Climate Change and Greenhouse Gas (GHG) Emissions

Why Is It Important?

Climate science plays a significant role in driving the transition to renewable energy sources and low-carbon technologies. As awareness of the need to mitigate climate change grows, there is increasing demand for cleaner, sustainable energy. This shift creates both risks and opportunities for PETRONAS.

We risk being left behind as the world transitions to a low-carbon economy, leading to stranded assets, lost revenue streams and reputational damage. However, we see opportunity to lead in the energy transition, leveraging our legacy, expertise and resources to develop greener technologies and business models.

What Is Our Approach?

PETRONAS is dedicated to our role as custodian of Malaysia's hydrocarbon resources and to meet customer energy demands, while contributing towards the climate ambitions of the Paris Agreement. Our NZCE 2050 Pathway was launched in November 2022, outlining the actions needed to achieve our net-zero ambitions. The development of the NZCE 2050 Pathway was informed by our business context, national policies, international frameworks, and scientific consensus on climate change.

In driving a focused delivery of the NZCE 2050 Pathway, 20 per cent of total capital expenditure will be allocated for decarbonisation projects and expansion into cleaner energy solutions from 2022 to 2026. We will also track our GHG emissions to ensure we are on the right trajectory to meet the targets.

We aspire to proactively strengthen transparency in reporting while shaping the national climate-related risk disclosure practice in Malaysia. We have commenced to apply the framework recommendations put forward by the Task Force on Climate-related Financial Disclosures (TCFD) to our assessment of climate risk. By aligning our strategic assessment of risk with TCFD, we strive to effectively manage and capitalise on climate-related risks and opportunities and accelerate progress towards our path to net zero.

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1 Governance

We recognise that climate change is a critical business issue, contributing to a set of risks and opportunities. We are taking more deliberate actions to elevate sustainability, especially climate-related discussions at the Board, to shape the long-term strategic direction of the company.

[The role of the Board in climate-related matters can be referred to in the Sustainability Statement section on page 155]

2 Addressing Climate-Related Risks and Opportunities

In November 2022, we defined our NZCE 2050 to accelerate and advance groupwide actions and commitment. The NZCE 2050 Pathway – with its short-, medium- and long term targets – will steer the group towards realising our ambitions.

The Pathway is two-pronged, reducing operational GHG emissions and increasing investments in business growth opportunities in the low carbon economy. PETRONAS will implement activities through four main decarbonisation levers – zero routine flaring and venting, energy efficiency, electrification and carbon capture and storage (CCS) – to reduce operational emissions as far as possible and offset remaining hard-to-abate emissions with nature-based climate solutions.

Safeguard the Environment

PETRONAS Energy Transition Strategy is Shaped In Response to Expectations of Changes in Customer Demand and Climate Risk Considerations

Core Business

- Operate oil and gas in a differentiated manner, with targets in place to produce carbon abated volumes at competitive cost to ensure asset portfolio is resilient to changes in demand.

New Business

- Capture growth opportunities in renewables and cleaner, less emission-intensive energy solutions, including wind and solar, hydrogen and green mobility.

Specialty Chemicals

- Strengthen presence in the specialty chemicals business segment, with an emphasis on strong sustainability attributes.

Carbon Capture and Storage (CCS)

- Position Malaysia as a leading CCS hub in Asia by offering CCS as a service for high emitting industries around the region.

Bio-based Value Chain

- Scale up bio-based products and offerings to meet changing customer preference.

Renewable Energy, Hydrogen and Green Mobility

- Establish Gentari as our clean energy solutions arm with strong growth portfolio in renewables, hydrogen and green mobility.

Net Zero Carbon Emissions (Operational Levers)

- Ongoing emissions reduction of our portfolio delivered through key abatement levers, based on their abatement potential and doability to ensure a credible Pathway to Net Zero Carbon Emissions by 2050.

Zero Routine Flaring and Venting

- Flare gas recovery projects, improved compressor capacity, vent-to-flare conversion and vent recovery projects.
- Delivery in support of the World Bank's Zero Routine Flaring by 2030 Initiative.
- Pledged to avoid routine flaring in new oil field developments and end routine flaring at existing oil production sites by 2030.

Energy Efficiency

- Digital solutions and process equipment advancement to uplift process optimisation initiatives, by optimising gas turbine operations, superior heat transfer, furnace, and boiler efficiency.

Electrification

- Renewable energy infrastructure to power our operations and processes, which include fuel gas replacement with electricity, where feasible.

Carbon Capture and Storage (CCS)

- CCS solutions delivered through technology partnerships.

[Details of Risks and Opportunities Quantification on Financial Performance can be referred on page 165]

3 Climate-Related Risks and Opportunities

Risk management accountability and oversight is an integral part of our governance including Climate Change governance. The Board reviews and considers our principal risks in the PETRONAS Corporate Risk Profile, covering operational and strategic risks based on periodic updates. The updates include an overview of the principal risks, a summary of material changes, as well as updates on mitigations and performance against key indicators. The Risk Management Committee, Executive Leadership Team (ELT) and Risk Committee assist the Board with the oversight of risk management including environmental, social, and governance (ESG) and climate-related risk management.

[Further details on risk governance can be referred to in the Risks Linked to Creating Values section on page 86]

We apply a groupwide approach to the management of risk through the establishment of the PETRONAS Risk Policy and complemented by the PETRONAS Resiliency Model, which the Enterprise Risk Management (ERM) Framework is part of. These policies and frameworks provide an integrated and holistic view of the overall strategy towards effective risk management.

[Details of PETRONAS Resiliency Model can be referred to in the Risks Linked to Creating Value section on page 87]

Our ERM includes requirements and guidance on the tools and processes involved to systematically identify, assess, evaluate, manage, report and monitor all types of risks. The ERM process requires a thorough assessment of entities and functional risks, including climate-related risks. It also includes an impact and likelihood assessment, which supports consideration of the relative significance of risks. Principal risks are identified and approved by management as pertinent risks to the entity and requires close monitoring.

[Details of Sustainability Risk and other principal risks can be referred to in the Risks Linked to Creating Value section on page 90]

Recognising the exposure of climate-related risks to our business operations and strategies, the impact of climate change has been taken into consideration and reflected in the development of relevant principal risks such as Sustainability Risks, Financial Liquidity Risk, Market Risk and Legal and Regulatory Risks. We are also strengthening our climate-related risk management efforts and corresponding disclosures to ensure they align with global sustainability frameworks and standards. Our efforts are positioned to align with the TCFD recommendations and the World Economic Forum's Stakeholder Capitalism Metrics.

We have been actively addressing climate change for almost a decade with our Climate Change Position and Framework which is the impetus of our climate change risk assessments that have been conducted since 2015. However, increasing stakeholders' expectations towards energy companies to align the climate risk assessment with global sustainability standards and frameworks has led us to progressively review and enhance our climate-related risk assessment approach.

We have adopted TCFD's categorisation of climate-related risks into two major categories which are transition risks and physical risks.

Safeguard the Environment

Transition Risks

Transition risks refer to potential risks arising from the global shift towards a more sustainable, net-zero economy, which encompasses policy, regulatory, market and technological changes that could impact our business operations.

One of the transition risks identified is the impact of oil and gas pricing or margins, which may reduce commercial returns stemming from the change in consumer preferences, regulatory pressure and/or our approach to sustainability. This in turn may result in diminished revenue, cash generation and returns realisation.

International Energy Agency (IEA) scenarios provide oil and gas prices, which are built on underlying assumptions of socio-economic growth and climate policies and commitments' development. For instance, oil prices are expected to be the lowest in the Net Zero Emissions by 2050 Scenario (NZE), due to reduced demand for oil. This would have a material impact on our upstream business. We also recognise carbon pricing as a means of driving emissions reduction across economic activities. Carbon pricing is used to assess our potential cost impact based on the different climate scenarios.

Furthermore, the energy transition calls for better disclosures and enhanced transparency given the impact of significant climate-related issues or risks to our financials. Our inability to respond at pace will lead to reduced access to capital, inflated capital cost and limited investment types. In addition, a downgrade of our ESG score may lead to higher borrowing costs, which further limits capacity to access capital markets.

Strategic measures to manage the implication of transition risks to our organisation are highlighted in the Our Approach to Climate-related Risks and Opportunities section. These measures are aligned with the mitigations and Key Risks Indicators of the identified principal risks in the PETRONAS Corporate Risk Profile, which are Sustainability Risk, Financial Liquidity Risk, Market Risk, and Legal and Regulatory Risk in the Risks Linked to Creating Value section.

[Further information on actions to address climate-change-related risks by our businesses can be referred to in the Business Review section]

Physical Risks

Physical risks resulting from climate change can be in the form of acute risks due to one-time events or chronic risks due to longer-term changes in climate patterns such as rise in sea levels and average global temperature, water shortages, and intense precipitation. Our physical assets and ongoing projects are exposed to physical risks as we have presence in more than 30 countries globally. Thus, we are not and will not be spared from the direct and indirect damages brought about by the impact of physical climate-related risks.

While actions are ongoing to manage physical risks, we continuously re-assess implications, taking into consideration the changing outlook for geographical locations where we are present. The re-assessment outcome serves as an imperative to strengthen our existing mitigation strategy in ensuring robustness and sustainability of our organisation moving forward.

Taking into account these factors, we will continue to pursue a deliberate energy transition strategy, balancing Core Business and New Business with our NZCE 2050 Pathway aligning with changing customer preferences, evolving regulations and increasing expectations by stakeholders for low-carbon energy solutions.

[Details of PETRONAS Energy Transition Strategy can be referred to on page 102]

Risks and Opportunities Quantification on Financial Performance

We have identified certain risks and opportunities to our business based on the three International Energy Agency (IEA) scenarios – Stated Policies Scenario (STEPS), Announced Pledges Scenario (APS), and Net Zero Emissions by 2050 Scenario (NZE). The scenarios were chosen based on their breadth that consider the world's different states based on energy makeup and carbon dioxide emission levels. They present three climate pathways, with temperature rise ranging from below 2°C to 2.7°C by 2100, providing granular and regional data breakdown.

The time horizons used were short term (2024), medium term (2030) and long term (2050). Identified risks relate to how oil, gas and carbon prices will impact PETRONAS Group EBITDA*, based on analysis for Upstream, Gas and Downstream businesses for FY2030. We have identified opportunities in renewable energy, hydrogen and green mobility based on their impact on our EBITDA for the New Energy business for FY2030. The chosen scenarios and the corresponding climate outcomes are summarised as below:

Stated Policies Scenario (STEPS)

- Reflects current policy context based on sector-by-sector assessments of specific policies and measures affecting the energy markets that are in place and those that have been announced by governments around the world, as of mid-2021.
- Includes relevant policy proposals, though implementation measures are yet to be developed to put them into effect.
- Where policies are time-limited, they are generally assumed to be replaced by measures of similar intensity, but the secenario does not assume future strengthening – or weakening – of future policy action, except where there already is specific evidence to the contrary.

Announced Pledges Scenario (APS)

- Assumes that all climate commitments made by governments around the world, including Nationally Determined Contributions (NDCs) and longer-term net zero targets, will be met in full and on-time.

Net Zero Emissions by 2050 Scenario (NZE)

- Sets out a narrow but achievable pathway for the global energy sector to achieve net zero carbon emissions by 2050, with developed economies reaching net zero emissions in advance of others.
- Does not rely on emissions reductions from outside the energy sector to achieve its goals.
- Assumes that non-energy emissions will be reduced with the same proportion as energy emissions. This is consistent with limiting the global temperature rise to 1.5°C without a temperature overshoot (with a 50 per cent probability).
- Meets key energy-related United Nation's Sustainable Development Goals, in particular achieving universal energy access by 2030.

Reduce our Scope 1 emissions (emissions directly associated with our operations) and Scope 2 emissions (includes the energy we buy to run them).

Establish a centralised Carbon Management Division to drive the decarbonisation of our upstream value chain.

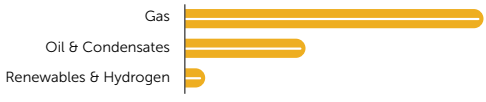
Manage our carbon storage portfolio for emissions produced by our operations.

Position Malaysia as a CCS solutions hub in the region.

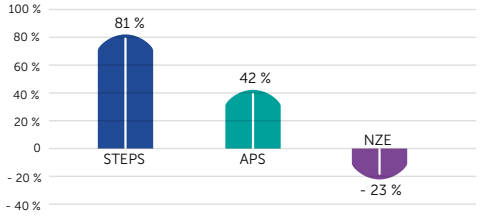
Position Gentari as a one-stop clean energy solutions provider. Designed for pace and innovation, Gentari is expected to run independently to deliver our renewables, hydrogen and green mobility aspirations.

Allocate approximately 20 per cent of our CAPEX for decarbonisation projects and expansion into cleaner energy solutions from 2022 to 2026 to reduce Group emissions and overall carbon intensity.

Estimated share of energy production in 2030



Potential Impact to PETRONAS Group EBITDA (2030)



** EBITDA stands for Earnings Before Interest, Taxes, Depreciation, and Amortisation, and is used to evaluate a company's operating performance.*

Safeguard the Environment

4 Metrics and Targets

We have revised our carbon emissions accounting method to adhere to international frameworks and sector specific guidance to give us a robust basis for Scope 1 and Scope 2, and a better understanding of Scope 3 GHG emissions. The financial year 2022 marks the beginning of disclosures of GHG emissions through both operational control and equity share approaches.

In charting our NZCE 2050 Pathway, PETRONAS has adopted the equity share approach to account for our emissions inventory and performance against mid- and long-term milestone targets, with 2019 as the base year.

Outline of two approaches GHG Emissions Accounting

Operational Control

- The Group has the authority to implement its operational policies.
- Applicable to our 2024 short-term GHG emissions targets and all methane emissions reduction targets.
- Enables the tracking of performance for all assets under our control.
- Drives immediate climate actions for direct and effective change.

Equity Share

- Reflects economic interest, which is the extent of rights a company has to the risks and rewards flowing from an operation.
- Applicable to our medium-term target of 25 per cent reduction in GHG emissions by 2030 and long-term target by 2050.
- Demonstrates our commitments on operational decarbonisation, including responsible and sustainable investments.
- Ensures our assets and investments are in line with our net zero aspiration.

Our Greenhouse Gas Emissions Reduction Targets (Scope 1 and Scope 2) and Ambitions

2024 & 2025	2030	2050
49.5 Million tCO_2e Cap emissions at 49.5 million tonnes of carbon dioxide equivalent (Million tCO_2e) from PETRONAS' Malaysia operations by 2024.	**25% Reduction** in PETRONAS Groupwide emissions, including:	**NET ZERO 2050** Net zero carbon emissions.
50% Reduction in methane emissions from PETRONAS Groupwide natural gas value chain operations by 2025.	**70% Reduction** in methane emissions from PETRONAS Groupwide natural gas value chain.	
	50% Reduction in methane emissions from Malaysia's natural gas value chain.	

Our 2024 short-term GHG emissions target and all methane emissions reduction targets are based on the operational control approach. This allows us to track performance of all assets under our control and to drive immediate climate actions for direct and effective change.

The equity share approach will guide our assets and investments to be in line with our Pathway and be reflected in our annual integrated report. This methodology allows for business' long-term energy transition pathway development and portfolio transition tracking.

As a result of our enhanced emissions accounting practices, which includes a change in organisational boundary, we have adjusted our 2019 baseline reference to 54.87 Million tCO_2e via equity share approach.

The Pathway has short-term and mid-term targets focusing on absolute GHG and methane emissions. The short-term target is to cap Scope 1 and Scope 2 emissions to 49.5 Million tCO_2e by 2024 for PETRONAS operated assets in Malaysia.

We have set a mid-term target to reduce 25 per cent GHG emissions for Scope 1 and Scope 2 under equity share approach by the year 2030.

A key area of our net-zero efforts is to reduce methane emissions. Methane is a primary component of natural gas and a more potent GHG than carbon dioxide. Thus, we have specified targets for methane emissions reduction as part of our broader GHG targets.

The target is to reduce methane emission groupwide by 50 per cent by 2025 and by 70 per cent by 2030. Additionally, we are committed to drive down methane emissions beyond PETRONAS' own operations within our industry. To this aim, we have established a 50 per cent methane emissions reduction target for Malaysia's natural gas value chain by 2030. The methane emissions reduction targets will support Malaysia's commitment to the Global Methane Pledge of reducing national methane emissions by 30 per cent by 2030.

Moving forward, PETRONAS is updating internal standards and procedures, and building capabilities in GHG and methane emissions management. Commencing in 2023, PETRONAS will commission third party assurance of Scope 1 and Scope 2 GHG emissions.

Footnote:
CO_2e = carbon dioxide equivalent. This unit converts all other GHGs into the common dominator of CO_2e using Global Warming Potential (GWP) factors following Intergovernmental Panel on Climate Change (IPCC) 4th Assessment Report (AR4).

Guided by international principles, frameworks and standards

- Greenhouse Gas Protocol Corporate Accounting and Reporting Standard
- Ipieca/API/IOGP Sustainability Reporting Guidance for the Oil and Gas Industry
- Ipieca Climate Change Reporting Framework
- ISO 14064-1:2018; ISO 14064-2:2019; ISO 14064-3:2019
- Methane Guiding Principles
- United Nations Environmental Programme (UNEP) Oil and Gas Methane Partnership 2.0 (OGMP2.0) Reporting Framework
- American Petroleum Institute (API) Compendium of GHG Emissions Methodologies for the Natural Gas and Oil Industry (2021)

Safeguard the Environment

2022 Greenhouse Gas (GHG) Emissions Management

As part of the embedment process and to ensure sustainable GHG management practice across PETRONAS operations, several initiatives were undertaken during 2022:

1 Enhancement of GHG Management System

Following the mainstreaming of GHG Management as part of PETRONAS HSE Mandatory Control Framework (MCF) in January 2022, PETRONAS has conducted four internal assurance activities – second line assurance and internal reviews – based on a risk-based approach. This activity helped to identify key gaps and enablers to improve GHG accounting and reporting.

2 GHG Digital Tools

PETRONAS has improved and automated the quantification of Scope 1 and Scope 2 GHG emissions in Gas business by linking activity data from plant information systems to the calculation tool, eliminating the need for human intervention in the process.

3 GHG Capability

PETRONAS has identified GHG Management as a crucial skill set to be developed as an enabler to realise our NZCE 2050 Pathway. A new discipline has been established under the HSE skill group with a set of competency requirements, recommended trainings and required resources across corporate and business functions.

4 Physical Impacts of Climate Change

A vulnerability assessment was conducted on PETRONAS' assets covering 1,140 locations in Upstream, Gas and Downstream in Malaysia as part of Malaysia's Fourth National Communication Report (NC4) to the United Nations Framework Convention on Climate Change (UNFCCC). Through this assessment populated in a Geographic Information System (GIS) system, climate hazards data such as sea level rise, coastal floods, river floods, droughts and temperature rise were gathered and forecasted up to year 2100 for Peninsular Malaysia, Sabah and Sarawak. This initiative has created value by identifying high risk assets and serves as an input to our adaptation strategy.

PETRONAS also has completed vulnerability assessments in South Africa for Downstream refinery and retail operations. Key climate hazards are floods and storms. A training and upskilling session was conducted for Engen staff to enable them to develop and maintain an adaptation plan.

Accelerating Methane Emissions Management in PETRONAS

We align our methane emissions management with the Methane Guiding Principles (MGP) that prioritise key actions along the natural gas supply chain.

As a signatory member of the Methane Guiding Principles, we commit to advancing robust performance across gas value chains, enhancing the accuracy and quality of methane emissions data, advocating best practices, sound policies, and regulations on methane emissions, capability building and increasing the transparency of methane emissions to better manage them.

In 2022, PETRONAS became a member of the United Nations Environment Programme (UNEP) Oil and Gas Methane Partnership 2.0 (OGMP2.0) Reporting Framework, a multi-stakeholder initiative established by UNEP and the Climate and Clean Air Coalition (CCAC). OGMP2.0 provides a comprehensive, measurement-based reporting framework that improves the accuracy and transparency of methane emissions reporting in the energy sector.

1 Advancing Techniques for Methane Measurement

Acknowledging the importance of reporting accurate methane emissions to facilitate effective reduction, PETRONAS is improving our quantification beyond the main emissions sources of flaring, venting and combustion. Rigorous efforts were made throughout 2022 to improve methane data accuracy for PETRONAS' natural gas value chain covering 11 common sources below:

Intended Releases:

- Venting of Hydrocarbon
- Flaring of Hydrocarbon
- Stationary Combustion
- Compressor Seals
- Pneumatic Devices
- Gas Dehydration
- Hydrocarbon Storage Tanks
- Liquids Unloading
- Well Completion/ Testing

Unintended Releases:

- Fugitive Emissions
- Loss of Primary Containment (Tier 3)

Methane quantification was based on best available operational data guided by internal and international standards from Oil and Gas Methane Partnership 2.0 (OGMP2.0) and Oil and Gas Climate Initiative (OGCI). Additionally, PETRONAS' Group Technical Solutions department have developed a quantification tool using location specific operational data and emission factors from the American Petroleum Institute (API) Compendium to perform the detailed quantification of methane emissions covering 11 common methane emissions sources.

Major methane sources i.e., flaring and venting, were measured using direct measurements (flowmeters) or quantified using detailed engineering calculations based on specific process parameters. For the remaining methane sources, improvements were made to the quantification by inventorying the equipment and components. Methane emissions were then estimated by multiplying the respective emission factors according to the equipment type with the number of equipment of the same type.

We are improving quantification of fugitive emissions by moving away from an estimation approach using production values, to a more detailed quantification method at component level, or using actual leak survey data where available. This method provides a better understanding of methane emissions from each source. A key finding was that quantified fugitive methane emissions using granular data were lower than calculated estimates. We also have a better understanding of our emissions from compressor seals and pneumatic devices, which were never quantified previously.

- **80 per cent** to **90 per cent** of our methane emissions along the natural gas value chain can be attributed to hydrocarbon venting, flaring and gas-driven pneumatic devices. We prioritise our mitigation measures to these areas through our current GHG emissions reduction projects.

2 Advocating for Methane Management to Partners

As the regulatory body overseeing Upstream operations in Malaysia and collaborating with partners across the ASEAN region, PETRONAS has initiated methane advocacy efforts nationally as well as internationally with the aim to increase awareness among our partners to effectively manage methane emissions. Through Malaysia Petroleum Management (MPM), PETRONAS rolled out the Exploration and Production Minimum Environmental Specification (MES) that outlines the requirements on methane emissions measurements, quantifications, and reporting by all upstream operators that are operating in Malaysia. Adhering to these standards ensures that reported methane emissions are accurate and consistent, thereby driving efforts towards reduction.

The ASEAN Energy Sector Methane Roundtable

Hosted by PETRONAS and supported by Thailand's PTT Public Company Limited (PTT) and Indonesia's Pertamina.

Objective:
To set a networking platform among the oil and gas players in Southeast Asia to advocate and promote effective methane emissions management.

Outcome:
- Attended by participants from ASEAN national oil companies, several energy companies, as well as international, multilateral and non-governmental organisations such as the International Energy Agency (IEA), World Bank, United Nations Environment Programme (UNEP) and the Environmental Defense Fund (EDF).
- Strong network presence at the roundtables set the foundation for promoting capability building and technical knowledge sharing, improving methane emissions management practices and transparency in performance reporting, aligned with internationally recognised frameworks and standards.

Safeguard the Environment

USAID Workshop on Innovative Technologies 2022

Conducted in collaboration with USAID Smart Power Programme (SPP), ASEAN Centre for Energy (ACE), PTT Exploration and Production (PTTEP) and Asia Natural Gas and Energy Association.

Objective:
To identify and measure oil and gas sector methane emissions in Southeast Asia.

Outcome:
- Attended by participants from ASEAN oil and gas operators, EDF, United States Environmental Protection Agency (US EPA) and methane emissions management technology providers.

3 Accelerating Competency for Methane Management

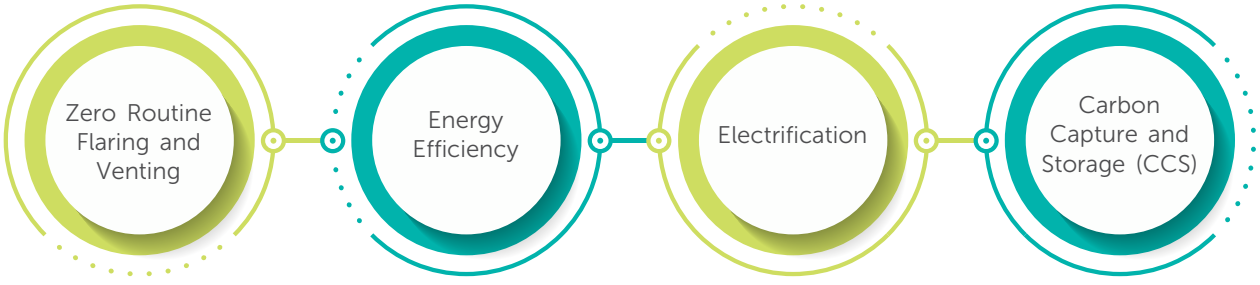
Since 2020, we have increased our efforts to raise awareness, build skills, and take action to reduce methane emissions throughout our operations. We conducted training sessions to improve employee knowledge on methane management and put into practice internal standards. These standards were aligned with industry expectations and guidance on managing methane emissions.

In addition, we developed e-learning modules on methane management to promote self-learning and increase awareness on achieving methane reduction targets.

In 2022, PETRONAS conducted five upskilling sessions on methane emissions management for 84 internal practitioners aimed at strengthening their understanding in support of operationalising our internal standards, aligning to industry expectations and guidance on methane emissions management. In addition, methane e-learning was also developed to create an avenue of self-development that could accelerate awareness on methane emissions management.

Harnessing the Power of Technology to Aid GHG Emissions Reduction

PETRONAS is continuously finding opportunities to reduce its carbon emissions to meet our NZCE 2050 Pathway through various climate actions. In 2022, we achieved GHG emissions reductions of 0.6 Million tCO_2e and cumulatively since 2013, we have reduced 18.1 Million tCO_2e of GHG emissions from our operations. PETRONAS has classified its operational emissions reduction efforts into four decarbonisation levers as follows:



In 2022, PETRONAS completed 44 projects and initiatives mainly covering zero routine flaring and venting reductions, energy efficiency, and electrification categories as follows:

1 Zero Routine Flaring and Venting

PETRONAS had conducted three flare reduction and one vent reduction projects in Upstream Business in Malaysia where 0.18 Million tCO_2e was reduced in 2022. The projects were conducted using technologies that recover the hydrocarbon gas and monetise it.

- Three Flare Reduction: Kinabalu (0.003 Million tCO_2e), Bintulu Integrated Facilities (0.09 Million tCO_2e), Sabah Oil and Gas Terminal (0.05 Million tCO_2e); and
- One Vent Reduction: Dulang (0.04 Million tCO_2e)

2 Energy Efficiency

40 energy efficiency and optimisation efforts throughout PETRONAS have also reduced 0.44 Million tCO_2e in 2022.

- Upstream: Three projects and 0.09 Million tCO_2e
- Gas: 15 projects and 0.19 Million tCO_2e
- Downstream: 22 projects and 0.16 Million tCO_2e

3 Electrification

The intent of electrification is to either increase efficiency or to switch to an electric source with a lower GHG emission factor compared to the existing practice. In 2022, Malaysia LNG Sdn Bhd signed a Power Purchase Agreement with Syarikat SESCO Bhd, a subsidiary of Sarawak Energy, for 90MW of hydroelectric power import to PLC in Bintulu. This will result in about 40 per cent of PLC to be powered by renewable energy and reduce Scope 1 GHG emissions.

4 Carbon Capture and Storage (CCS)

CCS efforts in PETRONAS are driven by the need to develop high carbon dioxide (CO_2) gas fields. PETRONAS has been conducting research and development (R&D) on various capture technologies and patented a single and multi-stage membrane technology for onshore and offshore application in the past years. PETRONAS has also identified potential storage sites in offshore Malaysia. This has become an enabler to the development of CCS projects in PETRONAS.

Upstream business has embarked on a CCS project in the Kasawari gas field in offshore Sarawak to reinject the inherent CO_2 from the gas reservoir into a neighbouring depleted oil and gas field. The CCS facility is expected to be in operation in stages starting from 2024 (Phase 1), with first injection in 2026 (Phase 2).

When operations are in full swing, the Kasawari project can potentially store 3.3 Million tonnes of CO_2 per annum in a depleted reservoir making it the largest offshore CCS project in the world.

In 2022, PETRONAS signed several Memoranda of Understanding (MoUs) on CCS to partner and explore opportunities across the CCS value chain. Moving forward PETRONAS is also looking into building a CCS hub and becoming a leader in the CCS business within the region.

Methane Emissions Management

PETRONAS continues to explore the optimal top-down methane measurement via various MoUs to assess emerging technologies. Among the technologies tested in 2022 were satellite and drone to measure methane emissions from onshore and nearshore facilities. Based on the evaluations, suitable top-down measurement technology will be selected to enable reconciliation with bottom-up measurement and meet OGMP2.0 Gold Standard expectations.

We tested satellite technology to measure methane emissions where the results showed no emissions above the detection threshold of 100kg/hr at PETRONAS sites.

PETRONAS is pursuing another remote sensing technology through strategic collaborations with a local drone service provider to test methane sensors on drones (multi-rotor type) at selected sites i.e. gas transmission assets, refineries and regasification terminals.

PETRONAS also entered into a collaboration to test a technology that enables continuous monitoring of methane emissions from the assets through visualisation as well as measurement capabilities.

Striving Towards GHG Emissions Reduction Targets

As a result of our enhanced emissions accounting practices, which includes a change in organisational boundary, we have adjusted our 2019 baseline reference to 54.87 Million tCO_2e (previously calculated 57.73 Million tCO_2e) via equity share approach.

PETRONAS' short-term GHG emission target is to cap Scope 1 and Scope 2 operational emissions to 49.5 Million tCO_2e by 2024 for PETRONAS operated assets in Malaysia. In 2022, operational emissions in Malaysia amounted to 46.11 Million tCO_2e (2021: 44.12 Million tCO_2e).

In 2022, we achieved 0.6 Million tCO_2e GHG emissions reduction from projects and cumulatively since 2013, we have reduced 18.1 Million tCO_2e of GHG emissions from the implementation of decarbonisation activities for PETRONAS Groupwide assets under operational control.

Safeguard the Environment

The mid-term target for 2030 is to reduce 25 per cent of PETRONAS' Groupwide Scope 1 and Scope 2 GHG emissions under equity share approach, compared to the base year of 2019. To date, the reduction amounts to 8.49 per cent, delivered through projects addressing flaring and venting reduction and energy efficiency.

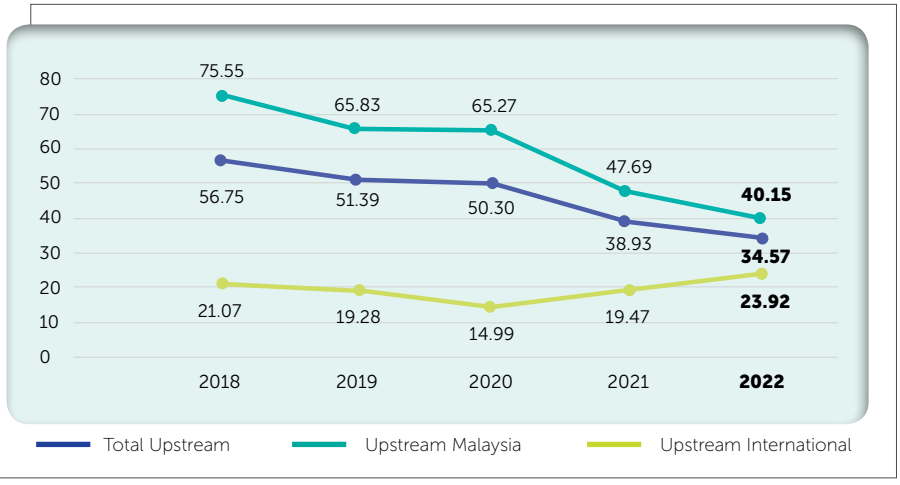
Our short-term methane target is to reduce 50 per cent of methane emissions from our natural gas value chain operations by 2025 compared to 2019. In 2022, we reduced absolute methane emissions by 49.88 per cent from 2019 levels, with Upstream flaring and venting reduction efforts playing a significant role. These efforts included setting flaring and venting targets, operational campaigns, and implementing capital expenditure projects. We plan to further reduce our methane footprint through continued reduction efforts and improved quantification accuracy.

Special Highlights

PETRONAS' commitment to the World Bank's Zero Routine Flaring by 2030 (ZRF) Initiative and UNEP's OGMP2.0 can be presented using the three key metrics below – Upstream GHG intensity, share of methane in total GHG emissions and reduction of hydrocarbon venting.

1 Upstream GHG Intensity Reduction

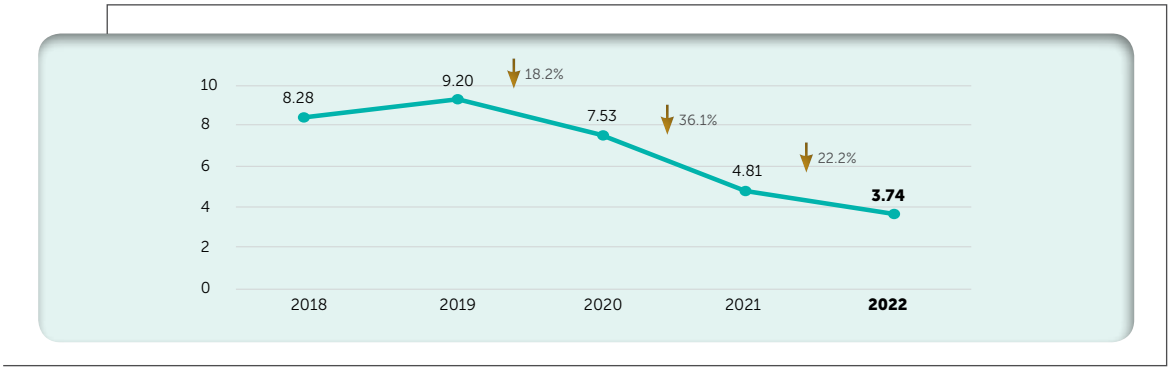
Upstream GHG Emissions Intensity under Operational Control Approach (tCO_2e/kboe)



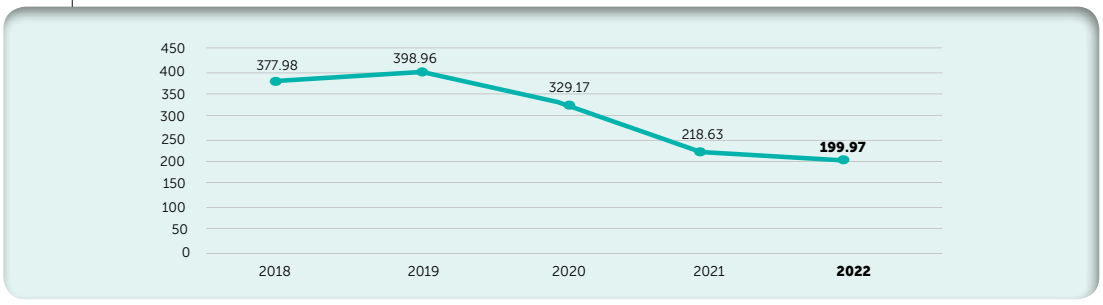
Upstream GHG intensity for total upstream operations has reduced by 32.73 per cent from 2019 driven by zero continuous flaring and venting requirement in PETRONAS Carbon Commitments.

2 Reduction of GHG Emissions Including Methane Through Venting Reduction Efforts

GHG Emissions Reduction from Venting under Operational Control Approach (Million tCO_2e)



Methane Emissions from Natural Gas Value Chain – Upstream and Gas only (thousand tonnes CH_4)



GHG Emissions Breakdown by Gases under Operational Control Approach (%)