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Achieving Resilience in the Energy Transition to Safeguard Indonesia's Economic Growth & Sustainable Development

IPA & Wood Mackenzie White Paper

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Overview of Structure

The purpose of this paper is three-fold—1) to assess the increasing significance of environmental sustainability as well as the challenges and trade-offs involved in balancing it with energy security and affordability, 2) to identify key levers to harness Indonesia's unique resources and capabilities to optimise the balance, and 3) to propose a framework with actionable goals to develop and implement these levers, with the goal of fostering a resilient and sustainable energy system. The paper proceeds as follows:

The Executive Summary outlines the key takeaways, including the context, implications for Indonesia, and recommendations for policymakers going forward.

Section 1 establishes the background, providing an overview of the global energy system and the ongoing energy transition, incorporating Wood Mackenzie's own outlooks.

Section 2 introduces the concept of the Energy Trilemma, highlighting the need to balance energy security, affordability, sustainability, and outlining the interplay between country-specific attributes, objectives, and the levers employed to achieve the country's priorities.

Section 3 evaluates Indonesia's current situation, development trajectory, and associated risks to identify the most suitable levers for enabling a well-balanced and sustainable growth, and transition.

Sections 4 and 5 highlight the significance of domestic oil & gas production and CCS development as key levers to address the Trilemma, and provide recommendations for unlocking their potential.

Section 6 concludes with a roadmap outlining the next steps in pursuing the proposed plans.

Executive Summary

Fossil fuels consumption has played a fundamental role in fuelling human development and driving economic growth but has elevated the atmospheric concentration of greenhouse gases (GHGs) beyond historical peaks, resulting in anthropogenic climate change. To address this existential threat, international organizations, governments, and civil societies have made a concerted effort to mitigate climate change through commitments such as the Paris Agreement and the Glasgow Climate Pact, with the goal of achieving net-zero emissions by 2050 to limit global warming to +1.5°C.

This objective calls for the fast deployment and scaling of low-carbon solutions, which requires unprecedented levels of investment in the energy transition. Multiple levers must be concurrently activated over the next decades, including technologies that are not yet economically and/or technologically feasible. While there are various pathways to reach net-zero by 2050, some fundamentals remain:

- **Renewable energy will play a pivotal role in decarbonising the power sector.**
- **In the face of sustained energy demand, gas will be the "bridge fuel" of the energy transition.**
- **CCS/CCUS will be a key tool of decarbonisation, particularly for hard-to-abate sectors.**

The energy transition, however, comes with its own set of challenges and risks that stem from the structural socio-economic changes that are needed to reduce anthropogenic emissions. **For the energy transition to not only be successful but also fair and just, countries are now strengthening their energy resilience to ensure that reducing emissions does not come at the expense of economic growth and human development.** Given limited time, limited resources, and competing interests, policymakers must balance trade-offs and establish priorities in their national energy policies across three categories: energy security, energy affordability, and environmental sustainability. These form the three pillars of the "Energy Trilemma."

In Indonesia, policymakers have thus far prioritised energy security and affordability, focusing primarily on meeting the rapidly growing energy requirements of economic development, urbanisation, and population growth. This political choice, coupled with the vast hydrocarbon natural resources of Indonesia, has resulted in an energy landscape characterised by the predominance of fossil fuels, the limited deployment of renewable energies, and the nascency of new low-carbon solutions. As Indonesia progresses on its energy transition journey, four macro-level themes will act as cornerstones of the country's energy landscape:

- **Growth in total energy supply** to sustain economic growth (in line with the Vision of Indonesia 2045).
- **Predominance of fossil fuels,** especially for end-uses without economically competitive alternatives.
- **Growth in renewable power generation**, to help decarbonise the Indonesian economy.
- **Deployment of low-carbon solutions**, limited by economic and technological readiness (e.g. the environmental benefits of EVs will be limited in countries with a carbon-intensive power sector).

However, with the country's commitment to achieve net-zero emissions by 2060, various decarbonisation measures have been put in place which now introduce uncertainty over the shape and balance of Indonesia's future energy landscape. As Indonesia delves into the details of balancing the priorities of the Energy Trilemma, several key questions remain unanswered:

- **How quickly will energy demand grow?** The implication on power generation in particular is key.
- **How quick and effective will be the reduction in coal power generation?** The actual impact of regulatory exceptions and the financing of early coal retirement remains unclear.
- **How quickly can renewable power be scaled?** Particularly in the face of wind/solar resources scarcity, infrastructure readiness, intermittency challenges, and overall economic feasibility.
- **What is the value of Indonesia's domestic oil & gas production in achieving energy resilience?**
- **What role should CCS/CCUS play in Indonesia's energy transition?** Particularly as it now constitutes the only readily available and operational decarbonisation solution.

This paper focuses on providing answers and actionable recommendations to the last two questions in a context where answers to the first three questions remain uncertain.

The value of domestic O&G production in achieving resilience in the energy transition

Unless the Indonesian E&P sector undergoes a drastic revitalisation, today's decrease in domestic oil & gas production in the face of increasing domestic energy demand will aggravate the country's existing oil import dependency and will turn Indonesia from a net exporter to a net importer of natural gas within the decade. Accordingly, the value of increased domestic oil and gas production is very clear:

- **Oil as a fuel and an industrial feedstock:** Improved balance of trade and payment, reduction in fuel wholesale sourcing costs/subsidies, protection from price volatility and supply disruptions, in-country value capture, multiplier effect, and incremental value from downstreaming.
- **Gas as an industrial feedstock**: All the benefits listed above for oil are equally applicable here. In addition, as gas forms an industrial feedstock with limited substitutes, increased domestic production will protect industrial users against feedstock cost volatility and supply shortages risks. The development of domestic gas supply will also enable the downstreaming of the gas value chain, into natural gas derivatives such as ammonia and methanol.
- **Gas as a fuel for power**: With the structural uncertainty surrounding future power demand, coal power supply and renewable power supply, domestic gas production acts as a variable of adjustment to guarantee power security, limit cost volatility and offer a baseload power solution of lower carbon intensity than coal.
- **Excess gas supply:** Any remaining supply can be exported to leverage booming regional demand.

Considering Indonesia's significant remaining oil & gas reserves, resources, and yet-to-find estimates as well the robust demand centres that exist domestically and regionally, both demand, and supply are in place. To grow domestic production, **what Indonesia now needs is greater investment to connect the two** by developing resources, carrying out exploration, and raising prospectivity, especially in frontier basins. Wood Mackenzie and IPA have identified four areas of improvements that, if addressed diligently, have the potential to materially increase Indonesia's investment attractiveness:

- **Fiscal competitiveness:** Limited incentives for existing projects and lack of flexibility in government share and cost recovery can hinder financial viability and attractiveness relative to peer regimes.
- **Fiscal stability:** Sudden unilateral changes in policies, uncertainty in assessing the impact of terms, and delays in finalizing laws pose challenges for long-term planning and erode investor confidence.
- **Ease of doing business:** Delays in project approvals, misalignments in regulatory actions, and a lack of clear long-term vision for CCS initiatives increase complexity and costs of CCS development.
- **Net-zero E&P investments:** Limited provisions for emissions reduction for Scopes 1-3 and offsets impede investment from environmentally conscious investors with corporate sustainability goals.

To address these blockers and considerations, Wood Mackenzie and IPA propose four actionable items:

- **Develop a long-term energy roadmap** which includes energy transition objectives and outlines the roles that different energy levers play in Indonesia's future decarbonised energy landscape:
    - Explicitly describe the energy levers (incl. domestic O&G and CCS/CCUS) and their expected contributions to Indonesia's long-term energy transition, security, and affordability.
    - Delineate the roles of the O&G stakeholders (private sector, SOE, regulatory, government) and their expected relationships/interactions in delivering the long-term roadmap.
    - Specification of anticipated decarbonisation plans across the value chain (Scopes 1, 2, and 3).

- **Establish an overarching legal framework:** This framework should regulate all E&P activities within Indonesia and enhance regulatory stability, transparency, and ease of doing business.
    - Clear and permanent rules governing the authority & responsibilities of stakeholders.
    - Clarity on legal enforcement mechanisms based on the new oil and gas law, prevailing regulations, & PSC/contracts.
    - Mechanisms to alleviate the current fear or criminalization for both regulators and contractors.
    - Streamlined procurement and licensing processes to reduce cost and accelerate development.
    - Simplified, fast, and reliable licensing procedures, with improved ministry coordination.

- **Enhance/redesign the fiscal regime:** Analysing each fiscal term and its relative impact on contractor returns allows identification of potential enhancements to ensure fiscal competitiveness.
    - Different sets of terms tailored to the specific challenges of different types of fields.
    - Guaranteeing a negotiated, reasonable and project-specific rate of return with mechanisms to share upside opportunities and downside risks (e.g., R-factor, discretionary mechanisms).
    - Incentives especially for existing brownfields and new marginal fields development (e.g.cring-fencing across PSC, investment credits, tax exemptions/holiday, CCS incentives).
    - Domestic gas pricing mechanisms (e.g. reforming to a market price set by sellers & buyers).
    - Contract flexibility (e.g., ability for existing PSCs to adopt new fiscal terms, flexibility to revisit new PSC terms, transferability of remaining definitive commitments to new areas).
    - Other measures could include adjustments to royalty/FTP, maximum/minimum contractor profit share rate, profit sharing structure (stepped vs. sliding scale), DMO, etc.

- **National GHG Emission Reduction Framework:** Developing a transparent framework which aligns with international best practices can be a key step towards promoting a "low-carbon" O&G sector.
    - Development of a roadmap specifically for energy transition.
    - Clear emission targets (e.g. measurable targets for reducing emissions based on NDC).
    - Baseline standards (e.g. minimum operational and decommissioning).
    - Incentives and mechanisms to encourage companies to reduce carbon emissions, adopt low-carbon technologies, implement energy-efficient practices, and invest in CCUS projects (e.g. ensuring that GHG emission reduction activities are part of upstream oil and gas activities (Petroleum Operation) / part of the operating costs).
    - Robust monitoring, reporting, and verification (MRV) to track emissions & ensure compliance which is in line with the industry's best practice.
    - Incentivisation of collaboration & knowledge sharing, including R&D for clean technologies, based on partnerships across industry, academia, and research institutions.

The role and ambition of CCS/CCUS for Indonesia's energy transition

The accelerated development of a robust CCS/CCUS industry in Indonesia will be crucial to reduce the country's carbon footprint and drive economic growth while leveraging the country's natural competitive advantages. If done successfully, Indonesia can extract significant value from:

- **International emissions capture:** Generate revenue from international emissions by providing storage services, enhance geopolitical standing as a regional leader in CCS offerings, and contribute to global climate action.
- **Domestic emissions capture:** Contribute to NDC, reduce local climate risks, improve overall investment attractiveness, enable the production of decarbonised products & services, and avoid carbon taxes on exports.
- **New economic secto**r: Benefits associated with creating a new industry aligned with the green economy and contributing to long-term sustainable prosperity (e.g. GDP, tax revenue, employment, foreign direct investment, balance of trade and payment, political strengthening, regional leadership).

To capture this value, Indonesia can leverage on the supply-side, its significant storage capacity (depleted oil & gas reservoirs, saline aquifers); on the demand-side, the significant demand for CO_2 storage across Asia, especially from countries with substantial carbon emissions, carbon pricing, and limited domestic storage solutions; internally, its existing E&P capabilities & infrastructure that offer a competitive advantage in injection, storage, and monitoring. **What Indonesia now needs is a fully functioning CCS/CCUS value chain and ecosystem that leverages existing E&P capabilities to connect supply with demand.**

The ambition of this CCS/CCUS vision can vary, however Wood Mackenzie and IPA recommend that in order to extract maximum value Indonesia should take the most aggressive approach: **capture CO_2 from domestic & international third party sources and store it in dedicated domestic CO_2 storage licenses** (which can but do not have to be working petroleum areas).

Two inspection workers at the Central Plant Platform and Bravo Flow Station Platform of Pertamina Hulu Energi ONWJ, offshore north of West Java, on Monday (3/4/2023).

Aditya Pradana Putra/IPA Convex 2023 Photo Competition "Energi Bagi Indonesia"

In addition to the first steps already taken by Indonesia to kick start the development of CCS/CCUS (Ministerial Reg. No. 2/2022, baseline-and-credit scheme (planned), 16 pre-FID projects, MoUs, JCM). Wood Mackenzie and IPA propose five areas of action to lay the foundation of Indonesia's CCS/CCUS industry:

- **Develop a comprehensive set of CCS/CCUS laws and regulations** encompassing the full value chain (domestic and international capture, transport, injection/storage, and monitoring):
    - Legalisation of the CCS value chain (e.g. storage outside of petroleum working areas).
    - Development of regulations to manage all processes (e.g. establishing operational standards, HSE, fiscal regime, licenses, monitoring requirements, and decommissioning requirements).
    - Appointment of a dedicated ministry responsible for governing and overseeing the CCS sector to ensure effective management, coordination, and periodic reviews.
    - Liability and financial mechanisms to address potential risks, including provisions for financial assurance, insurance requirements, and liability sharing arrangements among stakeholders.
    - Establishment of advisory channels with experts/industry groups like Indonesia Carbon Capture and Storage Centre (ICCSC), complementing existing initiatives by organisations like the Center of Excellence for CCS & CCUS at Institut Teknologi Bandung and Lemigas.

- **Design and ratify cross-border CO_2 emission management agreements**: Engaging with key countries to enable the storage of CO_2 from foreign emitters into O&G reservoirs or saline aquifers:
    - Identification of countries that have a shared interest in cross-border CO_2 transport and storage, considering factors such as proximity, existing infrastructure, and emission sources.
    - Cross-border emission accounting agreement to recognise CO_2 reduction in other countries.
    - CO_2 import and export agreement to enable the physical flows of CO_2 between countries (e.g. regulatory framework within which private parties can operate and transact freely).
    - Allocation of responsibilities among participating countries, including agreements on cost-sharing, funding arrangements for infrastructure development, and incentives.
    - Establishment of MRV to track the cross-border transactions (e.g. data sharing protocols).

- **Introduce a national carbon credit trading framework**: Mechanism to govern the generation and trading of carbon credits which allows purchase of carbon credits. Key requirements include:
    - Designing carbon credit units (e.g. carbon allowances, offsets, and other recognised units). Clear criteria for the issuance to ensure credibility and adherence to international standards.
    - Determining eligibility criteria for participation in the carbon credit trading. This may include requirements for MRV, project verification processes, and adherence to specific standards.
    - Designing registry system to track and record the issuance, transfer, and retirement of carbon credits. The registry is a central database to manage credits and facilitate trading.
    - Enhancing developers' access to private climate finance to support decarbonisation projects.

- **Offer fiscal incentives**: Incentives provided to accelerate the development of full commercial-scale CCS projects are key factors contributing to the commerciality of the operations.
    - Designing grants/subsidies/loans to accelerate Indonesia's commercial scale CCS projects.
    - Streamlining regulatory processes & permitting for projects by fast-tracking project approvals (e.g. simplification of the import of specialty goods & services needed for CCS projects, the inflows & outflows of capital, and the hiring of foreign talents with essential skills).
    - Examples of fiscal incentives used in other regimes include tax credits offering a per ton basis credit for CCUS project (USD 45Q) and direct investments (Norway Longship project).

- **Introduce a permanent & high carbon price** (e.g. carbon tax, ETS): economic incentive and long-term revenue visibility (pricing will require inputs from Ministry of Finance and other stakeholders).
    - Assessment of the potential impact including socio-economic implications and trade.
    - Establishing emission reduction targets that align with national or international commitments.
    - Developing a carbon pricing mechanism (e.g. carbon tax and "cap and trade" system).
    - Determining the carbon price level, based on the desired decarbonisation trajectory.
    - Establishing the compliance mechanisms for regulated entities including MRV and penalties.

Indonesia should initially prioritise providing CCS services to commercially ready foreign emitters in nearby countries with high carbon prices and limited storage capacity. As the domestic carbon price increases over time, Indonesia can develop the domestic CCS value chain and benefit from the cost reductions and lessons learnt obtained through international activities. In the meanwhile, **Indonesia needs to ensure that the public perception of CO_2 trade remains favourable**—rather than instilling an image of importing other countries' "waste products," policymakers need to emphasise the value in monetising the country's resources and highlight the appeal of developing the industry for longer-term domestic gains.

Next steps

Wood Mackenzie and IPA recommend adopting a phased approach to address our recommended action plans. The overarching vision and foundational frameworks must first be solidified and socialised across key stakeholders prior to full development and implementation. In the face of sometimes long lead times and imminent challenges, it is urgent for the government to start acting now in order to ensure the readiness and resilience of the country. Accordingly, Wood Mackenzie and IPA suggest adopting the following initiatives as part of the first phase of the process.

Fostering domestic O&G investments

- **Design a long-term energy roadmap** by building on DEN's existing work, ensuring that it incorporates clearly delineated roles of domestic O&G and CCS in the future energy landscape.
- **Engage with industry and stakeholders** to finalise key building blocks of a new overarching legal framework for the E&P sector, to not only facilitate the permitting and licensing processes for E&P activities but also ensure compatibility with CCS development plans.
- **Identify and design enhanced fiscal terms** that are fit for purpose (e.g. customising incentives based on field-specific attributes), drawing from lessons learned from previous domestic developments and benchmarks of countries with comparable challenges and asset characteristics.

Developing the CCS/CCUS industry

- **Design comprehensive regulations** that outline the legal and technical requirements for implementing CCS/CCUS projects, not only creating a supportive environment for commercial arrangements and transactions but also ensuring environmental protection, safety, and MRV.
- **Conduct at least one pilot project** to demonstrate the feasibility and commerciality of CCS/CCUS technologies, showcasing their potential in reducing emissions and achieving climate goals, while identifying potential hurdles to consider for future developments.
- **Initiate discussions with other governments** in the region to foster collaboration to not only engage in government to government (G2G) agreements covering partnerships and trade but also share knowledge, best practices, and resources to accelerate regional CCS development.

Throughout these initial processes, it will be crucial for the Indonesia policymakers to not only maintain close coordination among the internal constituents across the E&P and CCS value chains but also provide clarity in Indonesia's revamped strategic objectives to domestic and foreign stakeholders alike, ensuring that their interests remain aligned with Indonesia's long-term energy goals and development pathway.

Power plants that supply Java and Bali electricity in Indonesia.
shandy1177/Shutterstock

Figure 1: Roadmap of Actionable Items

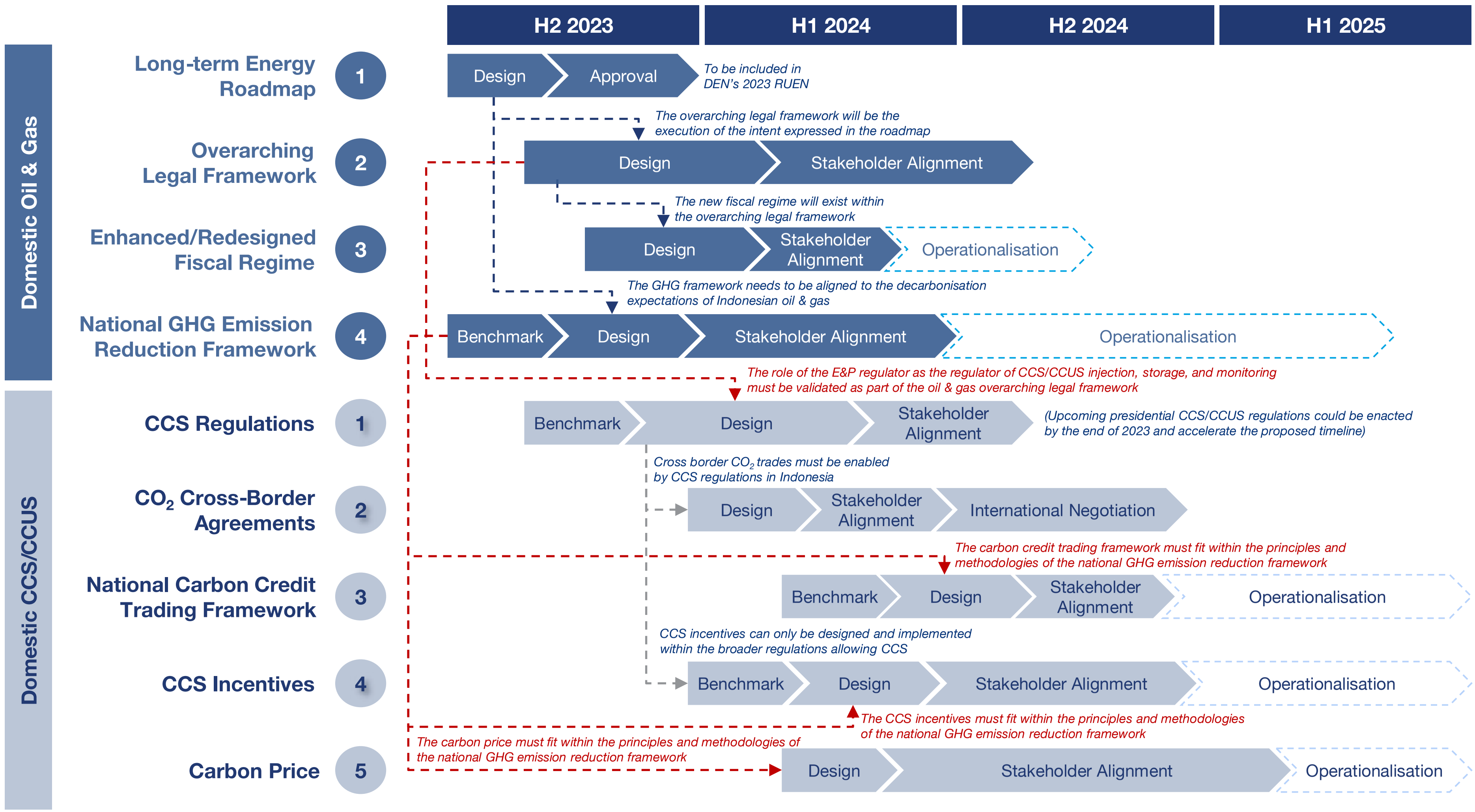


Table of Contents

01. OVERVIEW OF THE ENERGY TRANSITION 2
1.1. Fossil fuel consumption and its environmental impact 2
1.2. The need for energy transition 4

02. THE ENERGY TRILEMMA 10
2.1. What is the Energy Trilemma 10
2.2. Approaches to addressing the Energy Trilemma 12

03. THE ENERGY TRILEMMA IN INDONESIA 16
3.1. Current situation 16
3.2. Development trajectory and objectives 20
3.3. Identification of levers 23

04. GROWING DOMESTIC O&G PRODUCTION TO ADDRESS THE TRILEMMA 26
4.1. Value case 38
4.2. Blockers & enablers 43
4.3. Proposed solutions & recommendations 48

05. DEVELOPING DOMESTIC CCS/CCUS TO ADDRESS THE TRILEMMA 42
5.1. Value case 42
5.2. Blockers & enablers 52
5.3. Proposed solutions & recommendations 48

06. CONCLUSION & NEXT STEPS 54
APPENDIX 56

LIST OF FIGURES

Figure 1: Roadmap of Actionable Items x
Figure 2: Global Primary Energy Consumption and GDP (Historical) 2
Figure 3: Annual CO_2 Emissions by Source and Atmospheric CO_2 Level (Historical) 4
Figure 4: WM Base Case Scenario - Total Primary Energy Demand and Carbon Emissions 6
Figure 5: WM's Estimated Requirements for 1.5°C Target - Total Primary Energy Demand and Carbon Emissions 7
Figure 6: Comparison of WM's Base Case vs Estimated Requirements for 1.5°C Target 8
Figure 7: Illustration of the Energy Trilemma 11
Figure 8: Indonesia's Final Energy Demand Mix 18
Figure 9: Indonesia's Electricity Demand Mix 18
Figure 10: Indonesia's Coal, Oil, and Natural Gas Reserves & Annual Production (Historical) 19
Figure 11: Current Levelised Cost of Electricity (LCOE) of Selected Power Technologies in Indonesia 19
Figure 12: Final Energy Demand Outlook (BaU vs OPT) 21
Figure 13: Demand Outlook – Industrial (BaU vs OPT) 21
Figure 14: Demand Outlook – Electricity (BaU vs OPT) 22
Figure 15: RE Power Plant Capacity (BaU vs OPT) 22
Figure 16: Indonesia Oil Supply Demand Balance 27
Figure 17: Indonesia Gas Supply Demand Balance 28
Figure 18: Comparison of Total Primary Energy Mix Forecasts Across Government Scenarios 30
Figure 19: Indonesia Domestic Oil Production 31
Figure 20: Indonesia Domestic Gas Production 31
Figure 21: Wood Mackenzie's Upstream Competitiveness Index (UCI) Scores (Asia-Pacific Only) 33
Figure 22: Investment Decision Factors for E&P Companies 35
Figure 23: 4 Actions Plans for Fostering Investments in Domestic O&G Production 40
Figure 24: Illustrative Timeline for Action Plans for Fostering Investments in Domestic O&G Production 41
Figure 25: WM Estimate of CO_2 Storage Capacity by Basin (O&G Reservoir Only)* 45
Figure 26: 5 Actions to Establish the Fundamental Building Blocks of Indonesia's CCS Sector 53
Figure 27: Illustrative Timeline for Establishing the Fundamental Building Blocks of Indonesia's CCS Sector 53
Figure 28: Roadmap of Actionable Items 55

LIST OF TABLES

Table 1: Comparison of WM Base Case and Accelerated Transition (1.5°C) Scenarios 56
Table 2: Summary of Benefits & Challenges of Primary Energy Forms 57
Table 3: Summary of Benefits & Challenges of Low-carbon Solutions 58
Table 4: Comparison of DEN's BaU and OPT Scenarios 59

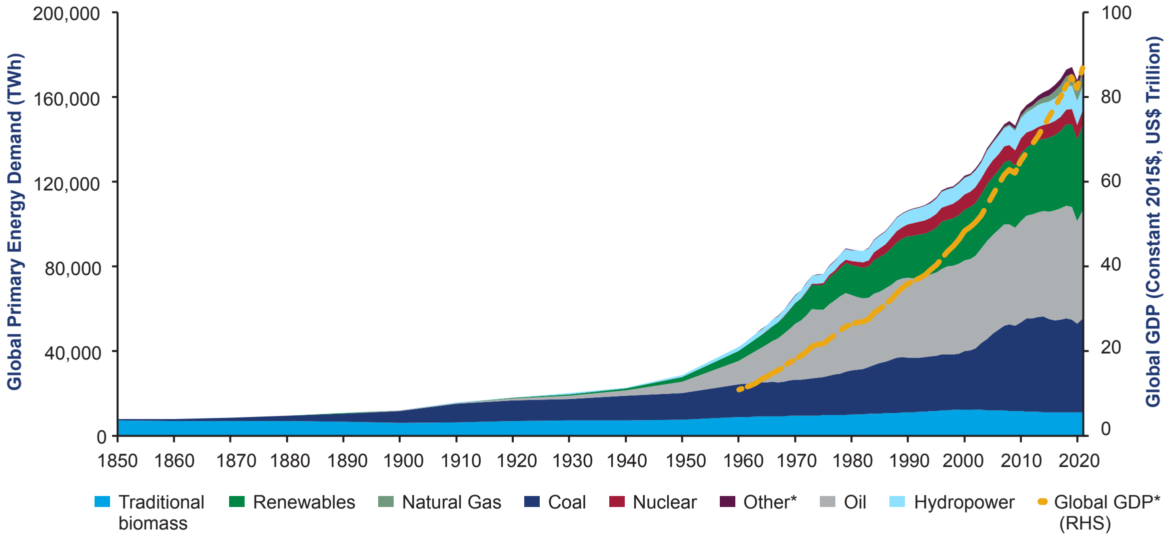
Achieving Resilience in the Energy Transition to Safeguard Indonesia's Economic Growth & Sustainable Development

01 Overview of the Energy Transition

1.1. Fossil fuel consumption and its environmental impact

Fossil fuels have been instrumental in driving economic development and increased productivity. With the advent of industrialisation, coal, followed by oil and natural gas, emerged as stable and storable forms of energy most suited for industrial activities with high energy density requirements. With technological advancements enabling economic transportation of commodities globally, the use of fossil fuels has rapidly become entrenched in modern economies, not only as fuel for transportation and power generation but also as feedstock for numerous industries, including those that provide vital services (e.g. medical services, refrigeration). Today, over 80% of global energy requirements are met with fossil fuels, with oil & gas demand expected to grow further in line with increasing economic activity in the near term.

Figure 2: Global Primary Energy Consumption and GDP (Historical)



*Note: * "Other" includes geothermal, biofuels, and waste energy*

*** Global GDP data available from 1960 onwards*

Source: World Bank, Vaclav Smil (2017), BP Statistical Review of World Energy, Wood Mackenzie

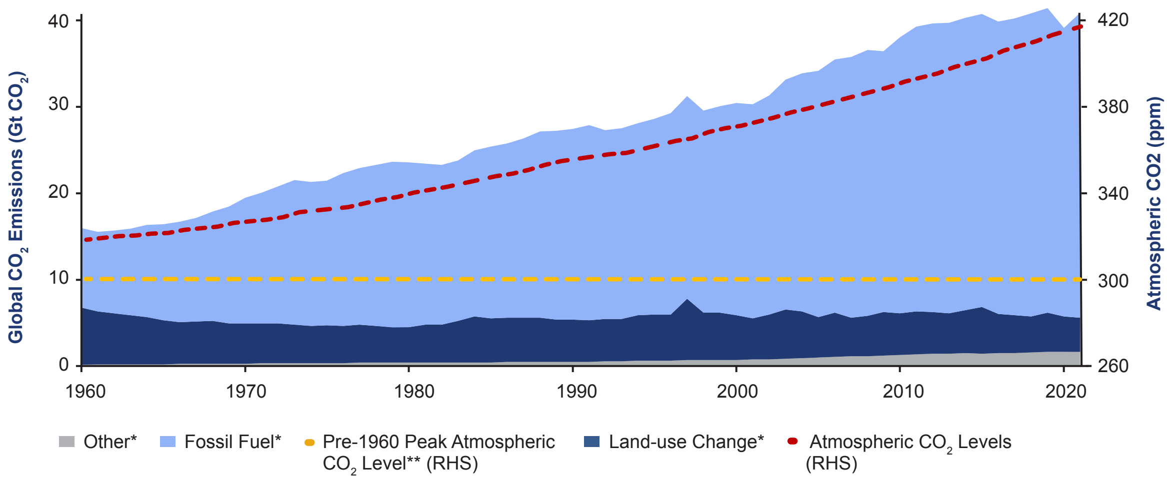
However, growing fossil fuel consumption has also had unintended consequences, including the release of greenhouse gases (GHGs). Carbon dioxide (CO_2), methane (CH_4), and nitrous oxides (N_2O) that are emitted as by-products from the fossil fuel value chain (e.g. extraction, transportation/storage, processing, and combustion) create a considerable strain on the earth's ecosystem, with the rate of emissions exceeding the rate at which natural cycles can remove them from the atmosphere. Accumulation of GHGs in turn leads to increased heat trapping—when solar radiation reaches the Earth's surface, it is absorbed and re-emitted as heat, but GHGs absorb the infrared radiation and prevent it from being released back into space. CO_2 is of particular concern among other GHGs due to its long-lasting presence in the atmosphere. Its high abundance and long atmospheric lifetime make CO_2 the primary driver of anthropogenic climate change.

Aerial view of jack up rig with towing vessel during towing operation.
m.afiqsyahmi/Shutterstock

Current CO_2 levels show a significant deviation from historical ranges. Atmospheric CO_2 levels had largely remained within 180-280 ppm over the past 800,000 years[1]. However, since the rise of oil & gas consumption since the mid-1950s, the atmospheric CO_2 level has consistently exceeded the historical peak, now exceeding 400 ppm. With emission levels from other sources remaining relatively constant over the past 70 years, fossil fuels are largely accountable for the increase in the atmospheric CO_2 concentration (Figure 3).

[1] US National Oceanic and Atmospheric Administration (NOAA) *via* National Aeronautics and Space Administration (NASA)'s publication. *Global Climate Change: Vital Signs of the Plant (2023); "ppm" stands for "parts per million."*

Figure 3: Annual CO_2 Emissions by Source and Atmospheric CO_2 Level (Historical)



*Note: *"Fossil Fuel" includes both combustion and flaring; "Land-use Change" refers to emissions from deforestation and degradation; "Other" includes cement production, among others*
*** Based on NOAA's reconstruction from ice cores, atmospheric CO_2 ranged between roughly 180-280 ppm over the past ~800,000 years; the peak of 300 ppm is estimated to have occurred ~330,000 years ago*

Source: Wood Mackenzie, Global Carbon Project – Global Carbon Budget (2022), National Aeronautics and Space Administration (NASA), National Oceanic and Atmospheric Administration (NOAA)

With global temperatures already ~1°C higher than pre-industrial levels, a further increase in GHG concentration will have a devasting impact on the planet, including:

- Rising sea levels due to melting land ice and thermal expansion of oceans.
- Increased severity and frequency of extreme weather events (storms, heat waves, etc.).
- Accelerated evaporation of surface water required for consumption and agriculture, among others
- Displacement of communities due to both direct and indirect effects of rising temperatures.

While some of the effects of global warming already becoming evident, the most severe impacts are yet to materialise. Waiting until these effects are fully visible would be too late to address the issue effectively and sufficiently. Considering the long-term consequences of global warming, it is imperative to take proactive climate action now to mitigate irreversible disruptions of human development and livelihood.

1.2. The need for energy transition

Recognising the need to minimise anthropogenic emissions, international organisations, governments, and civil societies have scaled and accelerated their efforts to mitigate climate change over the past 50 years. Convention on Long-range Transboundary Air Pollution (LRTAP) of 1979 and the Montreal Protocol of 1987 were early successes, which established the groundwork for the UN Framework Convention on Climate Change (UNFCCC). Under UNFCCC, a series of UN Climate Change Conferences (COP) took place, including COP 21 which resulted in the Paris Agreement and a global target to limit the increase in global temperature to 1.5°C above pre-industrial levels. This commitment was expanded with the Glasgow Climate Pact, which extended the coverage of net zero targets to countries responsible for 88% of emissions globally.

According to the IPCC, exceeding the 1.5°C threshold significantly reduces the ability to reverse environmental impacts and adapt to the severe consequences of climate change. The 1.5°C target is based on the concept of a global "emission budget" or "carbon budget," which represents the maximum allowable amount of cumulative global anthropogenic CO_2 emissions that would limit global warming to the given level.[2] The budget arises from the accumulated imbalance between the amount of CO_2 emitted and the amount offset by natural carbon sequestration—land and ocean sinks have only sequestered ~54% of total annual CO_2 emissions[3] since industrialisation. Given that the remaining carbon budget starting from 2020 was estimated to be 400 $GtCO_2$[4] and that 120.5 $GtCO_2$ have already been emitted between 2020-2022[5], the budget is expected to expire within 7 years if the current CO_2 emission rate persists (40.6 $GtCO_2$ per annum).

To remain within the carbon budget and achieve the 1.5°C target, the IPCC has reported that the global CO_2 emissions need to reach net zero by 2050[6]. Accordingly, more than 70 countries have committed to achieving net-zero, with various cities, institutions, and corporates also aligning their individual development/strategic plans to reduce their carbon footprint. Environmental, Social, and Governance (ESG) concerns have rapidly gained traction among not only government entities and civil societies but also the private sector, with many investors restricting capital allocation to low-carbon opportunities. The Glasgow Financial Alliance for Net Zero (GFANZ), for instance, coordinates net-zero efforts across all parts of the financial system, with major banks, asset managers, and insurers responsible for a total of US$130 trillion in assets as signatories. This shift has in turn triggered structural changes in many carbon-intensive companies, incentivising them to diversify their portfolio and mitigate the environmental impact of their existing operations.

In line with these trends, Wood Mackenzie anticipates continued progress towards decarbonisation going forward. Based on the current trajectory, Wood Mackenzie's base case scenario assumes the following:

- **Cumulative investments** across power & infrastructure, CCS, low-carbon hydrogen (H_2), mining and battery manufacturing, and upstream oil & gas will reach ~$40 trillion between 2022 and 2050.
- **Fossil fuel's share of total primary energy demand (TPED)** will decrease from 82% to 66% by 2050. Oil demand will begin to decline after 2033, while gas demand will continue to grow until 2040.
    - Wind & solar energy demand will increase by 6.3% & 7.8% CAGR in 2023-2050, respectively.
    - Coal & oil demand will decrease by 2.2% & 0.4% CAGR during the same period, respectively. Gas demand will increase slightly by 0.3% CAGR.
- **Early-stage low-carbon technologies** like carbon capture and storage (CCS), electric vehicle (EV), low-carbon hydrogen (H_2), and some biofuel types (e.g. sustainable aviation fuels (SAF)) will continue to gain momentum. CCS capacity reaches ~2 Bt. EV reaches 1 billion in vehicle stock. Green and blue H_2 capacities reach ~160 Mt and ~90 Mt, respectively. SAF demand reaches 20 Mtoe by 2050.

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[2] Intergovernmental Panel on Climate Change (IPCC). "Annex VII." *Climate Change 2021: The Physical Science Basis (2021).*

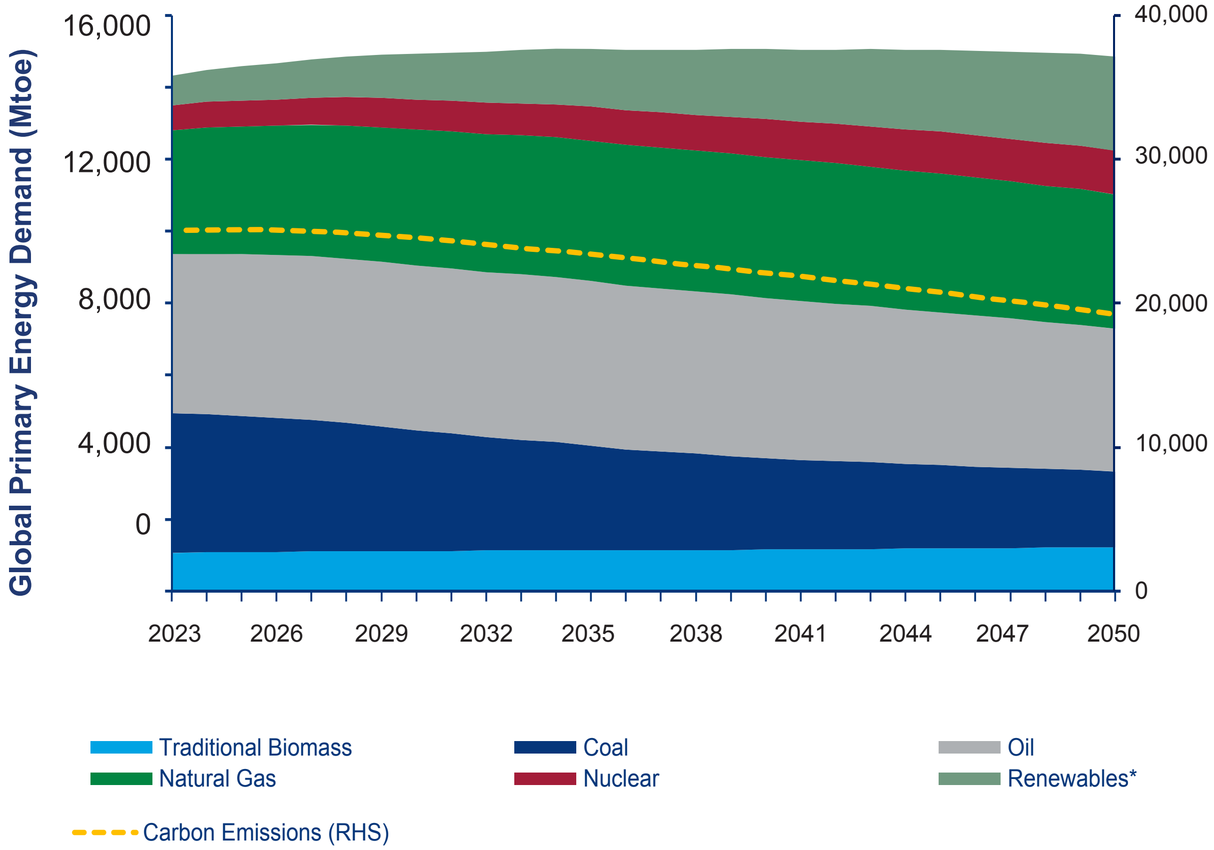
[3] Global Carbon Project. *The Carbon Budget 2022.*

[4] Intergovernmental Panel on Climate Change (IPCC). *The Special Report on Global Warming of 1.5°C; refers to 66% likelihood scenarios.*

[5] Global Carbon Project. *The Carbon Budget 2022.*

[6] Intergovernmental Panel on Climate Change (IPCC). *The Special Report on Global Warming of 1.5°C.*

Figure 4: WM Base Case Scenario - Total Primary Energy Demand and Carbon Emissions



Note: * *Renewables include solar, wind, hydropower, and geothermal*

Source: *Wood Mackenzie. Energy Transition Service Q2 2023*

However, Wood Mackenzie believes that the current developments will not be sufficient to achieve net-zero emission (and in turn, the 1.5°C target) by 2050. Considering the existing rate of policy/tech developments and committed renewable energy investments, Wood Mackenzie's base case will yield an increase of ~2.5°C, in line with the ranges estimated by organisations like Climate Action Tracker, the IEA and the UN. To reach the 1.5°C target, multiple solutions must be employed over the next decades, including some technologies that are not yet economically and/or technologically feasible. While there are various pathways to reach net-zero by 2050, Wood Mackenzie believes that there are some key fundamental factors, including:

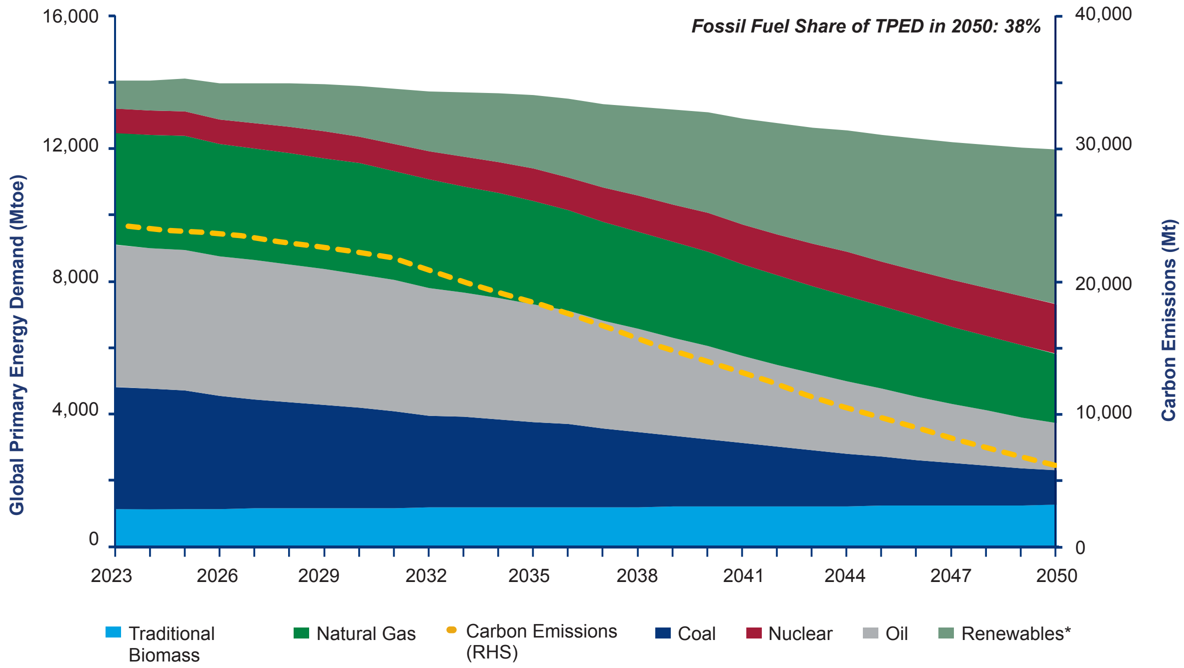
- **Renewable energy's crucial role in decarbonising the power sector.**
- **Gas' role & sustained demand as a "bridge fuel" for energy transition.**
- **CCS/CCUS' role as a key enabler of decarbonisation, particularly for the hard-to-abate sectors.**

Among various permutations of factors that could increase the probability of achieving the 1.5°C target, the following combination of trends underlies Wood Mackenzie's estimated requirements, among others:

- Required **cumulative investments** are US$20 trillion higher than the base case scenario.
- **Fossil fuel's share of TPED** needs to fall to 38% by 2050, compared to 66% under the base case, with oil demand declining from 2024 onwards and gas demand declining from 2026 onwards.
    - The rate of wind and solar energy demand growth will be 1.7% and 2.3% higher, respectively.
    - Coal and oil demand decreases by 4.6% and 4.0% CAGR in 2023-2050, respectively, while gas demand remains more resistant, decreasing by 1.8% CAGR during the same period.
- **Total CCS capacity** will be ~8 Bt higher than the base case. **Battery EV** stock will be ~700M higher. Green and blue H_2 capacities will be ~300 Mt and ~100 Mt higher, respectively. **SAF** demand will be 50 Mtoe higher.

These differences between the base case and the above combination of factors translate to a considerable divergence in the expected carbon footprint. Throughout the forecasted period (2023-2050), annual emissions are expected to decrease at a CAGR of 1.2% under the base case scenario, which translates to approximately 25 Bt of carbon emitted annual by 2050. In contrast, emission levels are expected to decrease at a CAGR of 5.5% under the 1.5°C scenario, limiting carbon emitted to ~7 Bt annually by 2050.

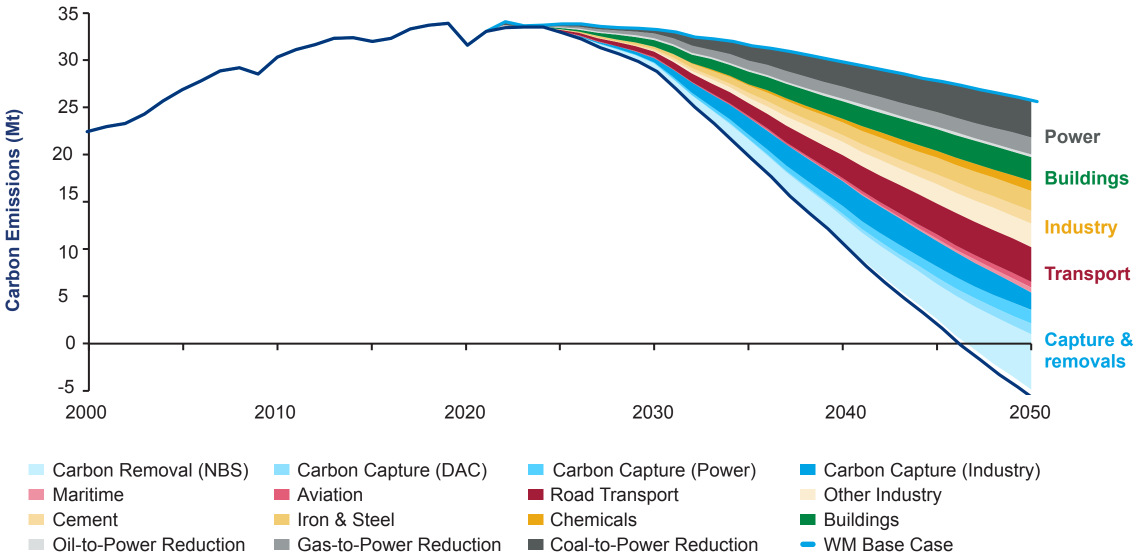
Figure 5: WM's Estimated Requirements for 1.5°C Target - Total Primary Energy Demand and Carbon Emissions



Note: * Renewables include solar, wind, hydropower, and geothermal

Source: Wood Mackenzie. Energy Transition Service Q2 2023

Figure 6: Comparison of WM's Base Case vs Estimated Requirements for 1.5°C Target



Source: *Wood Mackenzie. Accelerated Energy Transition 1.5°C scenario*

Increasing the probability of achieving the climate goals, however, comes at a cost. While the benefits of avoiding higher emissions and climate damage range from lower climate adaptation costs to avoided losses from increased extreme weather events, the expected downsides include higher upfront capital needs, higher workforce transition/job displacement especially across the carbon-intensive sectors, and higher costs associated with the decommissioning of assets with long remaining useful lives (e.g. coal plants, LNG regas terminals). As such, without careful planning and precautionary measures, sustainability measures may carry the risk of negatively impacting the pace of economic growth.

Furthermore, there are various other considerations that also need to be factored in:

- Increasing concerns about geopolitical tensions and the corresponding need on alleviate supply shortages and reduce price volatility in the near term.
- Growth in energy demand across sectors with limited low-carbon alternatives (e.g. industrial).
- Concerns about supply chain disruptions and monopolisation of the critical minerals required for developing renewable energies and low-carbon technologies.

Clearly, there are challenges and trade-offs associated with an accelerated energy transition. While ensuring the long-term sustainability of the energy system remains critical, the high foreseen economic costs of decarbonisation and its potential impact on the reliability of energy supply raise concerns about energy affordability and security, respectively. Given these conflicting interests and values, policymakers are tasked with the challenge of balancing the different priorities and values, which forms the basis of the "Energy Trilemma" discussed in detail in the following section.

Two workers at the LPG Production Booster System, Badak LNG, Bontang, East Kalimantan. The implementation of Badak LNG technology innovation is expected to increase LPG production to meet national demand.

Muhammad Adimaja/IPA Convex 2023 Photo Competition "Energi Bagi Indonesia"

02 The Energy Trilemma

2.1. What is the Energy Trilemma

The goal of the energy transition is not simply to reduce GHG emissions at all cost. Rather, it is essential to consider the broader context and consequences (e.g. while the pre-industrial era can be seen as a "net-zero world", it was accompanied by significant challenges such as high mortality rates, social violence, social inequality, and food scarcity). As such, a smooth transition entails finding a balance between reducing GHG emissions while sustaining continued human development and enabling greater levels of prosperity.

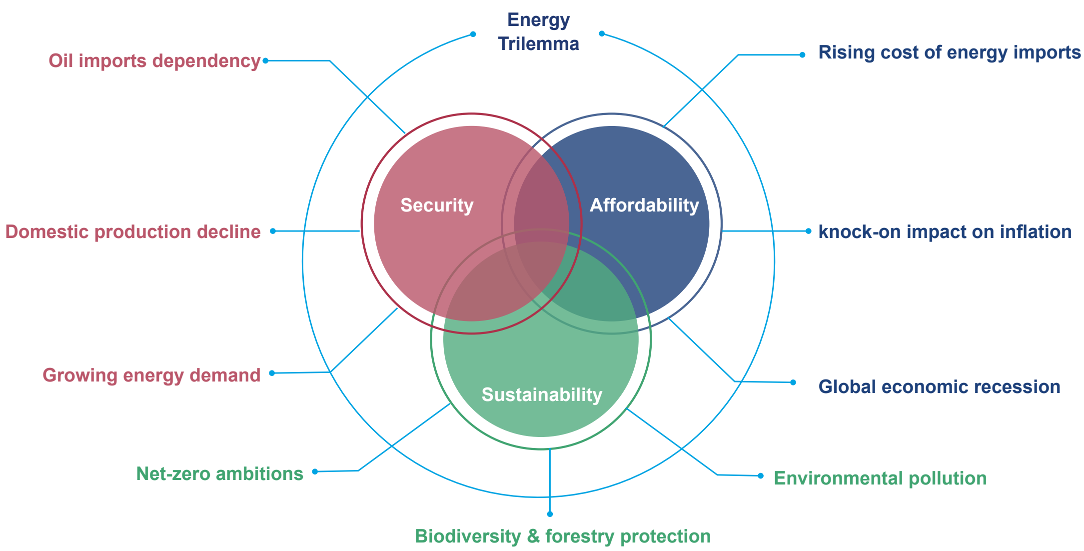
However, given limited time, limited resources, and competing interests, policymakers establish priorities based on feasibility, scale of impact, and stakeholder receptivity, among others. These various competing but interdependent factors that shape countries' energy policy can largely be grouped into three categories—energy security, energy affordability, and environmental sustainability. These form the three pillars of the "Energy Trilemma," a concept developed by the World Energy Council to highlight the challenges of balancing the key dimensions of the energy system. The values and goals promoted by the pillars are as follows:

- **Energy security** refers to a country's capacity to reliably meet current and future demand, and withstand system shocks. This involves diversifying energy sources, reducing dependence on energy imports, and securing energy infrastructures against disruptions. Achieving both domestic and region-level energy security is crucial particularly for fragmented and archipelagic countries.
- **Energy affordability** refers to a country's capacity to ensure that energy is accessible and available to all segments of society, regardless of income level or geographic location. Maintaining low and stable energy prices, shielded from the impact of inflation and/or external factors, is key. Poverty alleviation and equitable access to energy by the wider population are the central values of this pillar.
- **Environmental sustainability** refers to a country's capacity to address issues like GHG emissions, with the aim of mitigating the environmental impacts of energy production and consumption. Securing cleaner and more sustainable energy sources, reducing carbon footprint, and promoting energy efficiency and conservation are fundamental to ensuring longer-term sustainability of human activities.

These three pillars are closely interconnected. Securing abundant and stable supply lowers energy prices for the population, reducing energy poverty, and promoting socio-economic development, in turn enabling further investments in supply and infrastructure resilience. Diversifying the energy mix by expanding renewable energy usage can enhance both energy security and sustainability. Environmental sustainability can enhance energy affordability by ensuring that disadvantaged communities, often located in climate-vulnerable regions, are not disproportionately affected by the adverse impacts of climate change. Furthermore, with investors now closely evaluating ESG performance in decision-making, sustainability helps drive investments required to ensure security and affordability across the energy system, providing a "license to invest". Accordingly, a constructive interplay across the three pillars is essential for sustaining human development and prosperity.

However, finding a balance across the three pillars remains a challenge, partly due to differences in perceived urgency and priorities. Energy security and affordability have often been considered by politicians as issues that need to be addressed quickly to avoid immediate consequences. Policy actions like fuel subsidy programs are widely used for their direct & observable impact on the populations' living costs, which in turn help mitigate economic slowdown and social unrest.

Figure 7: Illustration of the Energy Trilemma



In contrast, sustainability has typically been viewed as a longer-term concern with less tangible consequences. Accordingly, from the perspective of a policymaker with shorter-term political needs and cycles, the expected return on investing in addressing sustainability issues has been lower than the short-term gains from devoting resources to security and affordability.

Nonetheless, with a global push towards promoting sustainability, priorities are beginning to change. Recognising the value and wealth to be gained from developing new economic sectors based on low-carbon energies, politicians, and investors in many countries are now aligned in capturing the benefits of investing in sustainability. Accordingly, growth in capital spent on clean energy technologies have accelerated globally, with annual investments now outpacing spending on fossil fuels. Meanwhile, budgets for fossil fuel development are facing increasing scrutiny, with capital discipline likely to prevail going forward. This in turn raises concerns about potential underinvestment in fossil fuels and its implication on energy security and affordability, particularly in countries that are highly dependent on them to meet their energy requirements.

Addressing the Energy Trilemma evidently requires a balanced & optimised allocation of resources to each of the three pillars. The goal of policymakers should be to maximise the overall benefits gained from the energy system while minimising the environment impact of economic activities. To identify and execute a well-integrated approach, policymakers need to begin by conducting a comprehensive assessment of the current situation, objectives, and suitable levers, as explored in detail in the following section.

2.2. Approaches to addressing the Energy Trilemma

The endowed resources and tools with which policymakers can shape their energy transition pathways differ for each country. As such, a key step towards developing a feasible and effective plan is understanding the unique circumstances and challenges of the country as well as their impact on its development trajectory & objectives, before identifying the specific levers that most appropriately suit the needs of the country.

2.2.1. Current situation

The key country-specific factors that collectively determine the starting point from which each country establish both short-term and long-term objectives and priorities include:

- **Geography/topography:** Landmass type (e.g. continental vs archipelagos) directly impacts the pace and cost of infrastructure development as well as resilience of the energy system.
    - Archipelagos, characterized by dispersed demand centres and geographical barriers, face challenges in developing energy infrastructure compared to inland countries.
    - Additionally, the vulnerability of archipelagos to extreme weather events and rising sea levels has significant implications for economic development and the livelihoods of coastal populations reliant on industries such as fishing, agriculture, and tourism.

- **Resource availability:** Resource endowments of countries vary, ranging from fossil fuel reserves to renewable energy potential; these include depleted O&G reservoirs and saline aquifers for CCS.
    - Economic resources, including companies, local talent, technological capabilities, and industrial expertise, also play a crucial role in shaping the direction and pace of the transition.

- **Socio-economic conditions:** Overall development status, affected by population size, urbanisation rates, industrial structure, and income level, directly influences a country's energy requirements.
    - Higher population growth and rapid industrialisation translate to greater energy consumption and increased pressure on the country's energy supply, whereas plateauing growth, coupled with higher income, may lead to greater flexibility and control in shaping the energy mix (e.g. introducing greater deployment of renewable energy and low-carbon solutions).

- **Policy frameworks & political institutions:** The design and implementation of energy transition policies are strongly shaped by the political and regulatory environments in place.
    - Government's capacity to implement frameworks, including energy roadmaps, regulations, carbon pricing mechanisms, and other low-carbon measures, is critical for energy transition.
    - Governments' ability to foster international cooperation, such as regional integration initiatives and cross-border trade, is likewise crucial especially for development of solutions like CCS.

These factors, among others, form the foundation on which a country's current energy landscape is developed. While some attributes provide benefits and competitive advantages, others set boundaries and limitations that make the Energy Trilemma especially challenging to address for some countries.

2.2.2. Development trajectory & objectives

Global support for the Paris Agreement suggests that the long-term objectives of most countries are aligned—promoting sustainability via decarbonising the energy system remains a key goal. Many countries, including developing nations with varying country-specific characteristics, have committed to net zero targets. However, countries' short- to medium-term transition plans can diverge substantially, primarily due to differences in their current situations and near-term incentives:

- Developed countries with advanced technological capabilities, infrastructure, and well-developed institutions can realise significant gains from expanding and finding new markets for their low-carbon products and intellectual property. These countries can more easily tap into the global capital markets to fund new ventures at a low cost, enabling them to build cost-competitive technologies.
- Conversely, developing countries, particularly those with fragmented landmass, access to cheap fossil fuels, and weaker institutions, will likely face significant challenges in adopting a smooth and unified energy transition due to competing priorities. Reconciling economic development with sustainability objectives is especially challenging for developing countries that have higher growth targets due to the carbon-intensive nature of growth processes.

As such, different mixes of country-specific characteristics can lead to divergences in countries' development plans and envisioned changes over the next 15-30 years. While some may be well-positioned to implement near term sustainability measures by leveraging existing infrastructures, institutions, and access to capital, others are likely to adopt a more phased approach to decarbonisation which balances their socio-economic priorities with decarbonisation goals. Regardless, all countries' approaches need to ensure that energy security and affordability are not compromised while also minimising carbon footprint.

2.2.3. Identification of levers

These varying near term objectives and priorities in turn affect the types of levers that countries will use to shape their energy transition pathways. They also affect the magnitude of change targeted via these levers—developing countries will likely opt for smaller incremental changes relative to their developed peers. Countries have two key non-mutually exclusive levers to consider for their energy development pathways:

- **Primary energy forms:** Policymakers can prioritise investments in either fossil fuels or low-carbon energies (or adopt a hybrid approach that balances resource allocation to both).
    - Given that fossil fuel value chains are major contributors to GHG emissions, reducing their share of the energy mix would enhance the sustainability of the energy system.
    - However, there are several limiting factors, including the scalability, cost, reliability, and interchangeability of renewables, that hinder the displacement of fossil fuels. Detailed descriptions of each primary energy form are provided in Table 2 in the Appendix.

- **Low-carbon solutions:** Policymakers can accelerate the adoption of low-carbon technologies to mitigate emissions, reduce reliance on carbon-intensive sources, and improve energy efficiency.
    - This includes innovative solutions like CCS/CCUS which offer potential opportunities to not only reduce emissions and avoid costs (carbon taxes), but also generate revenue through trading and storage services. Details of key solutions are provided in Table 3 in the Appendix.
    - These solutions can either be standalone drivers of decarbonisation (e.g. directly removing carbon from industries) or complement changes in primary energy mix (e.g. EVs depend on cleaner power sources to promote decarbonisation). They also vary in application—CCS is better suited to target large, static CO_2 sources whereas EVs are more effective in targeting mobile sources (e.g. transport). As such, distinct levers can be used to decarbonise different sectors, all of which work in parallel to promote the sustainability of the overall energy system.

Furthermore, the extent to which countries can effectively utilise the primary energy forms and low-carbon solutions is not solely determined by their availability, but also by the countries' ability to access and harness them. For example, a country may possess abundant O&G resources, but without an existing industry or infrastructure, utilisation will be limited. The same logic applies to other solutions such as CCS/CCUS and EVs. As such, it is important to view these levers in a dynamic context, recognising that the ability to leverage available resources depends on the establishment of necessary building blocks and supportive systems.

2.2.4. Implications

Country-specific attributes shape a country's energy transition objectives and priorities, which in turn determine the most suitable levers. These collectively form the country's energy development pathway, which influences how each pillar of the Trilemma will be addressed and prioritised. The transition pathways of two countries—India and Singapore—highlight how country-specific circumstances and objectives can result in distinct sets of starting points and near term levers that reflect their unique contexts and requirements.

India

India is representative of many developing nations with high economic growth. While decarbonisation remains a key objective, India continues to rely heavily on O&G to meet its energy needs in the near term.

- **Current situation:** A combination of diverse terrain, large population, and high poverty rates has posed challenges in ensuring reliable and equitable energy access. Key policy developments have included fuel subsidies, including the re-introduction of LPG subsidies for low-income consumers in 2022. Domestic oil production is in decline, while gas is poised for near-term growth with the ramp up of the KG-D6 fields. However, reliance on imports for both O&G will likely continue to increase. India currently depends on imports to meet 85% of its oil needs and 48% of gas requirements.
- **Development trajectory & objectives:** Under its "4-plank strategy for energy security", India has committed to reduce its import reliance via diversification of supply sources, renewed focus on finding and producing O&G domestically, and greater dependence on gas & green H_2 as transition fuels. As such, development of its indigenous resources will likely be a key enabler of growth in the near term.
- **Levers:** Developing domestic fossil fuels remains the chosen tool to build supply resilience. India is targeting to increase exploration acreage to 0.5 million sq. km by 2025 and 1 million sq. km by 2030 and has historically revised its fiscal terms to attract investors. While India will continue to simultaneously deploy RE and low-carbon solutions to meet overall increase in energy demand, fossil fuel's share of TPED is expected to remain stable (decreasing by <6% between 2023-2050).

While sustainability measures may be limited in the near term due to its current situation (e.g. high economic growth, import reliance, financial constraints), India must formulate an optimal plan for the development of RE and low-carbon solutions that ensures sustainability while preserving energy security and affordability.

Singapore

Singapore's prioritisation of sustainability and active investments in RE and low-carbon technologies align with its goal to augment energy security via diversification of the energy mix and reduction in import reliance.

- **Current situation:** Singapore is a developed country with strong institutions & regional cooperation and nationwide energy access. However, limited indigenous resources make Singapore highly dependent on imports, leading to high exposure to supply disruptions and volatility. As such, while its high-income level has helped absorb high energy costs, energy security remains a challenge.
- **Development trajectory & objectives:** With limited domestic fossil fuels to develop and high import dependence, Singapore has a clear incentive to diversify its energy sources and adopt low-carbon solutions. Leveraging its technological capabilities and high R&D capacities, its key objective has been to not only reduce carbon emissions via increasing the share of renewable energy, but also to reduce overall energy requirements and explore new markets (e.g. sustainable aviation fuels (SAF).

The FSO Arco Ardjuna, Pertamina Hulu Energi ONWJ, in the northern offshore of West Java. The facility has a capacity of 1 million barrels of oil and is able to store all crude oil produced from the area.
Aditya Pradana Putra/IPA Convex 2023 Photo Competition "Energi Bagi Indonesia"

- **Levers:** Singapore has adopted a combination of both primary energy and low-carbon solution levers. While the share of solar and wind energy in the power sector is currently negligible, Singapore is targeting 13% by 2050. It has also introduced the Early Adoption Incentives (EAI) to stimulate the sale of EVs by offering rebates to offset the higher purchase costs while taking measures to install public charging points and promote EV and battery R&D programs. SAF development is also in advanced stages, with initiatives like the SAF Credits program launched by Singapore Airlines and Temasek. Singapore is already the world's largest SAF producer since the Tuas refinery expansion in May 2023.

As the two case studies illustrate, there is no universal solution, or a "silver bullet", that fits all countries. Each country needs to determine its own combination of levers and strategies to address the Trilemma based on its unique starting points and objectives. Nonetheless, finding the right path forward is particularly critical for developing countries like Indonesia seeking to achieve both economic growth and long-term sustainability:

- The magnitude of incremental change required for energy transition is greater in the developing countries than in the developed economies. There is inherently less "leeway" for the former.
- A rapid transition without proper precautionary measures may overburden and create frictions in the existing systems, potentially undermining the broader political, social, and economic foundations.

Going forward, countries must ensure that they build sufficient resilience to accommodate these changes.

Achieving Resilience in the Energy Transition to Safeguard Indonesia's Economic Growth & Sustainable Development

Wood Mackenzie

03 The Energy Trilemma in Indonesia

The overarching approach outlined in Section 2—assessing the current situation, evaluating the development trajectory & objectives, and identifying key levers—provides a useful framework for addressing the following:

- Are Indonesia's current energy systems and developments optimal for addressing the Trilemma?
- If not, what is a transition pathway that enables Indonesia to balance the three pillars more effectively?

This section provides a review of each of the three components of the approach in Indonesia's context, which will then lay the groundwork for further analysing the key levers to address Indonesia's Energy Trilemma.

3.1. Current situation

3.1.1. Indonesia's country-specific characteristics

Like many developing countries, Indonesia faces a steep challenge of meeting a rapidly growing energy demand driven by increases in population and economic activities. While the country's archipelagic landmass poses additional difficulties in implementing a nation-wide energy transition and infrastructural development, its rich fossil fuel endowments, coupled with increasing political support and initiatives for decarbonisation, provide a strong foundation and starting point for addressing the Energy Trilemma.

- **Geography/topography:** The scattered islands in eastern Indonesia, among others, heighten the challenge of extending power infrastructures and ensuring energy access nationwide. Mountainous terrains further hinder cost-efficient infrastructure development.
  - Additionally, Indonesia's geography raises risks of supply disruptions: its location in the Pacific Ring of Fire makes it prone to volcanic and seismic activities, while its coastal regions remain susceptible to extreme weather events.
  - These topographic factors pose economic and logistical challenges in implementing a rapid transition; leveraging existing energy systems will likely be most suitable in many regions.

- **Resource availability:** Indonesia has material fossil fuel resources—it has the 2nd largest remaining marketable coal reserves in the world (~36 billion tonnes) and the 3rd largest remaining O&G reserves in APAC (~4 billion barrels & ~61 trillion cubic feet, respectively)[7] after Australia and China.
  - Biomass, hydro, and geothermal also have high potential and constitute a vast majority of Indonesia's current total renewable capacity, but much of the available potential remains inaccessible due to economic & structural constraints. Solar potential (irradiation) remains moderate in some regions, while wind power density remains weak throughout Indonesia.
  - Other resources include high CO_2 storage potential (O&G reservoir, saline formations) and metals (e.g. nickel, copper, cobalt, rare earth metals), which are key for low-carbon solutions.

[7] Indonesia Ministry of Energy and Mineral Resources (ESDM). *Handbook of Energy & Economic Statistics of Indonesia (2021).*

- **Socio-economic conditions:** Urbanisation centres in the island of Java are driving industrialisation while regions like Papua and East Nusa Tenggara are striving to address limitations to energy access.
    - Sustaining industrialisation and expanding energy access both depend on increased energy supply, irrespective of energy source. With GDP expected to rise by >4% p.a. over the next decade[8], resilience of the energy system will be key to withstand a potential supply crunch.

- **Policy frameworks & political institutions:** Regulations and initiatives, ranging from Presidential Regulation (PR) No. 112 of 2022 and MEMR Regulation No. 2 of 2023 to the Just Energy Transition Partnership (JETP), signal growing government support & political capacity to drive energy transition.
    - However, the exact scope and impact of these policies remain ambiguous—the government needs to provide further clarity regarding the execution of these measures.
    - Furthermore, continued development of new frameworks, including “cap-and-tax”, needs to progress to fully enable and accelerate the development of new solutions like CCS/CCUS.

3.1.2. Indonesia’s current energy landscape (energy mix & levers)

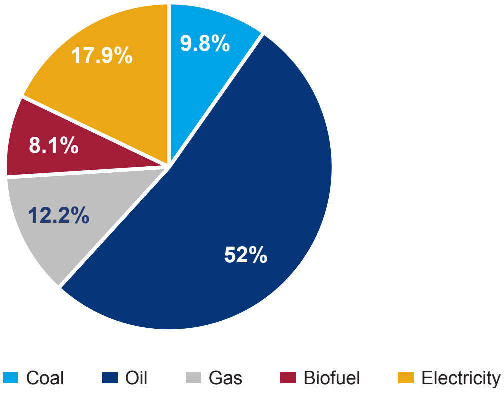
The country-specific attributes have thus far played a fundamental role in shaping the development of Indonesia’s energy system, which can largely be characterised by three key themes:
- **Predominance of fossil fuels.**
- **Limited deployment of renewable energies**
- **Nascent development and implementation of low-carbon solutions.**

Each of these themes are evaluated in greater depth below:

Predominance of fossil fuels
Rapid growth in energy demand over the past decade has largely been met by fossil fuels, which now collectively constitute 74% of final energy demand (excluding electricity) (Figure 8). Electricity, which constitutes most of the remaining final energy demand, is likewise dominated by fossil fuels, which collectively make up 85% of the total power demand (Figure 9).
- **Coal** plays a significant role in meeting Indonesia’s power and industrial demand, serving as a key energy source for both sectors—it accounts for ~65% of total power generation and ~27% of total industrial demand. The increased use of coal aligns with Indonesia’s rapid infrastructure development, capital goods production, and transportation needs.
- **Oil** demand primarily stems from the transport sector, followed by industrial and other sectors. Within the transport sector, fuel makes up ~90% of total demand, while within the industrial and smaller sectors like agriculture, oil makes up ~18% and ~60% of the respective total demands.
- **Gas** demand, like coal demand, stems primarily from the industrial and power sectors and are significant energy sources for each (~32% and ~26% of total demand, respectively).

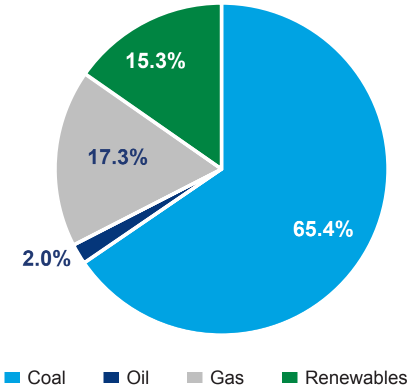
[8] Wood Mackenzie. *Macroeconomics - GDP Forecast (Q2 2023)*

Figure 8: Indonesia's Final Energy Demand Mix



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

Figure 9: Indonesia's Electricity Demand Mix



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

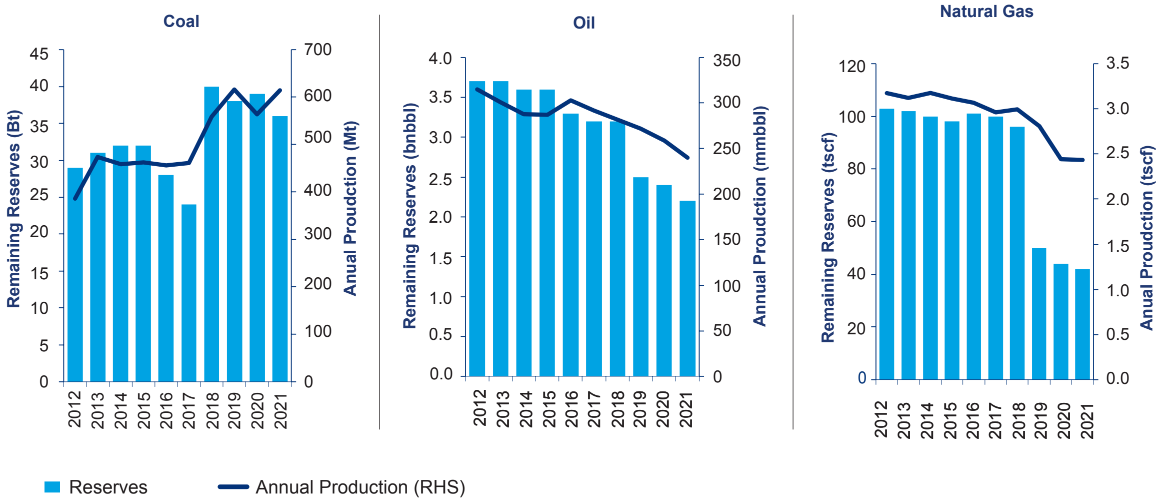
Fossil fuels likewise dominate Indonesia's primary energy supply mix. **Coal** is currently the largest contributor to Indonesia's primary energy mix, constituting 37.6%, followed by **oil** (33.4%), and **gas** (16.8%).

Their predominance can be attributed to several factors, including abundant domestic supply, subsidies, and policy support, which have contributed to their cost competitiveness, maturity, and development.

The prominence of fossil fuels in both energy consumption and domestic production capacity highlights the critical role of domestic resources in attaining energy self-sufficiency. However, with existing assets reaching maturity, oil, and gas supply has been declining, dipping below 700 kb/d and 6.7 bcf/d, respectively, in 2021. With a significant portion of oil demand already being met via imports, the ongoing production trends suggest that further increasing imports may be unavoidable unless Indonesia can unlock domestic O&G production from undeveloped reserves (detailed further in Section 4.2).

A woman cooking using household gas network from PT Pertamina Gas Negara (PGN). The community widely accepted household gas as a cheaper and cleaner source of energy.
Achmad Subagja/IPA Convex 2023 Photo Competition "Energi Bagi Indonesia"

Figure 10: Indonesia's Coal, Oil, and Natural Gas Reserves & Annual Production (Historical)



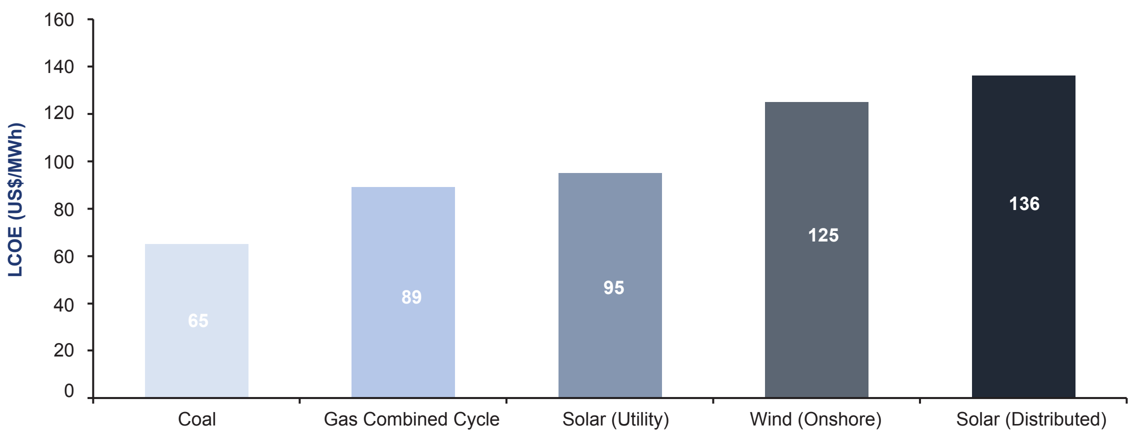
Source: Wood Mackenzie, National Energy Council – Indonesia Energy Outlook 2022

Limited deployment of renewable energies
Hydro and geothermal collectively contribute ~5% primarily as inputs for power generation in key demand centres like Sumatra, Java, and Sulawesi, while biomass makes up majority of the remaining demand. Solar and wind together constitute less than 0.2% of the primary energy mix. The progress toward achieving the minimum 23% RE target by 2025, as mandated by the National Energy Policy, remains challenging. There are several factors that have thus far hindered RE deployment (especially solar & wind):

- **High costs**: The levelized cost of electricity (LCOE) of utility solar currently exceeds coal power plants by ~$30/MWh (wind and distributed solar are currently even less economic) (Figure 11).
- **Modest potential**: Indonesia has a moderate average solar irradiation of ~4.9 KWh/m2/day (high irradiation limited to Nusa Tenggara and Java) and a low wind power density of 4.9 m/s (onshore).

While renewables will play a crucial role in decarbonising Indonesia's energy system, overcoming challenges such as costs, intermittency, and challenges in grid integration will be necessary to meet current RE targets.

Figure 11: Current Levelised Cost of Electricity (LCOE) of Selected Power Technologies in Indonesia



Source: Wood Mackenzie – Indonesia Power Market Report (2022)

Nascent development and implementation of low-carbon solutions
Penetration of low-carbon solutions, ranging from EVs to CCS/CCUS, has historically been limited, although capacity development and drafting of supporting policy frameworks are currently in progress of ~152 million vehicles currently in Indonesia, <1% (~15,000 vehicles) are electric[9], albeit Indonesia's ambitions to have 2.5 million total EVs on the road by 2025. Likewise, although several CCS/CCUS projects, including Tangguh, Gundih, and Sukowati, have undergone varying levels of development recently, most of the announced CCS opportunities remain prospects without firm commitments and capital spend. The absence of fully developed, implemented frameworks and infrastructures remains a key hurdle:

- The stagnant EV adoption is influenced by factors like **infrastructure limitations** and **purchasing power** (highlighting the need for energy affordability), while Indonesia's CCUS industry **lacks a domestic carbon pricing** mechanism and the ability to benefit from international pricing regimes.
- Other low-carbon technologies such as green hydrogen are likewise in nascent development stages with no commercial project, facing **economic, safety, and infrastructure-related hurdles** (e.g. long-distance transportation to utilisation sites).

Some low-carbon solutions like biofuels are more developed and better integrated into the energy mix—government mandate to blend biodiesel from palm oil with fossil diesel (e.g. B30, B35) has materialised in biomass constituting 4.4% of the primary energy mix[10]. Nonetheless, scalability issues and feedstock costs, among others, have thus far precluded a wider adoption and expansion of these measures.

3.2. Development trajectory and objectives

Evidently, the energy development pathway that Indonesia has thus far been focused on meeting the rapidly growing energy requirements of economic growth, urbanisation, and population growth. Key objectives have included maximising the energy supply and securing the most immediately accessible and economic means to gain access to energy sources. Indonesia has historically relied on tools like fuel subsidies to maximise energy affordability, shielding the population from global price fluctuations. However, due to limited access to financial resources, Indonesia has thus far been unable to invest more heavily in lower-carbon technologies. Additional capital, among other enablers, will be key to ensure that Indonesia can devote more resources to promoting sustainability without jeopardising energy security & affordability.

However, with increasing global efforts to promote sustainability, Indonesia has recently committed to meeting the net-zero target by 2060, signalling a shift in its development trajectory to additionally incorporate decarbonisation measures. This in turn raises the following questions: what implications does this shift have on Indonesia's energy mix if implemented, and how does it impact energy security and affordability? To understand the direction and magnitude of the possible changes, this paper relies on the projections presented in "Indonesia Energy Outlook 2022" published by the Indonesian National Energy Council (DEN), a government agency established under Law No. 30 of 2007 to design and formulate national energy policies[11]. The publication establishes two pathways—"Business as Usual" (BaU) scenario, which reflects current consumption patterns and existing development plans, and "Optimistic" (OPT) scenario, which reflects changes aligned with the Vision of Indonesia 2045 and the net-zero emission target by 2060. When viewed in conjunction, the two scenarios provide an understanding of the likely range of outcomes and the potential variability that must be factored in to create a resilient transition pathway.

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[9] The Diplomat. "*Can Indonesia Achieve Its Electric Vehicle Ambitions?" (2023).*

[10] National Energy Council. *Indonesia Energy Outlook (2022)*

[11] As an organisation responsible for establishing the National Energy General Plan and for outlining steps to mitigate energy crises, DEN's outlooks carry considerable weight in shaping the trajectories of Indonesia's energy landscape.

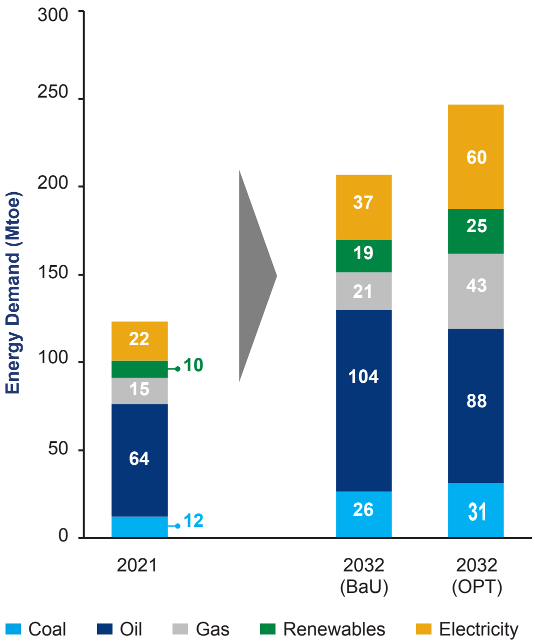
3.2.1. Similarities in outcome (commonalities between the scenarios)

Despite assuming different energy transition pathways, the two projections are aligned on several key trends:

- **Rapid economic recovery and growth will likely continue** over the next decade, resulting in a corresponding surge in energy consumption. Increase in overall energy demand is primarily driven by two sectors: industry and transport. Rapid urbanisation and population growth will translate to higher energy consumption in both sectors, as construction activities and motorisation rates increase.
  - BaU anticipates that by 2032, final energy demand will exceed 200 Mtoe (~4.8% CAGR).
  - OPT assumes an even higher growth of 6.6% CAGR, reflecting the industrial levels and mobility requirements underlying the Vision of Indonesia 2045.
  - Under both scenarios, demand increases across all energy sources over the decade, with oil and electricity increasing the most in absolute terms under BaU and OPT, respectively.

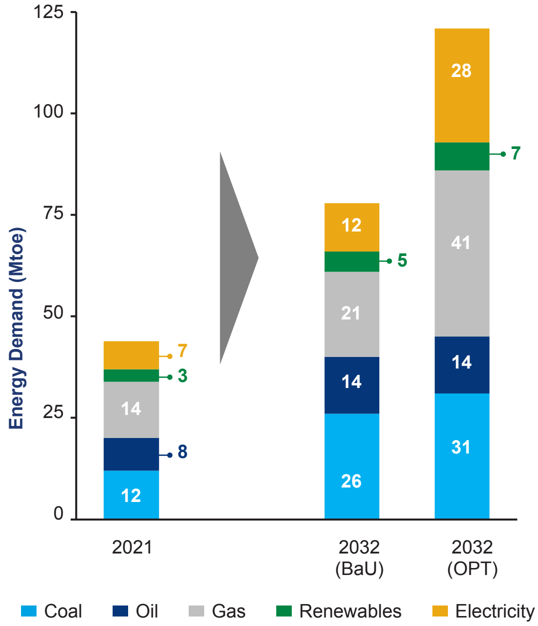
- **Fossil fuels will continue to dominate the energy mix**, meeting over 65% of final energy demand. Power demand likewise remains largely fossil fuel-based, despite the expansion of renewables.
  - Coal demand in the power sector remains high in both scenarios, contributing more than 66%.
  - Oil demand in transport will remain high under both scenarios. Even with advancements in the electrification of transport and expanded implementation of biofuel mandates, oil demand is expected to increase at 5.0% CAGR and 3.3% CAGR under BaU and OPT, respectively.
  - Demand for gas as an industrial feedstock, will be robust under both BaU and OPT scenarios. The fertilisers and petrochemical sub-sectors currently have limited alternatives to gas feedstock, making gas an irreplaceable resource for industrial expansion.
  - Similarly, consumption patterns consistent in other sectors (e.g. household, commercial, mining, etc.) are expected to remain, with fossil fuel-based input demand remaining substantial, including LPG, fuel, and natural gas.

Figure 12: Final Energy Demand Outlook (BaU vs OPT)



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

Figure 13: Demand Outlook – Industrial (BaU vs OPT)



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

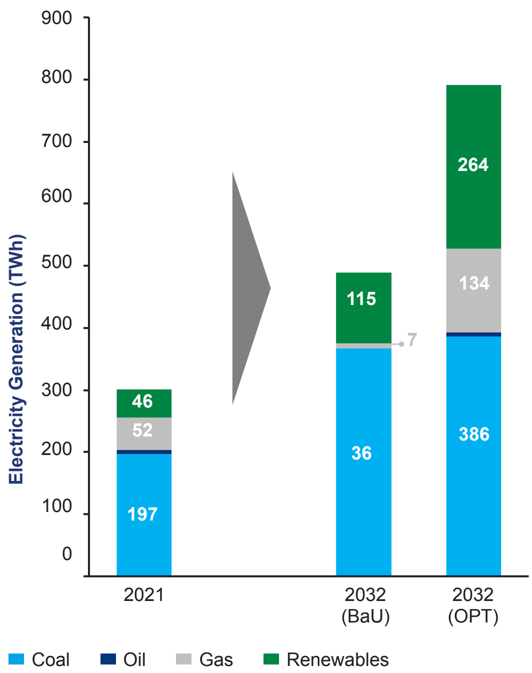
3.2.2. Differences in outcome (potential sources of variability)

Divergences between scenarios are especially important to note, considering the need to ensure that the energy system can accommodate potential variances in the future:

- **Gas demand in the power sector may be highly variable**; gas-generated electricity dropping to 7 TWh by 2032 under BaU whereas production increases to 134 TWh under OPT over the same period.
    - Unlike gas inputs for the industrial sector which have limited substitutes, gas in the power sector competes against highly cost-competitive coal as well as renewables.
    - Gas demand could also be sustained/increased as a lower-carbon fuel (a "bridge fuel" for the energy transition), replacing retiring/decommissioned coal capacities.

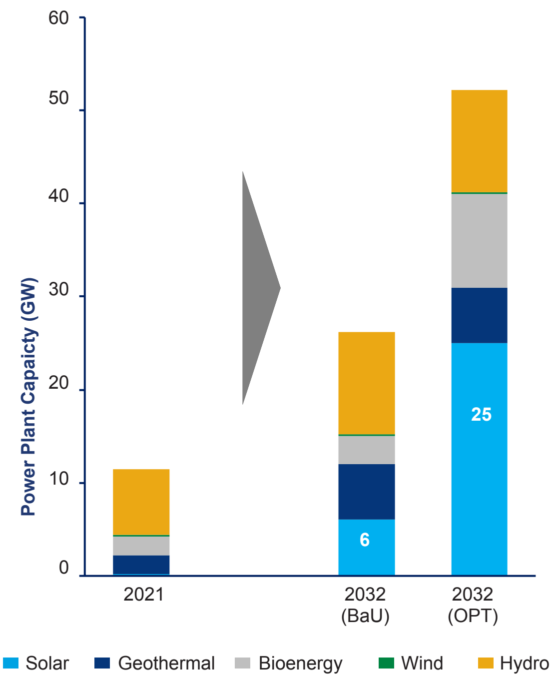
- **The role/scale of renewables remains highly uncertain** in the power and transport sectors.
    - Under the BaU and OPT scenarios, solar power capacity is forecasted to be 6GW and 25GW by 2032, respectively (Figure 15). This translates to solar constituting 23% and 48% of total RE capacity. While LCOE will improve in line with improvements in efficiency, design techniques, and economies of scale, significant hurdles (e.g. grid readiness, supply chain bottlenecks) must be overcome beforehand, introducing a high level of uncertainty.
    - EV adoption trajectories also pose uncertainties. EVs in Java is assumed to constitute 10% and 20% under BaU and OPT, respectively, by 2032. While the government has recently unveiled a subsidy program, the lack of charging infrastructure has thus far prevented a rapid uptake; establishing a domestic EV value chain may also take considerable amount of time.
    - Furthermore, OPT assumes the implementation of biofuel mandates. With feasibility tests of B40 currently in progress and ramp up remaining uncertain due to limitations like crude palm oil availability, biodiesel production capacity, and fuel specification standards, a country-wide execution of the B40 mandate may experience challenges and delays in adoption.

Figure 14: Demand Outlook – Electricity (BaU vs OPT)



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

Figure 15: RE Power Plant Capacity (BaU vs OPT)



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

3.3. Identification of levers

The analysis of potential development trajectories highlights several factors to consider in developing Indonesia's energy transition pathway:

- Enhancing economic development and livelihood in line with the Vision of Indonesia 2045 (e.g. OPT scenario) requires an accelerated growth of total energy supply relative to the base case.
- Irrespective of scenario, fossil fuel demand remains robust. Demand for oil and gas will continue to be highly inelastic for various end-uses—natural gas has limited alternatives as a key feedstock for numerous industrial activities, while oil continues to dominate the transport sector.
- In other sectors like power, the role of natural gas remains less predictable.

Each of these observations points to the crucial role that domestic fossil fuels will play in upholding Indonesia's energy security & affordability. Ensuring that the population has access to sufficient energy resources and building up the country's capacity to withstand potential volatilities in domestic demand and international supply remain central to Indonesia's objectives and priorities.

However, simply extending Indonesia's historical prioritisation of energy security and affordability alone may result in significant setbacks for Indonesia. Sustainability measures are crucial for realising its goals, including fulfilling the Nationally Determined Commitments (NDCs), enhancing international standing, attracting investors with net-zero targets and improving the competitiveness of Indonesian exports. Sustainability needs to also be progressed without delay, in parallel with Indonesia's efforts to secure energy supply.

How can Indonesia, then, achieve a suitable balance between continuing to rely on fossil fuels and meeting its sustainability goals? A benchmark of comparable countries suggests that a combination of two levers—increased domestic O&G investment and proactive CCS development—may be one feasible solution.

3.3.1. Benchmarking

Indonesia's neighbouring countries share the challenge of pursuing an energy transition pathway that reconciles the need to sustain economic growth with ambitious plans to lower the carbon-intensity of their respective energy systems. Malaysia, for example, is experiencing hurdles comparable to those in Indonesia when it comes to addressing the Energy Trilemma, including:

- Robust economic growth over the next decade and corresponding energy requirements.
- Heavy reliance on fossil fuels, coupled with rapidly declining O&G production due to field maturity.
- Limitations in the deployment of low-carbon solutions like EV and biofuels.
    - Despite ambitious EV targets and biofuel mandates (e.g. B10), there has been immaterial displacement of fossil fuels, particularly due to delays in the implementation of the initiatives.
- High cost-competitiveness of coal in both countries and the lack of visibility/certainty in the power mix.

Given these circumstances and boundaries, Malaysia has primarily adopted a strategy of 1) **increasing domestic O&G production** and 2) **developing its CCS/CCUS capacities** to meet its energy needs and net-zero targets (2050):

- With oil and gas expected to remain predominant in the countries' energy supply, Malaysia has sought out new investments to develop its domestic O&G production.
    - Malaysia has launched its MBR 2023, with an offer of up to 10 blocks and two clusters of DRO. Malaysia has been especially active in leveraging fiscal term adjustments to attract prospective investors, providing incentives to develop small field assets (SFA) and late-life assets (LLA) to expand its domestic production capacity.

- To offset the environmental impact of their continued reliance on oil & gas, Malaysia has prioritised investments in CCS/CCUS.
  - Malaysia has sanctioned its Kasawari Phase 2 CCS project, one of the largest offshore CCS projects in the world, with other planned projects like the Lang Lebah field (PTTEP) and the BIGST Cluster offshore Peninsular Malaysia (JX Nippon, PETRONAS Carigali). Furthermore, Malaysia has announced tax incentives that support companies undertaking in-house CCS activity and/or CCS services and companies using CCS services (focused initially on the upstream sector). With its proposed 2023 budget likely to establish to a carbon tax and carbon pricing mechanism, Malaysia has already begun to establish the key foundational blocks required for the CCS industry.

3.3.2. Implications

Faced with expected high oil & gas demand, declining domestic oil & gas production, and the uncertainty of alternative energies, neighbouring countries like Malaysia have turned to domestic O&G investments to build a more resilient energy system, coupled with CCS investments to achieve their net-zero emission targets. Given comparable country-specific attributes and objectives—to sustain growth and secure affordable energy—should Indonesia adopt a similar approach to addressing the Energy Trilemma? More specifically,

- What is the value of developing domestic oil & gas production specifically in the context of Indonesia?
- What role can CCS/CCUS play in Indonesia's energy transition, and what is required to develop the national CCS/CCUS industry?

While multiple levers and pathways must also be implemented in parallel to further accelerate the energy transition (as alluded to in Section 1.2), increased O&G production and CCS/CCUS deployment are both key levers that collectively target all three pillars of the Energy Trilemma. Furthermore, these levers are both readily accessible to Indonesia—abundance of domestic O&G resources and CCS storage capacities provide Indonesia with a competitive advantage. However, with regional competitors equally striving to attract capital and foreign interest to develop their capacities, Indonesia must take a proactive and timely step to accelerate the deployment of these levers.

LNG (Liquified Natural Gas) tanker anchored in Gas terminal gas tanks for storage.
GreenOak/Shutterstock

Wood Mackenzie

04 Growing Domestic O&G Production to Address the Trilemma

4.1. Value case

To ensure both energy availability and affordability, all available primary energies, including oil and gas for remote power generation, will continue to be required. Without access to a vast centralised grid and energy storage systems, renewables will remain susceptible to intermittency, requiring quick deployment of electricity from diesel generators. With geopolitical tensions, supply chain disruptions, and price volatility increasingly prevalent across the globe, achieving energy independence is increasingly considered a key requirement for national security, economic stability, and even investor competitiveness. Indonesia's overall oil and gas demand is expected to continue its upward trend for the foreseeable future, making it increasingly more susceptible to the uncertainties of foreign supply without a corresponding expansion of domestic production capacities to offset consumption growth. The direction of the domestic supply-demand balance in turn directly impacts several economic and non-economic indicators, ranging from the balance of payments/trade and cost of inputs to in-country value capture across the value chain and related businesses.

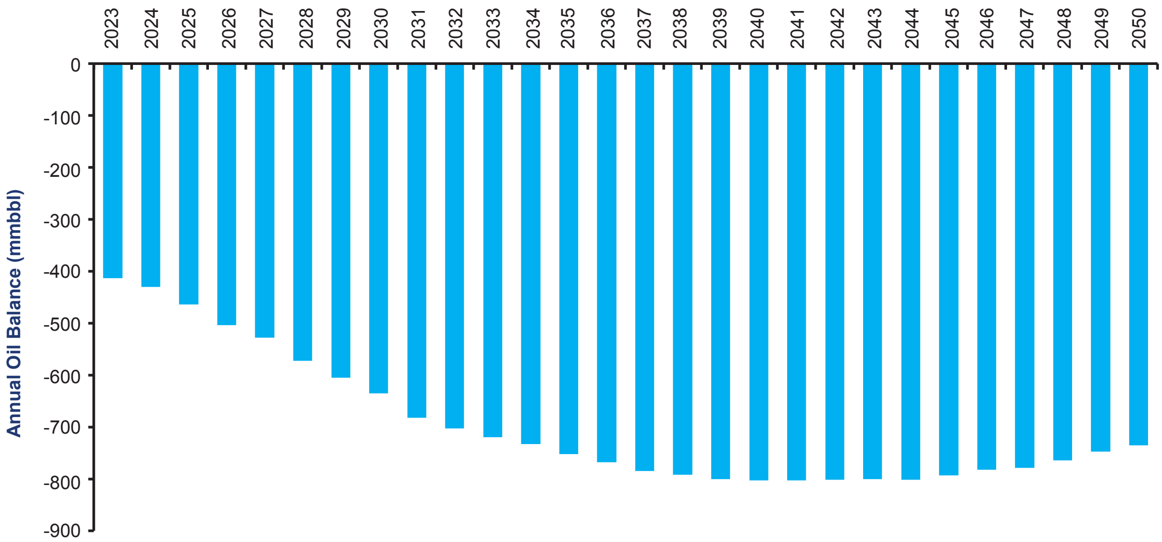
4.1.1. Oil as a fuel and an industrial feedstock

Without revitalised domestic production, Indonesia will face an increasingly tighter domestic oil supply-demand balance, resulting in higher import dependency (Figure 16). Accordingly, the expected benefits of increased domestic oil production are clear:

- **Improved Balance of Trade**: Reduces the need for oil imports and decreasing the import bill associated with oil. This reduction in import reliance can help mitigate trade deficits, promote self-sufficiency, and enhance Indonesia's economic competitiveness on the global stage.
- **Improved Balance of Payments**: Reduces the outflow of foreign currency for payments, contributing to an improved balance of payments. This allows Indonesia to retain more of its currency within the economy, strengthening its foreign currency reserves and supporting the stability of the rupiah.
- **Reduction in Fuel Wholesale Sourcing Costs/Subsidy**: Reduces reliance on expensive imported fuels, eliminating import taxes and duties, streamlining supply chains, and achieving economies of scale, resulting in overall cost savings for fuel procurement. The recent cut to fuel subsidies (and the corresponding spike in domestic prices) further highlights the need for greater domestic supply.
- **Protection from International Price Volatility**: Provides a level of protection from international price volatility by reducing the country's dependence on the global markets. By relying more on stable and secure domestic supply, Indonesia can mitigate the impact of sudden price fluctuations, ensuring a more predictable/stable energy pricing environment for industries and consumers within the country.
- **Protection from Supply Chain Disruptions**: Enhances energy security and provides protection from supply chain disruptions that may arise from geopolitical tensions, conflicts, or natural disasters. By reducing dependence on international supply chains, Indonesia can ensure a more reliable and uninterrupted supply of oil and safeguarding against potential disruptions, enhancing energy security.
- **In-country Value Capture and Downstream Expansion**: Mitigates a widening supply gap in the domestic markets for diesel/gas oil, gasoline, and other oil products by ensuring domestic feedstock availability for local refining capacities (e.g. capacity upgrades at the Cilacap refinery) and new grassroots refineries. Increased domestic production would strengthen the economics of planned upgrades and expansions (e.g. Balikpapan, Dumai and Balongan refineries).

- **Multiplier Effect and Value Chain Expansion**: Creates incremental value along the entire oil products value chain. This includes activities across E&P, refining, distribution, and related industries, leading to increased economic activity, job creation, and technological advancements, which further stimulate economic growth and development in the country.

Figure 16: Indonesia Oil Supply-Demand Balance



Source: Wood Mackenzie – Lens Database (Q2 2023)

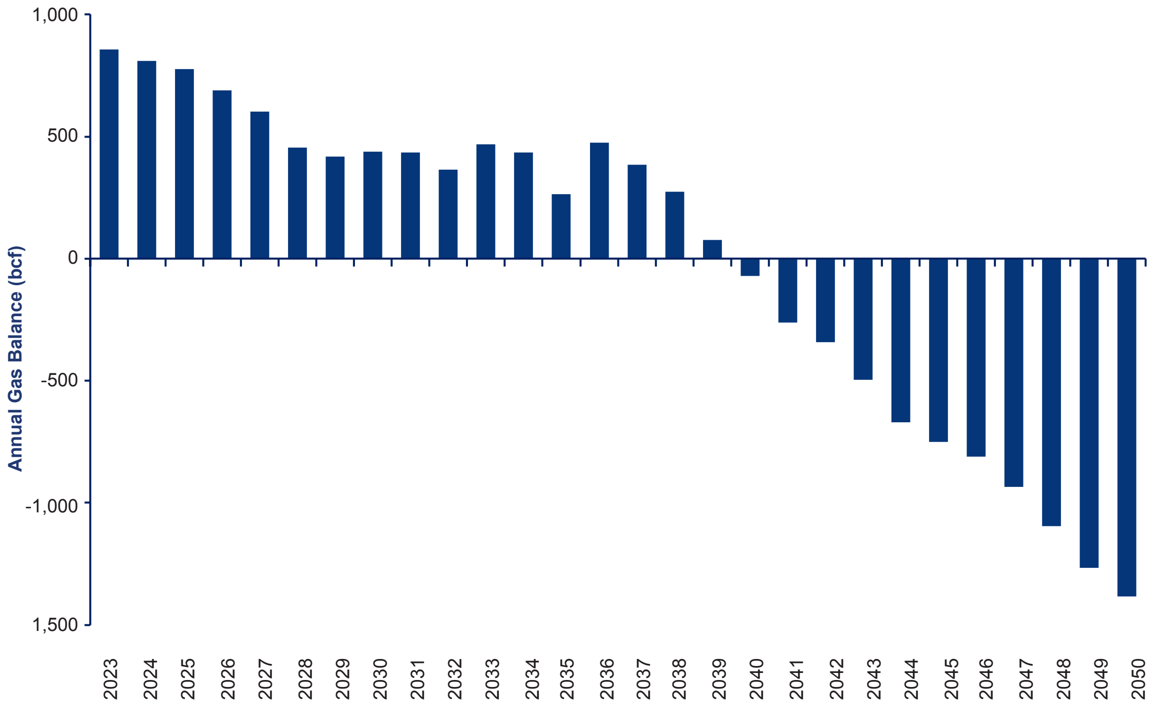
4.1.2. Gas as an industrial feedstock

Indonesia's natural gas markets are likewise at risk of experiencing a tight domestic supply-demand balance, resulting in Indonesia transitioning from a net gas exporter to importer by 2040 (Figure 17). This will be driven by an anticipated surge in domestic consumption as well as regional demand for both LNG and piped gas. However, as alluded to in Section 3.2, a more nuanced review of the two primary end-markets (industrial and power) is required to draw out the implications for gas supply requirements. The benefits of increasing natural gas domestic production must be considered separately for the two main usages of natural gas.

The industrial sector accounts for the largest share of gas demand in Indonesia (63% of total gas demand), and consumption will likely increase further in line with economic growth. Furthermore, natural gas as an industrial feedstock does not currently have a direct substitute. With domestic natural gas production expected to decline, there is a material risk that Indonesia's industrial sector might become dependent on natural gas imports. The benefits of increasing domestic natural gas production and maintaining Indonesia's as a net natural gas exporter are clear. Many of the benefits are comparable to those applicable for reducing oil imports—**improved balance of trade, improved balance of payments, protection from international price volatility,** and **protection from international supply chain disruptions.** Other key benefits include:

- **Reduction in Feedstock Costs & Reliance on Gas Pricing Adjustments**: Supports industries like petrochemicals, fertilisers, and manufacturing, allowing them to access a cost-effective source of feedstock, enhance their production efficiency, and lower operational expenses without the need for government-led pricing mechanisms, leading to overall improved competitiveness.
- **In-country Value Capture and Industrial Capacity Expansion:** Ensures cheap feedstock availability for potential expansions or new capacity (i.e. smelters & refineries) coming online.
- **Multiplier Effect and Value Chain Expansion:** Creates incremental value along the entire gas value chain, including new liquefaction projects (e.g. Abadi) and expansions (e.g. Tangguh).
- **Export Opportunities for Excess Gas:** Based on the RUEN estimate of gas demand in Indonesia (5 BSCFD) and the GOI target of 12 BSCFD by 2030, there is significant opportunity for the government to realise increased revenue stream from exporting the excess gas.
- **Natural Gas Downstreaming:** enables the development of gas derivative production such as ammonia or methanol.

Figure 17: Indonesia Gas Supply-Demand Balance



Source: Wood Mackenzie – Lens Database (Q2 2023)

4.1.3. Gas as a fuel for power

In contrast to gas demand in the industrial sector, which is expected to remain robust over the next decade under both BaU and OPT (increasing by 3.8% CAGR and 10.3% CAGR, respectively), gas demand in the power sector is more complex. At the global level, natural gas will increasingly replace coal in the power sector as a lower-carbon alternative, driven by international pressure from both governments and investors. This will likely contribute to a more sustained global demand for gas relative to coal. However, within the context of Indonesia, natural gas demand will remain variable due to uncertainties in the power mix.

The Indonesian government has certainly announced initiatives to reduce reliance on coal—PR No. 112/2022 outlines several restrictions for coal power development and operations:

- Within 10 years of the start of operations, the project must commit to reduce greenhouse gas emission by 35% compared with Indonesia's average coal plants emission in 2021, by deploying new technologies, using carbon offsets, and building new renewable energy power generation.
- New coal power plants must halt operation by 2050 at the latest.
- Coal projects that are already in the pipeline and strategic national projects that create jobs or boost economy growth (e.g. extractive resource industry integrated projects) are exempted.

However, the effectiveness of these policies remains unclear.

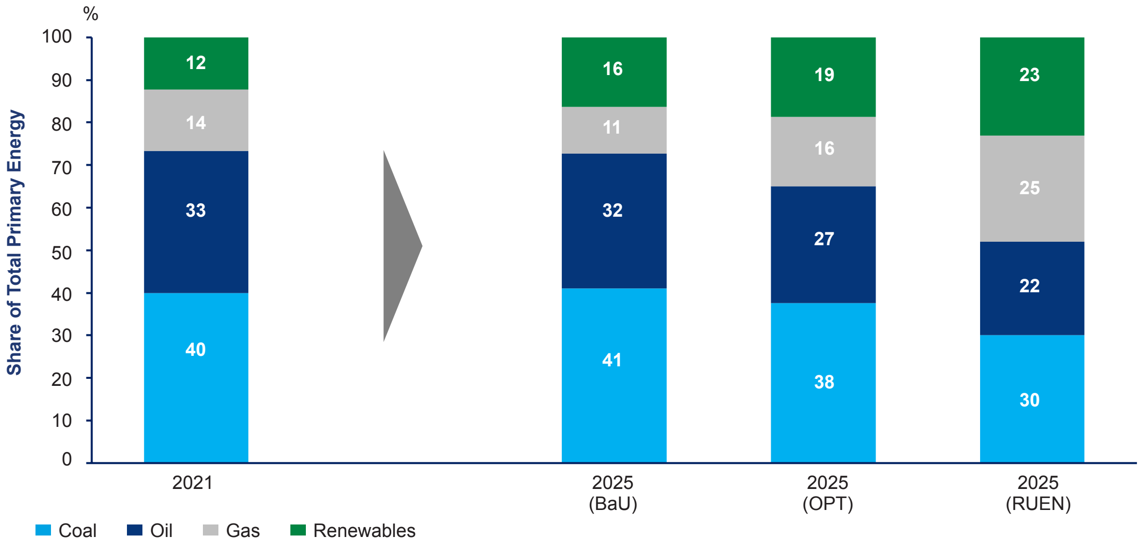
- For example, as the country plans new green industrial parks (e.g. in Tanah Kuning, North Kalimantan) to develop its nickel reserves (a key component for batteries and EVs), exemptions will be given to relevant coal power plants, prolonging the reliance on fossil fuels. To some extent, this offsets the beneficial environmental impact of EVs, with the reliance on unabated coal power increasing the full lifecycle carbon footprint of the vehicles.
- Financing the early retirement of coal power plants likewise remains ambiguous and will be expensive (e.g. US$1.36 bn. paid by the Alberta government for the early retirement of 6 coal power plants owned by Capital Power Corp., TransAlta Corp., and ATCO Ltd).
    - In November 2022, developed nations led by the U.S. and Japan announced the Just Energy Transition Partnership (JETP), an initial USD 20 bn deal (USD 10 bn in public funding and a further USD 10 bn from private sector investors) to help Indonesia shift from coal power to renewable, but the details of how the JETP will materialise, how firm the commitments are and whether they will in fact contribute to the early retirement of coal plants remain unclear.

As discussed in Section 3.2.2, unpredictability of renewable energy's role in the energy mix further adds to the unpredictability of demand for gas as a fuel for power. Renewables capacity will continue to increase, but the speed at which solar, wind, geothermal, and hydro can be scaled to the required levels is highly uncertain. Large-scale renewables deployment faces an array of challenges including:

- Raw materials availability for power generation units, batteries, and transmission infrastructure.
- Supply chain bottlenecks to source and import equipment into Indonesia.
- Availability of renewable resources and feasibility of transmitting renewable power from where it is found to where it is consumed.
- Need to develop the power infrastructure.
- Ability of the grids to handle intermittency.
- Cost competitiveness of renewable power, particularly when intermittency mitigations are costed-in.

Due to these uncertainties surrounding power demand, coal power generation, and renewable power generation, forecasting how Indonesia's power generation mix will evolve by 2050 and the role that natural gas is expected to play will be challenging. The Indonesian governments' own outlooks and development plans illustrate the complexity in understanding future gas needs. DEN's outlook suggests a vast range of possibilities for gas' role in the power markets, stating that electricity generated from gas may either decrease by 87% (BaU) or increase by 158% (OPT) by 2032. This wide variation resulted in two conflicting forecasts of gas' position in the overall energy mix, both of which also diverge from the government's projections based on the National Energy Policy (RUEN). With the latter forecast anticipating up to 25% gas share of total energy mix by 2025, both BaU and OPT scenarios may be underestimating the need for investments.

Figure 18: Comparison of Total Primary Energy Mix Forecasts Across Government Scenarios



Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

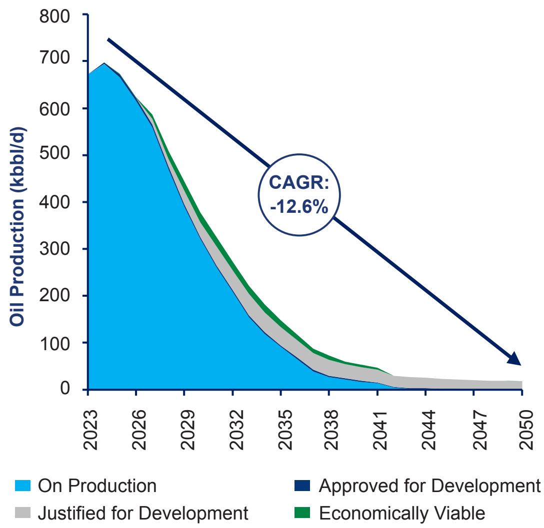
In the context of power generation, increasing domestic gas production is therefore about ensuring that despite the uncertainty of forecasting Indonesia's power generation mix, power security, and affordability will not be threatened, while at the same time promoting a cleaner and more sustainable investment:

- Domestic gas production shields against the uncertainty of not knowing accurately how power demand, coal, and renewable power generation will evolve. In case of supply shortages, gas-based power will play a crucial role in augmenting the resilience of the grid and ensuring energy security.
- Domestic gas offers the optionality of adjusting the country's strategy should external or internal elements require it (e.g. avoiding supply chain constraints due to geopolitical tensions and wars).
    - For this optionality to exist, however, early investment in gas production capacity is required—E&A and development of new wells require significant amount of time prior to first production.
- Domestic gas production for power will enable the deployment of renewable power if battery capacity struggles to keep pace with generation capacity. Gas as peak capacity allows to remove the bottleneck that batteries could put on renewable power growth.
- Domestic gas production offers the optionality of switching from coal to a less CO_2 emitting source of baseload power if the decarbonisation of coal power does not reach the targeted levels.
    - Phasing out coal too quickly can result in energy security issues, grid instability, and affordability. Adequate alternative energy sources, with proven and ready infrastructure, will be key to transition away from coal. As a reliable and dispatchable alternative to coal, gas will play a critical role in maintaining the resiliency of the energy system.
- Even if not used for power, excess domestic gas can be sold as piped or LNG export thus generating revenue for Indonesia, improving the balance of trade and improving the balance of payment.
- Increasing domestic gas production to avoid import dependency ensures the value remains in-country and has a multiplier effect on the entire energy value chain rather than being sent overseas.

4.2. Blockers & enablers

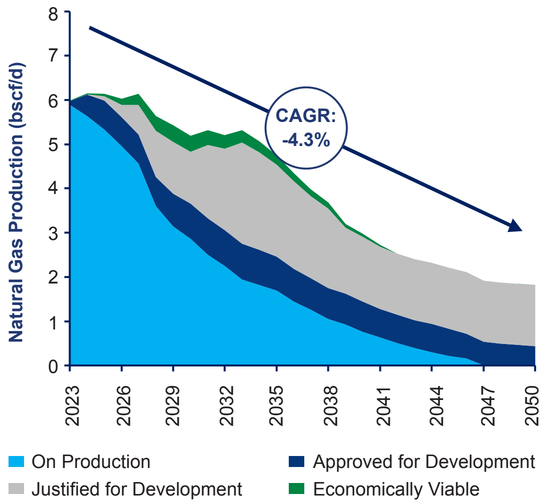
Without further investment, oil and gas production rates will remain far below Indonesia's targets of reaching 1 million b/d and 12 bcf/d, respectively, by 2030. Progress at the limited number of key development projects continues to stall, and Indonesia's long-term supply outlook is increasingly reliant on investment in mature fields and high-impact exploration. However, lower exploration activity in recent years, especially in high-impact plays, has translated to fewer material developments on the horizon. BP's FID of the Tangguh Expansion in 2016 was the last major project sanction. The outlook for the largest remaining pre-FID projects is challenging. INPEX's Masela (Abadi LNG) and Chevron's Indonesia Deepwater Development (IDD), while nationally important, are stalled by marginal economics, a rising requirement to mitigate carbon emissions, and participation uncertainty. Recent play-opening discovery Timpan will require further appraisal before it can be declared commercial. Accordingly, the historical decrease in remaining reserves and production observed in Figure 10 will likely continue after a slight uptick in 2024, with domestic oil and gas production expected to decrease at 12.6% CAGR and 4.3% CAGR, respectively, until 2050 (Figure 19 & Figure 20).

Figure 19: Indonesia Domestic Oil Production



Source: Wood Mackenzie – Lens Database (Q2 2023)

Figure 20: Indonesia Domestic Gas Production



Source: Wood Mackenzie – Lens Database (Q2 2023)

Nonetheless, untapped & undiscovered resource availability in Indonesia is likely substantial. The Ministry of Energy and Mineral Resources (ESDM) estimates that as of 1 Jan 2021, Indonesia has substantial reserves and contingent resources of oil and gas. This includes 3.95 billion barrels of oil reserves, 0.67 billion barrels of oil contingent resources, 60.61 trillion cubic feet (TSCF) of gas reserves, and 68.42 TSCF of gas contingent resources. Furthermore, Repsol's 2019 Kali Berau Dalam discovery onshore South Sumatra and Harbour Energy's 2022 Timpan find demonstrate that frontier plays within Indonesia's mature basins still hold potential for material "yet-to-find" (YTF) resources.

If resources were to be developed, existing markets will likely be able to absorb the additional production, either domestically (if demand, particularly in the power sector, remains robust as anticipated) or internationally, via regional LNG export (shipped to China, Japan, Korea, Taiwan) or regional pipelines (Singapore, Malaysia). By attracting greater investments and focusing on connecting the supply of oil and gas with the demand from domestic and regional markets, Indonesia can revitalise its domestic production and reduce import dependency. In turn, this would enable Indonesia to utilise gas as a key feedstock for domestic industries and maintain power supply security while also leveraging regional export opportunities.

With both demand and supply in place, what Indonesia currently requires is greater investment and E&P activities within the country. More exploration activity is still required, particularly in Eastern Indonesia's frontier basins, but to attract investments, prospectivity needs to be proven either through additional data or exploration success. As such, to maximise the benefits from its resources, Indonesia must act promptly, recognising that O&G development is a time-consuming process (estimated lead times for key assets like Abadi and Ganal PSC exceed 20 years). A timely appeal to domestic and international investors is crucial given that capital allocated to O&G investments is increasingly restricted in favour of low-carbon technologies. O&G players have also been focusing on the most advantaged resources (e.g. low-cost assets with low carbon intensity) and have been relinquishing assets that do not yield a quick payback. Accordingly, Indonesia must proactively attract foreign investors by creating an enabling environment and offering attractive opportunities that align with their financial and sustainability objectives.

Investment decisions are primarily based on three factors, among others (refer to Figure 22):

- **Return**: Profitability and financial viability of the investment, as measured by metrics such as net present value, internal rate of return, and payback period. This includes the impact of government profit sharing and other terms listed in the PSC/concessions that affect the economics of the projects.
- **Certainty & Stability:** In addition to legal considerations and guarantees listed under the contracts, fiscal stability (e.g. reliability and predictability of the governments' future modifications of contracts or introduction of new policies) as well as social/political/economic landscapes also affect investability.
- **ESG Performance:** Investors consider the emissions associated with the project's activities (Scope 1 and Scope 2), as well as indirect emissions from its value chain (Scope 3), to assess overall risk and exposure. Providing mechanisms and solutions to ensure decarbonization and reduce carbon risk is essential in attracting investors who prioritize sustainability and ESG-aligned investments.

These three factors, in turn, form the basis of the criteria that policymakers should strive to meet in order to increase the attractiveness of domestic O&G investments.

Given the need to attract more investments to unlock domestic O&G potential, policymakers need to address the following questions:

- What are the specific blockers that today hinder E&P investment attractiveness in Indonesia by limiting Return, Certainty, & Stability or ESG Performance?
- And how can Indonesia best address them to help drive new investments in the development of Indonesia's oil and gas resources?

Understanding which blockers have the most impact and can be best addressed is fundamental to prioritise efforts, given constrained time and resource. Historically, adjusting the fiscal terms has been the key levers that governments have used to adjust the attractiveness of O&G investments. Prospective investors often scrutinise the impact of fiscal terms on the economic viability of their investments, comparing the terms against those of comparable regimes. However, other blockers, including ease of doing business and net-zero concerns, are also key considerations.

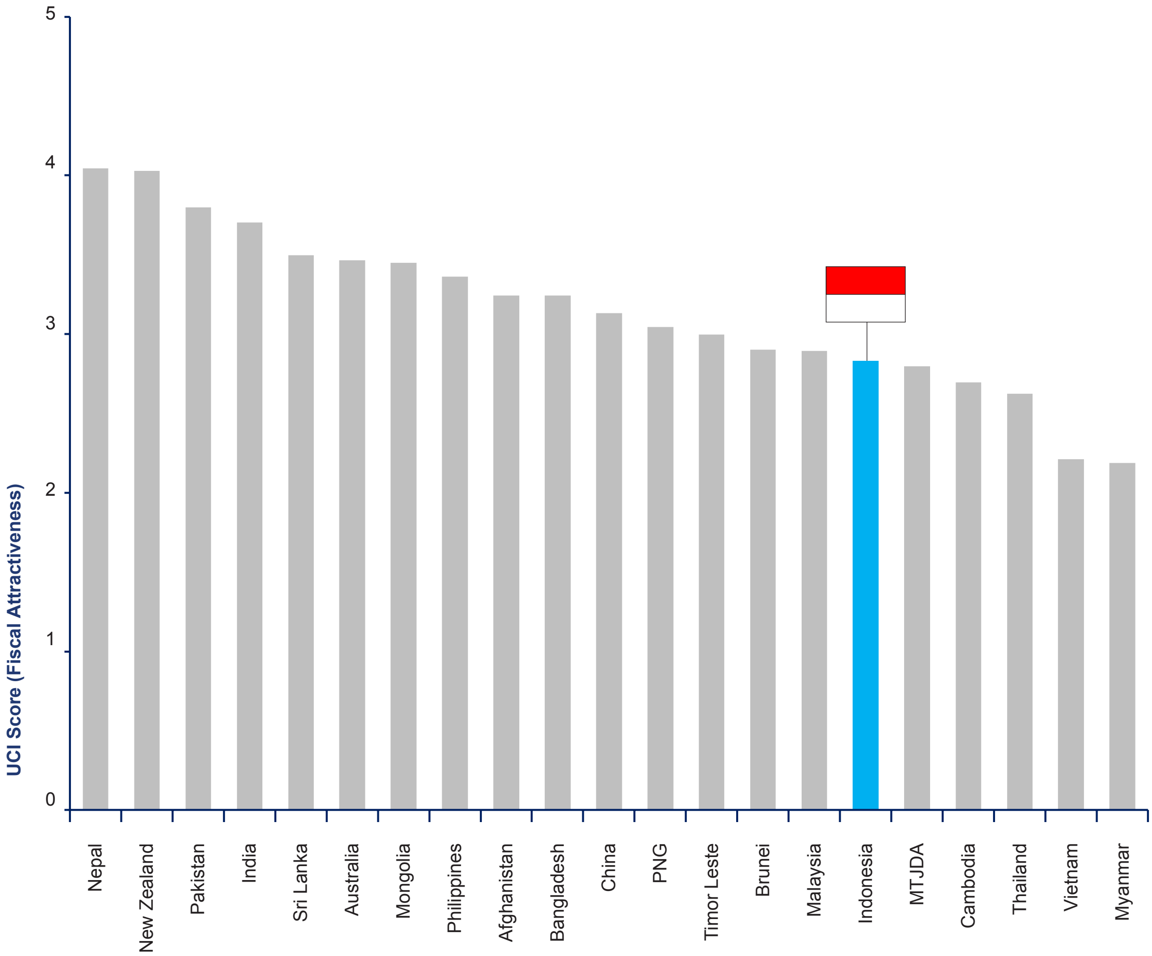
Indonesia's fiscal competitiveness

Wood Mackenzie and IPA's assessment of Indonesia's current fiscal terms suggests that returns provided to E&P investors may be further improved to become more competitiveness against neighboring O&G regimes (refer to Wood Mackenzie's Upstream Competitiveness Index ratings[12] provided in (Figure 21).

[12] Wood Mackenzie's Upstream Competitiveness Index contains ratings of countries' relative competitiveness of the fiscal terms for new licences (5 = best; 1 = worst), considering the government's share of future cash flows from a range of hypothetical developments under various prices. This is supplemented with considerations of bonuses payable and the level of carried state equity.

- **Limited incentives for existing projects**: While fiscal terms have been improved for new blocks and developments, such as custom duties, accelerated depreciation, and tax credits, these improvements do not extend to existing projects. This lack of incentives for brownfield redevelopments and enhanced oil recovery (EOR) hinders efforts to boost production from mature fields. Providing fiscal benefits to existing projects can encourage further investments in these areas, which have the potential to increase Indonesia's production.
- **Flexibility in government share and cost recovery**: Allowing greater flexibility in managing the government's share and cost recovery, particularly for marginal or challenging projects, can incentivise investments. The value of exploration and production (E&P) operations should be seen beyond direct government revenue. It can create a multiplier effect, generating additional value for the broader economy. Offering flexibility in fiscal terms can attract more investment and promote economic growth.
- **Balancing risk mitigation and innovation**: Precautionary measures taken to mitigate the risk of criminalization may inadvertently limit the capacity and willingness of government officials to make innovative decisions that support investments. Striking a balance between risk management and promoting innovation is essential. Encouraging an environment that allows for out-of-the-box and innovative decisions can support investments and drive the growth of the oil and gas sector.

Figure 21: Wood Mackenzie's Upstream Competitiveness Index (UCI) Scores (Asia-Pacific Only)



Source: Wood Mackenzie – Upstream Competitiveness Index (Q1 2023)

Indonesia's fiscal stability

Fiscal stability plays a vital role in encouraging investments in the oil and gas sector by providing a predictable environment and reducing uncertainty for investors, which in turn promotes long-term planning and enhances investor confidence.

- **Unilateral/unexpected changes**: If a country has a history of implementing unilateral and sudden changes to fiscal policies, it can create uncertainty for investors. Indonesia's introduction of the Gross Split system, changes in indirect taxes, and new requirements for revenue repatriation may have been perceived as arbitrary and may consequently have eroded investor confidence.
- **Difficulty in predicting the impact of fiscal terms**: The complexity of fiscal terms, such as those associated with the Gross Split system, can make it challenging for investors to accurately predict the financial outcomes of their investments. The fact that the splits are determined only at the time of the Plan of Development (POD), which can be years after the initial investments, adds further uncertainty. Investors need clarity and transparency in fiscal terms to assess the potential returns and risks associated with their investments.
- **Prolonged development stage of the new Oil & Gas Law**: Delays in finalizing the new Oil & Gas Law can contribute to investor uncertainty. Investors may adopt a "wait and see" approach until the law is issued, as they want to understand the regulatory framework and its potential impact on their investments. The perception of unclear authority and reach of SKK Migas can also lead to concerns about potential reversals or inconsistent decision-making.
- **Inconsistencies in the implementation of the 10% Participating Interest (PI) of the Regional Government-Owned Enterprises (BUMD)**: Inconsistent application of requirements related to the 10% PI of BUMDs may also introduce an additional layer of uncertainty for investors. Inconsistencies can create confusion about the obligations and rights of investors, leading to concerns about fairness and the stability of investment conditions.
- **Other concerns related to long-term fiscal changes**

Ease of Doing Business

The ease of doing business plays a vital role in promoting investments in the oil and gas sector by reducing administrative burdens, streamlining processes, and enhancing investor confidence.

- **Delays in the permitting process**: The perceived complexity and bureaucracy of Indonesia's permitting process, along with the involvement of multiple ministries, may create significant hurdles for oil and gas projects. While there have been significant improvements made by the government, obtaining permits may be time-consuming in many cases, leading to delays in approvals. Limited resources within SKK Migas for reviewing POD submissions may further prolong the process. The meticulous scrutiny of submissions and monitoring, driven by concerns like unintended criminalization and cost recovery-related requirements, can add to the administrative burden.
- **Misalignments in regulatory actions**: Enhanced coordination among ministries during the implementation of regulations is crucial to maintain a favourable business environment. It is necessary to conduct a comprehensive analysis of the potential impact before implementing regulations, such as the effect of the Land and Building Tax (LBT) on project economics during the production phase. Conflicting requirements, such as import duty exemptions and obligations to procure foreign goods through local vendors, further adds to the complexity of the regulatory landscape.
    - Additionally, there is a need for better integration of decision-making in exploration and production (E&P) activities into the broader national strategy for achieving net-zero emissions and developing carbon capture, utilization, and storage (CCS/CCUS) capabilities. The current decision-making processes and regulations in the oil and gas sector may not sufficiently align with long-term goals in these areas.

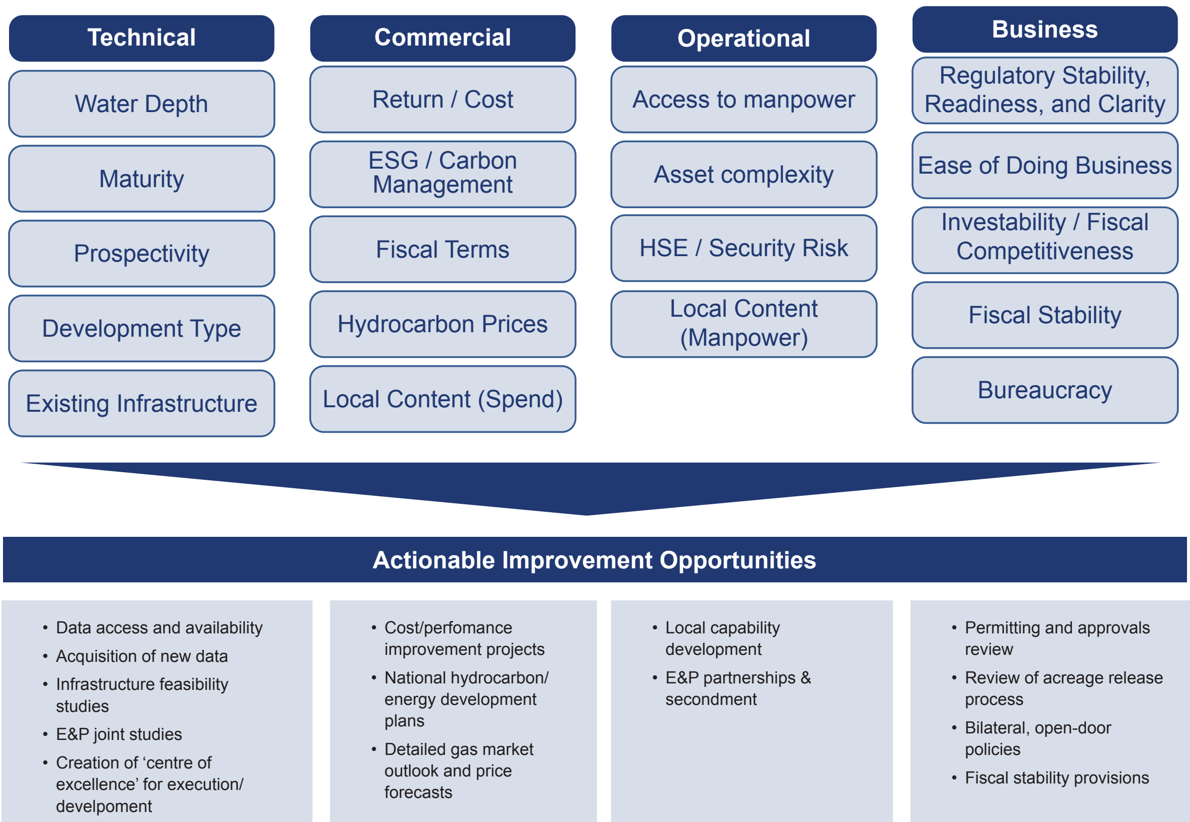
- **Long-Term Political Vision**: The oil and gas industry in Indonesia faces challenges related to long-term political vision and stability. The short duration of political cycles (~5 years) contrasts with the long-term investment horizon (20-25 years) required for E&P projects.
    - Changes in political vision driven by short-term interests can undermine investor confidence and disrupt long-term planning.
    - Accordingly, there is a need for a long-term oil and gas strategy that transcends party lines and provides a long-term guiding vision for the country addressing:
        - The role of O&G in the energy transition.
        - The level of decarbonisation expected from the O&G industry.

Net-zero E&P investments

Creating an environment that enables low-carbon E&P investments and ensuring alignment with the corporate net-zero targets are key steps to attract increasingly environmentally conscious investors.

- **Scope 1 & 2**: Efforts should be made to reduce scope 1 and 2 emissions, which involve minimizing venting, flaring, and leaks, as well as utilizing decarbonized power sources such as RE, gas with CCS, or coal with CCS. These measures can directly reduce emissions from E&P operations.
- **Scope 3**: Given that fossil fuel consumption accounts for 90% of the total carbon emissions in the E&P sector, broader decarbonisation efforts are necessary to reduce scope 3 emissions. This entails implementing CCS technology.
- **Offset**: To achieve net-zero, E&P projects will need access to carbon credits that allow them to offset emissions that cannot be abated through direct reduction. The government should focus on enabling access to and recognition of carbon credits through a dedicated regulatory framework as well as access to marketplaces. Carbon removal is a key step towards enabling offset optionalities.

Figure 22: Investment Decision Factors for E&P Companies



Source: Wood Mackenzie

4.3. Proposed solutions & recommendations

Wood Mackenzie and IPA have identified 4 overarching actions that will collectively enhance the investment appeal of Indonesia's upstream opportunities:

Long-term Energy Roadmap
Uncertainties about O&G's role in Indonesia's future energy landscape will likely dissuade prospective investors and companies from committing their capital to the upstream sector. The roadmap should elaborate on how domestic oil & gas production will help achieve Indonesia's energy resilience and sustain economic growth and development. As such, the roadmap should not be limited to just providing projections but also include:

- An articulation of the energy transition pathway, with explicit mention of the levers (e.g. oil & gas, CCUS, etc.) which outlines the specific role of each lever.
- Expected gains from domestic oil and gas production, differentiating between gas as a feedstock for the industry and gas as a fuel for power generation.
    - Ability of the domestic production to offer versatility and flexibility to de-risk the inherent uncertainties of long-term forecasts and projections.
- Role that the different actors of the Indonesian oil and gas value chain (private sector, SOE, regulator, government) are expected to play in capturing the benefits of O&G investments.
    - It is especially important to highlight that the government does not simply engage in unilateral actions but rather works closely with prospective investors to facilitate the development of required infrastructure, promote research and development, and enhance relationships with various stakeholders on the investors' behalf. Governments also address social and environmental concerns, ensure the equitable distribution of benefits, and engage in regional and international energy cooperation.
- Expected levels of decarbonisation across the oil and gas value chain, addressing scopes 1, 2 and 3 emissions.

Ultimately, this roadmap will not solely provide forecasts and projections but will clarify the role that the government expects domestic oil and gas production to play in the country's overarching energy strategy and will provide the rationale for this expectation.

Overarching Legal Framework
Establishing a comprehensive legal framework to oversee and regulate all E&P activities within Indonesia will enhance regulatory stability, transparency, and ease of doing business. The framework should include:

- Clear, permanent, and transparent rules governing the authority, roles, & responsibilities between different stakeholders including SKK Migas, PERTAMINA, ESDM, and other ministries.
    - Authority for the regulator to coordinate all related permitting requirements to be prescribed in the new oil and gas law to speed up the process and reduce bureaucracy.
    - This includes identifying and outlining the roles of the regulator for CO_2 injection, storage, and monitoring (expected to be the same as the E&P regulator).
    - As proposed by IPA, implementation of upstream businesses may be carried out directly by BUK Migas or via cooperation with Business Entities or Permanent Establishments (including SOEs), instead of first offering working areas to SOEs.
- Clarity on legal enforcement mechanisms and responsibilities which must be aligned with the new oil and gas law, prevailing regulations, & PSC/contracts.
    - Agreements and terms & conditions to be recognized by the government until the expiration of the PSC/contract.
    - PSCs/regulations must be timely to avoid any lag between the introduction of regulations and the impact).
        - They should also grant more leeway to contractors—IPA recommends greater flexibility in the requirement for PSC extension (application should be required no later than 2 years before it ends (as opposed to 5), to provide greater flexibility and certainty for the contractor).

  - Regulations should include clear processes and responsible parties for implementation & enforcement.
  - Implementation should not differ from the prescribed rules.

- Mechanisms to alleviate the current fear of criminalization for both regulators and contractors, including settling business disputes in a court of arbitration instead of a criminal court (we understand that a draft of presidential instruction has been discussed).
  - IPA is of the opinion that problems, disagreements, conflicts arising from or originating from the implementation of the PSC, including audit findings by state auditors, to be resolved through a conflict resolution mechanism based on the PSC.

- Streamlined procurement process (e.g. drilling, EPC) to reduce costs and accelerate development.
  - Long lead times in obtaining procurement approval (6-12 months) undermines the ease of doing business. Improving ease and speed of business approvals, accelerating field development approvals (POD), guaranteeing contractor right to freely export its share (petroleum), and guaranteeing flexibility and fairness to submit extension proposals are all key steps to improving the ease of doing business, based on IPA observations.
  - Norway and Kuwait's approach to standardising contract terms may also be considered to reduce duplication and improve coordination among contractors.

- Simplified, fast, and reliable licensing procedures, with improved coordination between ministries
  - According to IPA, allocating the responsibility of obtaining the permits needed in upstream oil and gas operations from the relevant Ministries / Institutions / Local Governments to BUK Migas to facilitate the processes.

- Flexibility in allocation/export requirements.
  - IPA is of the opinion that while the central government should continue to establish the allocation of the use of petroleum in the state and sets policies and the number of natural gas export quotas by considering the fulfilment of domestic needs, contractor should be given the right to export the petroleum part and natural gas.

Enhanced/redesigned Fiscal Regime

Improving Indonesia's fiscal competitiveness by catering to the requirements of investors is key; conducting a rigorous analysis of each existing fiscal term and its relative impact on contractor returns allows identification of thresholds (e.g. minimum requirements for the government, if any) and prioritisation of changes to be made to ensure competitiveness against peer regimes. There is no "one-size-fits-all" set of fiscal terms that encompass all prospects in Indonesia. Terms can be arranged and combined to create permutations that most appropriately suit the needs of both the government and the investors. However, there should be different sets of terms tailored to the specific challenges that different types of fields face. Different terms can be adjusted and combined under different permutations to target specific end-goals. Nonetheless, key areas of potential improvements include:

- Guaranteeing a negotiated, reasonable, and project-specific minimum rate of return (to be formally quantified) for the contractors and shared upside and downside risks.
  - A profitability-based fiscal regime (e.g. R-factor, IRR-based) may grant the flexibility required to adapt to different project types and price & cost fluctuations.
  - Discretionary mechanism/re-opener clause (governed by clearly defined rules) to ensure IRR targets are met in extreme situations that the profitability-based regime does not cover.
  - To avoid uncertainty, flexibility mechanisms should be based on known parameters so that investors can have visibility on the possible fiscal scenarios.

- Incentives (e.g. ring-fencing across PSC, investment credits, tax exemptions/holiday, incentives for CCS/CCUS) especially for existing brownfields, and new marginal fields/DRO development; field-specific terms suited for different asset types to suit investors' risk appetite.
    - Economics differ across assets that are deepwater (capital-intensive with high risk), small (lower materiality requiring cost efficiency and simplified concepts to suit shorter life), high contaminants (added challenges of contaminant management), frontier (requiring high technical expertise and risks), late life (maximising remaining production & managing decommissioning obligations), etc.

- Review of the domestic gas pricing mechanisms.
    - In most comparable fiscal regimes, gas prices reflect the market price (based on agreements between sellers and buyers). To be competitive, gas prices should reflect project economics and investor needs; direct subsidies to end-use industries may be considered.
    - Freedom for contractor to set price is key to ensure alignment with regional/global gas prices.

- Participating interest obligations.
    - IPA is of the opinion that 10% PI obligation should be carried out based on the business-to-business (B2B) principles.

- Contract flexibility.
    - Ability for existing PSCs to adapt to new fiscal terms to ensure development of marginal fields and extend the life of matured fields.
    - Flexibility to revisit fiscal terms of new PSCs offered to dynamically adjust the fiscal competitiveness of Indonesia as external conditions evolve.
    - Transferability of remaining definitive commitments that have not been implemented to other blocks or open areas.

- Other measures could include adjustments to royalty/FTP, maximum/minimum contractor profit share rate, profit sharing structure (stepped vs sliding scale), DMO, etc.

E&P countries globally, including Indonesia's regional competitors like Malaysia, have actively adjusted their fiscal regimes largely in favour of contractors to attract investments. For example, Malaysia has offered highly targeted/customised terms that address the challenges of specific asset types, increasing their competitiveness relative to other comparable assets in the region. Without a timely upgradation of fiscal terms to increase the appeal of its assets, Indonesia may fall behind its peers. Recommendations from key stakeholders like IPA, including fiscal adjustments and other improvement measures, will be crucial to enhance the investability of Indonesia's O&G opportunities.

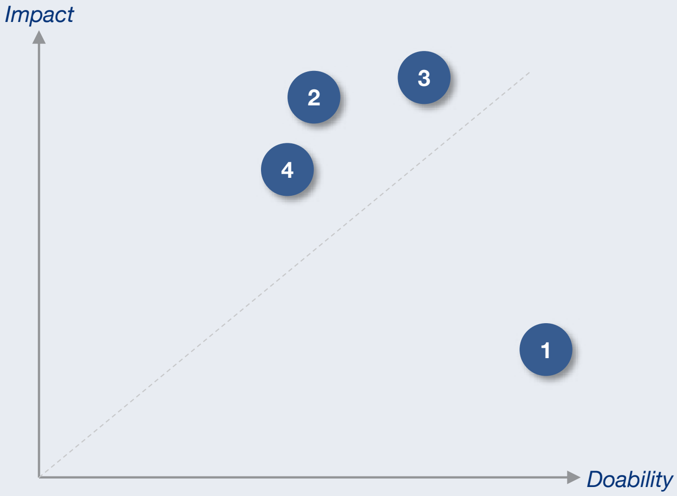
National GHG Emission Reduction Framework
Developing a transparent national framework for reducing GHG emissions which aligns with international best practices can be a key step towards promoting a "low-carbon" O&G sector. This framework will provide economic agents with actionable rules and methodologies to achieve net-zero emissions. It will allow companies to continue delivering their sustainability strategies and maintain their license to invest:

- Development of a roadmap specifically for energy transition.
- Clear emission reduction targets.
    - The framework should establish specific and measurable targets for reducing greenhouse GHG emissions from the oil and gas sector. These targets can be based on national commitments under international agreements such as the Paris Agreement or tailored to the country's specific circumstances and priorities.

- Sectoral emission baseline and inventory.
    - A comprehensive baseline and inventory of GHG emissions from the oil and gas sector should be established (e.g. minimum operational and decommissioning standards). This includes measuring and reporting emissions from exploration, production, processing, transportation, and distribution activities. The inventory provides a foundation for assessing progress and identifying areas of focus for emission reduction efforts.
- Incentives and mechanisms to encourage companies to reduce carbon emissions, adopt low-carbon technologies, implement energy-efficient practices, and invest in CCUS projects.
    - Ensuring that GHG emission reduction activities are part of upstream oil and gas activities (Petroleum Operation), so that related costs or expenses are treated as a part of the operating costs, can help incentivise investments.
- Robust monitoring, reporting, and verification (MRV) mechanisms to accurately track emissions and ensure compliance.
- Incentivisation of collaboration and knowledge sharing, including R&D initiatives in the field of clean technologies and partnerships between industry, academia, and research institutions to drive innovation in the sector.
- International carbon credit transfer mechanism will be key to enhancing CO_2 emission management.
- Capacity building and skills development.
    - The framework should prioritise capacity building and skills development programs to enhance the technical capabilities of the workforce in the oil and gas sector. This can include training on emissions measurement and reduction techniques, as well as promoting awareness and understanding of climate change mitigation strategies.

All 4 areas of actions should be progressed in parallel to address the urgent need to revitalise Indonesia's E&P production in the face of likely short- to mid-term domestic supply shortages.

Figure 23: 4 Actions Plans for Fostering Investments in Domestic O&G Production



1. Long-term Energy Roadmap
- The long-term energy roadmap can be part of and build on DEN's existing National Energy General Plan to further elaborate on the role and decarbonization expectations of domestic oil & gas, as has been articulated in this paper.
- This opportunity constitutes a "low hanging fruit" that will not directly impact investment attractiveness but will send a strong and clear message of reassurance and stability to the energy community looking to invest in Indonesia.

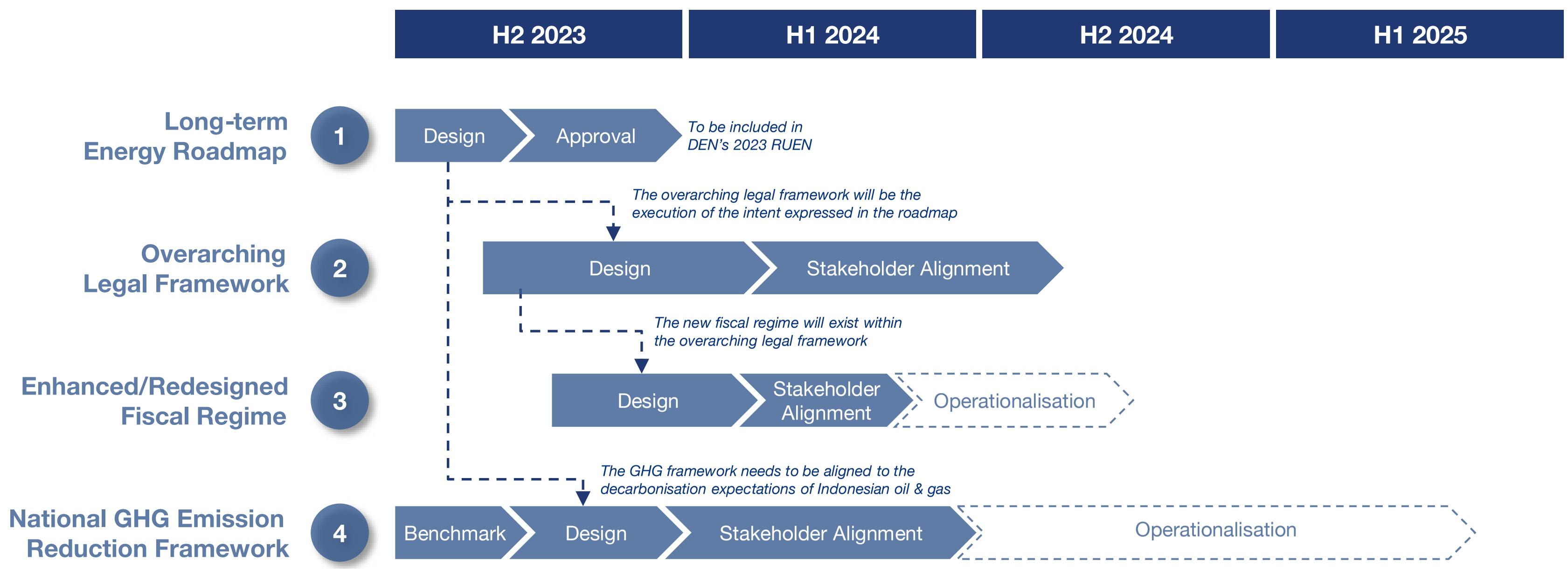
2. Overarching Legal Framework
- This framework is the fundamental piece of legislation that oversees and permanently regulates all E&P activities in Indonesia, with the aim to provide greater regulatory stability, enhanced regulatory transparency, and improved ease of doing business.
- Having been in discussion for many years without resolution, one of the main challenges will be the management of competing interest, the extensive cross-ministerial consultation and the stakeholder alignment needed to gain consensus on this new legal framework.

3. Enhanced/Redesigned Fiscal Regime
- An enhanced/redesigned fiscal regime can be designed in the span of only a few months and will have a significant impact on investment attractiveness because it constitutes one of the main drivers of investment return and the benefits yielded by the fiscal changes can easily be quantified and measured by investors.
- The main challenge will likely be stakeholder alignment within the government, particularly as the new fiscal regime will likely disrupt pre-conceived notions of what a fiscal regime can and cannot do, based on historical points of reference.

4. National GHG Emission Reduction Framework
- The underlying principles and methodologies of this framework can abide by existing and already implemented international best practices; operationalisation of the framework in a nation-wide system and alignment of the many national stakeholders however will likely prove very challenging
- Putting this framework in place will provide the rules and the playbook for the decarbonization of economic activities in Indonesia, something that cannot be recognized today. This will send a very strong signal to the international community and the investor community that Indonesia is supporting and enabling the move towards a decarbonized future.

Source: Wood Mackenzie

Figure 24: Illustrative Timeline for Action Plans for Fostering Investments in Domestic O&G Production



Source: Wood Mackenzie

05 Developing Domestic CCS/CCUS to Address the Trilemma

5.1. Value case

The International Energy Agency (IEA), the United Nations Framework Convention on Climate Change (UNFCCC), and the World Economic Forum, among other international and regional organisations, have all emphasised the important role that CCS/CCUS plays in mitigating GHG emissions and supporting a sustainable economic growth. The accelerated development of Indonesia's CCS/CCUS industry will be key to not only reducing its carbon footprint but also leveraging its competitive advantage to develop new economic sectors, with the potential to generate revenue.

Early successful projects can demonstrate how CCS/CCUS could meaningfully contribute to achieving Indonesia's net-zero target while also creating value for the country, fostering the domestic industry, enabling low-carbon products & services, and paving the way for decarbonisation at an international scale. The development of a robust CCS/CCUS industry in Indonesia is crucial for reducing the country's carbon footprint and driving economic growth while leveraging its competitive advantage. Indonesia is well-positioned overall to realise significant upsides both internationally and domestically:

International emissions capture

- **Generate revenue from international emissions**: Indonesia can attract international emitters who are willing to pay for CO_2 storage solutions. By providing storage services to other countries' emitters, Indonesia can generate income and contribute to its economic growth.
- **Enhance geopolitical standing**: Becoming a leader in decarbonization through CCS/CCUS can strengthen Indonesia's position on the regional and global stage. It showcases the country's commitment to addressing climate change and positions it as a key player in the global efforts to combat global warming.
- **Contribute to global climate action**: By actively participating in the fight against global warming, Indonesia can help create a more sustainable future for the planet. By reducing CO_2 emissions through CCS/CCUS, Indonesia can play a significant role in preserving the environment and ensuring a prosperous world for future generations.

Domestic emissions capture

- **Contribute to Indonesia's NDCs** by decarbonizing hard-to-abate sectors such as E&P (Exploration and Production), power generation, ammonia production, steel manufacturing, and more. By reducing emissions in these sectors, Indonesia can make progress towards its climate goals.
- **Reduce risks associated with global warming**. By capturing and storing CO_2 emissions, Indonesia can mitigate the impacts of climate change, such as rising sea levels, extreme weather events, and disruptions to ecosystems.
- **Improve investment attractiveness** by enabling net-zero activities across Scope 1, 2, and 3 emissions. This attracts companies that have corporate net-zero targets and encourages investment in Indonesian production capacity, not only in the E&P industry but also in other sectors.
- **Enable the production of decarbonised products and services** in Indonesia in order to increase export competitiveness and/or to sell at a premium.
- **Avoid the carbon taxation** of Indonesian exports through cross-border mechanisms and ensure the value remains in Indonesia rather than being paid to a foreign government.

There are also key associated benefits of creating a new economic sector aligned with the green economy, contributing to long-term sustainable prosperity. The development of CCS/CCUS can yield various benefits, including:

- **GDP growth**: The CCS/CCUS industry can stimulate economic growth by attracting investments, generating new business opportunities, and fostering innovation and technological advancements.
- **Tax revenues**: The growth of the CCS/CCUS sector can result in increased tax revenues for the government, providing additional resources for public services, and infrastructure development.
- **Employment**: The establishment of CCS/CCUS activities will create job opportunities across the value chain, from project development, and construction to operation and maintenance.
- **Foreign direct investment**: The emergence of a thriving CCS/CCUS industry can attract foreign direct investment, bringing in capital, expertise, and international collaborations, further bolstering the country's economic development.
- **Improvement of balance of trade and payment**: With the potential for exporting carbon capture technologies, services, and expertise, Indonesia can enhance its trade balance and reduce its reliance on carbon-intensive imports.
- **Capabilities and technological regional leadership**: By investing in the development of CCS/CCUS capabilities and technologies, Indonesia can position itself as a regional leader in this critical area, fostering expertise, knowledge transfer, and regional collaborations.
- **Political strengthening of Indonesia on the international scene**: Demonstrating leadership in CCS/CCUS can enhance Indonesia's standing, allowing the country to play an influential role in global climate action discussions and contribute to the global fight against climate change.

To realise the full potential gains listed above, Indonesia should pursue the **most expansive scope for its CCS projects**. Globally, varying CCS scopes have been adopted depending on site-specific characteristics, ranging from capturing from & injecting/storing in active petroleum working areas only to capturing from international parties to injecting/storing in dedicated domestic storage licenses:

- **Capture from & inject/store in active petroleum working areas only:** This scope involves capturing CO_2 emissions specifically from industrial facilities or power plants located within active petroleum working areas. The captured CO_2 is then injected and stored in underground reservoirs located within the same petroleum working area.
- **Capture from third-party sources and inject/store in active petroleum working areas:** This scope expands the CCUS operations to include capturing CO_2 emissions from third-party sources, which may include industrial facilities, power plants, or other sources. The captured CO_2 is then transported and injected into underground reservoirs located within active petroleum working areas.
- **Capture from domestic only third-party sources and inject/store in dedicated CO_2 storage licenses:** This scope involves capturing CO_2 emissions from third-party sources within the domestic jurisdiction. The captured CO_2 is then transported and injected into dedicated CO_2 storage licenses, which can include active petroleum working areas, depleted reservoirs, or saline aquifers specifically designated for CO_2 storage.
- **Capture from domestic & international third-party sources and inject/store in dedicated CO_2 storage licenses**: This is the broadest scope of CCUS, encompassing the capture of CO_2 emissions from both domestic and international third-party sources. The captured CO_2 is then transported and injected into dedicated CO_2 storage licenses, such as active petroleum working areas, depleted reservoirs, or saline aquifers designated for CO_2 storage.

Wood Mackenzie and IPA recommend that in order to extract maximum value, Indonesia should take the most ambitious approach: **capture CO_2 from domestic & international third-party sources and store it in dedicated domestic CO_2 storage licenses** (which can but do not have to be working petroleum areas).

The business model is also a critical component that shapes CCS project feasibility. The selection of models largely depends on investor preferences—different models offer varying levels of exposure, particularly regarding the upsides and risks associated with the ownership structure:

- **Standalone / fragmented value chain**: Different entities or companies handle different stages of the process. Typically, separate entities are responsible for capturing CO_2, transporting it, utilizing it, and storing it. Each entity focuses on its specific expertise or area of operation. For example, one company may specialize in CO_2 capture technologies, while another may focus on transportation infrastructure, and yet another may be involved in CO_2 utilization or storage. The entities may collaborate through contractual agreements or partnerships to ensure smooth coordination between the different stages.
- **Vertically integrated**: A single entity takes charge of the entire value chain, from CO_2 capture to utilization or storage. This means that the same organization handles all the stages involved in CCUS. By having control over the entire process, a vertically integrated company can potentially optimize efficiency and streamline operations. It allows for better coordination, technology integration, and decision-making. This model can be advantageous in terms of cost management, project execution, and technology development, as the entire process is under the same umbrella.
- **Hubs**: Multiple entities collaborate within a specific geographical region. These hubs act as centralised facilities that enable the integration of various CCUS activities. A hub may include CO_2 capture facilities, transport infrastructure, utilization facilities, and storage sites, all co-located in a specific area. The entities involved can be different companies, research institutions, or government bodies. By bringing together different expertise and resources, hubs promote collaboration and knowledge sharing, fostering innovation, and cost-effective implementation of CCUS projects.

The scope and business model of prospective CCS projects are part of the numerous project-specific characteristics that ultimately determine the scalability and commerciality of CCS in Indonesia. Location of end-use, availability of infrastructure, and size of storage/capture facility are only some of the additional considerations required during the project-by-project review to determine which projects are deemed most feasible and promising, which in turn should be the focus of Indonesia's developments in the near term.

Experiences of CCS/CCUS leaders serve as useful benchmarks for Indonesia's CCS development path. While still in early development stages, Norway, for example, has actively explored options to source from international 3rd party sources and has experienced high initial success and progress:

- **The Northern Lights Project** aims to establish a complete value chain for CO_2 capture, transport, and storage which involves transporting CO_2 from various industrial sources in Europe and storing it in offshore storage sites in the North Sea. By providing an "open-source infrastructure for CO_2 transport and storage, Northern Lights aims to contribute to establishing a commercial CCS market in Europe. On track for operations in 2024, Northern Lights will be the first to deliver cross-border CO_2 transport and storage as a service."[13] Key success factors include:
    - **Government-led R&D initiative**: With Technology Centre Mongstad (TCM) as a testing facility focused on R&D and demonstration of different capture technologies, Norway has created a collaborative and innovative environment which has led to a proliferation of CCUS assets & projects across all development stages.
    - **Collaboration and Partnerships**: The Northern Lights project is a collaboration across industry partners Equinor, Shell, and Total, the Norwegian state-owned company Gassnova, and countries (e.g. the Netherlands which signed the first cross-border agreement). The partnership brings together expertise, resources, and funding, enabling smooth progress.

[13] Northern Lights. "What We Do." https://norlights.com/what-we-do/.

Countries globally have begun to adopt successful pathways varying in emission sources, storage methods, and business models. These decisions hold the key to shaping Indonesia's strategic direction and governance structure for the CCS/CCUS industry, paving the way for significant synergies with the country's robust O&G sector. By setting an ambitious vision, Indonesia can position itself as a global leader in carbon capture and utilization, driving the transition towards a low-carbon economy while fostering technological innovation, creating new industries, attracting investments, and achieving long-term sustainable growth.

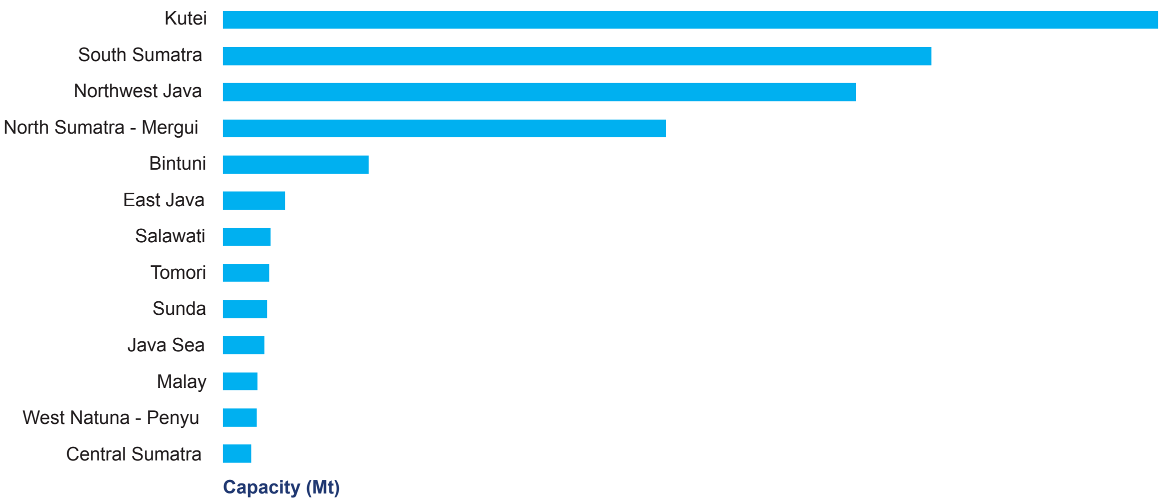
5.2. Blockers & enablers

Indonesia possesses significant storage capacity, particularly in the form of depleted oil and gas reservoirs, and saline aquifers. Depleted oil and gas reservoirs, resulting from historical exploration and production activities, offer well-understood subsurface formations that can potentially be utilized for CO_2 storage. While the capacity and effectiveness of individual storage prospects need further assessment, there is likely substantial storage potential in Indonesia—the Government of Indonesia estimates it to be around 2 Gt, while Wood Mackenzie estimates Indonesia's storage capacity at 7.4 gigatonnes (Gt). In addition to depleted reservoirs, saline aquifers hold even larger storage capacity, although detailed knowledge about their functioning and long-term storage capacity is currently limited. Extensive studies are required to understand saline aquifers and utilize them effectively as storage solutions. The Government of Indonesia estimates that Indonesia may have a storage capacity of 10 Gt within its saline aquifers, while ExxonMobil estimates that the capacity within Indonesia's saline aquifers may be closer to 80 Gt.[14]

Other competitive advantages that Indonesia has for the development of CCS/CCUS include:

- **Strong E&P industry**: Indonesia's well-established exploration and production industry has the technical capabilities and expertise to drive the entire CCS/CCUS value chain.
- **Repurposing existing infrastructure**: Existing E&P infrastructure, such as pipelines, can be repurposed for CO_2 transport and storage, reducing the need for extensive new infrastructure.
- **Proximity to Singapore**: Indonesia's proximity to Singapore enables collaboration and potential CO_2 transport for storage, leveraging existing gas pipelines, and commercial relationships.
- **Corporate relationships**: Established connections between emitters and E&P companies in Indonesia facilitate collaborations and partnerships for CCS/CCUS projects.

Figure 25: WM Estimate of CO_2 Storage Capacity by Basin (O&G Reservoir Only)*



Note: ** Figures exclude basin-scale/field scale saline formations' CO_2 storage potential; minimal reservoir storage capacities estimated for Seram, Barito, and Tarakan basins*

Source: *Wood Mackenzie Lens Database – Q2 2023*

[14] Energy Voice. "Indonesia Lagging Malaysia as CCS Starts to Grip Southeast Asia" (2022).

There is a significant demand for CO_2 storage in Indonesia and the wider Asia-Pacific (APAC) region, especially from countries with substantial carbon emissions, active carbon pricing mechanisms, and limited domestic storage solutions, including:

- **Indonesia:** With emissions of ~620 Mt of CO_2 in 2019, Indonesia can address its own emissions and contribute to its NDCs by developing a robust CCS/CCUS sector and utilizing its storage capacity.
  - The launch of a national carbon trading scheme targeting coal power plants has been announced; coverage will be expanded to oil and gas-fired power plants in subsequent phases.
  - A national carbon tax was planned to be introduced in 2022 but has been delayed thus far.
- **Singapore**: Despite its small size, Singapore has implemented a national carbon tax and could benefit from accessing CO_2 storage solutions in Indonesia to offset its emissions.
  - Under the Carbon Pricing Act, entities with an annual emission exceeding 25 $KtCO_2e$ are required to pay a carbon tax for their GHG emissions. The initial tax rate is set at SGD 5/ tCO_2e. The carbon tax is applied to power stations, refineries, and other facilities that produce 25,000 tCO_2e or more of greenhouse gas emissions annually.
- **South Korea**: With approximately 611 Mt of CO_2 emissions in 2019, South Korea's emissions trading scheme (ETS) has increased the demand for CO_2 storage solutions to meet emission reduction goals.
  - Under the Korean Emissions Trading Scheme (KETS), companies with an annual emission exceeding 125 $KtCO_2e$ and facilities with an annual emission exceeding 25 $KtCO_2e$ are allocated a certain number of emission allowances, and those that exceed their allowances must purchase additional permits from the market. The KETS covers the power, industry, buildings, domestic aviation, waste, transport, and public services. The emission allowances are gradually reduced each year to encourage emission reductions. The price of allowances is determined through market trading. The regime currently covers Scope 1 & 2 and targets companies. The cap is set at 3,048.3 $MtCO_2e$ for Phase 3 (2021-2025).
- **Japan**: With high carbon emissions of around 1,082 Mt of CO_2 in 2019, Japan could seek CO_2 storage options in Indonesia to offset its emissions and comply with its carbon pricing mechanisms.
  - Japan is now undertaking the first phase of ETS, involving voluntary participation from companies, that will continue for three years until the end of March 2026, marking a step forward in the development of its carbon pricing mechanism.

As such, it is worth noting that the primary bottleneck in CCS/CCUS development in Indonesia is not the lack of a market for Indonesia's storage capacity, but rather two overarching blockers:

- **Requirement for a fully developed value chain:** The successful implementation of CCS/CCUS requires the development of a comprehensive regulatory frameworks, investment mechanisms, and collaboration between stakeholders across the value chain.
- **Reliance on the emergence of economic activities:** A dynamic transactions for capture, transport, injection, storage, and monitoring solutions. This entails establishing a comprehensive network that includes technologies and infrastructure for capturing CO_2 emissions, transporting captured CO_2 to storage sites, injecting it into suitable storage formations, ensuring proper storage and monitoring, and enabling effective utilization of the stored CO_2. Moreover, to achieve a commercially competitive CCS/CCUS value chain, it is imperative to prioritise projects with the best commercial potential through careful selection and design. This approach ensures that the value chain is not only functional but also economically viable, attracting investment and fostering a competitive market.

To overcome these obstacles, various measures need to be in place. Concerted efforts are needed to conduct detailed studies on storage prospects, enhance knowledge about saline aquifers, and establish a functioning value chain. Additionally, substantial investments are required to accelerate the development of CCS/CCUS infrastructure and secure Indonesia's first-mover advantage in the pursuit of CCS/CCUS regional leadership. To attract the required capital, Indonesia needs to address three key elements:

- **Return**: Investors will evaluate the volume and timing of cash flows expected from CCS/CCUS projects. Different business models and levels of value chain integration offer varying investment value propositions, so it's crucial to demonstrate the financial viability and profitability of the projects. Governments can affect expected project returns with:
    - Financial incentives: Governments can provide financial incentives to encourage CCUS investment. This can include grants, subsidies, tax credits, or low-interest loans to offset upfront costs, reduce the cost of capital, or improve the project's financial viability. Financial incentives can help bridge the gap between the expected returns and the required returns for investors.
    - Carbon pricing mechanisms: Governments can implement or strengthen carbon pricing mechanisms, such as carbon taxes or emissions trading systems (ETS). By putting a price on carbon emissions, these mechanisms create a financial value for reducing emissions and provide a revenue stream for CCUS projects. Higher carbon prices can enhance the economic attractiveness of CCUS investments by increasing the potential returns.
- **Certainty & Stability**: Clear rules and regulations that govern CCS/CCUS activities in Indonesia need to be defined, providing certainty for investors in terms of project development, operational requirements, and potential changes to regulations. A well-defined role for CCS/CCUS in the political, economic, and social context of the country is also necessary.
    - Long-term contracts and offtake agreements: Governments can facilitate the signing of long-term contracts or offtake agreements with CCUS project developers. These agreements provide revenue certainty by securing customers for captured CO_2 or utilization products. They can give investors confidence in the project's revenue stream, reducing risks, and improving expected returns.
    - Regulatory support and streamlined permitting: Governments can streamline regulatory processes and provide regulatory support for CCUS projects. Clear and efficient permitting procedures, along with supportive regulations, can reduce project development timelines, minimize uncertainties, and enhance returns for investors. Governments can also establish regulatory frameworks that facilitate the deployment and operation of CCUS technologies.
- **ESG Performance**: Environmental, Social, and Governance (ESG) factors play a significant role in investment decisions. While CCS/CCUS for Enhanced Oil Recovery (EOR) or Enhanced Gas Recovery (EGR) may not be considered a green activity, investors are increasingly focused on climate-friendly CCS/CCUS initiatives. Emphasizing the utilization of CCS/CCUS for emission reduction rather than solely for EOR/EGR purposes will align with ESG standards and attract investors with sustainability goals. Governments can implement the following measures:
    - ESG criteria in funding and support programs: Governments can require or encourage CCUS projects to meet specific ESG criteria to be eligible for funding and support programs. This can include demonstrating strong environmental performance, adherence to social responsibility standards, and robust governance practices. Funding and support can be contingent upon meeting these criteria, incentivizing project developers to prioritize ESG considerations.
    - ESG reporting and transparency: Governments can mandate or encourage CCUS project developers to report on their ESG performance and impacts. This includes disclosing information on greenhouse gas emissions reductions, social and community benefits, and governance practices. Transparent reporting can help investors and stakeholders assess the ESG performance of projects and make informed decisions.
    - ESG standards and certification: Governments can establish ESG standards and certification systems specific to CCUS projects. These standards can help set clear expectations for ESG performance and provide a framework for project developers to follow. Certifications can help validate and recognize projects that meet or exceed the established ESG criteria, enhancing their marketability and attracting responsible investment.

Indonesia has already embarked on its CCS/CCUS journey, taking important steps to establish the necessary framework and initiate projects. Some key developments include:

- **ITB National Centre of Excellent for CCU and CCS in 2017**: The objective of the centre is to coordinate CCS research across different stakeholders and demonstrate pilot projects in Indonesia.
- **Ministerial Regulation no. 2/2022 on CCS/CCUS**: This regulation provides a legal basis for the implementation of CCS/CCUS activities in the working petroleum areas in Indonesia, outlining the requirements, procedures, and responsibilities for stakeholders involved in the sector.
- **Baseline-and-Credit System**: Indonesia has proposed a baseline-and-credit scheme applicable for the power sector, which is designed to support carbon capture projects by creating a market for carbon credits. Transition to a cap-and-tax mechanism may be feasible once a tax system is implemented. While delayed, the government remains fully committed to the initiative.
- **Pre-FID (Final Investment Decision) projects**: There are 16 pre-FID CCS/CCUS projects, reflecting high potential for investments. These projects range from capture to storage, and highlight the country's commitment to advancing CCS/CCUS technology.
- **MoUs (Memoranda of Understanding)**: Indonesia has entered into multiple MoUs with international partners, institutions, and companies, showcasing its intent to collaborate and exchange knowledge and expertise in the field of CCS/CCUS.
- **Joint Crediting Mechanism (JCM) agreement**: Indonesia has participated in the JCM, a bilateral cooperation mechanism that promotes low-carbon technology transfer and implementation. This agreement highlights Indonesia's commitment to international collaboration in addressing climate change through CCS/CCUS.

Nonetheless, there is still much work to be done in building a robust CCS/CCUS sector. This includes attracting investments, further developing associated infrastructure, establishing monitoring and verification systems, refining regulatory frameworks, and ensuring the successful implementation of projects.

With neighbouring countries like Malaysia actively developing their respective CCS/CCUS industries (e.g. sanction of large projects and announcement of tax incentives), Indonesia must quickly develop and implement an ambitious development plan to retain its position as a regional CCS leader.

5.3. Proposed solutions & recommendations

Wood Mackenzie and IPA have identified 5 overarching actions that will collectively provide the foundation on which Indonesia's CCS sector can develop:

CCS Regulations

Developing a comprehensive set of laws and regulations tailored for CCS activities that encompass the full value chain (capture, transport, injection/storage, and monitoring) is a fundamental step towards establishing a robust CCS industry. Regulations should include:

- Legalisation of the full value chain of CCS activities across all economic sectors, including allowing for storage outside of petroleum working areas and issuing standalone dedicated CCS licenses.
- Development of regulations to manage CCS activities across the entire value chain, establishing operational standards, HSE, fiscal regime, storage licenses, monitoring requirements, and decommissioning requirements, along with corresponding regulatory bodies.
    - Establish a permitting and licensing process that ensures compliance with environmental standards and regulatory requirements. This process should involve clear guidelines for project developers to obtain necessary permits, including CO_2 storage permits and permits for CO_2 transportation infrastructure.

- Appointment of a dedicated ministry responsible for governing and overseeing the CCS sector to ensure effective management and coordination of CCS activities.
    - Given the wide scope/cross-sectoral nature of the CCUS value chain (e.g. ranging from capture to trade/import), responsibilities and oversight should be spread across ministries. However, there should be one coordinating ministry that can be the interlocutor for investors. ESDM is likely ideally placed for the role considering the central role of Injection/Storage/Monitoring in the Indonesian CCUS story and the fact that these areas fall naturally under ESDM's scope.
        - For example, in Norway, the Ministry of Petroleum and Energy acts as the main responsible body overseeing CCUS, including the implementation of projects (e.g. the Longship Project) and international agreements (e.g. US-Norway MoU covering collaboration on CCS/CCUS), while other organisations like the Climate and Environment Agency specialises in specific fields (e.g. monitoring and regulating environmental aspects of CCUS projects to ensure compliance with regulations).

- Development of mechanism to periodically review and revise CCS regulations based on emerging technologies, scientific advancements, and lessons learned from implemented projects. Continuous monitoring and adjustments are key to optimising the regulatory framework.

- Liability and financial mechanisms to address potential risks and liabilities associated with CCS activities. This can include provisions for financial assurance, insurance requirements, and liability sharing arrangements among stakeholders.
    - Longer-term liability terms should define procedures and mechanisms for long-term liability management, including post-closure monitoring, site remediation, and potential transfer of responsibilities to future generations. The regulatory framework must address the long-term impacts and ensure the safe and secure storage of captured CO_2.
- Establishment of formal advisory channels with civil society and industry groups of experts like Indonesia Carbon Capture and Storage Centre (ICCSC).

CO_2 Cross-Border Agreements

Designing and ratifying cross-border CO_2 emission management agreements entail engaging with key APAC countries, enabling the storage of CO_2 from foreign emitters into Indonesian depleted oil & gas reservoirs or saline aquifers:
- Identification of countries that have a shared interest in cross-border CO_2 transport and storage, considering factors such as geographical proximity, existing infrastructure, CO_2 emission sources, and storage site availability.
- Cross-border CO_2 emission accounting agreement to recognise the reduction of CO_2 emissions in other countries through Indonesian CCS
- CO_2 import and export agreement to enable the physical flows of CO_2 between countries (in line with Indonesia's initiative through ASEAN). The goal of bilateral and/or regional agreements in CCUS should be to create the international regulatory framework within which commercial agents can operate; export/import decisions should be made between private parties rather than determined under the direction of governments.
    - Government-to-government (G2G) agreements can involve bilateral or multilateral arrangements, where countries agree to collaborate on emission reductions, carbon pricing mechanisms, or other forms of cooperation (Paris Agreement Article 6.2).
    - Private parties should be able to engage in business-to-business (B2B) transactions based on private commercial agreements; businesses can engage in emissions trading or other market activities to reduce emissions and comply with their respective country's targets.
        - G2G and B2B agreements play a complementary role in developing the CCS market

- Allocation of responsibilities and costs among participating countries, including agreements on cost-sharing mechanisms, funding arrangements for infrastructure development, financial incentives for CO_2 capture and storage projects, and mechanisms for addressing liability and risk management.
- Establishment of monitoring and reporting mechanisms to track the cross-border movement and storage of CO_2. This can include data sharing protocols, measurement and verification procedures, and regular reporting requirements to ensure compliance with agreed-upon targets and standards.
- Continuous review and enhancement to monitor the performance and effectiveness of the cross-border CO_2 agreements, making necessary adjustments and enhancements. Lessons learned, emerging technologies, and changing policy priorities must be reflected to ensure that the agreements remain relevant and contribute to long-term climate change mitigation efforts.

National Carbon Credit Trading Framework
Introducing a carbon credit trading framework to govern the generation and trading of carbon credits allows CO_2 emitters to purchase carbon credits to offset their emissions. Key requirements include: Designing carbon credit units to be traded within the framework. This could be in the form of carbon allowances, offsets, or other types of recognised units. The criteria for the issuance of these units must be determined to ensure their credibility and adherence to international standards.
- Determining eligibility criteria for participation in the carbon credit trading framework. This may include requirements for emissions monitoring & reporting, project verification processes, and adherence to specific standards or methodologies for calculating emissions reductions or removals.
- Establishment of emissions baseline against which emissions reductions or removals will be measured. This baseline provides a reference point for quantifying the carbon credits and enables the calculation of emission reductions achieved by participating entities or projects.
- Monitoring, Reporting, and Verification (MRV) mechanisms to ensure accurate measurement and accounting of emissions reductions or removals. Guidelines and methodologies for data collection, reporting, and verifications must be established to enhance transparency and credibility.
- Designing registry system to track and record the issuance, transfer, and retirement of carbon credits. The registry serves as a central database where participants can securely manage their credits, facilitating transparency, accountability, and efficient trading.
- Facilitating developers' access to private climate financing to support emission reduction projects

This framework can be underpinned by a new national carbon trading platform or could establish partnerships with existing reputable certifiers/voluntary carbon markets to provide the certification/ marketplace. In the context of international CO_2 trades, Indonesia's carbon credit trading framework could be integrated with other countries' carbon credit trading frameworks to increase market depth and liquidity (Note: this would automatically be the case if both countries rely on the same voluntary carbon market).

CCS Incentives
Offering fiscal incentives to accelerate the development of full commercial-scale CCS projects is a key step towards ensuring the commerciality of the operations.
- Designing the fiscal incentives to accelerate Indonesia's first commercial scale CCS projects, likely in the form of grants, subsidies, or low-interest loans to offset the CCS costs.
    - Setting up mechanisms for administering and disbursing the incentives involves creating a dedicated agency responsible for managing the incentive programs, establishing application processes and eligibility criteria, and ensuring transparent and efficient allocation of funds.

- Streamlining regulatory processes and permitting requirements for CCS projects involves identifying potential barriers and challenges and developing mechanisms to fast-track project approvals while ensuring safety and environmental standards are met.
    - Examples include simplification of 1) the import of specialty goods and services needed for the development of CCS projects, 2) the inflows and outflows of capital used to finance CCS projects, and 3) the hiring and employment of foreign talents possessing critical skills to the successful development and operations of CCS projects.
- Examples of fiscal incentives used in other regimes include:
    - (US 45Q) Tax credits offering a per-ton basis credit for CCUS project, applicable for both industrial and power sectors (higher credits for EOR and utilisation in products such as chemicals and building materials)
    - (Norway Longship project) Grants, loans, and direct investments to support the development of full-scale CCS projects (incl. capture, transport infrastructure, storage). Government takes an active role in project ownership, sharing both risks and rewards
    - (Canada CCUS Fund) Grants and repayable contributions to cover portion of the project costs, including capital expenses, operational expenses, and monitoring costs. Available for large-scale CCS projects across sectors (w/ focus on industrial & power).

Carbon Price

Introducing a permanent and high carbon price (e.g. carbon tax, ETS, investment incentives, fiscal incentives) provides the economic incentives and long-term revenue visibility required for the private sector to invest in CO_2 capture, transport, and storage. Setting the carbon price will require the Ministry of Finance consulting various ministries and stakeholders. Key steps to establish the carbon price include:

- Conducting economic analysis to assess the potential impacts of a carbon price on different sectors of the economy, including industries, households, and the overall competitiveness of the country. Social and economic implications, such as job creation, distributional effects, and international trade considerations must also be considered.
- Establishing emission reduction targets that align with national or international commitments, such as those outlined in the Paris Agreement, based on defined the trajectory for achieving these targets.
- Developing a carbon pricing mechanism depends on the country's specific circumstances and goals. Carbon tax and "cap-and-trade" system are two options—the former sets a price per ton of emission, while the latter caps the total emissions and allows trading of emission allowances.
- Determining the carbon price level, based on factors such as the desired emission reduction trajectory, economic impacts, and the social cost of carbon. This can be determined through economic modelling, stakeholder consultations, and cost-benefit analysis.
- Establishing the compliance mechanisms for regulated entities to meet their carbon obligations. This may include setting emission targets for covered sectors, establishing reporting and verification requirements, and penalties for non-compliance.

While developing these 5 mechanisms, Indonesia should initially prioritise making domestic CCS services available to emitters which are commercially ready. In the near term, this excludes domestic emitters as Indonesia does not yet have a carbon price that is high enough to incentivise CCS. The main source of revenue for Indonesian CCS services will be foreign emitters in countries with the following characteristics:

- Effective carbon prices high enough to incentivise capture.
- Lack of material carbon storage capacity.
- Sufficient geographical proximity to make Indonesia the most competitive storage option.

As such, the immediate priority for the Indonesian government should be to facilitate and promote the establishment of an international carbon capture and storage (CCS) value chain, through which neighbouring emitters can pay to store their CO_2 emissions in Indonesia.

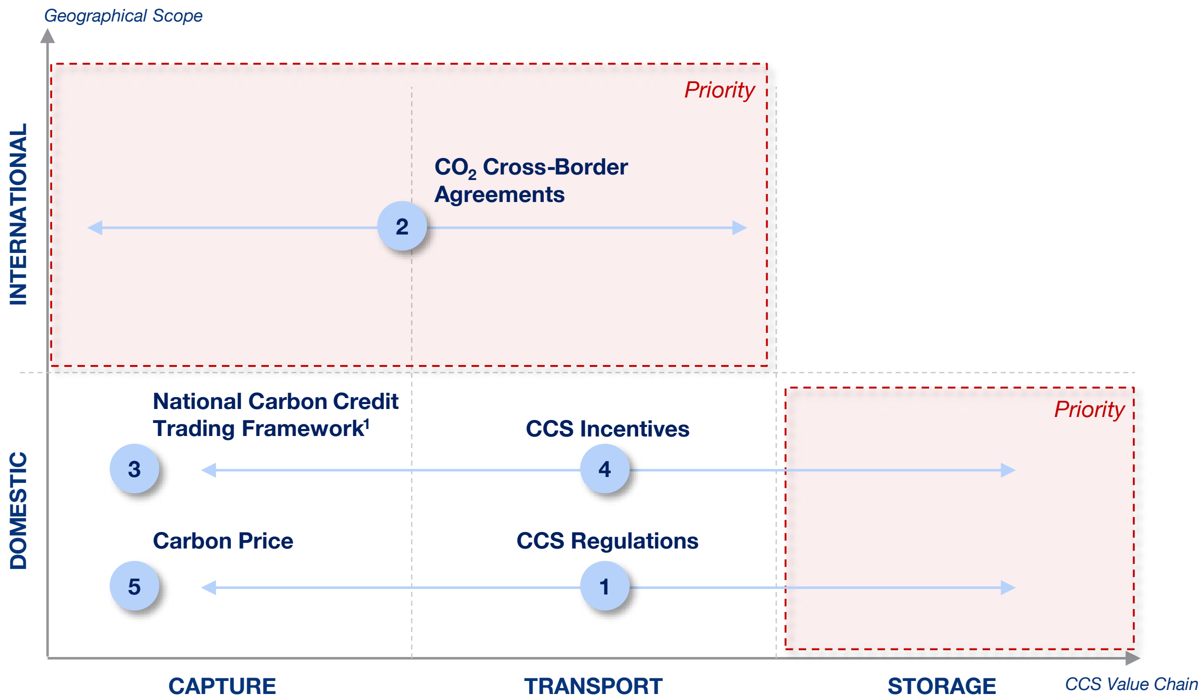
- Put in place the sets of laws and regulations that will govern CCS activities in Indonesia, particularly focusing on injection and storage (legalisation of CCS outside of petroleum working areas, injection/storage/monitoring regulator, storage fiscal regime, storage licensing criteria) to ensure Indonesian depleted reservoirs and aquifers are ready to receive CO_2 imports. This constitutes the only competitive differentiator that Indonesia can control in the race with neighbouring country to become the first regional CO_2 storage provider.

- Additionally, the government should prioritise the ratification of cross-border CO_2 emission management agreements with key Asia-Pacific emitters, such as Singapore, through government-to-government negotiations. These agreements would facilitate the smooth flow and storage of CO_2 emissions between countries, enabling Indonesia to capitalize on its strategic geographical proximity and establish itself as a preferred storage option for emitters in the region. By actively pursuing these initiatives, Indonesia can position itself as a leader in the international CCS market, attracting foreign investment and generating revenue from storing CO_2 emissions from countries with high carbon prices and limited storage capacity.

While initially, the priority will be to primarily focus on catering to international emitters, the Indonesian government must ensure that the public perception of CO_2 trade remains favourable—rather than instilling an image of importing other countries' "waste products," policymakers need to emphasise the value in monetising the country's natural resources and highlight the appeal of developing the industry for longer-term gains. Indonesia can gradually introduce a domestic carbon price and implement supportive measures for CO_2 capture to foster the development and readiness of domestic emitters. This gradual and long-term approach will help mitigate the potential negative impact of carbon pricing on Indonesia's economic growth.

As Indonesia's carbon price increases over time, domestic emitters will have the opportunity to leverage a more cost-effective CCS system that has incorporated the knowledge gained and efficiency improvements from handling international emissions in terms of transport, injection, storage, and monitoring. By adopting this progressive strategy, Indonesia can strike a balance between environmental sustainability and economic development, ensuring that its domestic emitters can benefit from lower CCS costs when the carbon price reaches a viable level.

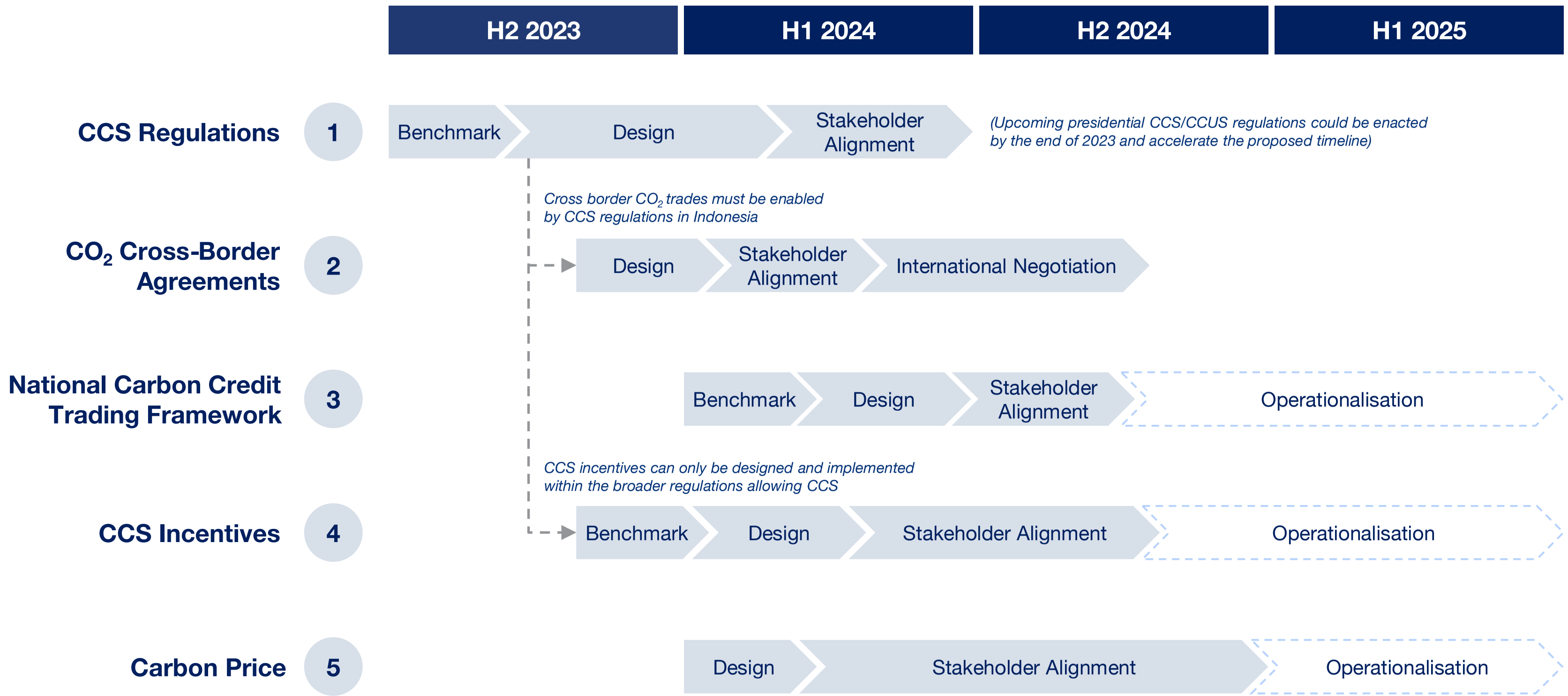
Figure 26: 5 Actions to Establish the Fundamental Building Blocks of Indonesia's CCS Sector



Note: 1. The national carbon credit framework must cover carbon avoidance/removal projects in Indonesia to incentivize domestic financing but could also allow the listing of international carbon projects;

Source: Wood Mackenzie

Figure 27: Illustrative Timeline for Establishing the Fundamental Building Blocks of Indonesia's CCS Sector



Source: Wood Mackenzie

06 Conclusion & Next Steps

Indonesia's sustainable economic growth and long-term development depend on successfully balancing the priorities of the Energy Trilemma. This entails effectively managing the trade-offs between energy security, affordability, and environmental sustainability to maximise Indonesia's gains given the constrained resources and strengthen the resilience of its energy system despite the variability and uncertainty of the future energy landscape. To achieve this, Indonesia must focus on 1) growing its domestic O&G production and 2) establishing a commercially viable and competitive CCS/CCUS industry. The combination of these two levers will be pivotal in achieving a reliable and affordable energy supply while minimizing Indonesia's carbon footprint, thereby addressing the challenges of the Energy Trilemma.

However, the limited investment in domestic O&G opportunities has led to a continued decline of indigenous O&G production, while the absence of supportive regulations and frameworks has delayed the advancement of Indonesia's CCS/CCUS value chain, inhibiting the country's competitive advantage and growth potential. To remove these blockers, policymakers must take proactive steps to foster investments in domestic O&G production and establish the fundamental building blocks of Indonesia's CCS industry. Wood Mackenzie and IPA have developed a packaged, action-based solution for each of the two levers, which must be considered in conjunction to maximise the effectiveness of the proposed plan. We believe that our solutions offer a least intrusive but high-impact transition pathway to solving Indonesia's Trilemma.

Wood Mackenzie and IPA recommend adopting a phased approach to address our recommended action plans. The overarching vision and foundational frameworks must first be solidified and socialised across key stakeholders prior to full development and implementation. In the face of sometimes long lead times and imminent challenges, it is urgent for the government to start acting now in order to ensure the readiness and resilience of the country. Accordingly, Wood Mackenzie and IPA suggest adopting the following initiatives as part of the first phase of the process.

Fostering domestic O&G investments:

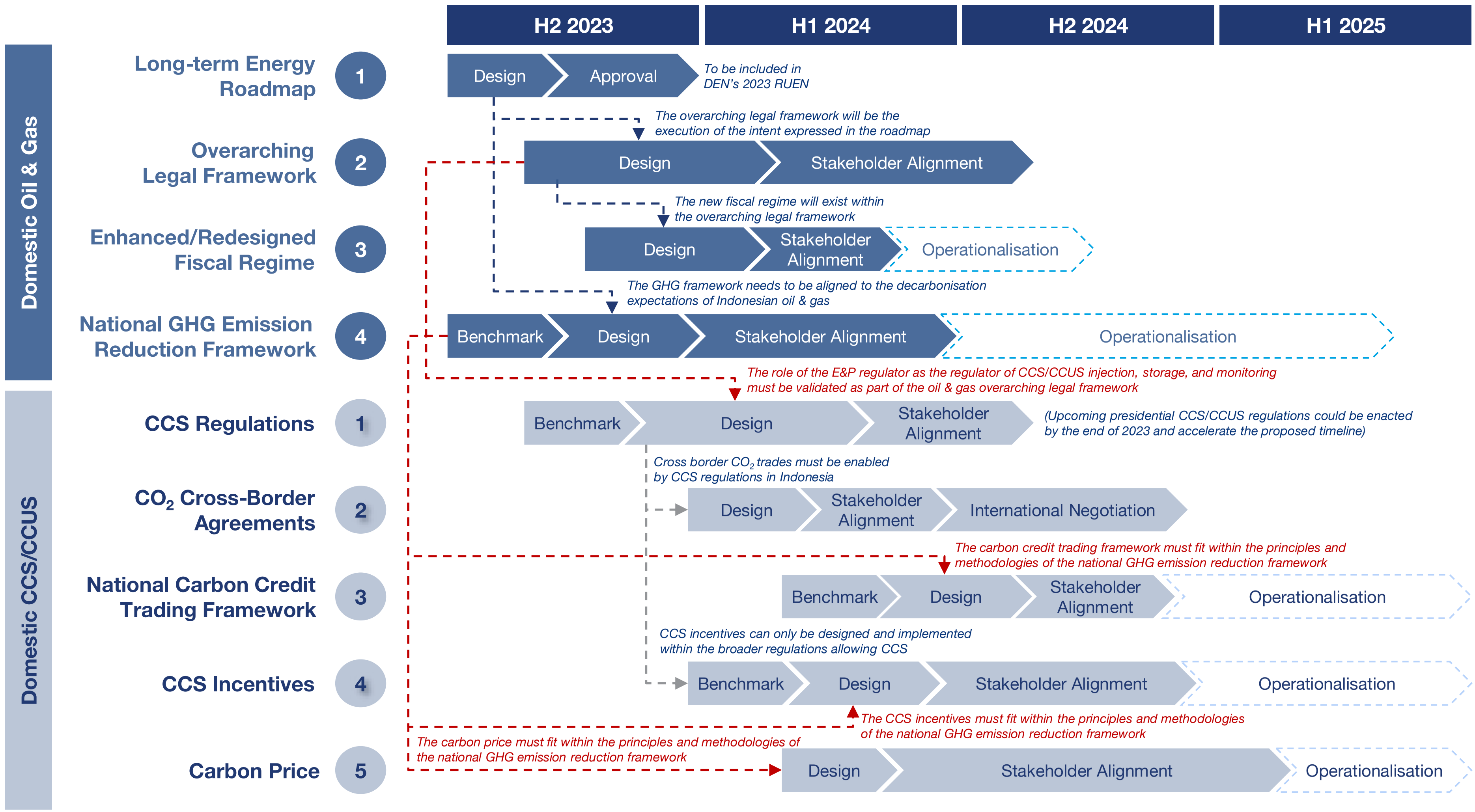
- **Design a long-term energy roadmap** by building on DEN's existing work, ensuring that it incorporates clearly delineated roles of domestic O&G and CCS in the future energy landscape.
- **Engage with industry and stakeholders** to finalise key building blocks of a new overarching legal framework for the E&P sector, to not only facilitate the permitting and licensing processes for E&P activities but also ensure compatibility with CCS development plans.
- **Identify and design enhanced fiscal terms** that are "fit-for-purpose" (e.g. customising incentives based on field-specific attributes), drawing from lessons learned from previous domestic developments and benchmarks of countries with comparable challenges and asset characteristics.

Developing the CCS/CCUS industry:

- **Design comprehensive regulations** that outline the legal and technical requirements for implementing CCS/CCUS projects, not only creating a supportive environment for commercial arrangements and transactions but also ensuring environmental protection, safety, and MRV.
- **Conduct at least one pilot project** to demonstrate the feasibility and commerciality of CCS/CCUS technologies, showcasing their potential in reducing emissions and achieving climate goals, while identifying potential hurdles to consider for future developments.
- **Initiate discussions with other governments** in the region to foster collaboration to not only engage in Government to Government (G2G) agreements covering partnerships and trade but also share knowledge, best practices, and resources to accelerate regional CCS development.

Throughout these initial processes, it will be crucial for the Indonesia policymakers to not only maintain close coordination among the internal constituents across the E&P and CCS value chains but also provide clarity in Indonesia's revamped strategic objectives to domestic and foreign stakeholders alike, ensuring that their interests remain aligned with Indonesia's long-term energy goals and development pathway.

Figure 28: Roadmap of Actionable Items



Appendix

Table 1: Comparison of WM Base Case and Accelerated Transition (1.5°C) Scenarios

	WM Base Case	WM Accelerated Transition (1.5°C)
Overview of Differences		
Trajectory	Consistent with 2.5 ˚C increase	Consistent with 1.5˚C increase (Net zero emissions by 2050)
Policy	Evolution of current policies and aligns with publicly available Sustainability Principles and Objectives (SPOs)	Aligned with the most ambitious goals of the Paris Agreement
Enablers	Steady advancement of current and nascent technologies	Early peak energy; rapid hydrogen and carbon removal deployment; consumer shift
Required Investments	~US$40 trillion	~US$60 trillion
Differences in Key Assumptions		
Primary Energy	Fossil fuel share: 66% (2050) • *Coal: 2.11 bntoe* • *Oil: 3.97 bntoe* • *Gas: 3.73 bntoe*	Fossil fuel share: 38% (2050) • *Coal: 1.03 bntoe* • *Oil: 1.42 bntoe* • *Gas: 2.09 bntoe*
Renewable (RE) & Storage Capacity	RE + storage share of power: 70% (2050) • *Renewable: 12.7 TW* • *Energy Storage: 2.4 TW*	RE + storage share of power: 78% (2050) • *Renewable: 17.0 TW* • *Energy Storage: 4.4 TW*
Transport	Battery EV (BEV) share: 45% (2050) • *BEV: ~1.0 bn stock* Biofuels demand: ~140 Mtoe • *Sustainable Aviation Fuel: ~20 Mtoe* • *Biodiesel: ~60 Mtoe* • *Biogasoline: ~60 Mtoe*	Battery EV (BEV) share: 80% (2050) • *BEV: ~1.7 bn stock* Biofuels demand: ~100 Mtoe • *Sustainable Aviation Fuel: ~65 Mtoe* • *Biodiesel: ~25 Mtoe* • *Biogasoline: ~10 Mtoe*
Low-carbon Hydrogen	Low-carbon H_2 capacity: 250 Mt • *Blue: ~160 Mt* • *Green: ~90 Mt*	Low-carbon H_2 capacity: 650 Mt • *Blue: ~235 Mt* • *Green: ~415 Mt*
Carbon Removal	Capture capacity: 2 Bt • *CCS: 2 Bt* • *NBS*: negligible* • *DAC*: negligible*	Capture capacity: 12 Bt • *CCS: 5 Bt* • *NBS*: 5.75 Bt* • *DAC*: 1.25 Bt*

*Note: * NBS = nature-based solutions; DAC = direct air capture*

Table 2: Summary of Benefits & Challenges of Primary Energy Forms

Primary Energy Forms	Benefits	Challenges
Biomass	• *Renewable energy source; waste reduction* • *Diverse end-use applications*	• *High land-use requirements & limited scalability* • *Low energy efficiency*
Coal	• *Proven & reliable; high dispatchability* • *Abundance / low-cost (before carbon tax)*	• *High environmental impact (CO_2 and pollutants)* • *Susceptibility to future regulations & imposed costs*
Oil	• *High energy density; economic storage/ transport* • *Proven technology & infrastructure* • *Diverse end-use applications*	• *High environmental impact (CO_2 and pollutants)* • *Susceptibility to future regulations & imposed costs* • *High price volatility & susceptibility to geopolitics*
Natural gas	• *Diverse end-use applications* • *High dispatchability* • *Proven technology & infrastructure*	• *Some environmental impact (CO_2 and pollutants)* • *High capital intensity* • *High price volatility & susceptibility to geopolitics*
Nuclear	• *Reliable baseload power* • *High energy density/content* • *No direct carbon emissions*	• *Radioactive waste* • *High perceived safety risks* • *High capital intensity*
Hydro	• *Renewable energy source; no direct emissions* • *Baseload power & auxiliary uses (e.g. flood control)* • *Long lifespan and durability*	• *High land-use requirements; limited suitable sites* • *High capital intensity* • *Vulnerability to climate change (precipitation, etc.)*
Geothermal	• *Renewable energy source; minimal GHG emissions* • *Reliable baseload power* • *Long lifespan and durability*	• *Location and resource constraints* • *Limited power generation potential/capacity* • *High capital intensity*
Solar	• *Renewable energy source; no direct emissions* • *Scalability of modules; potential for distributed gen.* • *Minimal operating/maintenance costs*	• *Intermittency/dependence on energy storage* • *High land-use requirements (for large-scale solar)* • *Geographical constraints (irradiation, weather)*
Wind	• *Renewable energy source; no direct emissions* • *Scalability of modules; potential for distributed gen.* • *Minimal operating/maintenance costs*	• *Intermittency/dependence on energy storage* • *Geographical constraints (wind patterns, weather)* • *High visual/noise impacts; threat to birds/bats*

Table 3: Summary of Benefits & Challenges of Low-carbon Solutions

Low-carbon Solutions	Benefits	Challenges
CCS/CCUS	• *Ability to target "hard-to-abate" sectors* • *Ability to leverage existing infrastructure* • *Potential for revenue generation*	• *Geographical/geological constraints* • *Reliance on carbon markets* • *High capital & energy intensity*
EV	• *Zero tailpipe emissions* • *Mature technologies* • *Potential to serve energy management functions*	• *Limitations in driving range / recharging* • *Lack of sufficient charging infrastructure* • *High battery costs*
Hydrogen	• *Versatility & wide applicability to various sectors* • *Zero emissions (fuel cells, combustion)* • *Ability to store/carry excess renewable energies*	• *High production costs (esp. electrolysis)* • *Limited infrastructure and storage capacities* • *Potential health/safety risks*
Biofuels	• *Mature & proven technology, with ongoing R&D* • *Lower emissions/carbon neutrality* • *Partial compatibility with existing infrastructure*	• *High land and water-use requirements* • *Highly energy-intensive; low energy efficiency* • *Dependence on policy support despite maturity*
Energy storage	• *Improved integration of RE; stability of the grid* • *Reduced costs from shaving peak demand*	• *High and often volatile input costs* • *Capacity limits (for longer duration); low efficiency*
EMS	• *Optimised electricity flow; enhanced efficiency* • *Improved integration of renewable energies*	• *Complexity and cost of system integration* • *Potential data/cybersecurity risks*
Carbon markets	• *Pathway to monetise decarbonisation* • *Increase of innovative mitigation approaches* • *Availability of funds to re-invest in clean energy*	• *Limited scope/coverage; int'l coordination* • *Complex & fragmented regulated frameworks* • *Potential market volatility and price fluctuations*

Table 4: Comparison of DEN's BaU and OPT Scenarios

	Business-as-Usual (BaU)	Optimistic (OPT)
Overview of Differences		
Trajectory	Growth of final energy demand by CAGR 4.8% over the next decade (207 Mtoe by 2032)	Growth of final energy demand by CAGR 6.6% over the next decade (248 Mtoe by 2032)
Policy	Ongoing policy developments	Consistent with Vision of Indonesia (2045) and net-zero emissions target (2060)
Enablers	Steady advancement of current and nascent technologies	Accelerated deployment of EV and biofuel utilisation in transport, fuel to gas, electricity, and biofuel substitution
Differences in Key Assumptions & Outputs		
Primary energy supply	Fossil fuel share: 83% (2032) • *Coal: 147 Mtoe* • *Oil: 100 Mtoe* • *Gas: 28 Mtoe*	Fossil fuel share: 72% (2032) • *Coal: 159 Mtoe* • *Oil: 86 Mtoe* • *Gas: 74 Mtoe*
Final energy demand	Fossil fuel share (excl. electricity): 73% (2032) • *Coal: 26 Mtoe* • *Oil: 104 Mtoe* • *Gas: 21 Mtoe* • *Renewables: 19 Mtoe* • *Electricity: 37 Mtoe*	Fossil fuel share (excl. electricity): 66% (2032) • *Coal: 31 Mtoe* • *Oil: 88 Mtoe* • *Gas: 43 Mtoe* • *Renewables: 25 Mtoe* • *Electricity: 60 Mtoe*
Electricity*	RE share of total electricity: 24% (2032) • *Hydro: 39 TWh* • *Geothermal: 39 TWh* • *Bioenergy: 26 TWh* • *Solar: 11 TWh* • *Wind: 0.5 TWh*	RE share of total electricity: 33% (2032) • *Hydro: 44 TWh* • *Geothermal: 39 TWh* • *Bioenergy: 114 TWh* • *Solar: 66 TWh* • *Wind: 0.5 TWh*
Industrial	Fossil fuel share (excl. electricity): 78% (2032) • *Coal: 26 Mtoe* • *Oil: 14 Mtoe* • *Gas: 21 Mtoe* • *Renewables: 5 Mtoe* • *Electricity: 12 Mtoe*	Fossil fuel share (excl. electricity): 71% (2032) • *Coal: 31 Mtoe* • *Oil: 14 Mtoe* • *Gas: 41 Mtoe* • *Renewables: 7 Mtoe* • *Electricity: 28 Mtoe*
Transport	Non-fuel share of total transport: 15% (2032) • *Electricity: 2%* • *Biofuel: 13%*	Non-fuel share of total transport: 31% (2032) • *Electricity: 13%* • *Biofuel: 18%*

*Note: * Expressed in annual production (TWh) terms*

Source: Nat'l Energy Council - Indonesia Energy Outlook 2022

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