ERIA Research Project Report 2022 No. 15

The Strategies of National Oil Companies in Southeast Asia under Energy Transition

Edited by

Economic Research Institute for ASEAN and East ASIA (ERIA)

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Economic Research Institute for ASEAN and East Asia (ERIA)

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Preface

At COP21, the Paris Agreement took effect, and as of COP26, more than 150 countries have declared carbon neutral (CN) targets with target years. Under these circumstances, Association of Southeast Asian Nations (ASEAN) national oil companies (NOCs) mainly engaged in the fossil fuel business must strengthen their efforts to reduce greenhouse gas (GHG) emissions while ensuring a stable energy supply in their existing businesses and low-carbon fields, such as renewable energy. Based on the above, we investigated and analysed existing and low-carbon energy field activities by the ASEAN NOCs and the major companies in Europe and the United States (hereinafter referred to as the 'Western majors.' We also discussed and made recommendations to the ASEAN NOCs regarding their efforts for low carbonisation and decarbonisation.

This report consists of five chapters. Chapter 1 analyses the climate change issue that led to this study, the outlook for global energy consumption, and the outlook for energy consumption in ASEAN. The report also discusses the issues that ASEAN faces in pursuing CN.

Chapter 2 provides an overview of the status of CN declarations with target years by major national governments and their measures for achieving them.

Since COP26, ASEAN national governments have also announced CN targets one after another. The NOCs, whose major shareholders are national governments, will also be required to develop their business strategies and initiatives in line with national policies. Chapter 3 presents and analyses the energy transition strategies and activities of ASEAN NOCs.

Chapter 4 discusses the energy transition strategies and efforts by the Western Majors actively engaged in low carbonisation and decarbonisation. Many examples can be used as a reference for the ASEAN NOCs to develop further low-carbonisation and decarbonisation strategies in the future.

Chapters 2 to 4 present and analyse the situation of each national government, the low-carbonisation and decarbonisation efforts by the ASEAN NOCs, and the low-carbonisation and decarbonisation efforts by the Western Majors. Based on the above, Chapter 5 provides recommendations to ASEAN national governments and the NOCs regarding their energy transition strategies and efforts.

Acknowledgements

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List of Abbreviations and Acronyms

ADB	Asian Development Bank
ADNOC	Abu Dhabi National Oil Company
APS	alternative policy scenario
ASEAN	Association of Southeast Asian Nations
BAU	business-as-usual scenario
BEV	battery electric vehicle
CC(U)S	carbon capture, (utilisation), and storage
CEO	chief executive officer
CN	carbon neutral/neutrality
COP	Conference of the Parties
DAC	direct air capture
EIB	European Investment Bank
ERIA	Economic Research Institute for ASEAN and East Asia
EU	European Union
EV	electric vehicle
FID	Final Investment Decision
GDP	gross domestic product
GGFR	Global Gas Flaring Reduction Partnership
GHG	greenhouse gas
GPSC	Global Power Synergy Public Company, Limited
IEA	International Energy Agency
IEEJ	Institute of Energy Economics, Japan
LNG	liquefied natural gas
LPG	liquefied petroleum gas
MoU	memorandum of understanding
NDC	nationally determined contributions
NOC	national oil company
NZE	net-zero emission

OGMP	Oil & Gas Methane Partnership
PV	photovoltaic
SAF	sustainable aviation fuel
UAE	United Arab Emirates
UK	United Kingdom
US	United States
ZEV	zero-emission vehicle
ZRF	zero routine flaring

Measurements

bbl	barrel
bcf/d	billion cubic feet per day
kboe	thousand-barrel oil equivalent
GW	gigawatt
GWh	gigawatt hour
Kb/d	thousand barrels per day
Mtoe	million tonnes of oil equivalent
MW	megawatt
MWac	megawatt alternate current
MWdc	megawatt direct current
MWh	megawatt hour
TWh	terawatt hour

Executive Summary

The Paris Agreement took effect at the Conference of the Parties (COP) 21. As of COP26, more than 150 countries have declared carbon neutral (CN) targets with target years. Thus, it is important to further accelerate low-carbonisation and decarbonisation efforts in the future.

Under these circumstances, the national oil companies (NOCs) of the Association of Southeast Asian Nations (ASEAN), mainly engaged in the fossil fuel business, must strengthen their efforts to reduce greenhouse gas (GHG) emissions while ensuring a stable energy supply in their existing businesses and low-carbon fields, such as renewable energy.

Table 1 compares the strategies and activities of the ASEAN NOCs and the Western Majors. Regarding the Net Zero Declaration, six companies except for Pertamina have set 2050 Net Zero targets. Shell, British Petroleum, and TotalEnergies target Scopes 1+2+3, while ExxonMobil, PETRONAS, and PTT target Scopes 1+2.

The strength of the oil majors and NOCs is their abundance of oil and natural gas assets. Thus, focusing on carbon dioxide capture (utilisation) and storage (CCS/CCUS) and hydrogen, for which existing assets can be used, would be effective. The Western Majors have already been operating their CCS projects. On the other hand, the ASEAN NOCs have signed memoranda of understanding (MoUs) with their partners. In the future, the CCS of oil majors' projects should be accelerated. Pertamina and PETRONAS are already moving in that direction, but a further acceleration of CCS is necessary. Moreover, as Thailand is the centre of automobile production in Southeast Asia, it makes sense for Thailand's PTT to enter the electric vehicle (EV) production and battery fields.

Each ASEAN NOC should develop a realistic road map in coordination with the other ASEAN NOCs and those in other regions while considering business structure, resource availability, and each country's natural geographical conditions. In addition, cooperation with Western Majors and other companies in different industries can also be effective. Based on this, it is important to formulate the most appropriate energy transition strategy for each company. Exchanges in technologies, financing, and human resource development can contribute to accelerating ASEAN NOC's energy transition road map and business structure transformation.

The Russian invasion of Ukraine in February 2022 affected all oil and gas companies. The impact of price hikes has been particularly significant in both positive and negative aspects, making a stable energy supply more important than ever. Various energy issues should be resolved simultaneously, including the stable supply of fossil fuels, decarbonisation during the energy transition period, and the introduction of new energy sources such as renewable energy.

Table 1. Comparison of Strategy and Activity between ASEAN NOCs and Western Majors

	Exxon Mobil	Shell	BP	TotalEnergies	PETRONAS	Pertamina	PTT
Net Zero Declaration	2050 *Oil & Gas Production	2050	2050	2050	2050 *Oral Declaration	NA	Net Zero GHG emission by 2050
Scope	1+2	1+2+3	1+2+3	1+2+3	1+2	NA	1+2
Flaring	Eliminate routine flaring by 2030	Eliminate routine flaring by 2030	—	Eliminate routine flaring by 2030	—	—	—
CCS Target	—	25 $MtCO_2$ by 2035	—	5 $MtCO_2$ by 2035	—	—	—
Major CCS Project & Alliance	Baytown Texas La Barge Wyoming	Northern Lights Quest Teesside	Teesside Humber Tangguh Moomba	Northern Lights Aramis Teesside	ExxonMobil Shell ADNOC Posco	ExxonMobil Masdar SK Group Marubeni Mitsui & Co.	INPEX JGC Holdings
Hydrogen Project & Alliance	Baytown Texas	Double Digit Share by 2035	10% share by 2030 H_2 Teesside	5-tonne Green H_2 per day By 2025	JERA ENEOS Masdar	SK Group Mitsubishi Pupuk	-
Renewables & Others	Biofuel Mobil EV Lubricants DAC	Biofuel Wind Farm PV EV Charge Link Salary	Biofuel Wind Farm PV EV Charge Link Salary	Biofuel Wind Farm PV EV Charge Battery	Ammonia PV CO_2 Transport	Biofuel Geothermal Ammonia PV EV Charge	EV Production EV Charge Battery PV

ADNOC = Abu Dhabi National Oil Company, CCS = carbon capture and storage, DAC = direct air capture, EV = electric vehicle, GHG = greenhouse gas, PV = photovoltaic.

Source: Author.

Definition of Scopes 1, 2, and 3

Scope 1: Direct emission of GHG by the operator (examples: fuel combustion, industrial process).

Scope 2: Indirect emissions due to the use of electricity, heat, and steam supplied by other companies.

Scope 3: Indirect emissions other than Scopes 1 and 2 (emissions from other companies related to the activities of the business operator).

Source: ME and METI, Japan (2022).

Chapter 1

Background of the Study

This chapter analyses the climate change issue by providing the background for this study, the outlook for global energy consumption, and the outlook for energy consumption in the Association of Southeast Asian Nations (ASEAN). This chapter also discusses issues in ASEAN's pursuit of carbon neutrality (CN).

1. Growing Climate Change Issue

Recently, there has been growing interest in climate change due to abnormal weather events such as floods caused by strong typhoons, droughts, heat waves, rising sea levels, wildfires, and other disasters. Awareness of these issues led to the first meeting of the Conference of the Parties (COP) 1 in 1995 to discuss a comprehensive framework for greenhouse gas (GHG) reduction. The Kyoto Protocol was adopted at COP3 in 1997, and the Paris Agreement took effect at COP21 in 2015.

2. Outlook for World Energy Consumption

Both natural and human-induced factors cause climate change. But current extreme weather events are thought to result from a rapid increase in atmospheric carbon dioxide (CO_2) emissions due to increased human industrial activities, intensifying the greenhouse effect.

At COP21 held in Paris in 2015, the Paris Agreement, a new framework for combating global warming, entered into force. The Paris Agreement limits global warming to below 2^0C, preferably to 1.5^0C, compared to pre-industrial levels. Subsequently, there were growing calls to limit the temperature increase to 1.5^0C because the 2-degree increase limit would not be enough to prevent the expected enormous impact.

The International Energy Agency (IEA) has set several future scenarios to limit future temperature increases.

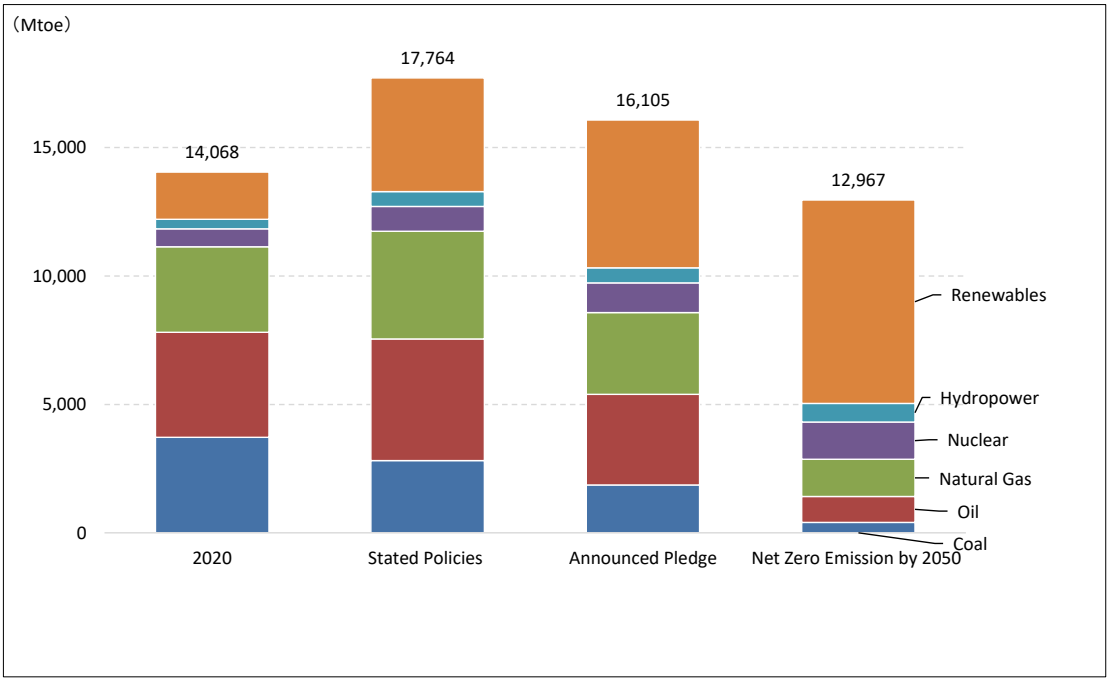
(1) Net zero emissions (NZEs) by 2050 scenario sets out a narrow but achievable pathway for the global energy sector to achieve net-zero CO_2 emissions by 2050.

(2) The announced pledges scenario 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.

(3) Stated policies scenario reflects current policy settings based on a sector-by-sector assessment of the specific policies in place, as well as those that governments worldwide have announced.

Figure 1.1 shows IEA's energy consumption outlook by scenario for 2050. Global primary energy consumption in 2050 is expected to reach 17,764 Mtoe, about 1.26 times higher than in 2020 under the announced policy scenario, and 16,105 Mtoe, about 1.14 times higher than in 2020 under the stated commitment scenario. On the other hand, the scenario for realising NZEs 2050, which is intended to limit the temperature increase to 1.5°C, is expected to reduce primary energy consumption to 12,967 Mtoe, about 0.92 times lower than in 2020. Therefore, to limit the temperature increase to 1.5°C, primary energy consumption must be reduced more than the 2020 level.

Figure 1.1. IEA World Primary Energy Consumption Outlook by Scenario (2050)



Source: IEA (2021).

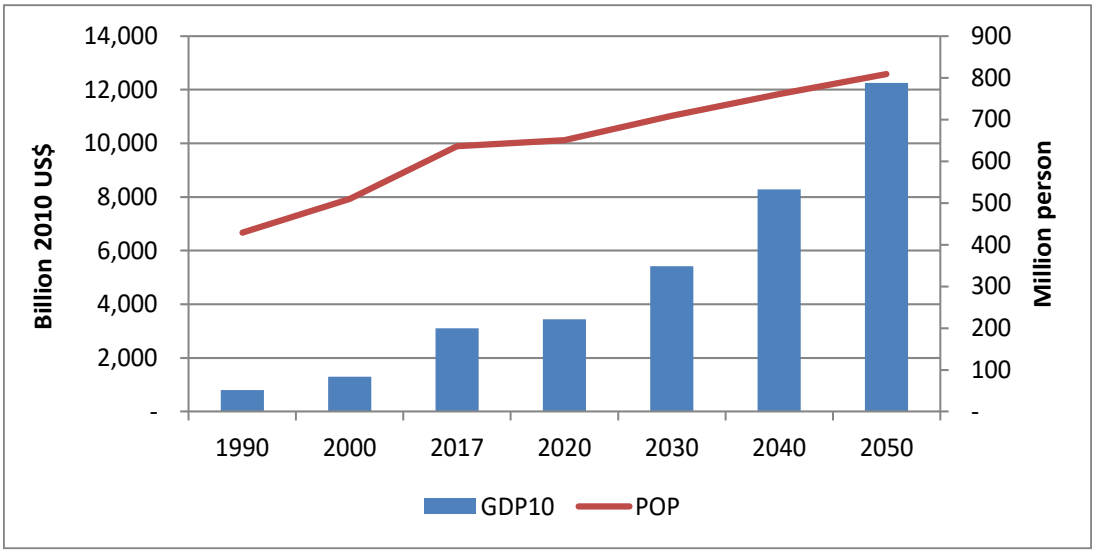
3. Energy Consumption Outlook in ASEAN

This section analyses the outlook for ASEAN-wide primary energy consumption, final energy consumption, and CO_2 emissions based on the ERIA Energy Outlook 2020 (ERIA, 2021).

3.1. Population and gross domestic product (GDP) outlook in ASEAN

Figure 1.2 shows ASEAN's population and GDP outlook as an assumption for future energy consumption. ASEAN's population is expected to continue to grow; at the same time, its GDP is also expected to grow steadily.

Figure 1.2. Population and GDP Outlook in ASEAN



Source: ERIA (2021).

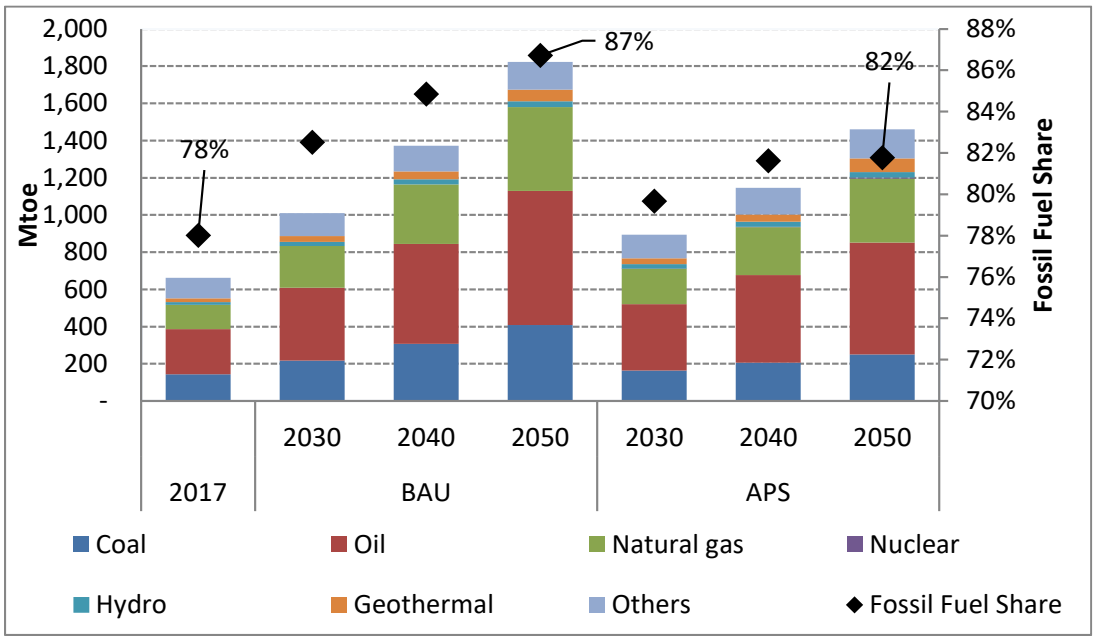
3.2. Primary energy consumption outlook in ASEAN

Figure 1.3 shows the primary energy consumption outlook in ASEAN. The primary energy consumption in ASEAN is expected to increase 2.8-fold from 662 Mtoe in 2017 to 1,823 Mtoe in 2050 under the business-as-usual scenario (BAU), and the alternative policy scenario[1] (APS) projects a 2.2-fold increase to 1,461 Mtoe in 2050. The share of fossil fuels, which emit CO_2 during combustion,[2] is expected to rise from 78% in 2017 to 87% in 2050 in BAU and 82% in 2050 in the APS.

[1] Additional energy savings and renewable energy penetration might be achieved.

[2] Coal, oil, and natural gas.

Figure 1.3. Primary Energy Consumption Outlook in ASEAN

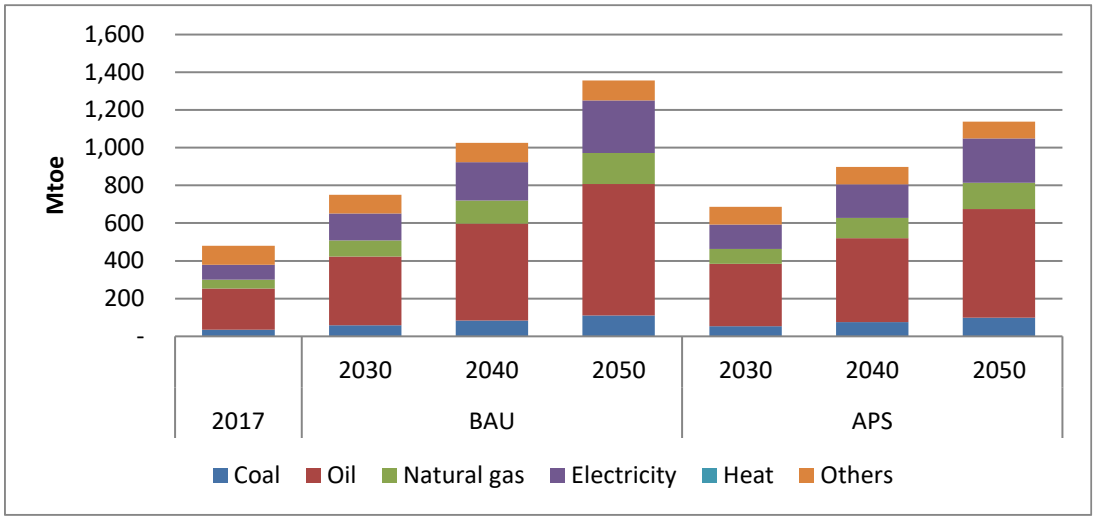


Source: ERIA (2021).

3.3. Final energy consumption outlook in ASEAN

Figure 1.4 shows the final energy consumption outlook in ASEAN. It is expected to increase a 2.8-fold from 480 Mtoe in 2017 to 1,356 Mtoe in 2050 in BAU and a 2.4-fold to 1,139 Mtoe in 2050 in the APS.

Figure 1.4. Final Energy Consumption Outlook in ASEAN

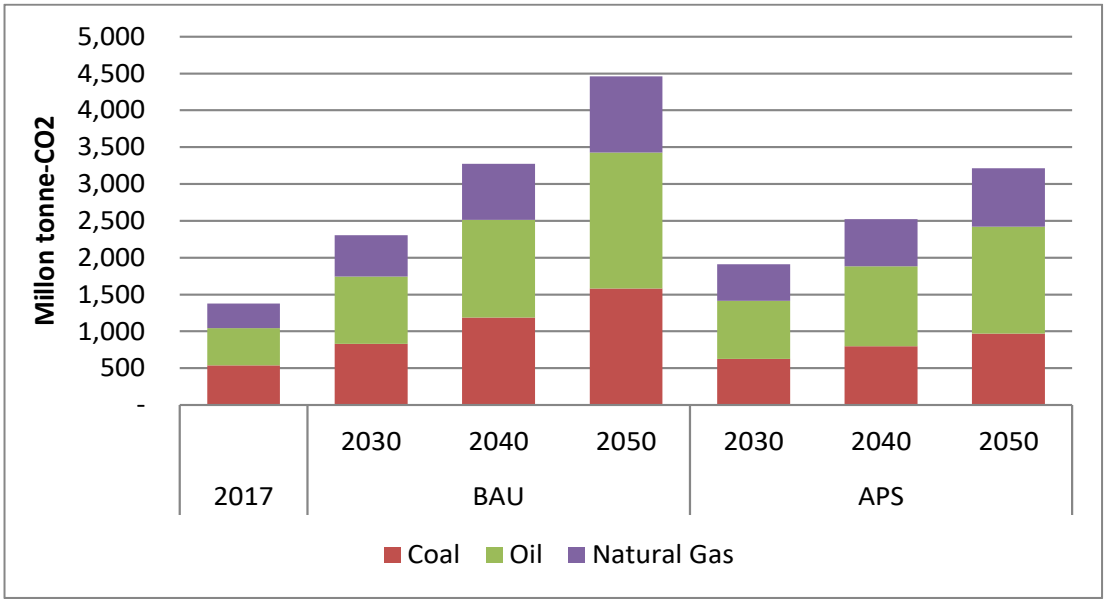


Source: ERIA (2021).

3.4. CO_2 emission from fuel combustion outlook in ASEAN

Figure 1.5 shows ASEAN's outlook for energy-derived CO_2 emissions. CO_2 emissions in ASEAN are estimated to increase 3.2-fold from 1,378 million tonnes in 2017 to 4,461 million tonnes in 2050 in BAU, and 2.3-fold to 3,212 million tonnes in 2050 in the APS.

Figure 1.5. CO_2 Emission from Fuel Combustion Outlook in ASEAN



Source: ERIA (2021).

4. ASEAN's Tasks for Carbon Neutrality

4.1. Carbon neutrality in a brief period: a huge financial burden

The IEA World Primary Energy Consumption Outlook by Scenario (2050) was created using the back-cast method (a method of first drawing a target future image and then tracing the path to realise that future image from the future to the present). However, Outlook 2022 of the Institute of Energy Economics, Japan (IEEJ) is created by the fore-cast method (a method of exploring the future starting from the present). IEEJ outlook 2022 estimates that the average cost required to achieve CN in 2050 in ASEAN is US$213/tonne-$CO_2$. The additional cost for CO_2 reduction will amount to a yearly average of 2.5% of ASEAN's total GDP through 2050. Incidentally, according to the IEA's net-zero road map, the global yearly average cost for realising CN by 2050 is expected to be 1% of total GDP, indicating that developing countries

must bear relatively inflated costs. Given these, pursuing CN in a brief period could result in a huge increase in the national burden on ASEAN.

4.2. Planning and technical assistance for realising carbon neutrality

The above suggests that developed countries and ASEAN are in different situations; therefore, the costs for realising CN are vastly different. Thus, it is not appropriate to uniformly require ASEAN countries to follow a path for transition to CN like that for developed countries. Instead, it is necessary to consider the various realities of the respective countries, provide technical assistance, and develop a process chart for CN suited to each country.

5. Importance of National Oil Companies

National oil companies (NOCs) are less susceptible to decarbonisation pressures from nongovernmental organisations, institutional investors, and judicial organs. Their shareholders are their home governments, and if their governments do not require strong climate change countermeasures, they can continue to invest in upstream sectors and fossil fuel businesses as they have in the past. The energy transition from fossil to non-fossil fuels is expected to proceed gradually. The NOCs of oil-producing and emerging countries may become even more influential in the international market as important fossil fuel suppliers during the energy transition period.

Under these circumstances, ASEAN NOCs, in handling fossil fuels, must strengthen GHG emission reduction measures as they ensure a stable energy supply and strengthen their efforts in their existing businesses and low-carbon fields, such as renewable energy.

Based on the above, it is necessary to implement case studies and comparative analysis of existing efforts and low-carbon energy business sector initiatives by the ASEAN NOCs and the Western majors, and to study and make recommendations to the ASEAN NOCs regarding their efforts towards low carbonisation and decarbonisation.

Chapter 2

Climate Pressure on Oil and Gas Business

Since the Paris Agreement took effect, developed countries have declared CN targets. This chapter overviews each country's CN declaration status (CN with target year) and their measures for realising their targets.

1. Each Government's Move towards Low Carbonisation and Decarbonisation

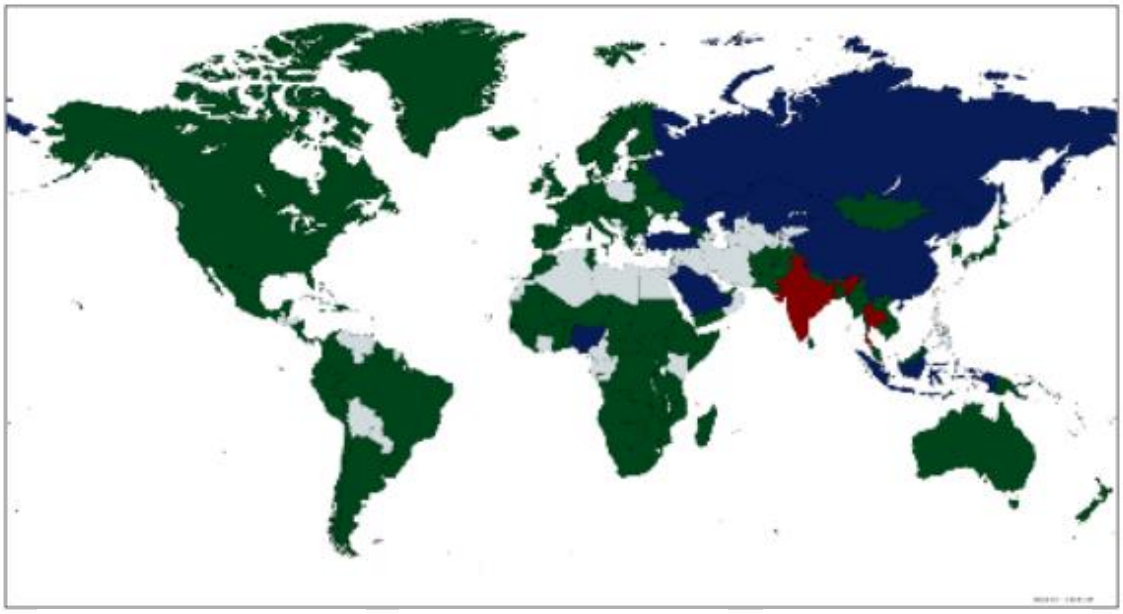
1.2. Number of countries committed to CN

First, 121 countries declared CN to be achieved by 2050 at the end of COP25 (December 2019), but those were small countries with GHG emissions except for the European Union (EU) countries. As of December 2019, CO_2 emissions by the countries committed to CN accounted for 17.9% of worldwide CO_2 emissions; only the EU, the United Kingdom (UK), and Canada amongst the G7 nations were involved in the commitment.

Subsequently, President Xi Jinping announced in September 2020 at the United Nations General Assembly that China would aim for CN in 2060. Prime Minister Kan announced in October 2020 in his statement of belief that Japan would aim for CN in 2050. President Biden decreed as soon as he took office in January 2021 that the United States (US) would return to the Paris Agreement. The US set a CN target for 2050. Other countries announced their CN targets one after the other in preparation for COP26 in November 2021. As of COP26, over 150 countries (all G20 countries) announced their CN targets with target years. The number of countries that declared CN achievement by 2050 was 144 (42.2%); 152 countries (80.6%) declared CN achievement by 2060; and 154 countries (88.2%), by 2070. As shown in Figure 2.1, 88% of global emissions is covered by countries' net-zero ambitions as of November 2021. To view the latest information, please visit Net Zero Tracker.[3]

[3] https://zerotracker.net/

Figure 2.1. Countries and Regions that Announced CN as of November 2021



Source: METI, Japan (December 2021

2. Status of CN Declarations by Major Countries

In June 2019, the UK revised its Climate Change Act and became the first G7 country to have a CN target by 2050. In March 2020, the EU declared to achieve CN by 2050, with a CO_2 reduction of at least 55% of the 1990 level by 2030. In September 2020, China declared CN to be achieved by 2060 at the United Nations General Assembly. In October of the same year, Japan declared CN achievement by 2050. In February the next year, the US officially returned to the Paris Agreement and targeted CN achievement by 2050. Momentum for CN declarations grew in the run-up to COP26; and in October 2021, Australia declared CN achievement by 2050. In the same month, Russia announced its goal of achieving CN by 2060, and in the same month, Saudi Arabia also announced its goal of attaining CN by 2060. At COP26 in November 2021, India announced its goal of achieving CN by 2070.

In response to this trend, ASEAN countries also declared CN. In September 2021, Malaysia declared CN achievement by 2050; in November 2021, Viet Nam and Thailand declared CN achievement by 2050 at COP26. In the same month, Indonesia declared CN achievement by 2060.

Table 2.1 shows the CN declaration status with the target year for each country.

Table 2.1. Year of Carbon Neutrality as of November 2021

Country/Region	Year of Carbon Neutrality
Australia	2050
China	2060
European Union	2050
India	2070
Indonesia	2060
Japan	2050
Malaysia	2050
Russian Federation	2060
Saudi Arabia	2060
Thailand	2050
United Kingdom	2050
United States	2050
Viet Nam	2050

Source: Author.

3. Green-related Measures Taken by Each Country

Each country is also developing measures to achieve its CN targets. The EU has developed a public and private €1 trillion (US$1 trillion) (Green Deal investment plan for 10 years, from 2020 to 2030. The UK is planning budgetary measures for realising CN, namely, £12 billion (US$14 billion) in government spending and £42 billion (US$49 billion) in induced private investment by 2030. Both are expected to create 250,000 jobs and reduce CO_2 emissions by 180 million tonnes- CO_2 (2023–2032). The UK is also planning intensive investment in its '10-point plan for a green industrial revolution (offshore wind, hydrogen, nuclear, zero-emission vehicle [ZEV], public transport, jet zero and green ships, greener buildings, CCUS, protecting our natural environment, green finance, and innovation).' Out of its €50 billion (US$50.7 billion) economic stimulus package for advanced technology support, Germany will invest €7 billion (US$7.1 billion) in hydrogen-related technologies, €2.5 billion (US$2.5 billion) in electric-charging infrastructure, and about €9.3 (US$9.4 billion) billion in green technology development (energy systems, vehicles, and hydrogen). France will invest €30 billion (US$30 billion) as a total project cost over 2 years in clean energy, infrastructures, and other measures.

The US will invest US$2 trillion in decarbonisation fields such as EV promotion, green buildings, and energy technology development.

4. Lending Policies of the EIB and ADB

Growing concern about climate change issues has created a challenging atmosphere for investments in fossil fuels. Amidst this situation, the Asian Development Bank (ADB) has decided not to invest in constructing new coal-fired power plants. It intends to promote the early abolition of coal-fired power generation and the transition to renewable energy. ADB will stop financing new coal-fired power plants, natural gas exploration, and nuclear power generation.

The European Investment Bank (EIB) will stop funding projects utilising fossil fuels, including gas, at the end of 2021. The EIB has also set a goal of financing €1 trillion in the environmental sustainability field, including climate change, between 2020 and 2030.

Chapter 3

The Strategy of Selected NOCs in the ASEAN Region

In response to the CN declarations by ASEAN national governments, NOCs, whose major shareholders are national governments, are expected to be required to develop business strategies and initiatives in line with national policies. This section introduces and analyses ASEAN NOCs' energy transition strategies and initiatives.

1. Major Oil Companies of ASEAN

Amongst the NOCs representing ASEAN countries, we selected three companies (Table 3.1) interested in climate change countermeasures.

Table 3.1. Selected NOCs in ASEAN

Country	Malaysia	Indonesia	Thailand
Company	PETRONAS	Pertamina	PTT

Source: Author.

2. Decarbonisation Efforts by the Major NOCs in ASEAN

Table 3.2 overviews the decarbonisation efforts of selected ASEAN NOCs.

Table 3.2. Decarbonisation Activities of Selected ASEAN NOCs

	PETRONAS	**Pertamina**	**PTT**
GHG emission net-zero target	Net zero (Scopes 1＋2) by 2050 Announced in October 2020 Oral declaration by the CEO	No net-zero targets by 2050	Net-zero GHG emission by 2050 (Scopes 1+2)
Decarbonisation activities	Solar power, ammonia, hydrogen, CCS, etc.	Solar power, geothermal, biorefinery, CCS, etc.	EV, charging station, battery, biofuels, etc.

CCS = carbon capture and storage, CEO = chief executive officer.
Source: Author.

3. The Relationship between ASEAN Governments and NOCs regarding CN Targets and Strategies

3.1. Importance of NOCs' role in government GHG emission reduction targets

Data on GHG emissions from ASEAN countries are unavailable, but NOCs' GHG emissions are expected to account for a large proportion of energy-related GHG emissions. Therefore, to reduce GHG emissions nationwide, it is necessary to reduce NOC GHG emissions. Since the government is a major NOC shareholder and has a great influence on NOCs, the government can actively instruct NOCs to reduce GHG emissions.

3.2. Hearing ASEAN NOCs

We asked the three NOCs (Pertamina, PETRONAS, and PTT) about the relationship between the government and NOCs regarding CN targets and strategies. The PTT and Pertamina responded as follows**.**

The government of Thailand has set the country's target for GHG emission reduction but did not allocate a specific target on the PTT. The government does not impose any GHG emission reduction targets on the PTT, leaving the PTT to set a target for itself. The government gives the PTT the right to set its own CN target and strategy, with the country's CN target as a reference and guide. The PTT then sets its target and strategy to align with and contribute to the national target. The government assigns the Ministry of Natural Resources to collect the data from the NOCs at some level of audit (not a full-scale one).

On the other hand, the government of Indonesia has already set GHG emission reduction targets for the energy, forestry, waste, industrial processes, and product use, and agriculture sectors. It will set a target for each subsector, including NOCs, through the Ministry of Environment and Forestry (MOEF) regulation. The government will impose GHG emission reduction targets reached by NOCs, as stated in the MOEF regulation. NOCs are obliged to develop a CN strategy. A target and strategy shall be designed to meet the GHG reduction target and NZE aspiration of the government. NOCs will contribute to achieving the country's CN target by reaching each subsector's GHG emission reduction target through NOCs' NZE road map, decarbonisation initiatives (including carbon offset), and initiating carbon trading activity. The government will apply a cap-trade-tax mechanism that will trigger NOCs to meet the GHG emission reduction target.

4. GHG Emission and GHG Emission–Reduction Activities by Segment

4.1. GHG emission at a glance

Various industries emit GHGs in each ASEAN country, but the oil, gas, and chemical companies emit more GHGs. The supply chains or segments of these companies are roughly divided into upstream, downstream, and others. Which segment of these companies emits the most GHGs?

From 2021, British Petroleum (BP) and Pertamina would disclose GHG emissions by segment. Shell has released figures by segment since 2017 and total energies since 2015. The definition

of the 'segment' may differ for each company, so it is impossible to make a simple comparison. But the published figures (Scope 1) are summarised in Table 3.3.

Naturally, different business portfolios have different segments that emit a lot of GHGs. However, as a major trend, the ratio of upstream and refinery and petrochemical sectors is high, and the major segments of oil companies emit a large amount of GHG. Therefore, the NOC must select and implement effective strategies and measures for upstream and refinery and petrochemical to reduce GHG emissions from existing businesses through its efforts.

Table 3.3. GHG Emissions Scope 1 Comparison by Segment

GHG Emissions Scope 1	**Segment**	**Pertamina**	**Shell**	**BP**	**TotalEnergies**
Emission Amount (Million tonnes CO_2e) in 2021	Total	23.26	60.0	33.2	34.0
	Upstream	11.59	11.7	15.5	14.0
	Integrated Gas	-	15.5	-	5.0
	Refining and Petrochemical	8.52	31.1	16.9	15.0
	Others	3.16	1.6	0.8	>0
Proportion By segment	Upstream	50.0%	19.5%	46.7%	41.1%
	Integrated Gas	-	25.8%	-	14.7%
	Refining and Petrochemical	36.6%	51.8%	50.9%	44.1%
	Others	13.4%	2.7%	2.4%	-

Notes: Shell's integrated gas: The Integrated Gas business manages liquefied natural gas (LNG) activities and the conversion of natural gas into gas-to-liquids fuels and other products, as well as our New Energies portfolio. TotalEnergies Integrated gas includes integrated gas, renewables, and power, excluding upstream gas operations.
Source: Author.

4.2. PETRONAS, Malaysia

1) GHG reduction targets

In October 2020, PETRONAS's CEO, Tengku Muhammad Taufik, declared the realisation of CN (Scopes 1+2) by 2050. He set a target for realising renewable generation capacity of 3,000 MW and GHG emissions of no more than 49.5 million tonne-CO_2 eq by 2024 (PETRONAS, 2021). As

shown in Table 3.4., PETRONAS disclosed the GHG emission performance (total GHG emission and GHG intensity by segment).

Table 3.4. GHG Emission and GHG Intensity, PETRONAS

Million tonne-CO_2e	2017	2018	2019	2020	2021
Malaysia operation	53.6	48.1	51.6	46.3	43.8
International operation	2.9	2.0	2.2	2.0	1.4
Total GHG emission	56.5	50.1	53.8	48.3	45.2
GHG intensity	2017	2018	2019	2020	2021
Upstream (tCO_2e/kboe)	88.7	74.2	64.6	65.9	47.9
Refineries (tCO_2e/bbl)	0.017	0.018	0.018	0.019	0.018
Petrochemicals(tCO_2e/tonnes)	0.77	0.68	0.68	0.66	0.67

Source: PETRONAS (2021, pp.218–19).

2) Major efforts

a) Upstream

PETRONAS reduced 340,000 tonne-CO_2 eq GHG emissions in its upstream businesses in 2020 and became a signatory member of the Methane Guiding Principles (PETRONAS, 2020).

b) Product

PETRONAS is engaged in the marketing of biodiesel-blended light oil and other products.

c) CCS/hydrogen/ammonia/methanation/CO_2 transport

Hydrogen

In February 2021, PETRONAS signed an MoU relating to low-carbon energy, such as hydrogen and ammonia, with JERA, Japan. This signing resulted from both companies' shared vision of achieving net-zero carbon emissions. PETRONAS signed an MoU on renewable energy and green hydrogen fields with Masdar, United Arab Emirates (UAE), in March 2021. Both companies explore renewable energy opportunities across Asia and beyond. PETRONAS also signed a comprehensive and strategic collaboration agreement on hydrogen and CCS fields with the Abu Dhabi National Oil Company (ADNOC), UAE, in March 2021. Both companies explore opportunities for collaboration across the full oil and gas value chain and hydrogen and CCS.

In September 2021, PETRONAS subsidiary PETRONAS Gas & New Energy Sdn Bhd (PGNESB) and ENEOS, Japan, signed an MoU for joint research on the hydrogen supply chain. Its objective

is to establish a procurement and supply network for transporting hydrogen produced in Malaysia to ENEOS' refineries. The duration of the joint research is 1 year.

Ammonia

In August 2021, PETRONAS Energy Canada, a wholly owned subsidiary of PETRONAS, and Itochu agreed to research ammonia production in Alberta, Canada, jointly by 2026.

In October 2021, PETRONAS, Malaysian state-owned utility Tenaga Nasional Berhad, and Japan's IHI agreed on project research for ammonia co-combustion at coal-fired power plants. The study ran through February 2022.

Methanation

In November 2021, PETRONAS, Sumitomo Corporation, and Tokyo Gas agreed to conduct project research to synthesise carbon-neutral methane by methanation of green hydrogen and CO_2 in Malaysia and introduce it to Japan.

Carbon Capture and Storage

In November 2021, PETRONAS and ExxonMobil agreed to conduct the feasibility study of a CCS project off the Malay Peninsula. Furthermore, in December 2021, PETRONAS announced that it would cooperate (CCS technology-related cooperation) with Posco International and Posco Engineering & Construction, subsidiaries of Korean steelmaker Posco.

In January 2022, PETRONAS announced a CCS joint research with Sarawak Shell Berhad (Shell).

CO_2 transport

In February 2022, PETRONAS signed an MoU with Mitsui O.S.K. Lines to develop a business for the marine transportation of liquefied CO_2.

d) Renewables

According to the PETRONAS Integrated Report 2020, PETRONAS plans to introduce 3,000 MW of renewable energy generation by 2024. According to the report, the total solar power generation capacity is 600 MW (including the capacity of those under construction).

In April 2019, PETRONAS acquired Amplus Energy Solutions Pte Ltd (M +), a Singaporean renewable energy venture company, to establish M+by PETRONAS.

As shown in Table 3.5, PETRONAS is increasing its solar power generation in Malaysia and abroad.

Table 3.5. Solar Power Generation by PETRONAS

MWh	2016	2017	2018	2019	2020	2021
Malaysia	671.6	582.5	581.5	687.2	1,789.3	1,878.9
Overseas	261.0	285.0	274.0	444.4	386.0	442.3

Source: PETRONAS (2021).

4.3. Pertamina, Indonesia

1) GHG reduction target

In April 2021, a press release reported that Pertamina reduced GHG emissions by 27.08% in 2020. However, the press release did not mention the base year and scenario in which the reduction ratio was calculated. Pertamina aims to lower GHG emissions by 30% in 2030 (baseline: 2010), following Indonesia's commitment to reduce emissions based on the Paris Agreement. Pertamina also targets an increase in new relationship energy total capacity to 10.2 GW by 2026.

Pertamina is committed to reducing GHG emissions by 8.1 million tonnes to realise the Indonesian government's CN goal by 2060. As part of its efforts, PERTAMINA will invest US$8.3 billion CAPEX to expand its utilisation of new renewable energy.

Pertamina (2021) again recalculated the baseline for total CO_2 eq emissions for Scopes 1 and 2 for all sub-holdings and their respective subsidiaries, services, and portfolio subsidiaries, as well as operating units/business units under the Pertamina Group. Table 3.6 shows the GHG emissions by segment under Pertamina.

Table 3.6. GHG Emission by Segment under Pertamina

Beban Emisi GRK Cakupan 1 berdasarkan Parameter [305-1] [CCE-4] [CCE-5]
GHG Emission Scope 1 based on Parameter

Cakupan 1 *Scope 1*	Satuan *Unit*	2021	2020	2019
Emisi GRK Langsung Cakupan 1 *Direct GHG Emission Scope 1*	Juta Ton CO_2 *Million Tonnes CO_2*	23.26	21.02	18.31
Karbon Dioksida | *Carbon dioxide (CO_2)*	Juta Ton *Million Tonnes*	20.29	19.73	15.79
Metana | *Methane (CH_4)*		0.0671	0.0397	0.0488
Nitrogen oksida | *Nitrous oxide (N_2O)*		0.0044	0.0010	0.0044
Emisi Cakupan 1 berdasarkan segmen bisnis | *Scope 1 emission by business segment*				
*Upstream**	Juta Ton *Million Tonnes*	11.59	10.29	5.52
Refining & Petrochemical		8.52	7.31	12.5
Commercial & Trading		0.14	0.54	0.21
Power New Renewable Energy		0.11	0.21	0.07
Gas		0.48	0.81	0.01
Integrated Marine Logistics		2.43	1.86	-
Emisi Cakupan 1 berdasarkan sumber | *Scope 1 emission by source*				
Pembakaran | *Combustion*	Juta Ton *Million Tonnes*	14.62	12.86	13.11
Routine Flaring		2.38	1.80	0.95
Non Routine Flaring		0.27	0.22	0.10
Safety Flaring		0.27	-	-
Venting and Process		5.30	5.81	2.78
Fugitives		0.41	0.34	1.36

*Termasuk Badak LNG
Including Badak LNG

Beban Emisi GRK Cakupan 2 [305-2][CCE-4]
GHG Emissions Scope 2

Segmen *Segment*	Satuan *Unit*	2021	2020	2019
Upstream	Ribu ton CO_2eq *Thousand ton CO_2eq*	188.20	171.22	28.01
Refining and Petrochemical		46.02	52.73	37.17
Commercial and Trading		74.29	94.48	110.21
Power & New and Renewable Energy		1.85	1.60	-
Gas		9.44	19.77	11.09
Total		319.80	339.81	186.49

Beban Emisi GRK Cakupan 3 [305-3] [CCE-4] [11.1.7]
GHG Emissions Scope 3

Cakupan 3 *Scope 3*	Satuan *Unit*	2021	2020	2019
Penggunaan Produk yang Dijual – Kategori 11 *Use of Sold Product – Category 11*	Juta ton CO_2eq *Million ton CO_2eq*	154.05	144.24	160.41

Source: Pertamina (2021, pp.93–94).

2) Scenarios for realising CN

In December 2021, Pertamina presented the Indonesian government's scenario for realising CN by 2060. The company states that it can significantly reduce CO_2 emissions by, amongst other things, sharing renewable energy in the power generation sector and increasing the use of EVs. It will reduce the use of oil and coal while continuing the use of natural gas. The company analysed CO_2 emissions under three scenarios: low transition, market driven, and green transition. Of these, only the green transition scenario could achieve CN by 2060. Under this scenario, the share of renewable energy in primary energy would be 82% in 2060. Most vehicles travelling domestically will be EVs, and the fossil fuels used will be mainly natural gas, reducing the use of oil and coal. Under this scenario, oil demand peaks out in 2028, while domestically produced natural gas alone may be insufficient. Under this scenario, GHG emissions will peak at 670 million tonnes in 2030 and decrease to 270 million tonnes in 2060. The company is considering utilising carbon absorption techniques such as CCUS. At present, however, the high cost of their introduction and the inability to accurately calculate the amount of carbon that can be absorbed are obstacles to large-scale introduction.

3) Major efforts

a) Upstream

Pertamina is endeavouring to improve the efficiency of upstream facilities, for example, by utilising associated gas in power generation facilities in oil and gas fields. The company is also working on the effective use of flaring.

b) Refinery

Pertamina converted its Cilacap refinery into a biorefinery. In addition, the company is planning to build a new biorefinery in Plaju. Plaju and Cilacap have a strategic role in supporting the road map for the development of Indonesian biofuels, as stated in the General National Energy Plan.

c) Retail

Pertamina is reforming its service stations with a new concept, 'Green Energy Station.'

d) CCS/Hydrogen

In June 2021, Pertamina signed an MoU with JAPEX and LEMIGAS to jointly conduct the feasibility study of the CCUS project in the Sukowati oil field. For Pertamina, this collaboration will greatly support Indonesia's commitment to reducing GHG emissions.

In June 2021, Pertamina signed a joint research agreement on CCUS with a Japanese group (JANUS, JGC Corporation, and J-Power) and Institut Teknologi Bandung. The feasibility study collaboration took place from June 2021 to February 2022. Furthermore, EPC will be carried out in 2022–2024 and is expected to be operational in 2026.

In January 2022, it signed an MoU with Chiyoda Corporation for joint technology development and application in CCUS and hydrogen production.

In February 2022, it signed an MoU with Marubeni Corporation for the joint development of CCUS and other decarbonisation projects.

In the same month, PGN, a state-owned gas company under Pertamina, signed an MoU with SKE&S, a liquefied natural gas (LNG) company of the SK Group of Korea, to cooperate in CCS and hydrogen businesses.

In March 2022, Pertamina, Mitsubishi Corporation, and Pupuk Indonesia, an Indonesian state-owned fertiliser producer, will cooperate on green hydrogen, green ammonia, and CCUS technologies.

In April 2022, Pertamina launched a joint study with Mitsui & Co., Ltd. to commercialise CCUS in Indonesia.

In May 2022, Pertamina signed an MoU with ExxonMobil on CCS candidate sites off the coast of Indonesia and on transportation methods.

e) Renewables/Others

In June 2021, Pertamina set targets for the energy supply mix in 2030 to reduce petroleum-based fuels and liquefied petroleum gas to 64% while increasing natural gas and renewable energy to 19% and 17%, respectively. The company plans to make 17% of its overall energy businesses green energy portfolios by 2030. In addition, it plans to allocate 9% of its capital-investment spending for 2020–2024 to renewable energy development.

In November 2021, Pertamina NRE planned to have total clean energy installed capacity of 3.2 GW by 2022. The breakdown is 1.8 GW of gas electric power generation, 908 MW of geothermal power generation, and 480 MW of Energi Baru dan Terbarukan (EBT). In Indonesian, EBT means renewable energy (power generated by geothermal, hydro, solar, wind, biomass, and other energy sources).

In November 2021, Pertamina NRE and Masdar of the UAE signed an MoU on developing clean energy solutions (solar and wind power plants, as well as green and blue hydrogen).

4.4. PTT, Thailand

1) GHG reduction target

According to the 56-1 One Report 2021 (PTT, 2021), PTT reviewed long-term GHG emission targets (Scopes 1 and 2 including national and international operations) to be 15% reduction in 2030 compared to GHG emission in 2020 and set a target to achieve carbon neutrality within 2040 and net-zero GHG emission by 2050. According to the 56-1 One Report 2020 (PTT, 2020), the company had set its carbon pricing at US$20/tonne-$CO_2$. In November 2020, PTT was targeting an electricity generating capacity of 16 GW by 2030 – 8 GW from fossil-based sources and 8 GW from renewables. In August 2021, PTT was increasing its renewable power target to 12 gigawatts (GW) by 2030, from 8 GW.

Table 3.7 shows GHG emissions from 2018 to 2021 by PTT.

Table 3.7. GHG Emission by PTT

Million tonne-CO_2	2018	2019	2020	2021
GHG emission Scope 1	29.88	29.94	29.03	31.73
GHG emission Scope 2	1.91	1.98	1.66	1.42
GHG emission Scope 3	127.05	126.36	116.15	113.48

Source: PTT (2021, p.150).

2) Major activities

a) Upstream

PTT withdrew from its coal business while strengthening its LNG value chain. The company is working on flare reduction and methane leakage reduction.

b) Product

The company markets petroleum products that reduce GHG emissions, such as gasohol 91, gasohol 95, gasohol E20, gasohol E85, diesel B10, diesel B20, and diesel ultra-force.

c) CCS/Hydrogen/Ammonia

In April 2022, PTT Exploration and Production (PTTEP), INPEX, and JGC Holdings signed an MoU for CCS development in Thailand. This is expected to lead to the creation of energy transition–related businesses involving hydrogen, ammonia, and other clean energy sources.

In May 2022, PTT and Saudi Arabian Oil Company (Aramco) signed an MoU including clean energy (blue and green hydrogen), carbon capture, and EVs.

d) EVs, batteries, and charging points

PTT aims at comprehensive businesses ranging from EVs to charging stations.

Electric vehicles

In May 2021, PTT signed an MoU for EV development and manufacturing with Taiwan's Foxconn. In July 2021, PTT established a new EV business company, EVME Plus. In September 2021, they established a joint venture company. They are also embarking on EV production and development of storage batteries and charging stations, with a plan for local initial public offerings in 2025. PTT's EV subsidiary Arun Plus and Foxconn's subsidiary Lin Yin International Investments are planning to go on a joint venture. The EV plant in Thailand designs, manufactures, assembles EVs, and produces the main EV components. It plans to start production of 50,000 units per year over the next 2 to 3 years, increasing to 150,000 units.

In March 2022, PTT exhibited its products for the first time at the Bangkok International Motor Show and unveiled a prototype vehicle developed with its partner Foxconn. The company plans to construct a plant in Thailand and start production in 2024. In April 2022, PTT launched a joint venture with Foxconn for the commissioned production of EVs in China.

Batteries

PTT will widely expand its battery business with a focus on passenger car–type EVs, motorcycles, buses, trucks, boats, etc. In January 2022, PTT established Nuovo Plus, a company handling its EV battery business. Nuovo Plus plans to be responsible for EV batteries and construct energy storage systems. PTT will reorganise its battery business structure for EVs. In February 2022, Global Power Synergy Public Company, Limited (GPSC) will transfer its battery plant and all related assets to Nuovo Plus. The battery-related business will be integrated into Nuovo Plus, producing batteries and taking charge of the energy storage system business.

Charging facilities

PTT Oil and Retail Business (PTTOR), PTT's retail business company, has set a target of constructing 300 EV-charging stations by 2022.

e) Solar power

In July 2021, PTT's power generation subsidiary GPSC acquired a 41.6% stake in Avaada Energy, an Indian solar power company. The GPSC considers India as a focus country for renewable energy expansion. Avaada has built India's largest portfolio of solar power projects,

aggregating to 1 GW capacity. Another 11 GW project pipeline has been developed across emerging African and Asian countries.

5. Summary of Chapter 3

5.1. CN declaration status of ASEAN countries and NOCs

Chapter 3 discussed the relationship between the government and NOCs regarding CN targets and strategies, GHG emissions by a segment of oil and gas companies, and the strategies and initiatives of the three NOC companies representing ASEAN.

Here, the CN declaration status of the governments of ASEAN countries and the CN declaration status of the three representative NOC companies are summarised. Table 3.8 shows the relationship between the CN target of NOCs and each government. Malaysia and PETRONAS and Thailand and PTT have the same CN target year 2050. Meanwhile, Indonesia has announced a CN for 2060, but Pertamina has not yet set a CN target year. Regarding the interim target for 2030, Malaysia submitted an NDC (Table 3.8). But PETRONAS has not set a GHG reduction target for 2030. Thailand has set the 2030 NDC (Table 3.8), but the 2030 reduction rate of PTT and the base year do not match the NDC. On the other hand, Indonesia's 2030 NDC and Pertamina's 2030 reduction targets are almost the same. The Pertamina Sustainability Report 2021 cites a provision supporting the national GHG emission reduction target of 2030, suggesting the Indonesian government's NDC-conscious goal setting.

Table 3.8. Year of CN and 2030 Interim Target, Nationwide and NOC

	Malaysia	**Indonesia**	**Thailand**
Year of CN (Nationwide)	2050	2060	2050
Year of CN (NOC)	PETRONAS 2050 (Scopes 1+2)	Pertamina NA	PTT 2050 (Scopes 1+2)
2030 Target (NDC)	▲45% (Unconditional) (Baseline: 2005) Economy-wide carbon intensity (against GDP) reduction	▲41% (Conditional) ▲29 % (Unconditional) (Baseline: BAU scenario of emission projection started in 2010)	▲25% (Conditional) ▲20% (Unconditional) (Baseline: BAU projection from reference year 2005)
2030 Target (NOC)	PETRONAS NA	Pertamina	PTT

		▲30 % GHG reduction (Baseline: 2010) Supporting the national GHG emission reduction target of 2030	▲15 % GHG reduction (Baseline: 2020)

Source: Author.

5.2. How to set the CN strategy for NOCs

The Thai government does not impose any GHG emission reduction targets on PTT. Instead, PTT must decide and set a target by itself. The government gives PTT the right to set its own CN target and strategy.

On the other hand, the government of Indonesia has already set the GHG emission reduction targets for each sector and will set the target for each subsector, including NOCs. NOCs are obliged to develop a CN strategy. NOC's target and strategy shall be developed to meet the GHG reduction target and NZE aspiration stated by the government. NOCs will contribute to achieving the country's CN target by reaching each subsector's GHG emission reduction target through the NOCs' NZE road map, decarbonisation initiatives (including carbon offset), and initiation of carbon-trading activities.

Whether the government imposes GHG reduction targets on the NOCs, the NOCs need to develop a CN strategy. So, how should NOCs formulate the CN strategy?

The 'Strategy Matrix' helps formulate the CN strategy: the markets are taken on the horizontal axis and classified into the existing and new markets. Products are taken on the vertical axis and classified into existing and new products. Measures to become existing products in the current market include reducing methane and flaring, and improving energy efficiency of upstream platforms, refineries, and chemical plants. Sustainable aviation fuel (SAF) is a new product in the existing aviation fuel market. Renewable energies have already entered the market by various companies. Although these are existing products, a new market for oil and gas companies is created. Hydrogen, ammonia, CCS, etc. are energies and sectors that will be new as the market develops. Since each company has a different business portfolio, the position of each measure in the strategy matrix should also be different.

Table 3.9 is an example of a 'Strategic Matrix for Energy Transition.'

Table 3.9. Example of a Strategic Matrix for Energy Transition

		Markets	
		Existing	**New**
Products	Existing	Methane reduction Zero flaring Energy efficiency	Renewables (Solar power) (Wind power) (Geothermal)
	New	SAF Biofuel, biogas, bioplastic EV and battery productions EV fluid Charging point	Hydrogen Ammonia CCUS, DAC Carbon credit

CCUS = carbon dioxide capture, utilisation, and storage; DAC = direct air capture; EV = electric vehicle; SAF = sustainable aviation fuel.
Source: Author.

Which markets or products the business portfolio is devoted to from the above strategic matrix depends on the company's management resources and the geographical situation of the operating countries. Therefore, it is necessary to assemble the optimal strategy matrix for the company.

Examples comprising a basic strategy are (i) reduction of emissions from existing facilities (methane, flaring, improvement of energy efficiency); (ii) utilisation of negative emissions such as CCUS and DAC; (iii) challenge to new energy, innovative technology, and renewable energy such as hydrogen, PV, and wind power; (iv) utilisation of offsets such as plantation and credit and so on.

Once a strategy has been formulated, it is necessary to go through the plan-do-check-action cycle to see if the concrete measures that support the strategy are working well.

An example is in Table 3.10: a cycle of completing an intermediate target for the next 10 years or so converted into million tonnes CO_2e and a reduction target matrix for each strategy, breaking down numerical targets and reviewing the progress results of each year in the Sustainability Report.

Table 3.10. Strategic Matrix of GHG Emission Reduction Initiative Form

Million tonnes CO_2e	**Total GHG Emission Reduction Target**	**Methane and Flaring**	**Energy Efficiency**	**CCUS DAC**	**Renewables and New Energy**	**Offset**
2025						
2030						
2035						

Source: Author.

Chapter 4

Efforts in the Majors/Non-ASEAN NOCs

This chapter analyses the energy transition strategies and activities of majors in Europe and the US (i.e., Western majors) actively engaged in low-carbonisation and decarbonisation efforts.

This chapter also provides examples that may be useful for ASEAN NOCs in developing future low-carbon and decarbonisation strategies.

1. Comparison of GHG Emission Reduction Targets of the Western Majors

Four companies – ExxonMobil, Shell, BP, and TotalEnergies – which are large-scale and active in climate change countermeasures amongst the Western majors, are selected as examples.

Table 4.1 compares the GHG emission reduction targets of the four Western majors, all of which have set a 2050 net-zero target.

TotalEnergies and BP have a net-zero GHG emission target, including Scope 3 for 2050, which is an ambitious target aiming to reduce emissions by at least 40% by 2030. Subsequently, Shell also set a similar goal of net-zero GHG emissions, including Scope 3 for 2050, with a reduction rate of more than 20% by 2030, a lower reduction rate than that of the two companies mentioned above. In October 2021, however, Shell changed its target to reduce GHG emissions by 50% from the 2016 level by 2030 (Scopes 1+2).[4] On the other hand, ExxonMobil has declared net-zero emissions by 2050 (Scope 1+2) but has not included Scope 3. Its GHG reduction target is based on GHG emission intensity, while those of the other three Western Majors are based on the amount of reduction.

[4] Shell Global Home Page, Our Approach to Climate Change and the Energy Transition, https://reports.shell.com/sustainability-report/2021/achieving-net-zero-emissions/energy-transition/climate-change-and-the-energy-transition.html (accessed 10 March 2022).

Table 4.1. Comparison of GHG Emission Reduction Target by Western Majors

	GHG Emission	GHG Emission Reduction Target by 2030	GHG Emission Reduction Target by 2050
Total Energies	All its operations, from production to the energy products used by its customers	-40% *worldwide -30% *Europe	Net zero (Scopes 1+2+3)
BP	Operation activities and oil and gas production	-30～35% *Operations -35～40% *Oil and gas	Net zero (Scopes 1+2+3)
Shell	GHG emissions from all operations and the energy products	-20% * In October 2021, Shell announced an absolute emissions reduction target of 50% by 2030, compared with 2016. * Shell is appealing the Dutch Hague District Court's ruling that global net carbon emissions must be reduced by 45% from 2019 by 2030.	Net zero (Scopes 1+2+3)
ExxonMobil	GHG emissions from its operating assets	Corporate-wide GHG emission intensity: 20%–30% reduction	Net zero (Scopes 1+2)

Source: Author.

2. Comparison of Western Majors' GHG Emission Reduction Targets and Upstream Activities

Table 4.2 compares Western Majors' GHG emission reduction targets, annual CCS targets, flaring elimination periods, and methane emission reductions.

Table 4.2. GHG Emission Reduction Target and Activities in Upstream by Western Majors

	Shell	BP	TotalEnergies	ExxonMobil
GHG emission reduction target	Net zero from Scopes 1+2 emissions from all operations by 2050. Net-zero Scope 3 emissions from all the energy products by 2050.	Net zero across BP's operations by 2050 (Scopes 1+2) Net zero on carbon in BP's oil and gas production by 2050 (Scope 3)	Net zero across Total's worldwide operations by 2050 or sooner (Scopes 1+2+3) Net Zero across all its production and energy products used by its customers in Europe by 2050 or sooner (Scope 1+2+3)	Net zero emissions from its operating assets by 2050 This ambition applies to Scopes 1 and 2 GHG emissions.
CCUS introduction target (annual recovery)	2035: 25 million tonne-CO_2	—	2030: 5 million tonne-CO_2	—
Flaring	Eliminate routine flaring by 2030	—	Eliminate routine flaring by 2030	Eliminate routine flaring by 2030
Methane	Maintain methane emission intensity below 0.2% by 2025	2025 target: 0.2%	<0.1% CH4 intensity for operated gas assets	70%–80% reduction in corporate-wide methane intensity

Source: Author.

3. Situation of Individual Companies

3.1. ExxonMobil

1) GHG reduction targets

In January 2022, ExxonMobil announced that it would reduce GHG emissions to zero by 2050 (Scopes 1+2). However, Scope 3 was not included. The company also updated its emission

reduction target. The company aims to reduce the emission density of GHGs generated by its corporate activities by 20%–30% from the 2016 level by 2030. The company states that if it achieves its target, the absolute number of emissions will also decrease by 20% by 2030. Specific measures include reducing excess gas (flare) in oil fields, preventing the leakage of methane gas, which has a greenhouse effect, and promoting the commercialisation of CCS. The company has already announced a policy of virtually zero emissions by 2030 for production in Permian, Texas, US, and is set to expand its efforts to other regions.

According to the Advancing Climate Solutions 2022 Progress Report (ExxonMobil, 2022), the company's GHG reduction targets by 2030 are as follows:

- 20%–30% reduction in corporate-wide GHG intensity and an absolute decrease of approximately 20% (or about 23 million metric tonnes)
- 40%–50% reduction in upstream GHG intensity and an absolute decrease of roughly 30% (or about 15 million metric tonnes)
- 70%–80% reduction in corporate-wide methane intensity
- 60%–70% reduction in corporate-wide flaring intensity

2) Investment plan

ExxonMobil plans to invest US$20 billion–US$25 billion annually in its entire investment program through 2027. Of the amount, the company will invest US$15 billion in decarbonisation-related activities. According to the report, the company plans to strengthen its methane gas leakage prevention measures and its businesses related to CCS, hydrogen, and biofuel.

3) Major efforts

a) Upstream

Methane

ExxonMobil set a goal of reducing methane intensity by 70%–80%. Figure 4.1 shows how it uses satellite technology and ground-based sensor technology are used to obtain methane emission data. ExxonMobil is participating in the US and EU’s Global Methane Pledge and the US Methane Emissions Reduction Action Plan.

Figure 4.1. ExxonMobil's Methane Measurement Technology

Source: ExxonMobil (2022).

Flaring

ExxonMobil has set a goal of reducing flaring intensity by 60%–70%. It also participates in the World Bank's Global Gas Flaring Reduction Partnership and Zero Routine Flaring by 2030 (ZRF2030).

b) Biofuel

In January 2022, ExxonMobil acquired a 49.9% stake in Norwegian biofuel producer Biojet AS. Biojet AS plans to build five biofuel production facilities in Norway, which will start operations in 2025. The five facilities have an annual production capacity of 3 million bbl., and ExxonMobil will purchase all of it.

c) CCS/Hydrogen

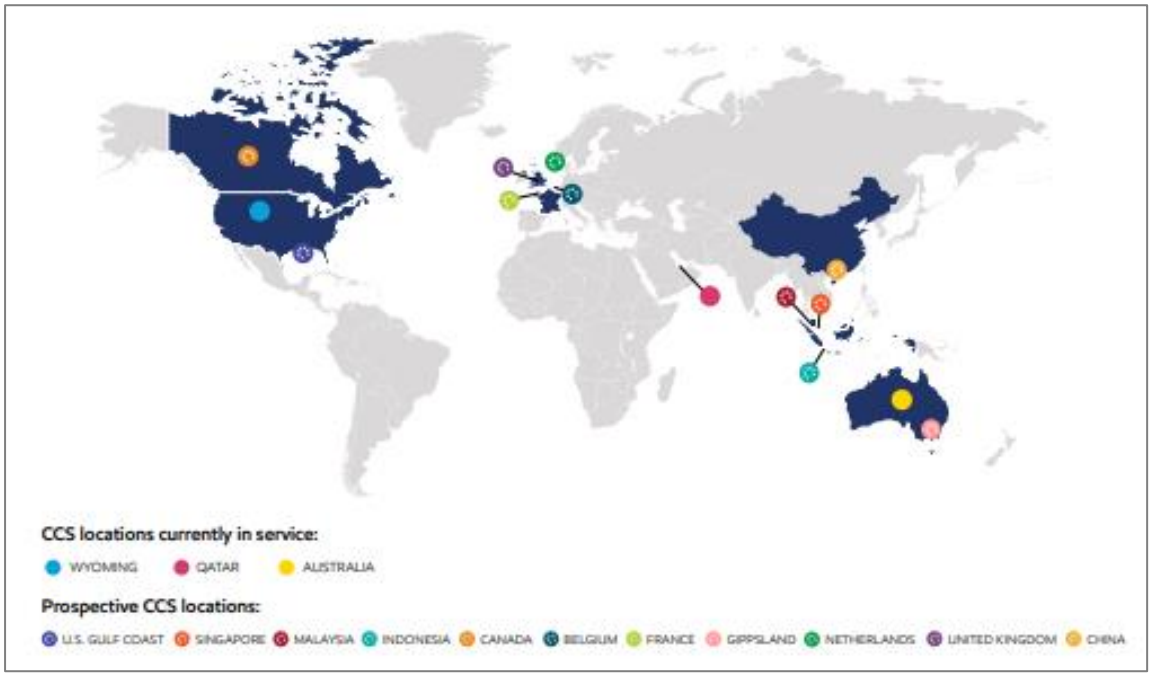
ExxonMobil's CCS history is longer than 30 years; it has a 20% share of the world's CCS capital. Figure 4.2 on ExxonMobil CCS Project Map shows specific projects. The projects include a hydrogen project with CCS at a Rotterdam refinery in Rotterdam, Netherlands; a CCS project at the Port of Antwerp, Belgium; and La Barge CCS project in Wyoming, US. In La Barge, the

capacity will be expanded by another 1 million tonnes from the current 7 million tonnes per year. ExxonMobil also plans to produce 1 bcf/d of natural gas–derived blue hydrogen and conduct the largest-class CCS in the world at its Baytown refining and petrochemical complex in Texas. This will allow the company to reduce CO_2 emissions (Scopes 1+2) by 30% and double its CCS capacity.

The company is also actively promoting CCS collaborations in the ASEAN region. It will jointly partner with PETRONAS in CCS technology development and Pertamina to survey potential CCS sites and transportation methods. It has also launched a scheme for developing a network of CCS facilities across several countries in Southeast Asia and plans to make Singapore the hub for the network. Singapore has a high concentration of power plants and oil refineries but no domestic CO_2 storage sites. In contrast, oil- and gas-producing countries, such as Indonesia and Malaysia, have oil fields with declining production – oil fields providing good conditions for CO_2 storage.

ExxonMobil is also working on DAC, not only on CCS.

Figure 4.2. ExxonMobil's CCS Project Map



Source: ExxonMobil (2022).

4) Divestment

Fossil fuel assets such as petroleum, coal, and natural gas are anticipated to significantly lose their value because they can no longer be utilised when GHG emissions must be reduced in response to global warming. The Western Majors are moving to sell their risky assets to prevent such a stranded-asset risk.

In January 2022, ExxonMobil started selling its shale gas assets in the Appalachian Basin in Ohio, US.

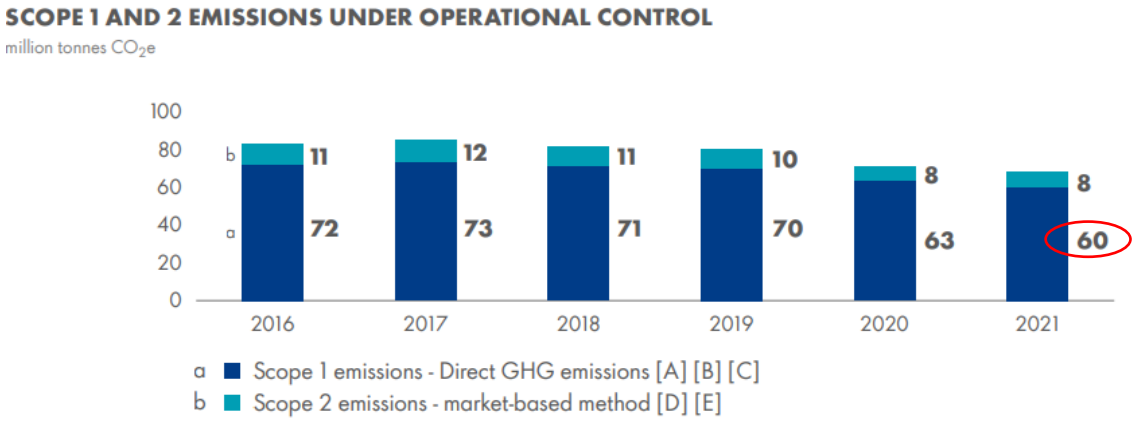
3.2. Shell

1) GHG reduction target

Shell announced its targets for reducing GHG emissions to zero by 2050 through Scopes 1+2+3.

According to the Shell Sustainability Report 2021 (Shell plc, 2021c), in 2021, Shell's total combined Scopes 1 and 2 absolute GHG emissions were 68 million tonnes on a CO_2 equivalent basis (Figure 4.3). Shell's Scope 3 emissions from energy products included in net carbon intensity were 1,299 million tonnes CO_2e.

Figure 4.3. Shell's GHG Emissions Transition (Scopes 1+2)



Source: Shell plc (2021).

Table 4.4 shows the breakdown of GHG emissions transition (Scope 1) by business and emission sources.

Table 4.3. Shell's GHG Scope 1 Emissions Transition by Business and Source (Scope 1)

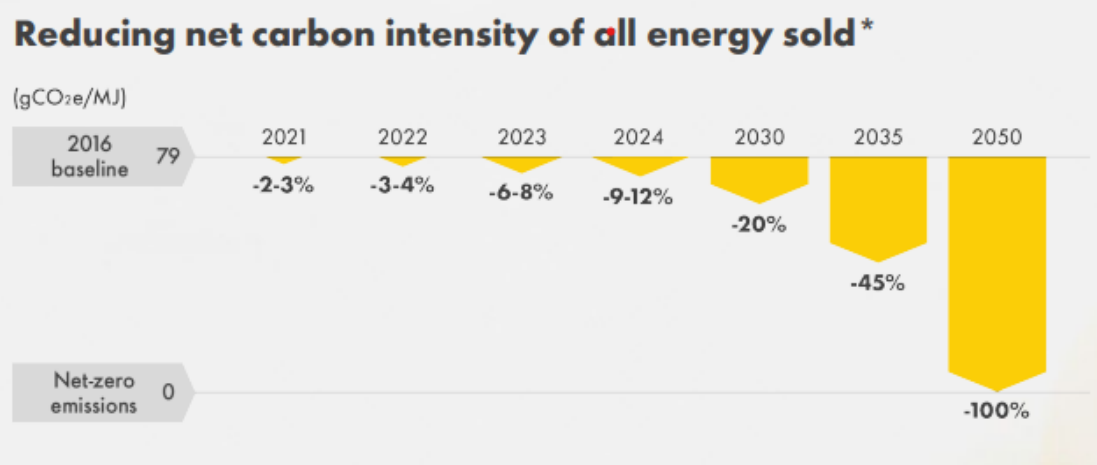
Scope 1 GHG emissions (operational control) [A] [B] [C] [D]

	Unit	2021	2020	2019	2018	2017
Direct GHG emissions (Scope 1)	million tonnes CO_2e	**60**	63	70	71	73
Carbon dioxide (CO_2)	million tonnes	**58**	61	67	69	70
Methane (CH_4)	thousand tonnes	**55**	67	91	92	123
Nitrous oxide (N_2O)	thousand tonnes	**1**	1	1	1	1
Hydrofluorocarbons (HFCs)	tonnes	**25**	30	29	31	22
Sulphur hexafluoride (SF_6)	tonnes	**0.01**	0.01	0.01	0.03	0.01
Perfluorocarbons (PFC)	tonnes	**0**	0	0	0	0
Nitrogen trifluoride (NF_3)	tonnes	**0**	0	0	0	0
Scope 1 emissions by business						
Upstream	million tonnes CO_2e	**11.7**	12.8	12.9	14.8	19.6
Integrated Gas	million tonnes CO_2e	**15.5**	14.1	16.3	13.0	12.0
Downstream	million tonnes CO_2e	**32.6**	35.8	40.2	42.7	41.1
Refining [E]	million tonnes CO_2e	**20.1**	23.4	28.0	29.1	27.8
Chemicals	million tonnes CO_2e	**11.0**	10.8	10.5	11.6	11.4
Other Downstream [F]	million tonnes CO_2e	**1.4**	1.6	1.8	2.1	2.0
Other [G]	million tonnes CO_2e	**0.2**	0.2	0.2	0.8	0.2

Source: Shell plc (2021).

Shell's GHG emission intensity (net carbon footprint) reduction targets (Shell plc, n.d.) are shown in Figure 4.4.

Figure 4.4. Shell's Net Carbon Footprint Reduction Targets



Source: Shell plc (n.d.).

2) Scenario

According to the Energy Transformation Scenarios, Shell (2021a) presented three scenarios – Waves, Islands, and Sky 1.5 –on the assumption of demand having been affected by COVID-19.

3) Major efforts

a) Upstream

Methane

Shell has set a goal of maintaining its methane emission intensity below 0.2% by 2025. The company uses infrared cameras to measure methane emissions, utilising drones and introducing advanced technologies to repair leaks (Figure 4.5).

Figure 4.5. Shell's Methane Measurement Using a Drone in Permian Basin

Source: Shell (2021b).

Flaring

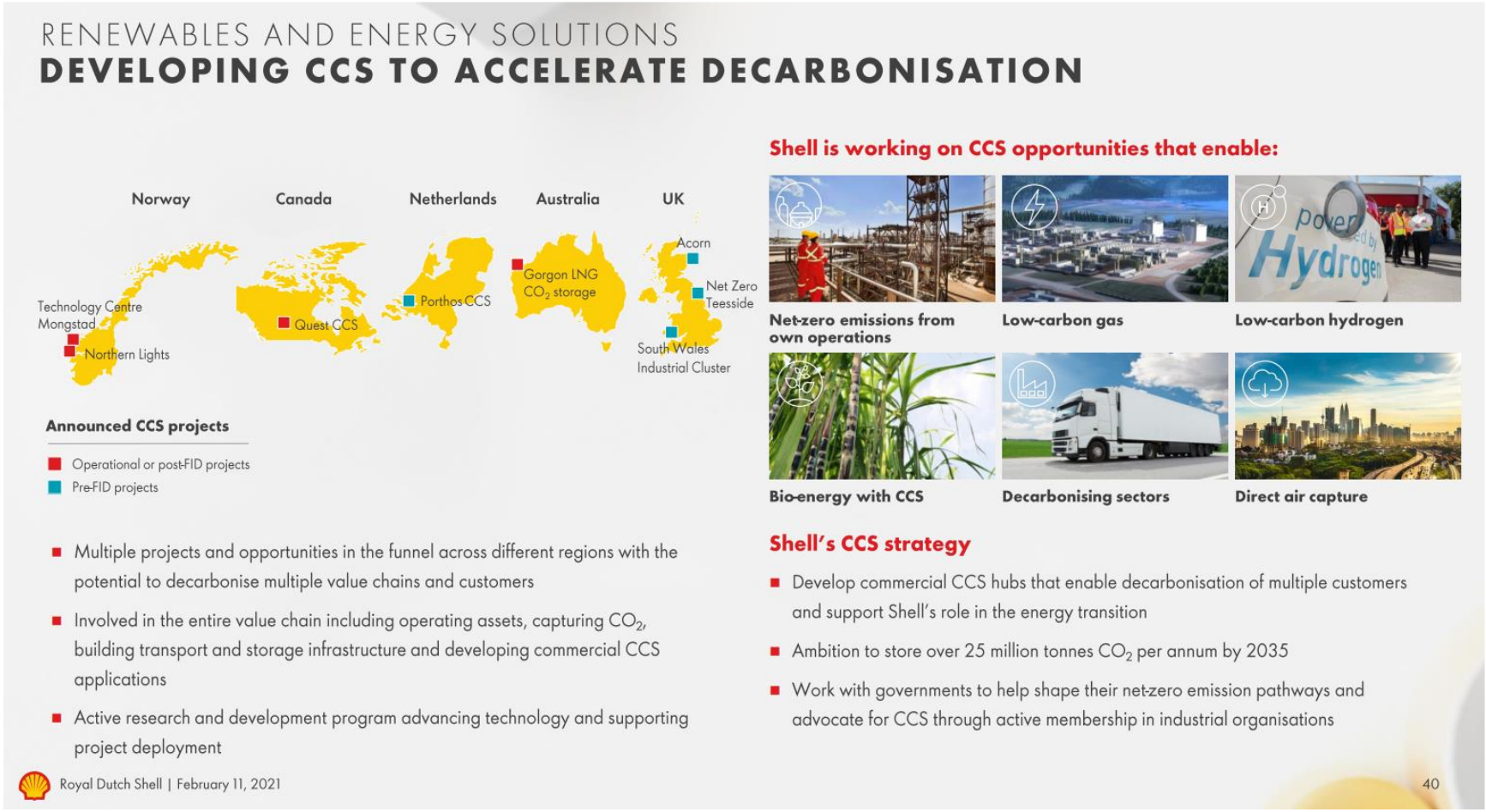
Shell has announced its plan to eliminate flaring by 2030. It also participates in the World Bank's Global Gas Flaring Reduction Partnership (GGFR) and Zero Routine Flaring by 2030 (ZRF 2030).

b) CCS

Shell plans to increase its CCS capacity to 25 million tonnes/year by 2035. It is working with Equinor and TotalEnergies on the Northern Lights CCS Project [5]in the North Sea off the coast of Norway and the Quest CCS Project in Alberta, Canada. It is also participating in the Porthos CCS Project with ExxonMobil at the Port of Rotterdam. Figure 4.6 shows Shell's CCS project map.

[5] https://norlights.com/

Figure 4.6. Shell's CCS Project Map



Source: Shell (2021b).

(c) Hydrogen

Electrolysis plant

Shell planned to build electrolysis plants in Rotterdam, Netherlands, in January 2022, and Hamburg, Germany (200 MW and 100 MW, respectively). The company will also install Europe's largest 10 MW polymer electrolyte membrane (PEM: polyelectrolyte multilayer) electrolysis plant at its Rheinland refinery, producing up to 1,300 tonnes of green hydrogen per year.

In January 2022, Shell started green hydrogen production in China with a local joint venture in Zhangjiakou, Hebei Province. It built a 20 MW electrolyser to provide green hydrogen to fuel cell vehicles at the Beijing Winter Olympics. It plans to expand the capacity of the electrolyser to 60 MW over the next 2 years.

Shell, RWE, Gasunie, and Equinor will start the Aqua Sector Project, Germany's first large-scale marine hydrogen park initiative. The project will construct an electrolysis plant of approximately 300 MW capacity to produce offshore 20,000 tonnes of green hydrogen per year. The green hydrogen is planned to be transported via a pipeline in 2028.

Green/blue hydrogen

In April 2022, Shell, and Mitsubishi Corporation's subsidiaries Eneco and Equinor plan to build about a 4 GW offshore wind power plant off the coast of the Netherlands to produce 400,000 tonnes of green hydrogen annually by 2030.

d) Biofuel/others

SAF

In September 2021, Shell planned to build one of Europe's largest facilities for producing sustainable aviation fuel (SAF) and renewable diesel fuel in Rotterdam, the Netherlands, with an annual production capacity of 820,000 tonnes. Moreover, in June 2021, the company will collaborate with Rolls-Royce to demonstrate a next-generation engine that uses SAF by 100%.

In April 2021, Shell and LanzaJet, Inc., a SAF producer, are planning to build a commercial-scale plant to produce 10 million gallons/year of jet fuel from alcohol (Alcohol-to-Jet: AtJ) in Georgia, US.

Bioethanol

In November 2016, with Cosan, a Brazilian biotech company, Shell established a joint venture company Raisen (Shell's investment share: 44%).

Low-carbon fuel

In May 2021, Shell, Bosch, and Volkswagen developed blue gasoline with a low CO_2 emission intensity. This gasoline is blended with 33% renewable fuel and is expected to reduce CO_2 emissions (wheel to wheel) by at least 20%.

e) Wind power

Shell has wind power interests in several countries, including onshore in the US and off the coasts of the US and the Netherlands. Shell is expanding wind power activities, which include developing wind projects on floating platforms in deeper waters off the shores of France, Ireland, Norway, Scotland, and South Korea. According to the Shell Sustainability Report 2021, at the end of 2021, the Shell share of total installed capacity combined from onshore and offshore wind was 466 MW alternating current (MWac), with a further Shell share of 838 MWac under construction.

The Americas

Shell is constructing wind power plants with a capacity of 2.2 GW in Mayflower (Shell's investment share: 50%) and 4.8 GW in Atlantic Shores, US (Shell's investment share: 50%).

Europe

Crosswind, a joint venture company of Shell and Mitsubishi Corporation's subsidiary Eneco, will build Hollandse Kust (Noord) offshore wind power plant (759 MW) in the Netherlands (Shell's investment share: 79.9%). The two companies are also planning hydrogen production using the offshore wind power plant. In January 2022, Shell and Scottish Power obtained two sites for wind power generation equivalent to 5 GW on Scotland's eastern and northeastern coasts. In February 2021, Shell agreed to supply Amazon.com with electricity derived from renewable energy generated from an offshore wind power plant in the Netherlands.

Asia/Pacific

Shell is building a floating wind power plant (Munmu Baram with 1.4 GW capacity) in South Korea (Shell's investment share: 80%).

f) Solar power

According to the Shell Sustainability Report 2021, at the end of 2021, Shell's share of installed solar power capacity was 734 MW direct current (MWdc), with 1,484 MWdc under construction.

The Americas

In November 2021, Shell Canada and Silicon Ranch announced to build a 58 MW solar power plant at Shell's Energy and Chemicals Park Scotford in Alberta, Canada.

Europe

In March 2019, Shell opened a solar power plant (27 MW capacity) at the Moerdijk Chemical Plant in the Netherlands.

Asia/Pacific

Shell installed roof-mounted solar power generation panels at 216 service stations in Malaysia and solar power generation facilities at seven lubricant plants in Singapore and other countries. In January 2021, Shell opened the Qabas Solar Power Plant with a capacity of 25 MW in Oman.

Shell Australia is constructing a 120 MW solar power plant in Queensland, Australia (Gangarri Project).

g) Charging point

Figure 4.7 shows that over 60,000 EV-charging points are operating in 14 countries. Shell plans to increase the number of EV-charging points from 60,000-plus to 500,000 by 2025.

Figure 4.7. Shell's EV-Charging Station

Source: Shell (2021b).

Europe

In February 2021, Shell acquired Ubitricity, Europe's largest roadside charging network. In September 2021, Shell planned to install 50,000 roadside charging points in the UK through Ubitricity by 2025.

Asia

In August 2019, Shell planned to install Southeast Asia's first EV-charging equipment at service stations in Singapore and launch EV-charging service 'Shell Recharge.' In March 2022, Shell also partnered with BYD, a Chinese battery and automotive giant, to provide charging services. The two companies plan to jointly establish BYD Shell EV service centres in the European market and a joint venture company for charging business in China.

h) Others

According to the Shell Sustainability Report 2020 (Shell plc, 2020), Shell is linking the salaries of its more than 16,500 employees to its goal of reducing its GHG emission intensity (net carbon footprint) by 6% to 8% by 2023 compared with 2016.

3.3. BP

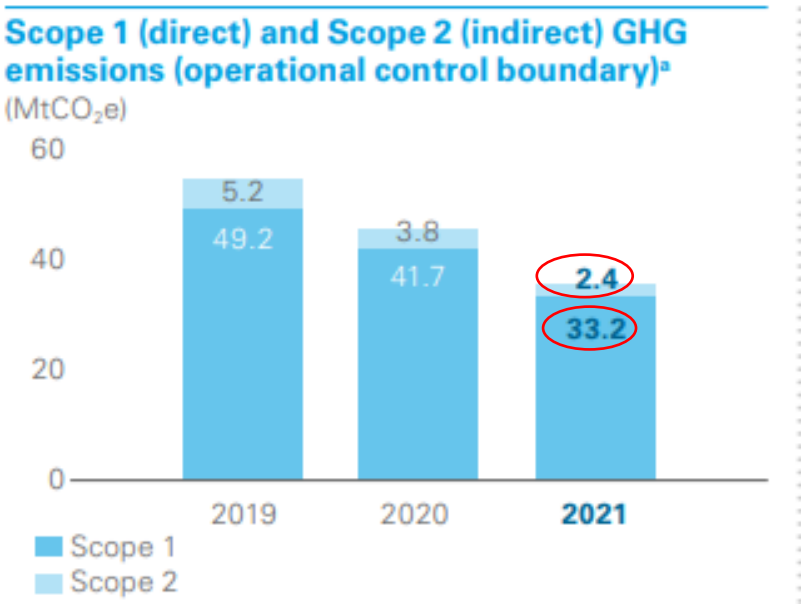
1) GHG reduction targets

According to the BP Sustainability Report 2020, GHG reduction targets are as follows:

- Aim 1: Net zero in absolute quantity in the company's operation activities (Scopes 1+2) by 2050 (set in February 2020)
- Aim 2: Net-zero emissions in absolute quantity in upstream oil and gas production by 2050 (Scope 3), *excluding Rosneft's investment.
- Aim 3: Reduce the carbon intensity of products to be marketed by 50% by 2050
- Aim 4: Install methane leakage-measuring equipment in all oil and gas facilities by 2023 to reduce methane intensity by 50%; encourage its joint ventures to set methane intensity at 0.2%.
- Aim 5: Increase the proportion of investment in non-oil and -gas businesses.

According to the Sustainability Report 2021 (BP, 2021), BP's combined Scopes 1+2 emissions in 2021 were 35.6 million tonnes CO_2e. Scope 1 emissions were 33.2 million tonnes CO_2e, and Scope 2 emissions were 2.4 million tonnes CO_2e (Figure 4.8).

Figure 4.8. BP Scope 1 (Direct) and Scope 2 (Indirect) GHG Emissions



Source: BP (2021).

According to the ESG date sheet 2022, BP disclosed the GHG emissions and intensity of Scopes 1+2 by unit (production and refining) (Table 4.4).

Table 4.4. BP GHG Emissions and Intensity (Scopes 1+2) by Unit

Metric	Unit	2017	2018	2019	2020	2021
GHG – Operational control [l]						
Scope 1 (direct) greenhouse gas emissions [m]	$MtCO_2e$	50.5	48.8	49.2	41.7	**33.2**
production	$MtCO_2e$	–	–	–	–	**15.5**
refining	$MtCO_2e$	–	–	–	–	**16.9**
Scope 1 (direct) carbon dioxide emissions	$MtCO_2e$	47.8	46.4	46.8	39.8	**32.0**
production	$MtCO_2e$	–	–	–	–	**14.4**
refining	$MtCO_2e$	–	–	–	–	**16.9**
Scope 1 (direct) methane emissions	Mt	0.11	0.09	0.10	0.07	**0.05**
production	Mt	–	–	–	–	**0.04**
refining	Mt	–	–	–	–	**0.00**
Sustainable GHG emissions reductions (Scope 1 and 2) [n]	$MtCO_2e$	0.5	1.3	1.4	1.0	**1.6**
Scope 2 (indirect) emissions	$MtCO_2e$	6.1	5.4	5.2	3.8	**2.4**
production	$MtCO_2e$	–	–	–	–	**0.0**
refining	$MtCO_2e$	–	–	–	–	**2.2**
Greenhouse gas intensity (Scope 1 and 2)						
production [o]	tCO_2e per thousand boe of production	–	–	–	–	**15.9**
refineries [p]	tCO_2e per utilized equivalent distillation capacity	–	–	–	–	**1,060**
petrochemicals [q]	tCO_2e per thousand tonnes of production	–	–	–	–	**688**
Methane intensity [r]	%	0.2	0.16	0.14	0.12	**0.07**
Flaring [s]	kt	1,987	1,634	1,395	831	**967**

l Operational control data comprises 100% of emissions from activities operated by bp, going beyond the IPIECA guidelines by including emissions from certain other activities such as contracted drilling activities.

m We provide data on GHG emissions material to our businesses on a carbon dioxide-equivalent basis. This includes CO_2 and methane for Scope 1 emissions.

n Sustainable emissions reductions (SERs) result from actions or interventions that have led to ongoing reductions in Scope 1 (direct) and/or Scope 2 (indirect) greenhouse gas (GHG) emissions (carbon dioxide and methane) such that GHG emissions would have been higher in the reporting year if the intervention had not taken place. SERs must meet three criteria: a specific intervention that has reduced GHG emissions, the reduction must be quantifiable and the reduction is expected to be ongoing. Reductions are reportable for a 12-month period from the start of the intervention/action.

o Scope 1 (direct) and Scope 2 (indirect) GHG emissions in tCO_2e from bp operated production assets per thousand boe of gross upstream oil and gas production.

p Scope 1 (direct) and Scope 2 (indirect) GHG emissions in tCO_2e from bp operated refineries per utilized equivalent distillation capacity.

q Scope 1 (direct) and Scope 2 (indirect) GHG emissions in tCO_2e from bp operated petrochemical facilities per thousand tonnes of petrochemicals produced.

r Methane intensity refers to the amount of methane emissions from bp's operated upstream oil and gas assets as a percentage of the total gas that goes to market from those operations. Our methodology is aligned with the Oil and Gas Climate Initiative's (OGCI). Methane intensity was previously reported to one decimal place but is now reported to two, in order to better demonstrate year-on-year changes.

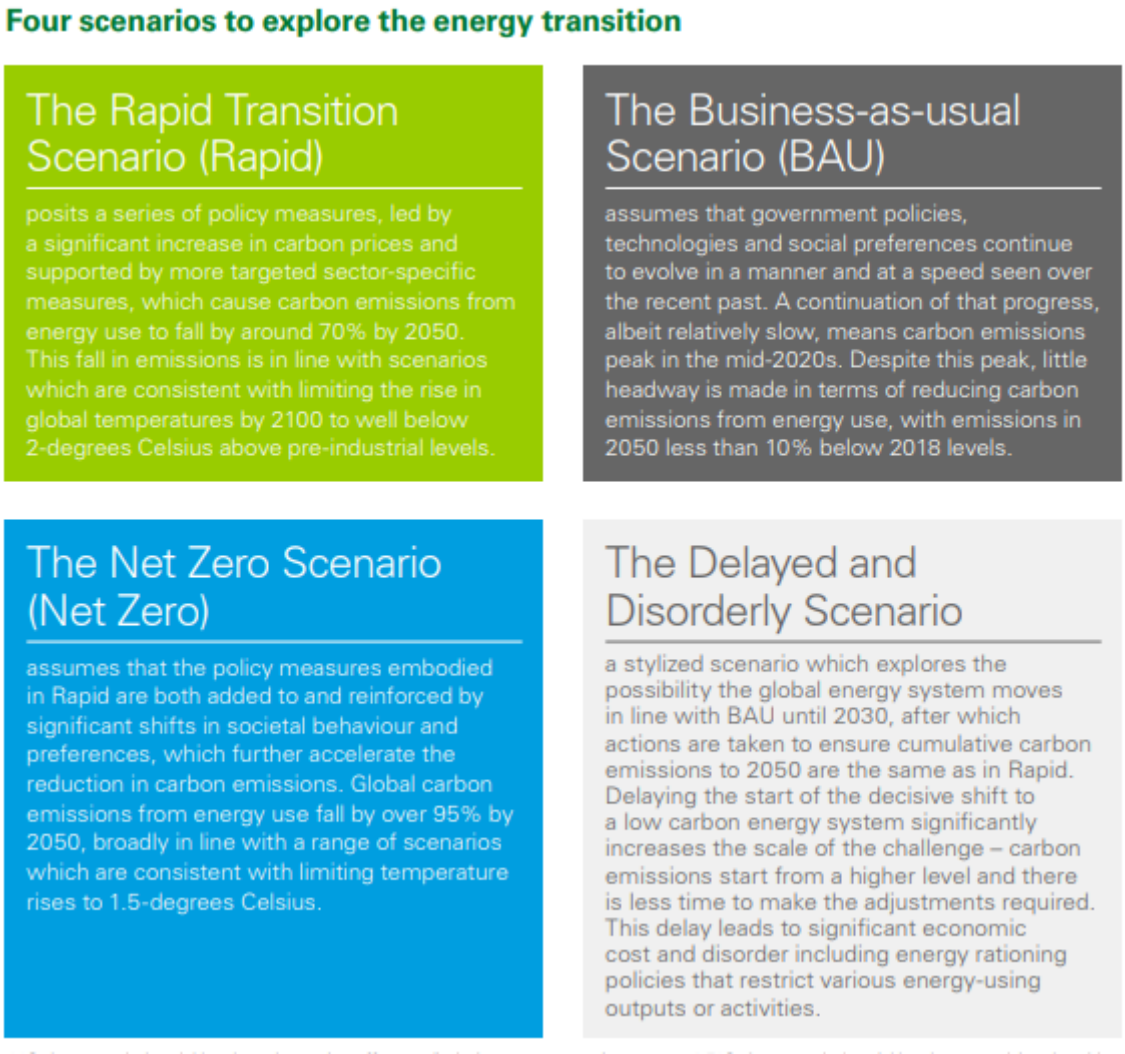
s We report the total hydrocarbons flared from our upstream operations.

Source: BP (2022).

2) Scenario

Figure 4.9 shows that BP has developed four scenarios to obtain the energy outlook for 2050.

Figure 4.9. BP's Scenario



Source: BP (2020).

3) Major efforts

a) Upstream

Methane

By 2023, BP plans to install methane leakage measurement equipment at all oil and gas facilities, reduce methane emission intensity by 50%, and encourage its joint ventures to set their methane emission intensity at 0.2%. The company will introduce satellite, drone, and aircraft-based technologies for measuring methane emissions and digitally measure the reduction of methane emissions using Flare IQ technology developed by Baker Hughes.

Flaring

The company will utilise Flare IQ developed by Baker Hughes as well as cloud computers and complex models to measure flaring conditions and provide second-by-second feedback (BP, 2020a).

It is also participating in the World Bank's GGFR Partnership and ZRF by 2030.

b) Retail

Reliance BP Mobility, a joint venture between BP and Reliance Industry, opened Jio BP-branded service stations (SSs) in Navi Mumbai, Maharashtra. It will also study the handling of low-carbon fuels in the future. Reliance BP Mobility operates more than 1,400 SSs and plans to gradually revamp them into Jio BP-branded SSs.

c) CCS

BP is participating in the Net Zero Teesside CCS Project in the northeastern part of the UK and plans to store 10 million tonne-CO_2 annually as an operator.

It will implement its CCS projects at Australia's Santos and Moombagas processing plants.

MIMI, a natural gas development company jointly invested by BP, Woodside, Mitsubishi Corporation, and Mitsui & Co., will start CCS project research in Australia.

d) Hydrogen

BP aims to have a 10% hydrogen share in core markets by 2030.

Hydrogen production

In November 2020, BP and Ørsted signed a letter of intent regarding green hydrogen. They will build a 50 MW electrolyser at the Lingen refinery in Germany. This green hydrogen project will be powered by electricity generated by the Ørsted offshore wind power plant in the North Sea. The produced hydrogen will be used at said refinery. In November 2021, BP planned to build a facility (HyGreen Teesside) in northeast England that can produce up to 500 MW of green hydrogen by 2030. The plan's first stage is to install a hydrogen production facility with a capacity of approximately 60 MW, aiming to start production by 2025. A final investment decision (FID) is scheduled for 2023. In March 2022, Scotland Aberdeen City Council and BP started a joint venture to build green hydrogen production, storage, and marketing facilities. Hydrogen production will begin in 2024.

Blue/green hydrogen

In March 2021, BP planned to build a hydrogen production facility (H_2Teesside) at Net Zero Teesside to produce up to 1 GW of blue hydrogen by 2030, equivalent to 20% of the UK's hydrogen goal. BP plans to make FID in 2024. The project will reform natural gas to produce hydrogen and capture and store emitted CO_2. In January 2022, BP agreed to a strategic

framework agreement with Oman's Ministry of Energy and Mineral Resources to develop renewable energy and green hydrogen by 2030.

e) Biofuel

According to the Low Carbon Electricity and Energy (BP, 2020b), BP plans to increase its bioenergy production from 22 Kb/d in 2019 to 50 Kb/d in 2025 and to more than 100 Kb/d in 2030.

Sustainable aviation fuel

BP has already supplied SAF to 18 airports in 6 countries and aims to achieve a 20% share of the global SAF market by 2030 (BP, 2021a).

Bio bunker fuel

In December 2021, BP and Maersk Tankers successfully tested the use of biofuel-blended shipping fuel for tankers.

f) Wind power

The Americas

In September 2020, BP and Equinor signed a strategic partnership contract regarding offshore wind power generation in the US. The two companies will invest US$1.1 billion in the Empire Wind (New York) and Beacon Wind (Massachusetts) wind power generation projects in the US (BP's investment share: 50%). Empire Wind has a power generating capacity of 2 GW and Beacon Wind 2.4 GW.

Europe

In June 2021, BP participated in an offshore wind power generation project off the coast of Norway with Statkraft and Aker Offshore Wind, both Norway's state-owned electricity companies. In January 2022, BP and EnBW acquired the lease rights to an offshore wind power generation project (known as Morven) on the east coast of Scotland. This project is for fixed-bottom type offshore wind power generation with a capacity of approximately 2.9 GW.

Asia/Pacific

In March 2022, BP and Marubeni Corporation signed a partnership contract with BP Alternative Energy Investments Limited (BPAEIL), a wholly owned renewable energy subsidiary of BP, for a decarbonisation project, including offshore wind power generation joint development and hydrogen utilisation.

g) Solar power

In December 2017, BP and Lightsource Renewable Energy Holdings, a UK renewable energy development and power generation company, formed a strategic alliance. As a result, BP invested in Lightsource by 43%, namely, US$200 million, and Lightsource changed its name to Lightsource BP.

h) Charging point

BP plans to increase the number of its EV charging bases from 11,000 in 2021 to 70,000 in 2030.

The Americas

In January 2018, BP acquired a US$5 million stake in quick-charging system manufacturer Free Wire Inc., US. In June 2021, it also invested US$7 million in IoTecha, a smart quick-charging company of the country. IoTecha's technology uses the internet of things to connect EV chargers to the power grid, automate payments, and optimise the charging process.

Europe

In June 2018, BP acquired Chargemaster, the largest charging network company in the UK. In May 2018, BP also invested in Store Dot, a developer of quick-charge batteries. BP would invest 1 billion pounds in deploying quick and ultra-quick charging facilities throughout the UK. In March 2021, BP and Volkswagen signed an MoU for ultra-quick EV charging facilities in the UK, Germany, and Europe.

Asia/Pacific

In August 2019, BP partnered with DiDi to expand the use of quick chargers in China. The joint venture plans to build a network of EV-charging hubs in China.

Reliance BP Mobility, a joint venture between BP and Reliance Industry, has also installed charging points for EVs at Jio BP-branded service stations.

i) Others

BP is linking remunerations to its about 28,000 employees and executives with GHG emission reduction (BP, 2020a). BP has also opened the ‘Discover Net Zero course’ at BP University to educate its employees.

j) Investment in decarbonisation

BP plans to increase investment in the low-carbon energy field to US$5 billion per year, 10 times the current level while projecting the reduction of oil and gas production by 40% by 2030.

3.4. Total energies

In May 2021, the company changed its name to TotalEnergies to clarify its stance of becoming less dependent on oil as a general energy company. The company declared its goal of becoming one of the world's top five renewable energy companies.

1) GHG reduction targets

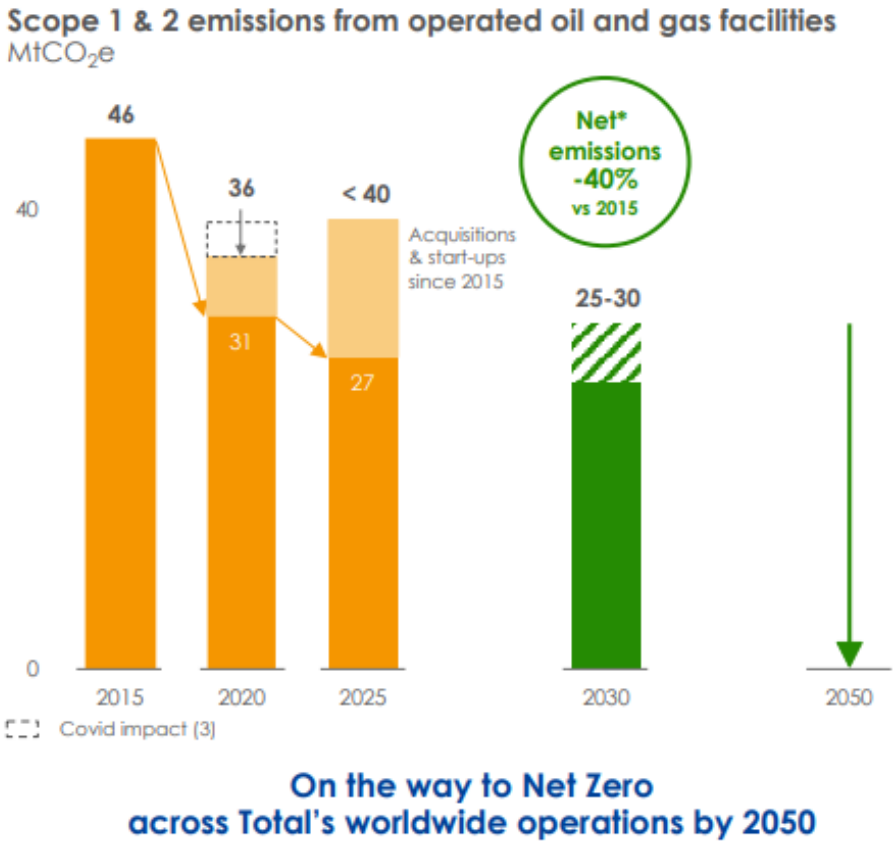
GHG reduction targets are as follows:

- Net zero across TotalEnergies’s worldwide operations by 2050 or sooner
- (Scopes 1+2+3)

- Net zero across all its production and energy products used by its customers in Europe by 2050 or sooner (Scopes 1+2+3)
- Revising its interim targets, as shown in Figure 4.12, to reduce GHG emissions (Scopes 1+2) from its oil and gas facilities by 40% in 2030 from the 2015 level

According to the Climate Roadmap in Action February 2021 (TotalEnergies, 2021a), TotalEnergies revised Scopes 1+2 emissions from operated oil and gas facilities in 2030 (Figure 4.10).

Figure 4.10. New Commitment Scopes 1+2: −40% in 2030 vs 2015



Source: TotalEnergies (2021a).

Form 20-F 2021 (Annual Report) reveals that TotalEnergies's indicators (2021b) related to climate change are as follows (Table 4.5):

Table 4.5. Indicators Related to Climate Change (TotalEnergies)

Indicators related to climate change[1]

GHG emissions		Operated emissions 2021	2020	2019	2015
SCOPE 1 Direct GHG emissions	Mt CO_2e	**34* *(33)***	**38* *(36)***	**41**	**42**
BREAKDOWN BY SEGMENT					
Upstream oil & gas activities	Mt CO_2e	14	16	18	19
Integrated Gas, Renewables & Power, excluding upstream gas operations	Mt CO_2e	5	3	3	–
Refining & Chemicals	Mt CO_2e	15* *(14)*	17	20	22
Marketing & Services	Mt CO_2e	<1	<1	<1	<1
BREAKDOWN BY GEOGRAPHY					
Europe: EU 27 + Norway + UK + Switzerland	Mt CO_2e	20* *(19)*	22* *(21)*	24	22
Eurasia (incl. Russia) / Oceania	Mt CO_2e	1	1	1	5
Africa	Mt CO_2e	9	10	11	12
Americas	Mt CO_2e	5	4	4	4
BREAKDOWN BY TYPE OF GAS					
CO_2	Mt CO_2e	32	34	39	39
CH_4	Mt CO_2e	1	2	2	2
N_2O	Mt CO_2e	<1	<1	<1	<1
SCOPE 2 Indirect emissions from energy use	Mt CO_2e	**2* *(2)***	**3* *(3)***	**4**	**4**
Of which Europe: EU 27+ Norway + UK + Switzerland	Mt CO_2e	1* *(1)*	2* *(2)*	2	2
SCOPE 1+2	Mt CO_2e	**37* *(35.7)***	**41* *(38)***	**44**	**46**
Intensity of GHG emissions (Scope 1+2) of Upstream oil & gas activities[a]	kg CO_2e/boe	17	18	19	21

Source: TotalEnergies (2021b).

2) Scenario

TotalEnergies has developed two scenarios (Figure 4.11).

Figure 4.11. TotalEnergies's Two-demand Scenario

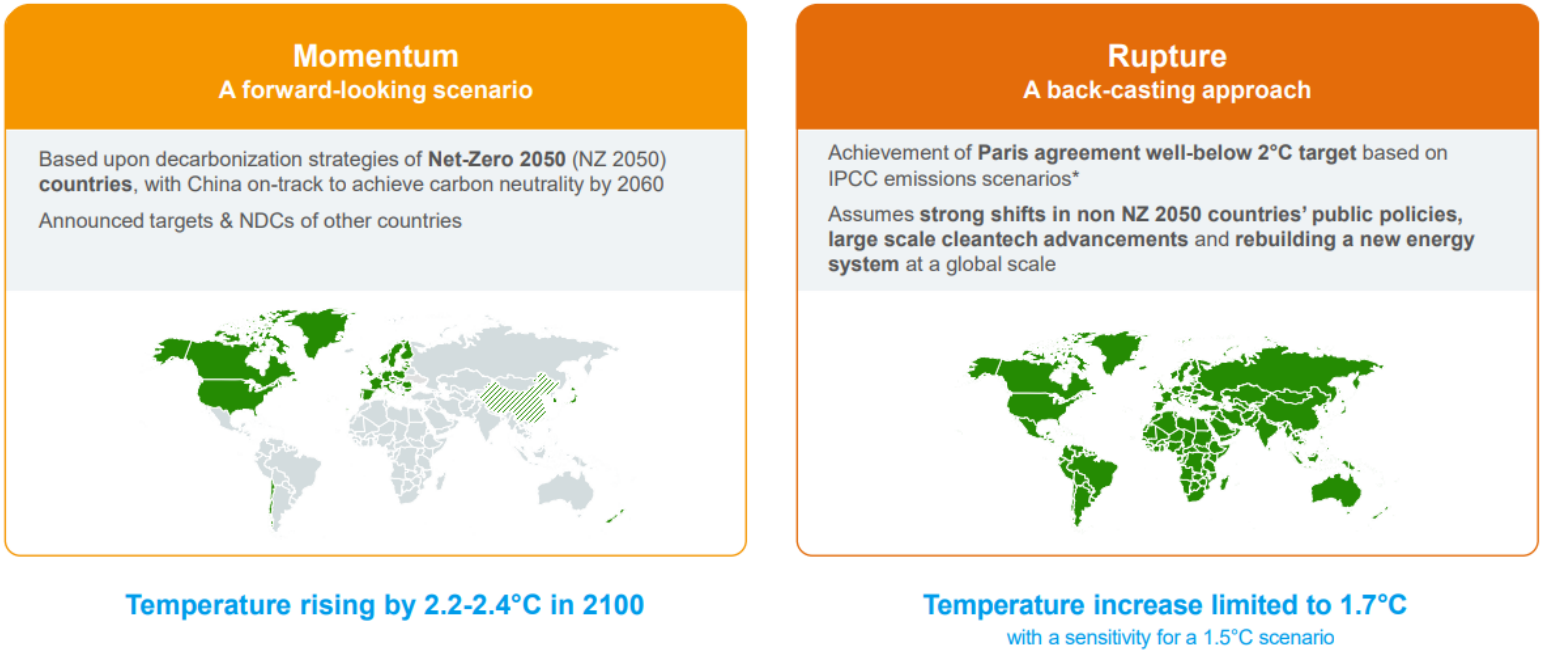
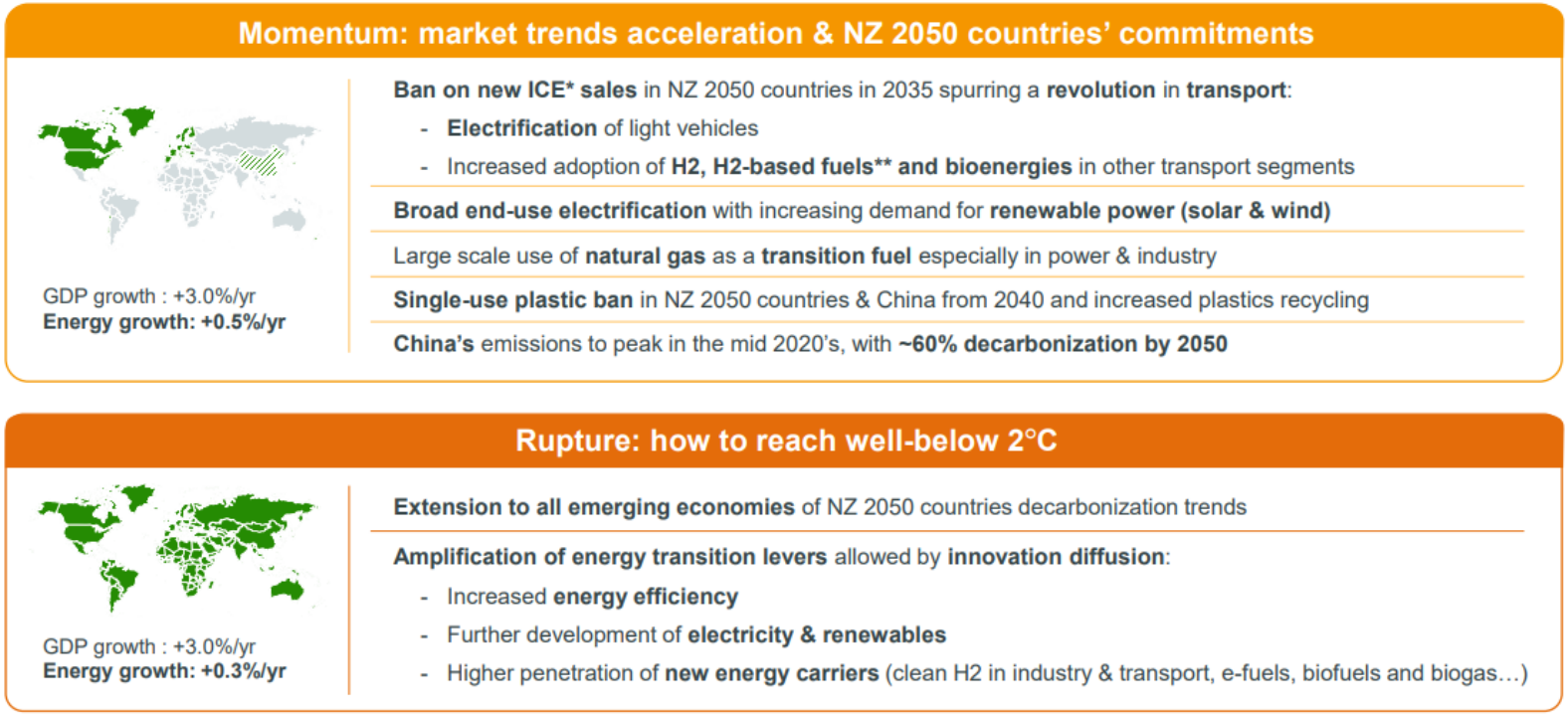


Figure 4.11. Continued



Source: TotalEnergies (2021c) .

3) Major efforts

a) Upstream

Methane

According to the Sustainability Climate 2022 Progress Report, TotalEnergies has set targets for reducing methane emissions from its operating oil and gas facilities by 50% in 2025 and by 80% in 2030 compared with the 2020 level. In addition, since 2014, the company has been participating in the second phase (OGMP 2.0) of the United Nations Environment Program's OGMP Initiative (Oil and Gas Methane Partnership).

The company is working with GHGSat to identify, quantify, and reduce methane gas emissions from their operations. It is developing a satellite imaging technology to monitor methane gas leakages from offshore facilities. This technology, called Glint Mode, observes sunlight glints on the ocean surface, nullifying interference with data acquisition. At the same time, satellite images are utilised in combination with on-site measurements by AUSEA1, an ultra-lightweight drone-mounted spectrometre developed by the company (Figure 4.12).

Figure 4.12. TotalEnergies's Methane Measurement Technology

Source: TotalEnergies (2021a).

Flaring

According to the Sustainability Climate 2022 Progress Report (TotalEnergies, 2022), TotalEnergies has set a new target to bring the level below 0.1 million cubic metres per day starting in 2025. TotalEnergies will eliminate routine flaring by 2030. The company is participating in the World Bank's GGFR Partnership and ZRF by 2030.

b) Refinery

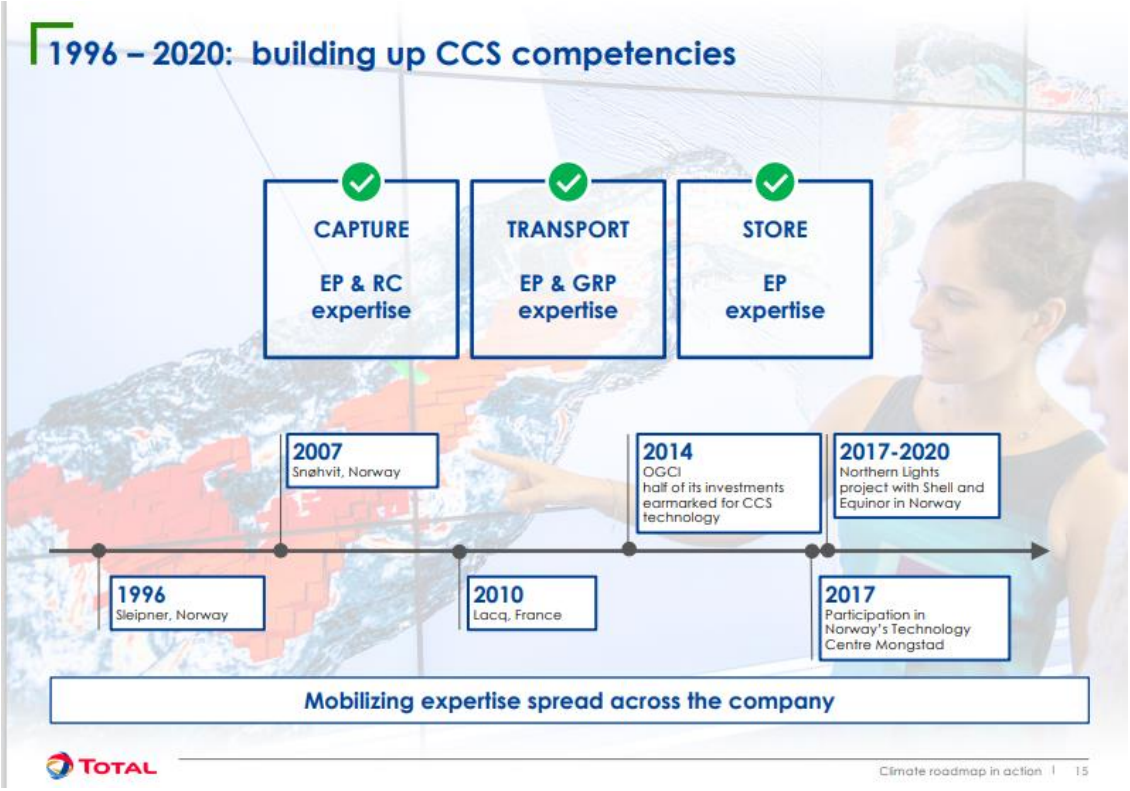
TotalEnergies has invested US$450 million to improve the energy efficiency of its refineries and chemical facilities since 2010 and has improved its energy efficiency by more than 10% through 250 projects. According to the Getting to Net Zero (TotalEnergies, 2020), the company will introduce an energy efficiency index, GEEI, and adopt an energy management system

capable of measuring, recording, and auditing energy efficiency according to standards such as ISO 50001. It has also installed 170 wireless sensors in its steam blast furnaces.

c) CCS

TotalEnergies plans to invest in CCS and DAC. Its annual budget as of 2021 was US$100 million, with a target storage capacity of 10 million tonne-CO_2 per year by 2030. TotalEnergies has been developing CCS technology since 1996 (Figure 4.13).

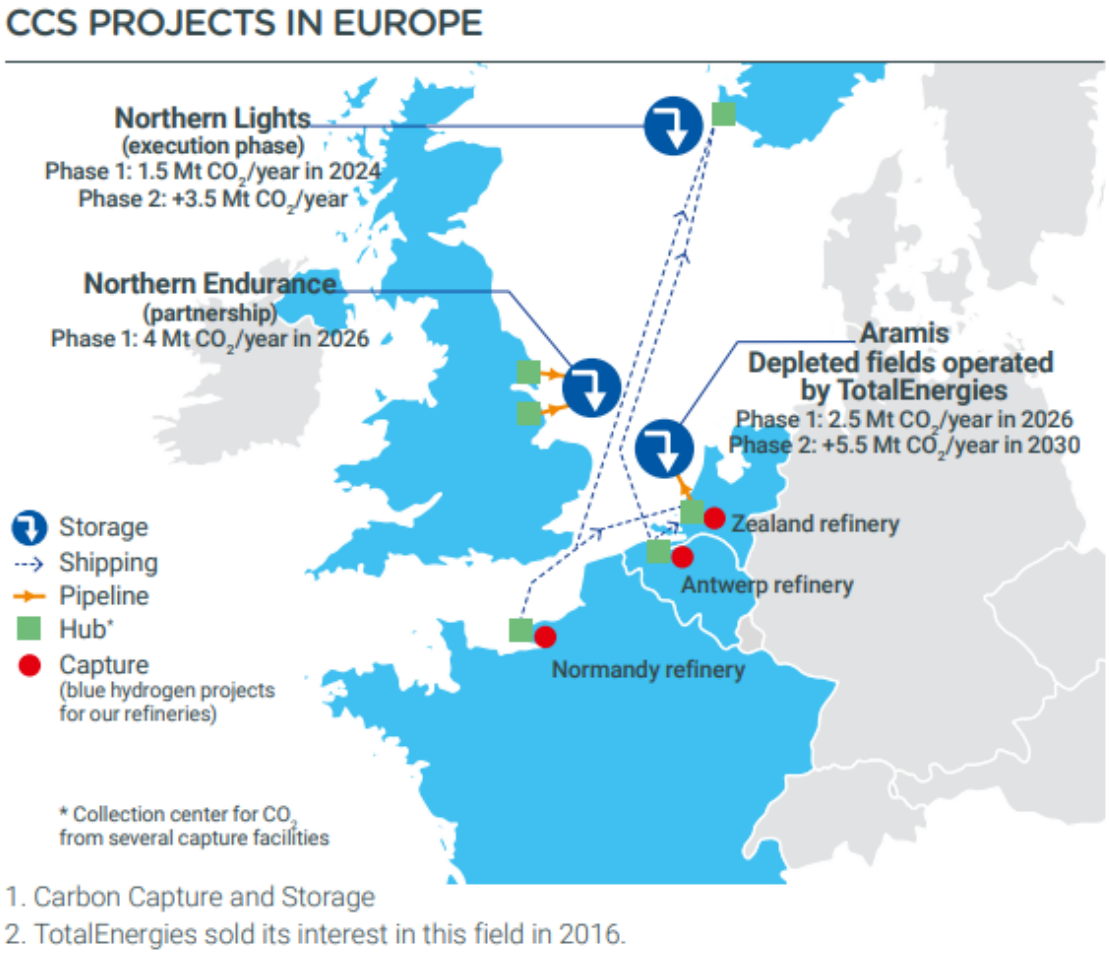
Figure 4.13. History of TotalEnergies's CCS Project



Source: TotalEnergies (2021a).

Major CCS projects in Europe include Northern Lights, Net Zero Teesside, and Aramis. Aramis aims to implement FID by 2023 and start operation in 2026. CCS projects at refineries include Antwerp, Normandy, and Zeeland (Figure 4.14).

Figure 4.14. CCS Project Map of TotalEnergies in Europe



Source: TotalEnergies (2022, p.36).

In September 2021, TotalEnergies and Air Liquide cooperated in decarbonising hydrogen production at TotalEnergies's Normandy platform. Air Liquide would supply low-carbon hydrogen to TotalEnergies by utilising Air Liquide's hydrogen network in Normandy and by introducing large-scale CCS.

In November 2020, TotalEnergies signed a strategic framework agreement with ADNOC of the UAE to engage in joint research, development, and dissemination in the CCUS field. At the same time, TotalEnergies developed GEOSX, a simulator of CO_2 reservoir behaviour in CCUS, with the Lawrence Livermore Laboratory of Stanford University, US.

d) Hydrogen/ammonia

Electrolysis plant

In January 2021, TotalEnergies and Engie partnered on the Masshylia Project to produce renewable hydrogen at the La Mède biorefinery. The project would produce 5 tonnes/day of

hydrogen from a solar power plant (100 MW) and a water electrolysis hydrogen production unit (40 MW) to supply hydrogen to the biorefinery. The construction was scheduled to start in 2022, with the operation expected to begin in 2024.

Ammonia

In April 2022, TotalEnergies Marine Fuels Pte Ltd, Pavilion Energy Singapore Pte Ltd, the Maritime and Port Authority of Singapore, Mitsui O.S.K. Lines (MOL), Itochu Corporation, and others signed an MoU to establish an ammonia fuel supply chain in Singapore, including ammonia bunkering vessels.

Hydrogen station

TotalEnergies is developing hydrogen stations through H_2 Mobility, Germany.

e) Biofuel

Biorefinery

La Mède refinery, France, will be converted into a biorefinery, with a production capacity of 500,000 tonnes/year. Grandpuits refinery, France, will be converted into a biorefinery at the cost of €500 million.

SAF

In September 2021, TotalEnergies and Safran signed a strategic partnership agreement to make current aircraft engines compatible with fuels containing SAF by up to 100%.

In April 2022, TotalEnergies and ENEOS will conduct a feasibility study for SAF production. The raw materials for SAF will be procured from Nomura Jimusho Inc. (Minato Ward, Tokyo), a chemical trading company, and SAF production will be studied at ENEOS' Negishi Refinery (Yokohama City) with the technologies of TotalEnergies utilised. A mass production system will be established by 2025 to produce 300,000 tonnes per year.

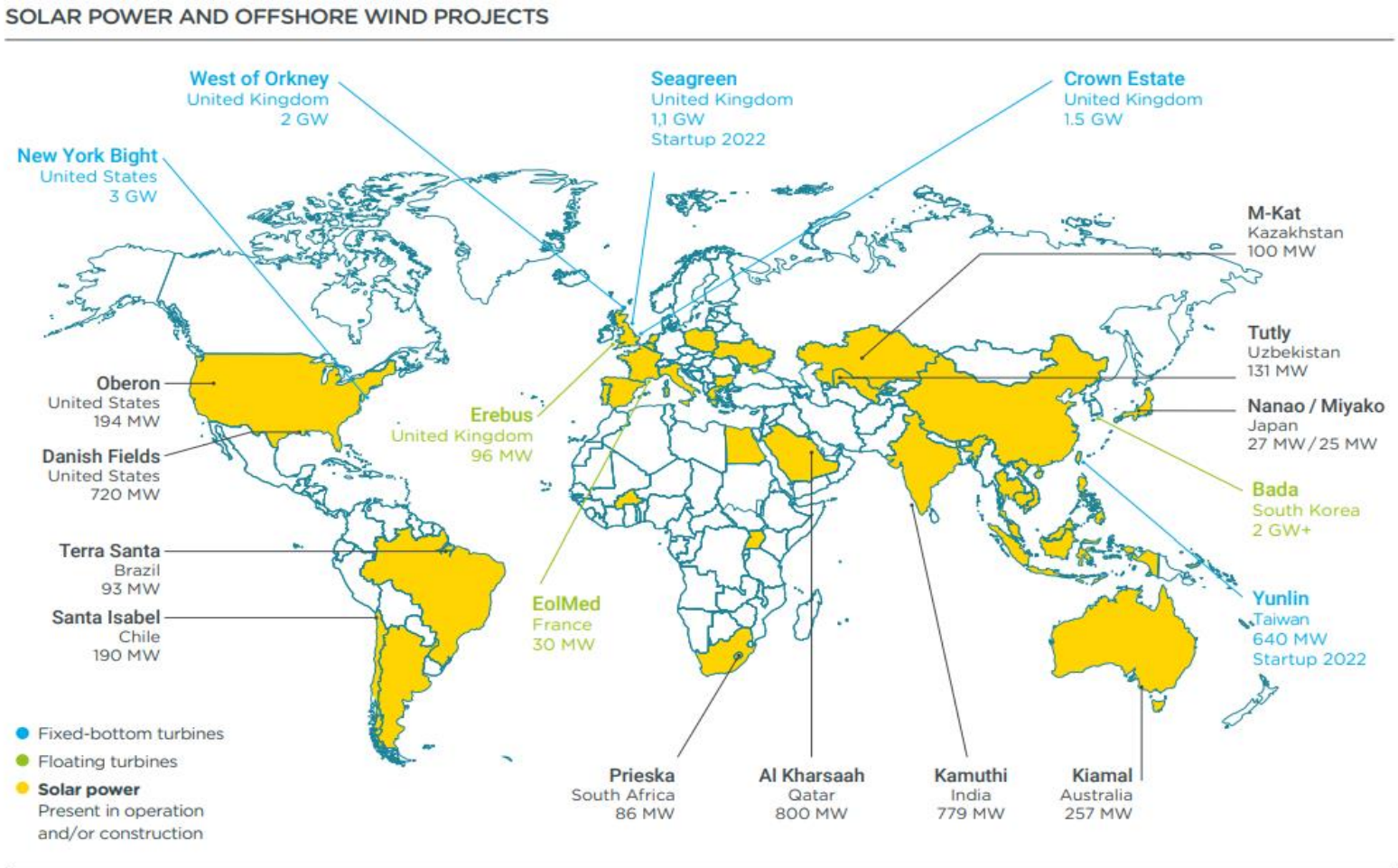
Biomethane

In November 2021, a joint venture company between TotalEnergies and the US-based Clean Energy will build a biomethane production facility in the US state of Texas. For the company, this is the first biomethane production in the US. It plans to produce more than 40 GWh of biomethane annually. In February 2022, TotalEnergies and Veolia of France agreed to promote the production of up to 1.5 TWh of biomethane per year domestically and internationally by 2025.

f) Wind power

TotalEnergies aims to install renewable electricity capacity of 35 GW in 2025 and 100 GW in 2030. Figure 4.15 shows a project map for solar and offshore wind power generation.

Figure 4.15. Location of Solar and Wind Power of TotalEnergies



Source: TotalEnergies (2022).

In October 2021, with Ireland's Simply Blue Group, TotalEnergies established a joint venture company, TotalEnergies SBE US, to deploy floating offshore wind power generation projects in the US. In March 2022, TotalEnergies and EnBW won the bid to develop a 3 GW offshore wind power plant on the East Coast of New York and New Jersey for US$795 million. The plant will start operation in 2028.

g) Solar power

TotalEnergies aims at a solar energy account for three-quarters of the 35 GW the company wants to develop by 2025.

The company has installed solar panels at 1,700 service stations (SSs) worldwide since 2016 and plans to expand solar panel installations to 5,000 locations in 57 countries. When completed, this initiative will have solar panels installed in 30% of the world's SSs, equivalent to a solar power generation capacity of 125 MW.

Europe

TotalEnergies and Ignis of Spain will develop a solar power facility in the Andalucia region, Madrid. It is scheduled to be completed in 2025.

Asia/Pacific

In January 2021, TotalEnergies and 174 Power Global (a wholly owned subsidiary of Hanwha Group of Korea) will establish a 50/50 joint venture to develop a solar power generation and energy storage project. In November 2021, Total Eren, a renewable energy company invested by TotalEnergies, entered the Cambodian solar power generation market by acquiring the power generation facilities of Risen Energy, a Chinese manufacturer of solar power products. In April 2022, TotalEnergies and ENEOS planned to jointly start a business in Asia to support their corporate customers' private solar power consumption. They planned to invest 50% each in the joint business and develop a power generation capacity of 2 GW over the next 5 years.

h) Charging point

TotalEnergies plans to install 150,000 charging points worldwide by 2025.

Europe

In 2019, TotalEnergies established EV Charge for the mobility electrification business, including charging facilities. TotalEnergies plans to build 1,000 high output charging points at 300 service stations by 2022 and expand charging points to 150,000 locations in Europe by 2025.

Asia/Pacific

In July 2021, TotalEnergies acquired Blue Charge, an EV-charging facility operator in Singapore. Blue Charge is Singapore's largest EV-charging operator deploying approximately 1,500 charging facilities. The Singapore government has set the goal of increasing the number of EV-charging facilities in the country to 60,000 by 2030. In September 2021, TotalEnergies established a 50–50 joint venture company with China Three Gorges Corporation, China's

leading hydropower generation company. The two companies plan to install and operate more than 11,000 charging points in Hubei Province by 2025.

i) Others

Battery

In September 2020, TotalEnergies's subsidiary Saft and Groupe PSA/Opel established a joint venture, Automotive Cell Company. They plan to develop and manufacture high-performance batteries for the automotive industry. Saft has built a new high-capacity battery plant (480 MWh) in Zhuhai, China. In December 2021, TotalEnergies opened the largest battery-type energy storage facility in France (capacity: 61 MW).

LNG bunkering

In November 2020, TotalEnergies implemented its first LNG bunkering to the world's largest LNG-fueled container ship at the port of Rotterdam, Netherlands. This bunkering supplied approximately 17,300 m^3 of LNG, which was the largest-scale LNG bunkering in the world.

j) Investment in decarbonisation

In September 2020, TotalEnergies planned to convert its Grandpuit refinery in France into a production base for renewable diesel fuel, SAF, and bioplastic and invest €500 million by 2024.

3.5. Efforts for decarbonisation and energy transition in the oil supply chain

The methods of measuring methane leakage using a drone, satellite, aircraft, and infrared cameras, as well as flaring reduction and routine flaring elimination, which the Western Majors are also working on, will be useful for ASEAN NOCs having upstream sectors (Table 4.6).

For ASEAN NOCs with a lot of oil and gas fields, promoting CCS and CCUS is also effective in utilising existing assets. Therefore, it is indispensable to accumulate knowledge on technical and cost issues by resolving them on one's own and by cooperating with other companies in the same industry and different industries, governments, and academia.

In the downstream sector, refineries should be converted into and maintained as highly efficient and energy-saving, using waste heat, cogeneration, in-house power generation, etc., to improve refinery efficiency.

Installing solar panels on the roofs of service stations and introducing in-house power generators reduce GHG emissions from the marketing sector and are effective as disaster countermeasures.

Table 4.6. Decarbonisation and Energy Transition Efforts in Oil Supply Chain

	Upstream (Oil Field Development and Production)	Downstream (Oil Refining)	Marketing
Scopes 1+2	・Methane emission reduction (Monitoring by drone, satellite, etc.) ・Flaring reduction ・Venting reduction ・CCS	・Improvement of refinery efficiency ・Cogeneration ・Waste heat utilisation ・Off-gas treatment ・CCS ・In-house power generation ・Biorefinery	・PV equipment installation on service station roofs ・PV equipment installation on lubricant oil plant roofs ・In-house power generation
Scope 3		・Low-carbon fuel production	・EV charging point ・Hydrogen station ・Lubricants for EVs ・Biofuel ・SAF

Source: Author.

4. Comparison of Strategies and Efforts by ASEAN NOCs and Western Majors

Finally, we compare the strategies and efforts of ASEAN NOCs and Western Majors. As the first step, setting a net-zero target year and determining a scope can define the range of efforts for low carbonisation and decarbonation.

Six companies have set their goal of net-zero by 2050, but Pertamina is excluded (Table 4.7). Shell, BP, and TotalEnergies target Scopes 1+2+3, while ExxonMobil, PETRONAS, and PTT target Scopes 1+2.

The strength of the oil majors and NOCs is their abundance of oil and natural gas assets. Thus, focusing on CCS (CCUS) and hydrogen, for which existing assets can be used, would be effective. The Western Majors already have been operating their CCS projects. On the other hand, the ASEAN NOCs are at the stage of having signed MoUs with their partners. Therefore, in the future, the CCS of projects of the oil majors needs to be accelerated. Pertamina and PETRONAS are already moving in that direction but need to accelerate CCS further. Moreover, Thailand is the centre of automobile production in Southeast Asia, so it makes sense for PTT to enter the EV production and battery fields.

Table 4.7. Comparison of Strategy and Activity between ASEAN NOCs and Western Majors

	Exxon Mobil	Shell	BP	Total Energies	PETRONAS	Pertamina	PTT
Net-zero declaration	2050 *Oil and gas production	2050	2050	2050	2050 *Oral declaration	NA	Net-zero GHG emission by 2050
Scope	1+2	1+2+3	1+2+3	1+2+3	1+2	NA	1+2
Flaring	Eliminate routine flaring by 2030	Eliminate routine flaring By 2030	—	Eliminate routine flaring by 2030	—	—	—
CCS target	—	25 $MtCO_2$ by 2035	—	5 $MtCO_2$ by 2035	—	—	—
Major CCS project and alliance	Baytown Texas La Barge Wyoming	Northern Lights Quest Teesside	Teesside Humber Tangguh Moomba	Northern Lights Aramis Teesside	ExxonMobil Shell ADNOC Posco	ExxonMobil Masdar SK Group Marubeni Mitsui & Co.	INPEX JGC Holdings
Hydrogen project and alliance	Baytown Texas	Double-digit share by 2035	10% share by 2030 H_2 Teesside	5-tonne Green H_2 per day by 2025	JERA ENEOS Masdar	SK Group Mitsubishi Pupuk	—
Renewables and others	Biofuel Mobil EV Lubricants DAC	Biofuel Wind Farm PV EV charge Link salary	Biofuel Wind Farm PV EV charge Link salary	Biofuel Wind Farm PV EV charge Battery	Ammonia PV CO_2 Transport	Biofuel Geothermal Ammonia PV EV charge	EV Production EV charge Battery PV

Source: Author.

Chapter 5

Suggestions for the ASEAN NOCs

We have analysed the low carbonisation and decarbonisation efforts of the ASEAN NOCs and the Western Majors. Based on these analyses, we will provide recommendations on energy transition strategies and approaches to the ASEAN governments and NOCs.

1. Determination of Direction and the Scope of Efforts

1.1. Importance of CN declarations by governments

For the NOCs, CN declarations by national governments, which are also their major shareholders, mean significantly. A CN declaration by a government is a major milestone towards the country's CN, and the declaration clarifies the direction towards decarbonisation and the time required to achieve it.

Since COP26, ASEAN countries have also declared CN. Malaysia, Thailand, and Viet Nam have expressed their 2050 CN goal, and Indonesia, its 2060 CN goal. If the government has declared CN, the NOC of the country will eventually have to declare CN.

1.2. Importance of CN declaration for companies

Some companies, such as PETRONAS (Figure 5.1), have declared CN, even when the government has not done so. In the future, more ASEAN NOCs are expected to declare CN. Whether a company has announced CN or not will have a significant bearing on its overall business. Since converting a business portfolio takes time, and each NOC has its speed and priorities in its efforts towards achieving CN, it is important for each NOC to develop a road map that suits itself.

Figure 5.1. PETRONAS's CN Declaration*

'We are making this commitment to make a positive change – not only to ride the energy transition – but because a fundamental shift is needed and the organization wants to be part of the solution, for the world that yearns for a path towards a more sustainable future.' said Tengku Taufik

* PETRONAS Declares Aspiration: To achieve net-zero carbon emissions by 2050, https://www.petronas.com/sustainability/net-zero-carbon-emissions.

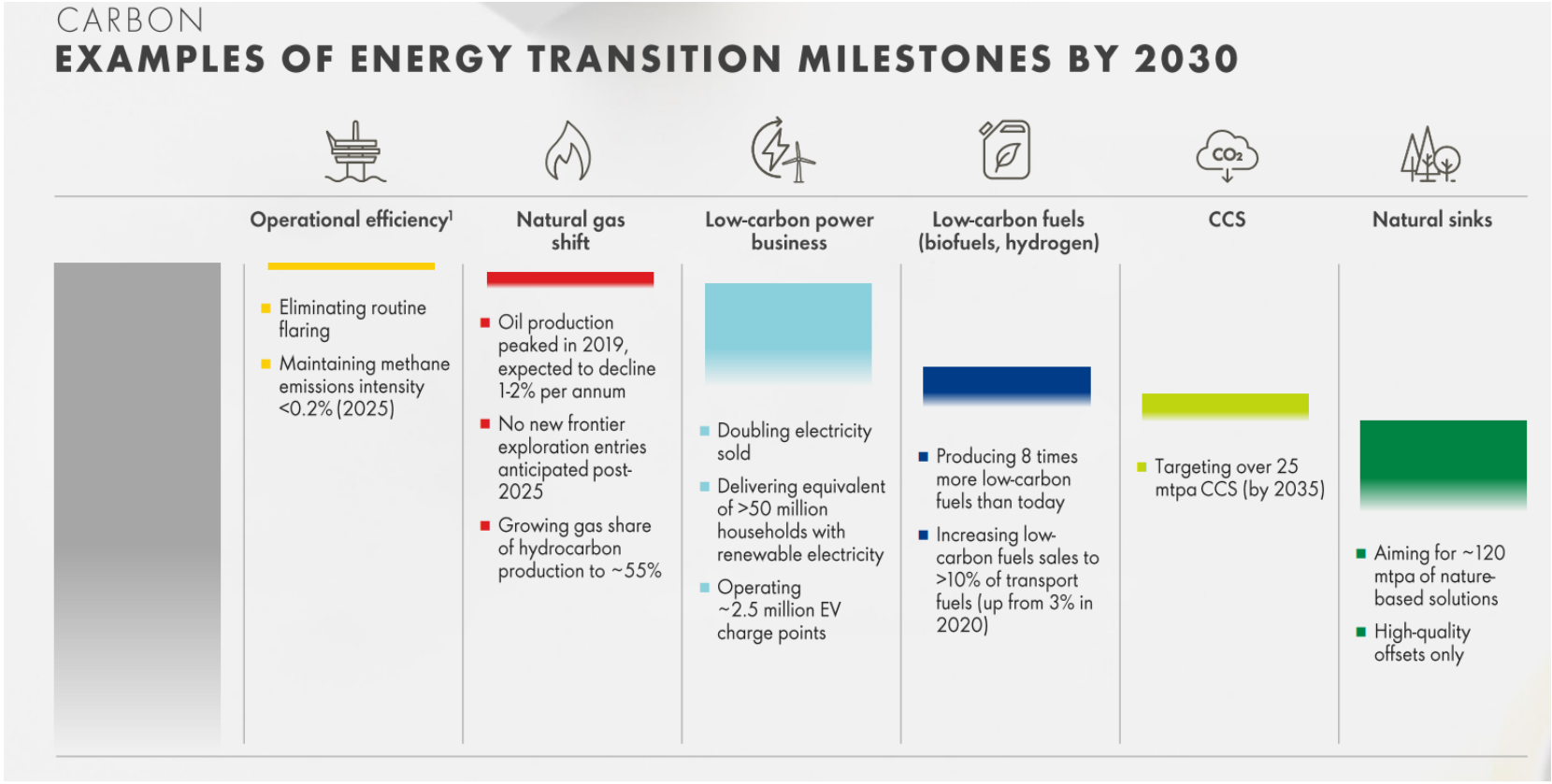
1.3. Development of a road map

In a CN declaration, it is essential to make the declaration and develop a road map that outlines concrete measures to realise CN. However, the situations and management resources of the Western Majors are different from those of the ASEAN NOCs, and the costs for realising CN also are very different. Given the diverse realities of the ASEAN NOCs, each NOC should develop a road map that suits itself. Figures 5.2, and 5.3 are examples of road maps.

Figure 5.2. PTT's Road Map

Source: PTT, Workshop materials, 19 April 2022, p.14.

Figure 5.3. Shell's Road Map to 2030



Source: Shell (2021b).

1.4. Securing the investment budget

It is important to secure an investment budget to ensure that the road map does not turn out to be merely a pipe dream. Since an energy transition strategy is a long road with a medium- to long-term period such as 'realisation by 2050', scales different from usual are necessary for the time required for investment recovery (payout time) and internal rate of return. For reference, Table 5.1 presents Shell's investment criteria.

Table 5.1. Shell Investment Criteria

	Growth		**Transition**		**Upstream**
	Marketing	**Renewable Energy Business**	**Integrated Gas Business**	**Chemicals**	**Upstream Business**
Typical project characteristics	Lower requirements for equity capital (self-owned capital) associated with the growth of sustainable cash flow		Capital intensification with a long-term cash flow profile and limited lower price potential		Risk-associated high volatility
Average project return (IRR)	15%～25%	＞10%	14%～18%	10%～15%	20%～25%
Payout time (time for investment recovery)	4 to 8 years	—	Before 2040	Within 10 years	Before 2035

IRR = internal rate of return.
Source: Shell (2021b).

It is also necessary to reorganise own company's business portfolio. For example, an upstream portfolio can be reduced in the medium to long term. However, investment in LNG and CCS can be increased, or a renewable energy portfolio can be increased. Table 5.2 shows examples of the capital investment policies of Western Majors.

Table 5.2. Example of Capital Investment Policies of Western Majors

Company	Investment Composition
Shell	Reducing the allocation to the upstream sector from 42% to 25%–30% in 2020–2025 and beyond, reducing the allocation to the gas chemical sector from 43% to 30%–40%, and increasing the allocation to the renewable energy and sales sector from 16% to 35%–40%
BP	Increasing the share of investment in two sectors, namely, the low-carbon electricity and energy sector (including gas) and the consumer and mobility sector (including lubricants and hydrogen), from 15% in 2019 to 40% in 2030
TotalEnergies	Maintaining the allocation to LNG at 15%–20% of the overall investment until 2030. The share of renewable energy and electricity will be increased from an average of 10% over the past 5 years to 15% from 2021 to 2025 and to 20% from 2026 to 2030.
ExxonMobil	Investing US$15 billion in decarbonisation through 2027. Cultivating new businesses dealing with methane gas leakage, CCS, hydrogen, and biofuels. Investing an overall annual capital until 2027 of US$20 billion–US$25 billion.

CCS = carbon dioxide capture and storage.
Source: Author.

In ASEAN countries, it is difficult to finance an investment budget for energy transition domestically because the domestic financial markets are not well developed, so NOCs must rely on foreign investment. It is necessary to improve the predictability of long-term investment to attract foreign investment; that is, the transparency (information disclosure) and consistency of policies, such as fossil fuel and renewable energy, should be further enhanced. In addition, it is necessary to establish related laws and guidelines (for example: securing land for CCUS and wind power generation, etc.), formulate technical and safety standards, and make efforts to increase the sense of security for investment.

1.5. Selection of renewable energy according to geographical conditions

Activities in the field of non-fossil energy, especially in new energy such as renewable energy, are challenging for NOCs, having been involved in the fossil fuel business for many years and lacking experience and know-how in the new energy field. In addition, renewable energy has a relatively low energy density, and the amount of renewable energy that can be introduced depends on natural and land conditions. The key point, therefore, is to introduce a program that matches each country's geographical situation and characteristics.

Each ASEAN country has its geographic characteristics. Each country needs to take advantage of its geographical conditions and work on renewable energy in which it can excel. Thailand and Viet Nam can focus on solar power generation by taking advantage of long sunshine hours. In the case of Viet Nam, onshore and offshore wind power generation is promising, taking advantage of abundant wind and shoaling beach conditions. Indonesia is said to have the world's second-largest potential geothermal resource next to the US. Efforts to take advantage of this are already under way, but there is room for further promotion.

NOCs have been involved in the oil and gas business, which generates large-scale sales (profits). On the other hand, the renewable energy business has relatively small sales and large differences in business scale. It remains to be seen whether new businesses such as renewable energy will grow enough to maintain management's bottom line. The Western Majors are also utilising acquisitions, spin-offs, and corporate alliances. Establishing a separate company for each business is helpful to ensure management flexibility and independence and evaluate renewable energy businesses based on an evaluation axis different from the fossil fuel business and a long-term perspective. In the current energy transition period, the way of thinking that new businesses, such as the renewable energy businesses, are complements to, not replacements of, the oil and gas business is also important.

1.6. Importance of collaboration and partnership

In developing a road map, companies will naturally become aware of resources lacking in them. On the financial side, companies may utilise government support (e.g., subsidies) and financing, such as green bonds and transition bonds for the energy transition. On the technological side (hydrogen, CCUS, ammonia, offshore wind power, batteries, etc.), they should collaborate with other companies in the same industry, those in different industries, universities, and other academic circles, and develop their road maps by complementing one another's technologies, funds, and human resources rather than producing everything in-house.

Examples of collaboration:

- Industry–academia–government (foundations, universities)
- Between companies in the same industry (e.g., collaboration between oil companies)
- Across different industries (oil and chemical, oil and information technology, etc.)

The digital field is a major frontier for companies engaged in the traditional oil and gas industry. Great opportunities can arise through the use of digitalisation to combine green transformation with digital transformation. There is much room for digitalisation, such as installing infrared sensors in upstream facilities, pipelines, and refineries and using 5G communications to monitor real-time data on flow rates and GHG leakage to reduce methane emissions.

The following are examples of collaborations and partnerships:

Shell is collaborating with the German chemical company BASF on carbon capture technologies and with the National University of Singapore for joint research. TotalEnergies has strategic alliances with Microsoft and Amazon.com.

A similar movement can be seen regarding the ASEAN NOCs (Figure 5.4). Such movements include a comprehensive strategic alliance between PETRONAS and ADNOC (in the fields of hydrogen, CCUS, research and development, technologies for enhanced oil recovery, etc.); alliances amongst PETRONAS, Pertamina, and Western Majors (ExxonMobil, Shell, etc.) on CCS; and partnership between PTT and Taiwan's Foxconn on EVs.

Figure 5.4. Examples of ASEAN NOCs' Collaboration

Source: Home pages of the respective companies.

Because decarbonisation is a new field even for rival companies, it is where ASEAN NOCs can pursue bilateral strategic dialogues. In addition to cooperation amongst individual companies, it is also effective for the ASEAN NOCs to utilise intra-regional platforms, such as the ASEAN Council on Petroleum, where they can cooperate.

1.7. Support from the government

CN affects each country's economy and the overall lives of the people. No matter how much effort an NOC makes in its field, distortion and the fallacy of composition may result unless its country does not move towards CN in a balanced manner.

Governments' establishment of regulatory frameworks and incentives such as subsidies are key factors that can support the efforts of NOCs. Also, government initiatives in some European countries and the US promote solar and wind power generation and EVs. In particular, the government's role in developing battery electric vehicles (BEVs) is significant. For example, it is important for each government to develop a BEV strategy and present clear policies, such as providing subsidies to expand the BEV market. For example, Norway, where EVs are widely used, imposes carbon and registration taxes on conventional vehicles that use fossil fuels but does not impose such taxes on BEVs, providing substantial incentives to BEV users.

Particularly in new fields such as new energy and BEVs, the balance with other energy policy goals (accessibility, affordability) also needs to be considered. Balancing the overall energy needs of a country without too much focus on post-fossil fuel divestment or renewable energy investment is the role that only its government can play. The role of each government is precisely the creation of an ecosystem for overall energy.

2. Summary

Each ASEAN NOC should develop a realistic road map in coordination with other ASEAN NOCs and NOCs in other regions while considering business structure, available resources, and each country's natural geographical conditions. In addition, partnering with Western Majors or companies in different industries can also be effective. Based on this, it is very important to formulate the most appropriate energy transition strategy for each company by exchanging technologies, financing, and human resource development to realise its road map and implement energy transition and business structure transformation.

The Russian invasion of Ukraine in February 2022 affected all oil and gas companies. The impact of price hikes has been particularly significant on both the positive and negative sides, making a stable energy supply more important than ever. Various energy issues must be resolved simultaneously, including the stable supply of fossil fuels, decarbonisation during the energy transition period, and the introduction of new energy sources, such as renewable energy.

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