Brunei's economy and its 2050 goals towards net zero. To take the recommendations forward, Brunei must be prepared to engage outside-in expertise. The select green opportunities in this report are not novel and some have been successfully adopted by other nations. Opportunities of carbon capture storage (CCS) services and clean hydrogen export may seem bold initiatives but are currently actively pursued globally. The UK has developed a whole-of-nation approach up to 2050 for CCS deployment and is a market leader in these areas with a mandate to support the international community to deliver net zero in tandem with economic growth. Leveraging such external support will accelerate Brunei's green economy development.

### ESTABLISH A DEDICATED, EMPOWERED ORGANISATION

A 'top-down' approach to greening the economy will be needed to offer clarity and simplicity to a demanding and complex problem. With a long history of oil and gas dependency Brunei's ability to organise internal and external stakeholders around green economic opportunities will determine the effectiveness of implementation.

An overarching dedicated organisation or agency to drive change is vital. This organisation must be empowered to implement across all ministries and agencies.

### START COMMUNICATING AND EDUCATING

His Majesty The Sultan is already a champion of sustainable long-term goals. However, the public plays an important part as well. Adopting and promoting new sustainability practices, participating in conservation acts and educating neighbours, families and friends, contributes to the adoption of green economy solutions and behavioural change.

The current level of climate change awareness is low. Most citizens are not fully aware of the impact of climate change on Brunei, the importance of economic diversification, or the opportunities and pace of change occurring regionally. Early active communication and education will play an important role in kickstarting the green economy transition.

For industry partners, clear definitions around green are needed as well as well communicated implementation timeline to align expectations with action.

# Appendix

# 8 GLOBAL GREEN ECONOMY TRENDS THAT CAN IMPACT BRUNEI

The global and regional movement towards a greener economy can result in both risks and losses to Brunei in the event of inaction, or can bring opportunities for the country

## GLOBAL TRENDS

The market for innovative goods and services facilitating the green transition to a net-zero economy will reach USD 10.3 Tn by 2050, equivalent to 5% of the projected global GDP.[1] This reveals how green economic opportunities not only fulfill pressing environmental needs but also produce substantial economic opportunities.

However, the transition to a green economy comes with challenges that are only growing. Southeast Asia faces a substantial investment gap in achieving its ambitious net-zero targets. The region needs USD 1.5 Tn in cumulative investment by 2030 but is currently receiving relatively smaller green capital flows of USD 5.2 Bn in 2022.[2]

As such, capturing the potential prosperity of a green economy and overcoming its mounting risks and challenges will require a huge global effort in developing strategic policies, fostering international cooperation and setting ambitious commitments among many other key actions.

Overall, this appendix examines 8 key global trends of the green economy, then explores the potential risks and opportunities they pose for the development of Brunei's green economy.

### 1 Profitability and Cost

Fossil fuels will no longer be the primary energy source by 2050 (in a net-zero scenario). By 2030 Asia Pacific is expected to see the LCOE of renewable energy be 23% lower than the overall LCOE of fossil fuel projects.[3] Renewable energy investment portfolios are outperforming listed fossil fuel investment portfolios. Additionally, Over 40 nations have adopted carbon pricing mechanisms. The EU is enforcing its Carbon Border Adjustment Mechanism (CBAM) and carbon taxation is also on the rise in SEA.

**Risk to Brunei:** Brunei's export-led development to the EU will be affected by CBAM, especially as the EU is Brunei's 7th largest trading partner in goods. In addition, as the LCOE of renewables falls, demand for Brunei's fossil fuel exports will drop, leading to job losses and threats to economic growth.

**Opportunity for Brunei:** Brunei should utilise its abundant solar resources of 2.3 GW to produce solar energy and green hydrogen, which can then be used as clean energy sources for domestic use and export.[4] Brunei should also phase out its fossil fuel subsidies, which comprise 6% of its total GDP, diverting public funds away from fossil fuels and towards renewable energy and tech solutions like CCS.

### 2 Policy Commitments and Targets

The UN's COP28 summit saw nearly 200 countries pledge to transition away from fossil fuels. Regional agreements like the EU Green Deal and ASEAN Green Deal also outline ambitious plans to decarbonise. In Southeast Asia, ASEAN pledged a 32% energy-intensive reduction (based on 2005 levels), a 23% renewable energy share in ASEAN's energy mix, as well as a 35% renewable energy share in installed power capacity by 2025.[5]

Financial sector: Financial institutions are increasing efforts towards fossil fuel divestment. For example, members of the Glasgow Financial Alliance for Net Zero have committed to reach net zero in their lending and investment portfolios by 2050.

**Risk to Brunei:** Brunei may face challenges in securing investment and financing for O&G projects. This shift may pose a large hurdle to the economic development of Brunei, as the country's GDP and export revenues are highly reliant on O&G.

**Opportunity for Brunei:** In addition to utilising its large solar energy potential to increase the production of renewable energy, Brunei can also leverage on its position via the ASEAN Centre for Climate Change to support and advance the region's sustainability targets.

1 Arup, 2023
2 Organisation for Economic Co-operation and Development, 2023
3 Wood Mackenzie, 2020
4 World Economic Forum, 2022 (System Value Analysis)
5 ASEAN Main Portal, 2020

# 8 GLOBAL GREEN ECONOMY TRENDS THAT CAN IMPACT BRUNEI

The global and regional movement towards a greener economy can result in both risks and losses to Brunei in the event of inaction, or can bring opportunities for the country

## 3 Climate Financing

Average annual climate finance flows reached nearly USD 1.3 Tn in 2021/2022, almost twice that of 2019/2020 levels.[1] However, Southeast Asia still requires USD 210 Bn annually up to 2030 for climate investments.[2]

Green sukuk (Islamic bonds) is a new finance instrument with the potential to mobilise USD 2 Tn into the Islamic finance market to fund green and sustainable projects in the future.[3] Malaysia issued the world's first green sukuk in 2017 to finance PV power plant construction.

Countries are also establishing green financial taxonomies. Brunei and Vietnam have cited a need for it to improve deficits in green finance.

**Risk to Brunei:** Financial institutions are increasingly divesting from fossil fuels and advancing green investment, which poses challenges in securing investment and financing for Brunei's O&G projects. This shift may hinder Brunei's economic growth, as its GDP and export revenue are highly reliant on O&G.

**Opportunity for Brunei:** Brunei should work towards diversifying and transitioning its energy sector towards renewable energy production to attract the growing pool of green investors. Brunei can facilitate this through the development of an enabling environment.

## 4 Technology Advancement

Carbon capture and storage (CCS) is a huge emerging technology that can accelerate the global transition to net zero emissions. Global investments in CCS projects have been rising rapidly. CCS technology also facilitates clean hydrogen production, whose demand is set to rapidly increase in the next few decades.

Advancements in renewable energy are also boosting affordability and ease of deployment. Advanced photovoltaics allow for more efficient and lower-cost solar power deployment.

Electric vehicles are on the rise due to rapidly falling battery costs, infrastructure investment and increasing vehicle variety. The EV market is estimated to rise at a CAGR of 17.8% from 2023 to 2030. 1-2 billion EVs are required by 2050 for the world to achieve net zero.[5]

**Risk to Brunei:** Tech advancements will help scale alternative fuels, putting Brunei's O&G industry and its economy at risk due to the expected drop in demand in the next decades.

**Opportunity for Brunei:** With rising investments and demand for CCS projects, Brunei can leverage O&G expertise to explore and invest in CCS technologies. Brunei should also leverage on these technologies for clean hydrogen production, to diversify its energy mix.

## 5 Green Skills Development

Globally, 30 million new clean energy jobs are anticipated to be created by 2030, according to IEA.[5] The CCS sector is expected to create 80,000 to 100,000 jobs by 2050 globally. In Southeast Asia, 6.7 million new green jobs are expected to be created by 2050 according to IRENA, to meet clean energy transition needs.[6] However, this transition may render some jobs obsolete. The IEA anticipates 5 million jobs to be lost from the fossil fuel sector. In 2021, petroleum jobs in the U.S. declined by 6.4%, equivalent to a loss of 31,000 jobs.[7]

**Risk to Brunei:** The green skills transition may result in job displacement, notably O&G which contributes 55% to its national GDP, potentially leading to a rise in unemployment. Substantial effort and time are required in retraining and upskilling the entire workforce, putting Brunei at risk if upskilling efforts come later.

**Opportunity for Brunei:** O&G workers have skills that can be redeployed into emerging energy sectors like hydrogen and CCS. Over 90% of the UK's O&G workforce have medium to high skills transferability into offshore wind, CCS, and hydrogen.[8] Brunei's position as host to ASEAN's Centre for Climate Change can also help drive research and policymaking for green skills development in ASEAN, in which the region needs direction.

1 Climate Policy Initiative, 2023
2 Asian Development Bank, 2023
3 World Bank, 2019
5 International Energy Agency. 2023
6 International Renewable Energy Agency, 2023
7 U.S. Department of Energy, 2021
8 Robert Gordon University, 2021

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The global and regional movement towards a greener economy can result in both risks and losses to Brunei in the event of inaction, or can bring opportunities for the country

### 6 Regional Partnerships and Strategies

Addressing climate change impact has become a collective effort for regions, adopting more collaborative approaches by pooling expertise and efforts. The ASEAN Power Grid is an example of the region's plan to integrate national power systems, harnessing ASEAN's huge potential for renewable energy to ensure long-term energy security and affordability.

ASEAN member states have accelerated efforts for collaboration and knowledge sharing via the establishment of the ASEAN Centre for Climate Change announced in 2021 set to be in Brunei. The centre aims to become a hub for climate research and policymaking regionally.

**Risk to Brunei:** In 2018 only 0.05% of Brunei's electricity was derived from renewable energy sources,[1] its contribution to the region's renewable target is uncertain and may be modest. Neighbours with more renewable energy efforts like Vietnam and Indonesia may gain a competitive edge over Brunei in supplying renewable energy to the region.

**Opportunity for Brunei:** With Brunei as the host of the ASEAN Centre for Climate Change, Brunei can serve as a centralised hub for climate research and policymaking in the region, contributing meaningfully towards the region's sustainability goals via the Centre.

### 7 Emerging Industries and Opportunities

O&G-dependent nations are shifting their energy mix towards renewable energy. Such countries are seeking to diversify their economic makeup with new opportunities by investing in non-oil sectors such as agriculture/ agribusiness, tourism, and manufacturing, as well as fostering knowledge-based economies.

Large O&G MNCs such as Shell have also released net-zero targets for 2050, releasing an energy transition strategy to reduce dependency on O&G and develop capabilities in renewable energy.

Many oil-rich nations are largely diversifying by investing in non-oil sectors such as tourism, manufacturing, downstream O&G, agriculture, renewable energy development, technology, and financial markets.

**Risk to Brunei:** Brunei remains largely O&G dependent. If Brunei delays its transition away from fossil fuels, the country may face more economic risks and lose potential investments.

**Opportunity for Brunei:** Investing in non-oil sectors like tourism, manufacturing, agriculture, and knowledge-based industries can create new jobs, income streams, and resilience, as well as strengthen self-sufficiency by boosting local production and reducing import reliance.

### 8 Geopolitics and Global Trade Dynamics

Conflict and war significantly impact global supply chains, resulting in trade restrictions, a rise in production costs and transport costs. Other major disruptors include natural disasters, which will likely grow more intense and frequent due to climate change.

Regionally, Asian economies are growing more interlinked. The shared growth potential of Asian economies also offers an attractive market for businesses to access. Strategic alliances such as the Indo-Pacific Economic Framework (IPEF), China-ASEAN FTA, Regional Comprehensive Economic Partnership (RCEP) and the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) promote greater integration of Asia-wide supply chains.

**Risk to Brunei:** Brunei's reliance on exports and foreign trade puts the country at risk of high market volatility resulting from natural disasters or geopolitical tension. Brunei will need to strengthen its local economy and reduce reliance on global supply chains to boost resilience.

**Opportunity for Brunei:** Brunei can leverage ASEAN's growing integration and alliances to enhance regional trade relationships and access growing markets within the region.

1 International Energy Agency

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