



PTT TCFD Report 2022

PTT Public Company Limited
*Aligned with Task Force on Climate-Related
Financial Disclosures (TCFD)*

TCFD

TASK FORCE ON
CLIMATE-RELATED
FINANCIAL
DISCLOSURES

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Governance

Strategy

Risk Management

Metrics & Targets

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

Recommendation Disclosure

Disclosure Source

a) Describe the board's oversight of climate-related risks and opportunities.

Page 8-9

b) Describe management's role in assessing and managing climate-related risks and opportunities.

Page 8, 10

Governance

Strategy

Risk Management

Metrics & Targets

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

Recommendation Disclosure

Disclosure Source

- | | |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term. | Page 12-13, 18 |
| b) Describe the impact of climate-related risks and opportunities on the organization's business, strategy, and financial planning. | Page 13-17, 18-22, 23 |
| c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario. | Page 24-25 |



Governance

Strategy

Risk Management

Metrics & Targets

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

Recommendation Disclosure	Disclosure Source
a) Describe the organization's processes for identifying and assessing climate-related risks.	Page 29-30
b) Describe the organization's processes for managing climate-related risks.	Page 31-32
c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	Page 27-28

Governance

Strategy

Risk Management

Metrics & Targets

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

Recommendation Disclosure

Disclosure Source

a) Disclose the metrics used by the organization to assess climate-related risks and opportunities in line with its strategy and risk management process.

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b) Disclose Scope 1, Scope 2, and if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.

Page 35-37

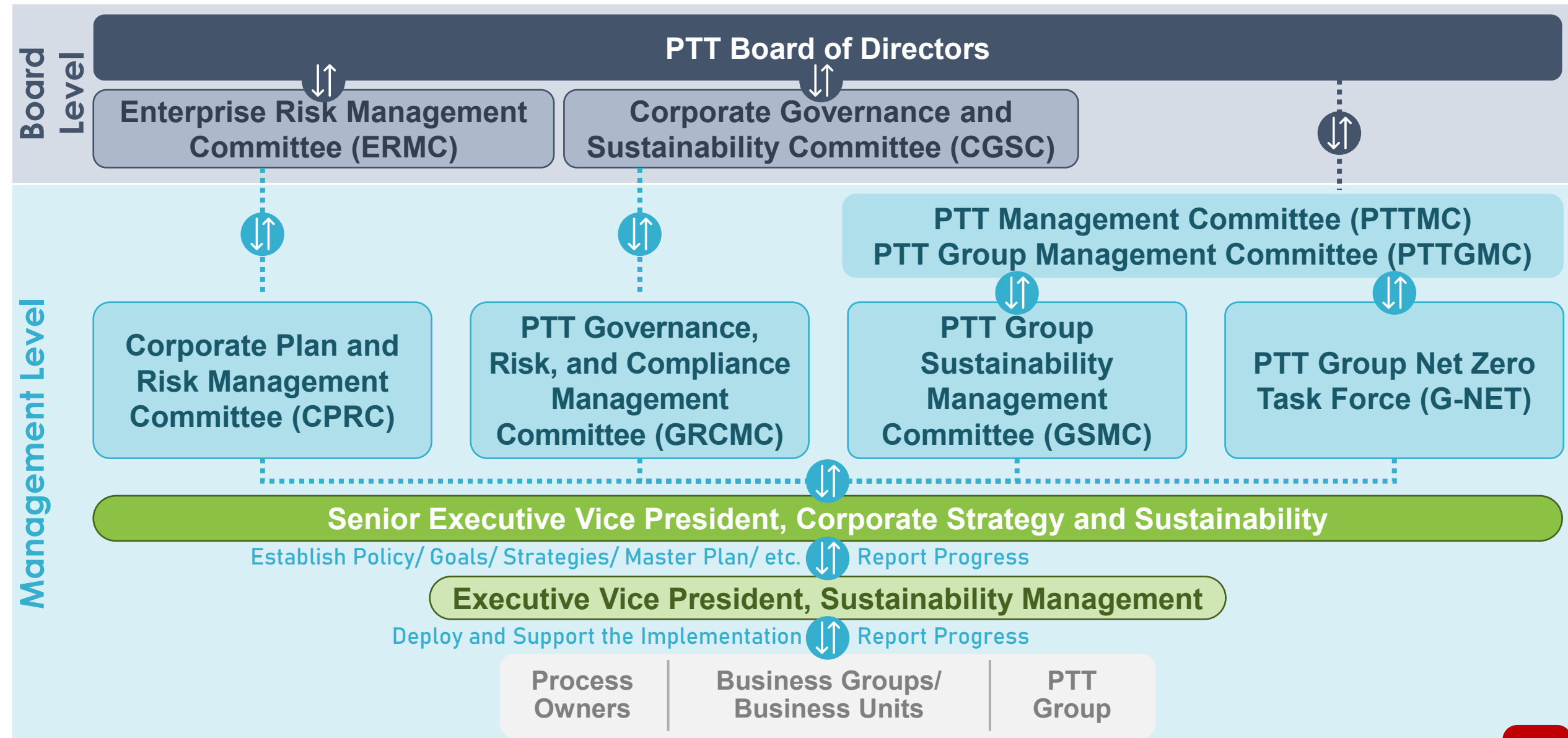
c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.

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GOVERNANCE



Climate Change Governance Structure



Climate Change Management Role

The Executive Vice President of the Sustainability Management function directly reports to the Senior Executive Vice President, Corporate Strategy and Sustainability, **responsible for PTT and PTT Group sustainability management** consisting of establishing policies, strategies, standards, mechanisms, master plans, etc. for deployment to business units and PTT Group company levels. **Sustainability management roles and responsibilities (including climate-related risks and opportunities)** are as follows:

Governing Body	Roles and Responsibilities	Meeting Frequency
Board Level		
PTT Board of Directors (BoD)	BoD is responsible for endorsing the “3P Decarbonization Pathways” and assigns CGSC and ERMC to govern and manage sustainability including climate-related issues which establish risk management guidelines comprehensively and ensure executives’ management and efficient system or process for risk management.	Monthly
Corporate Governance and Sustainability Committee (CGSC)	CGSC is responsible for establishing objectives, targets, policies, strategies, master plans, guidelines, and sustainability management plans covering environmental (including climate action management), social, and governance (ESG) corresponding to PTT’s strategies and targets, national and international standards and practices, as well as monitor the implementation of sustainability management, provide advice and recommendations to PTT Governance Risk and Compliance Management Committee (GRCMC), and report to the board.	Quarterly
Enterprise Risk Management Committee (ERMC)	ERMC is responsible for supervising and reviewing risk policies, scopes, and management (including climate-related risks). The Board also monitors the risk management measures and progress from the proposed corporate business strategy to mitigate the climate risks and supervise the Corporate Plan and Risk Management Committee (CPRC) for further actions.	Quarterly

Climate Change Management Role (Management Level) cont. >>

Climate Change Management Role (cont.)

Governing Body	Roles and Responsibilities	Meeting Frequency
Management Level		
PTT Governance, Risk, and Compliance Management Committee (GRCMC)	<ul style="list-style-type: none"> Determine sustainability management (including climate action) short-term and long-term business plans corresponding to the CGSC's policy framework. Supervise and monitor the sustainability management performance progress according to the plan including suggestions and consulting to achieve operational efficiency. 	Quarterly
Corporate Plan and Risk Management Committee (CPRC)	<ul style="list-style-type: none"> Consider and review the list of corporate risks covering climate-related risks, risk management plans, and progress including the assignment of the responsible team for risk management before presenting to ERM and relevant governing management. Drive and monitor the development of enterprise risk management processes in line with international standards and encourage corporate values in raising awareness of risk management. Screen and recommend the risk management plan embedded with climate change and environmental management corresponding to the strategic direction investment portfolio and business goals to ERM and the board approvals. 	Monthly
PTT Group Sustainability Management Committee (GSMC)	<ul style="list-style-type: none"> Consider and approve PTT Group's policies, goals, scope, strategic plans, and directions for sustainable business operations (including climate action and environment management) in line with international standards and support the business operations. Consider and approve PTT Group's sustainable business risk management. Drive, support, monitor, report, and advice about business plans corresponding to the PTT Group's strategic directions and business targets. 	Quarterly
PTT Group Net Zero Task Force (G-NET)	<p>G-NET is responsible for establishing strategic directions and targets by initiating and executing supporting mechanisms to efficiently move towards net zero greenhouse gas emissions and be responsive to the stakeholder expectations.</p>	Quarterly

STRATEGY



PTT has implemented a comprehensive approach to address climate-related risks and opportunities. The strategic planning involves regular reviews and analysis of climate-related risks across short- (annually), medium- (5-7 years), and long-term (more than 10 years) time horizons. PTT conducts scenario analysis to assess the financial implications and impact levels of these risks and aligns the planning with decarbonization goals. The approach corresponds with the Paris Agreement goal, aiming to limit global warming to below 2°C and achieve global Net Zero by 2050. PTT has set a medium-term target to reduce the GHG emissions by 15% in 2030 compared to the base year in 2020. Our long-term goals are to achieve Carbon Neutrality by 2040 and Net Zero Emissions by 2050. These efforts contribute to Thailand's commitment to reducing GHG emissions by 20% by 2030, demonstrating PTT's commitment to climate action.



According to the Recommendation of the Task Force on Climate-related Financial Disclosure (TCFD), PTT has applied the physical and transition climate scenario analysis to assess and understand how climate change will affect the business operations over time. Both types of risk assessments cover four business segments across PTT Group's value chain:

- 1) Upstream Exploration & Production, 2) Downstream, Retail, Refining, and Petrochemical, 3) Infrastructure (Power), and 4) Natural Gas.

Physical Risk Assessment

Scope of Assessment

4

Asset Types

- Oil & Gas: Onshore
- Refineries & Processing
- Manufacturing & Chemicals
- Power: Natural Gas

2

Timeframes

2030

2050

6

Climate Hazards

Acute
Event-driven

Chronic
Longer-term shifts

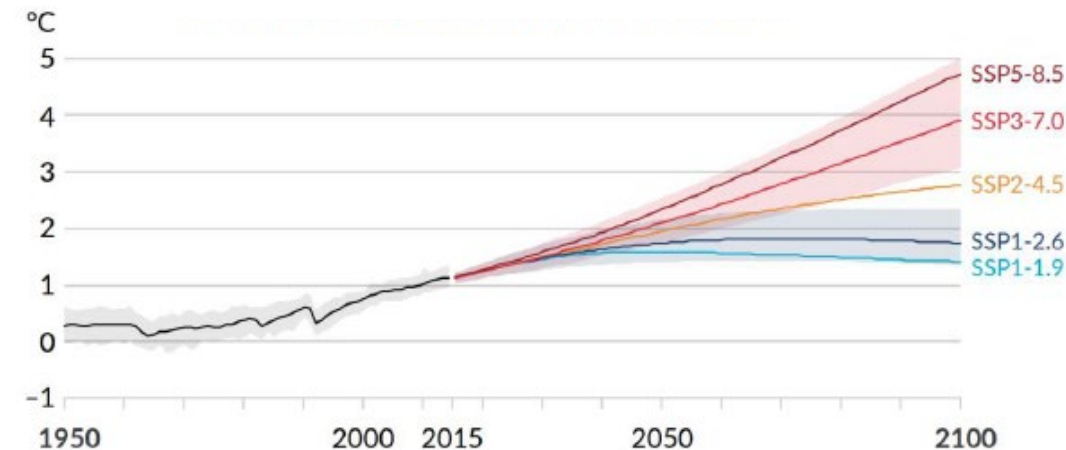
- Water Stress & Drought
- Extreme Heat
- Storms/ Extreme Wind
- River (Fluvial) Flood
- Coastal Flood
- Extreme Rainfall (Pluvial) Flood

3 Scenarios –

Shared Socioeconomic Pathways (SSPs) from IPCC Assessment Report 6

- **SSP1-2.6** a low emissions scenario that stays below 2°C warming by 2100, aligned to current commitments under the Paris Agreement.
- **SSP3-7.0** is a new scenario that didn't exist in AR 5. This scenario complements SSP5-8.5 as a more realistic worst-case outcome. Similar to SSP2-4.5, it is between the high and low extremes and offers an opportunity to explore a situation that previously could not be assessed.
- **SSP5-8.5** a high emissions scenario, which follows a 'business as usual' trajectory, assuming no additional climate policy and seeing CO₂ emissions triple by 2100. The selection of this scenario follows TCFD guidance to assess stressed exposure to physical climate change risks.

Global surface temperature change under the 5 SSPs



Source: IPCC ARG WGI Summary For Policymakers

Physical Climate Change Events











Hazard Types

Acute

Chronic



Evaluation of 6 climate-related natural hazards for PTT's value chain

Event Types	Physical Exposures
<p>Extreme Heat</p>  	<p>In onshore oil and gas, it increases energy costs for liquefying natural gas and demands more cooling for heat-sensitive assets and indoor areas. Refineries and processing face reduced efficiency, lower output, and compromised product quality. Natural gas power has a low risk but requires increased liquefaction and cooling. Manufacturing and chemicals face moderate risks with additional cooling needs and compromised safety thresholds. Regulatory risks, unsafe working conditions, and decreased productivity are concerns.</p>
<p>Extreme Rainfall/ River Flooding</p>  	<p>In onshore oil and gas, it damages infrastructure, including drilling rigs, pipelines, and storage facilities, leading to unsafe working conditions and contamination of waterways. Refineries and processing face operational damage, unforeseen shutdowns, and potential pipe ruptures, causing downtime, safety risks, and increased oil discharge. Chemical manufacturing suffers property damage, requiring evacuations, impacting the environment, and posing regulatory risks. Natural gas power sees infrastructure and operational damage, downtime, and reputational harm. Ground instability and gas leaks from flooded pipelines are additional concerns.</p>
<p>Storms/ Extreme Wind</p>  	<p>In onshore oil and gas, they damage infrastructure, disrupt operations and supply chains, and increase the risk of oil spills and gas leaks. Refineries and processing face structural damage, equipment breakdowns, and disruptions to utilities, leading to shutdowns and productivity loss. Chemical manufacturing suffers property damage, with potentially hazardous waste release and reputational impacts. Natural gas power sees physical damage to above-ground infrastructure, disruptions to operations and potential gas supply. Evacuations, blocked access, and revenue damage are common concerns across industries.</p>
<p>Water Stress & Drought</p>  	<p>In onshore oil and gas, reduced water availability leads to water competition, tougher environmental regulations, and reputational risks. Refineries and processing face decreased output, potential closures, and reduced productivity due to limited water for hydraulic fracturing and cooling systems. Chemical manufacturing suffers production delays and downtime, with lower water quality and availability impacting operations. Natural gas power experiences downtime and competition for water, requiring alternative sources and potential disruptions to construction and expansion. Increased water costs and reputational issues are common during water stress and drought.</p>
<p>Coastal Flooding</p>  	<p>In onshore oil and gas, infrastructure near the coast is vulnerable to damage and corrosion from saltwater. Refineries and processing facilities face physical damage to operational infrastructure, potential oil spills, and capacity challenges in water treatment. Chemical manufacturing is at risk of asset damage, hazardous waste release, and reputational impacts. Coastal flooding can disrupt transport networks and halt production. Natural gas power infrastructure is susceptible to damage and corrosion, leading to downtime and associated costs.</p>

Climate Risk Score by Hazard (1/3)



Extreme Heat

Facilities	Baseline	2030			2050		
		SSP1-2.6	SSP3-7.0	SSP5-8.5	SSP1-2.6	SSP3-7.0	SSP5-8.5
Gas Processing	Low Risk	High Risk	High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Exploration and Production	Low Risk	High Risk	High Risk	Very High Risk	High Risk	Very High Risk	Very High Risk
Gas Terminal	Moderate Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Oil Terminal	Low Risk	High Risk	High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Petrochemical	Low Risk	High Risk	High Risk	High Risk	High Risk	Very High Risk	Very High Risk
Refinery	Moderate Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Utility	Low Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	High Risk

Legend

Very High Risk	Very High Risk
High Risk	High Risk
Moderate Risk	Moderate Risk
Low Risk	Low Risk
Minimal Risk	Minimal Risk



Extreme Rainfall Flooding

Facilities	Baseline	2030			2050		
		SSP1-2.6	SSP3-7.0	SSP5-8.5	SSP1-2.6	SSP3-7.0	SSP5-8.5
Gas Processing	Very High Risk	Very High Risk	Very High Risk	Very High Risk	High Risk	High Risk	High Risk
Exploration and Production	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk	Minimal Risk	Low Risk
Gas Terminal	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Oil Terminal	Low Risk	Moderate Risk	Moderate Risk	Moderate Risk	Low Risk	Moderate Risk	Moderate Risk
Petrochemical	High Risk	High Risk	Moderate Risk	High Risk	Moderate Risk	Low Risk	Moderate Risk
Refinery	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Utility	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk

Climate Risk Score by Hazard (2/3)

River Flooding



Facilities	Baseline	2030			2050		
		SSP1-2.6	SSP3-7.0	SSP5-8.5	SSP1-2.6	SSP3-7.0	SSP5-8.5
Gas Processing							
Exploration and Production							
Gas Terminal							
Oil Terminal							
Petrochemical							
Refinery							
Utility							

Legend

	Very High Risk
	High Risk
	Moderate Risk
	Low Risk
	Minimal Risk

Storms/ Extreme wind



Facilities	Baseline	2030			2050		
		SSP1-2.6	SSP3-7.0	SSP5-8.5	SSP1-2.6	SSP3-7.0	SSP5-8.5
Gas Processing							
Exploration and Production							
Gas Terminal							
Oil Terminal							
Petrochemical							
Refinery							
Utility							



Water Stress and Drought

Facilities	Baseline	2030			2050		
		SSP1-2.6	SSP3-7.0	SSP5-8.5	SSP1-2.6	SSP3-7.0	SSP5-8.5
Gas Processing	Low Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk
Exploration and Production	High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Gas Terminal	Moderate Risk	High Risk	High Risk	High Risk	High Risk	High Risk	Moderate Risk
Oil Terminal	High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Petrochemical	Moderate Risk	High Risk	High Risk	High Risk	High Risk	High Risk	High Risk
Refinery	High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk	Very High Risk
Utility	Moderate Risk	High Risk	High Risk	High Risk	High Risk	High Risk	High Risk

Legend

Very High Risk	Very High Risk
High Risk	High Risk
Moderate Risk	Moderate Risk
Low Risk	Low Risk
Minimal Risk	Minimal Risk



Coastal Flooding

Facilities	Baseline	2030			2050		
		SSP1-2.6	SSP3-7.0	SSP5-8.5	SSP1-2.6	SSP3-7.0	SSP5-8.5
Gas Processing	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Exploration and Production	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk	Moderate Risk
Gas Terminal	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Oil Terminal	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Petrochemical	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Refinery	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk
Utility	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk	Minimal Risk

Scope of Assessment

4

Business Groups from PTT's Value Chain

- Upstream Exploration & Production
- Downstream Oil Retail, Refining, and Petrochemical
- Infrastructure (Power)
- Natural Gas

Transition Drivers



Policy & Legal



Market



Technology



Reputation

Climate Scenarios (PTT & IEA)

Projects of future pathways mapped based on greenhouse gas emissions and considered under two time horizons by **2030 (mid term)** and **2050 (long term)**.

PTT assesses climate change risk using two climate scenarios: PTT's Clean Scenario and Clear Scenario. With the update of the IEA World Energy Outlook 2022, we reviewed the Clean and Clear scenarios with the STEPS and APS data to extrapolate risks towards 2050. The methodology is based on the average ratio of Clean/STEPS and Clear/APS in the baseline, 2030 and 2040 to estimate the data points in 2050. The results suggest that Clean and Clear scenarios are largely in line with STEPS and APS in terms of oil demand in 2040 and 2050. However, Clean and Clear scenarios are more positive towards the change in oil demand in 2030 according to Thailand's Gas Plan where it is projected to increase while APS reports a slight decrease in 2030.

Base case – PTT Clean Scenario, supported by IEA Stated Policies Scenario (STEPS)



Temperature outcome of **2.7°C -3.3°C by 2100**

Accounts for existing policies

No future strengthening, or weakening, of policy

Sector-by-sector outlook

A scenario that explores where the energy system might go, considering current stated policies, without additional policy implementation. The global warming will reach 2.5°C by 2100

Low Carbon scenario – PTT Clear scenario, supported by IEA Announced Pledges Scenario (APS)



Temperature outcome of **<2.0°C by 2100**

Surge in clean energy investment

Rapid shift away from fossil fuels

A clean energy world

A scenario which assumes that all climate commitments made by governments around the world will be met in full and on time. The global warming will reach 1.7°C by 2100, in line with the below 2 °C goal under the Paris Agreement.

Transition risk largely driven by carbon pricing, low carbon transport and stakeholder pressure

Average RISK Clean to Clear		
Timeframe	2030	2050
Upstream	Limited	Higher Risk

Average OPPORTUNITY Clean to Clear		
Timeframe	2030	2050
Upstream	Limited	Lower

Average Risk & Opportunity Clean to Clear		
Timeframe	2030	2050
Upstream	Limited	Higher Risk

The risk/ opportunity scores (scenario deltas multiplied by normalised likelihood X impact ratings) for each indicator are netted off against each other to obtain average risk/ opportunity score. The average score is then compared to the ranges assigned to the different rating levels (limited, low, moderate, to high risk) to assign the overall rating

Climate Transition Drivers Screening						Upstream O&G Risk / Opportunity	
Risk/Opportunity Description	Impact Type	TCFD Category	Financial Impact	Scenario Indicator	2030	2050	
1 Mandatory Carbon Pricing	Risk	Policy & Legal	OPEX	CO ₂ Price			
2 Decreasing oil demand	Risk	Market	Revenue	Oil demand			
3 Changing gas demand as a transition energy	Risk	Market	Revenue	Natural gas demand			
4 Low-carbon technologies for O&G exploration	Risk	Technology	CAPEX; OPEX	Share of electricity consumption in the industrial sector			
5 Low carbon transport for PTT operations	Risk	Technology	CAPEX; OPEX	Transport CO ₂ emissions			
6 Waste gas recovery for reducing venting and flaring	Opportunity	Technology	CAPEX; OPEX	Total CO ₂ emissions (including flaring)			
7 Stranded assets due to stakeholder pressure	Risk	Reputation	Valuation	Annual average investment spending in oil and gas			
Average Risk & Opportunity at Business Segment Level (Upstream O&G)							

- Upstream business is expected to encounter the highest rise in transition risk from **mandatory carbon pricing, low-carbon transport and stranded assets**. Carbon pricing has become a key instrument for countries to disincentivize emissions. Carbon prices may be lower in the early stage, but they tend to increase much higher in a low-carbon scenario to effectively support countries to meet their climate goals. In addition, the pursuit of **low-carbon transport** would entail a higher CAPEX in clean energy carriers and associated fleets and infrastructure. Upstream business is also exposed to the **stranding risk** as investors start exiting high carbon investments.
- Oil demand and gas demand** are expected to peak soon and would either stagnate (for gas) or start dropping (for oil) at a global level. PTT's exposure to these drivers remain **moderate** because of its presence in emerging nations in Asia. In the meantime, PTT would have to deploy low-carbon technologies such as electrification at a larger scale, leading to **much higher CAPEX and OPEX**, in a low-carbon world.
- A **limited opportunity** was identified for **waste gas recovery** which could reduce OPEX and recover CAPEX in a reasonable timeframe.

Opportunity Score Key			
High Opp.	Mod. Opp.	Low Opp.	Limited Opp.

Risk Score Key			
Limited Risk	Low Risk	Mod. Risk	High Risk

Electric mobility may present a high risk, while circular economy provides a low opportunity

Average RISK Clean to Clear		
Timeframe	2030	2050
Downstream	Limited	High Risk

Average OPPORTUNITY Clean to Clear		
Timeframe	2030	2050
Downstream	Limited	Lower Opp.

Average Risk & Opportunity Clean to Clear		
Timeframe	2030	2050
Downstream	Limited	Moderate Risk

Climate Transition Drivers Screening						Downstream Risk / Opportunity	
Risk/Opportunity	Description	Impact type	TCFD Category	Financial Impact	Scenario Indicator	2030	2050
1	Mandatory Carbon Pricing	Risk	Policy & Legal	OPEX	CO ₂ Price		
2	Circular economy for petrochemical products	Opportunity	Market	Revenue	Plastic recycling rates		
3	Market shift towards electric mobility	Risk	Market	Revenue	Share of electricity in transport		
4	Decreasing demand for refinery products	Risk	Market	Revenue	Demand for refinery products		
5	Decarbonization Technologies For downstream O&G	Risk	Technology	CAPEX; OPEX	Transformation of hydrogen in oil refining		
6	Low Carbon Transport for PTT Operations	Risk	Technology	CAPEX; OPEX	Transport CO ₂ emissions		
7	Stranded assets due to stakeholder pressure	Risk	Reputation	Valuation	Refinery capacity at risk		

Average Risk & Opportunity at Business Segment Level (Downstream O&G)

The risk/ opportunity scores (scenario deltas multiplied by normalised likelihood X impact ratings) for each indicator are netted off against each other to obtain average risk/ opportunity score. The average score is then compared to the ranges assigned to the different rating levels (limited, low, moderate, to high risk) to assign the overall rating

- Downstream business is expected to encounter the highest rise in transition risk from **mandatory carbon pricing** and **market shift towards electric mobility** (See Page 36 for the description on carbon pricing impact). Electric mobility would dominate the transport sector in a low-carbon world. While it would stimulate a higher demand for petrochemical products, this positive impact could be outweighed by a greater threat on PTT's revenue from oil retail and refining business. Given the fast-growing EV market, the impact might be realized by 2030.
- Decreasing demand for refinery products** would gradually show its impact as the economy shifts towards electrification. This could contribute to the risk of **stranding** where certain refining capacity would be idled due to a low market demand and stakeholder pressure.
- Decarbonization technologies for downstream O&G** were assessed by the transformation of grey hydrogen to green hydrogen in oil refining, as refineries and petrochemical operations use huge volumes of hydrogen. However, this has been identified as a limited risk.
- As Thailand is promoting the Bio-Circular-Green (BCG) economy model. **Circular economy** may present a **low opportunity** for PTT's petrochemical business as the company is proactive to develop circular products and production processes.

Opportunity Score Key			
High Opp.	Mod. Opp.	Low Opp.	Limited Opp.

Risk Score Key			
Limited Risk	Low Risk	Mod. Risk	High Risk

Main risk from the deployment of decarbonization technologies with limited opportunities

Average RISK Clean to Clear

Timeframe	2030	2050
Infrastructure (Power)	Limited	Moderate Risk

Average OPPORTUNITY Clean to Clear

Timeframe	2030	2050
Infrastructure (Power)	Limited	Limited

Average Risk & Opportunity Clean to Clear

Timeframe	2030	2050
Infrastructure (Power)	Limited	Moderate Risk

Climate Transition Drivers Screening						Infrastructure Risk / Opportunity	
Risk/Opportunity Description	Impact type	TCFD Category	Financial Impact	Indicator	2030	2050	
1 Mandatory carbon pricing	Risk	Policy & Legal	OPEX	CO ₂ Price			
2 Policy on decarbonizing energy mix	Risk	Policy & Legal	Revenue	Share of electricity generated from unabated fossil fuels			
3 Rising trend in electrification	Opportunity	Market	Revenue	Share of electricity in total energy consumption			
4 Maturity of renewable electricity generation	Opportunity	Market	CAPEX; OPEX	Average LCOE - solar and wind			
5 Decarbonization Technologies for the power sector	Risk	Technology	CAPEX; OPEX	Share of fossil fuels with CCUS, hydrogen and ammonia in power generation			
6 Stranded assets due to stakeholder pressure	Risk	Reputation	Valuation	Annual average investment spending in unabated fossil fuels for power generation			
Average Risk & Opportunity at Business Segment Level (Infrastructure/Power)							

The risk/ opportunity scores (scenario deltas multiplied by normalised likelihood X impact ratings) for each indicator are netted off against each other to obtain average risk/ opportunity score. The average score is then compared to the ranges assigned to the different rating levels (limited, low, moderate, to high risk) to assign the overall rating

- Infrastructure (power) business is expected to encounter the highest rise in transition risk from **decarbonization technologies**. The most important technologies for PTT's existing power plants (of which a majority are gas-fired) would be CCUS and the blend of hydrogen or ammonia with natural gas. These technologies would have to be more widely deployed in a low-carbon world, leading to much higher CAPEX and OPEX associated with the respective technologies. This also links to the **lower risk** from a reducing share of electricity generated from unabated fossil fuel as governments seek to **decarbonize the energy mix**.
- Carbon pricing risk** shows a **moderate risk**, suggesting the importance to continuously seek decarbonisation of PTT's power operations. Meanwhile, **stranding risk** may exist, although **limited**, as investors shift their interest away from unabated fossil fuels.
- Two opportunities were identified from the **increase of electrification** and **maturity of renewable electricity generation**. The former would create a higher market demand for electricity in general, while the latter would help to reduce the CAPEX and OPEX associated with PTT's planned renewable capacity expansion. However, both opportunities were assessed as **limited** as the level of electrification has been higher and renewable energy has become much cheaper even at the baseline.

Opportunity Score Key

High Opp.	Mod. Opp.	Low Opp.	Limited Opp.

Risk Score Key

Limited Risk	Low Risk	Mod. Risk	High Risk

Similar risk profile to the upstream business, with a limited opportunity from energy efficiency

Average RISK Clean to Clear		
Timeframe	2030	2050
Natural gas	Limited	High Risk

Average OPPORTUNITY Clean to Clear		
Timeframe	2030	2050
Natural gas	Limited	Limited

Average Risk & Opportunity Clean to Clear		
Timeframe	2030	2050
Natural gas	Limited	High Risk

Climate Change Drivers Screening						Natural gas Risk / Opportunity	
Risk/Opportunity Description	Impact type	TCFD Category	Financial Impact	Indicator	2030	2050	
1 Mandatory carbon pricing	Risk	Policy & Legal	OPEX	CO ₂ Price			
2 Changing gas demand as a transition energy	Risk	Market	Revenue	Natural gas demand			
3 Gas mobility in the low-carbon transition	Risk	Market	Revenue	Natural gas use in the transport sector			
4 Low-carbon technologies for gas processing	Risk	Technology	CAPEX; OPEX	Share of electricity consumption in the industrial sector			
5 Low-carbon transport for PTT Operations	Risk	Technology	CAPEX; OPEX	Transport CO ₂ emissions			
6 Energy efficiency improvement	Opportunity	Technology	OPEX	Energy consumption in the industrial sector			
7 Stranded assets due to stakeholder pressure	Risk	Reputation	Valuation	Annual average investment spending in oil and gas			
Average Risk & Opportunity at Business Segment Level (Natural Gas Value Chain)							

The risk/ opportunity scores (scenario deltas multiplied by normalised likelihood X impact ratings) for each indicator are netted off against each other to obtain average risk/ opportunity score. The average score is then compared to the ranges assigned to the different rating levels (limited, low, moderate, to high risk) to assign the overall rating

- The risk profile of PTT's gas value chain appears like that of the upstream business. **Carbon pricing** was found presenting the highest risk. Carbon prices may be lower in the early stage, but they tend to increase much higher in a low-carbon scenario to effectively support countries to meet their climate goals. The pursuit of **low-carbon transport** would entail a higher CAPEX in clean energy carriers and associated fleets and infrastructure. Gas business could also face a **stranding risk** as investors shift further towards clean energy options. These risks were assessed as moderate to high by 2050
- The changing gas demand** would not be a risk until after 2030. However, PTT should be careful about any new deployment of gas assets to reduce the effect of carbon lock-in in a longer term. Specific to the transport sector, **natural gas mobility** could be replaced by electricity and low-carbon gaseous fuels (such as biomethane, hydrogen, synthetic methane) more extensively, becoming a limited risk to PTT's NGV sales.
- To reduce its own emissions, PTT would have to deploy low-carbon technologies such as electrification (i.e., fuel switch from fossil fuels to electricity) more extensively in a low-carbon world, leading to higher CAPEX and potentially OPEX too. On the other hand, a **low opportunity** may be seized from cost-saving **energy efficiency improvement** such as process optimization, although the magnitude is assessed limited.

Opportunity Score Key			
High Opp.	Mod. Opp.	Low Opp.	Limited Opp.

Risk Score Key			
Limited Risk	Low Risk	Mod. Risk	High Risk

The climate-related scenario analysis enables the identification of potential risks and opportunities on the business model. PTT incorporates these results as a part of developing the outlook for the energy transition during the environmental scanning process of the strategy and business planning. The annual planning involves the executives from the Group level and business groups throughout the Top Executive Thinking Session and the Strategic Thinking Session. The strategy is then presented and approved by the Board. To drive the plan for decarbonization strategy to meet the goal of the Paris Agreement, PTT will regularly review the impacts based on the changing situations and adjust the plans, as well as the budget planning and performance metrics accordingly.



3P Decarbonization Pathways



PTT integrated climate-related risks and opportunities into key factors in determining strategic directions and corporate targets for 2030, namely – Business Growth – expanding growth in the potential energy business, New Growth – growing the future energy business and other potential businesses beyond energy, and Clean Growth – driving PTT Group’s greenhouse gas emission reduction. These targets reflect our commitment to transform businesses into a low-carbon society towards Net Zero Emissions in 2050. To drive these goals, PTT has defined the 3P Decarbonization Pathways to execute potential decarbonization initiatives.



3P Decarbonization Pathways

Pursuit of Lower Emissions



Link with Clean Growth Target to reduce as much greenhouse gas emissions as possible

Key Performance

- Carbon Capture and Storage (CCS)
- Carbon Capture and Utilization (CCU)
- Use renewable energy and hydrogen in operation areas
- Energy efficiency and optimization projects

Clean Growth

Portfolio Transformation



Build growth from future energy business, with the increase in green portfolio proportion and hydrocarbon portfolio management

Key Performance

- Achieve business growth from future energy business
- Increase the ratio of renewable energy generation
- Reduce investment proportion in fossil fuel
- Promote the use of electric vehicles in Thailand

Business Growth New Growth

Partnership with Nature and Society



Increase volume of absorption and storage of carbon dioxide by nature-based solutions, through reforestation, forest protection, and increasing green area

Key Performance

- Protect one million Rai of forest from permanent reforestation project under the Royal Patronage, commenced since 1994
- Continuously grow one million Rai of new forests, and another one million Rai with PTT Group

BUSINESS GROWTH

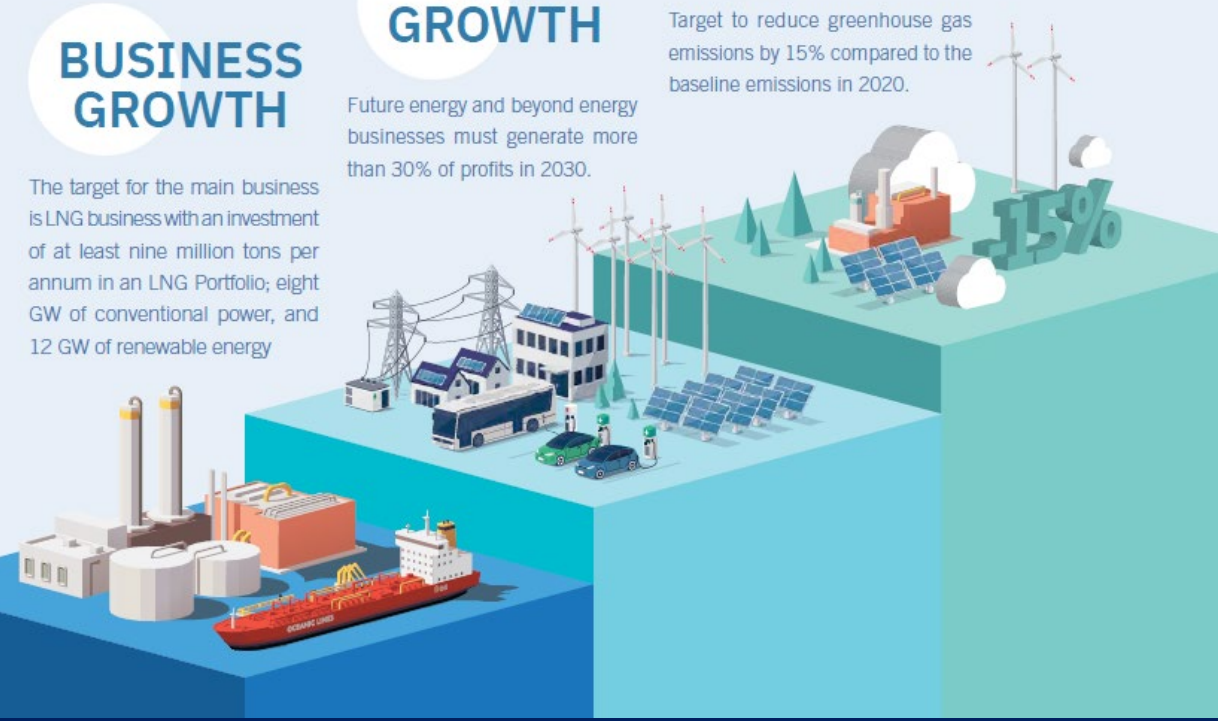
The target for the main business is LNG business with an investment of at least nine million tons per annum in an LNG Portfolio; eight GW of conventional power, and 12 GW of renewable energy

NEW GROWTH

Future energy and beyond energy businesses must generate more than 30% of profits in 2030.

CLEAN GROWTH

Target to reduce greenhouse gas emissions by 15% compared to the baseline emissions in 2020.

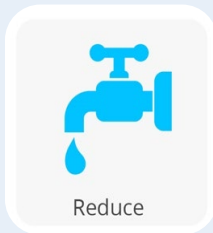


According to the physical risk assessment, water stress/draught is one of the high-risk climate hazards that require responsive management. PTT thus places importance on integrated water management involving water conservation, water consumption efficiency, the 3Rs Principle (reduce, reuse, recycle) in line with the Circular Economy perspective. PTT ensures that its operation and subsidiaries will not encroach water rights and availability amongst local communities, while adhering to regulations related to the water management guidelines dictated by Thailand National Strategy.

The impact of water shortage on PTT Group's production capacity

PTT assessed the financial impact from water scarcity using scenario analysis based on decreasing water supply – 30%, 40%, and 50% water reduction. The impact may lead to temporary production halt leading to decrease in revenue.

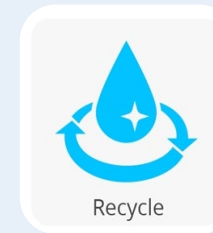
Major Projects for Water Management



- Cooling water system from an open to a closed system
- Wastewater from the dehydration process as makeup water in the Acid Gas Removal Unit (AGRU)
- Desalination



- Reverse Osmosis Intermediated for water coolant
- Condensate water in the steam production process



- Feasibility study of wastewater treatment using the Eco-Industrial system
- Recycled Greywater Prototype Innovation Project

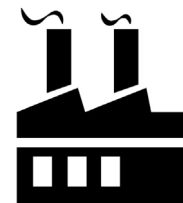
Estimated cost of measures ≈ 890,000,000 baht

Targets



Office Building:

Reduce water intensity (liters per person per day) in 2030 by 10% for office buildings compared to the 2013 base year



Operation:

Control and monitor PTT Group's freshwater withdrawal not exceeding 74 million cubic meters in 2022

RISK MANAGEMENT



Integrated Enterprise Risk Management



Vision/ Mission



Strategic Objective



Strategic Planning

(Embedded with the Enterprise Risk Management)

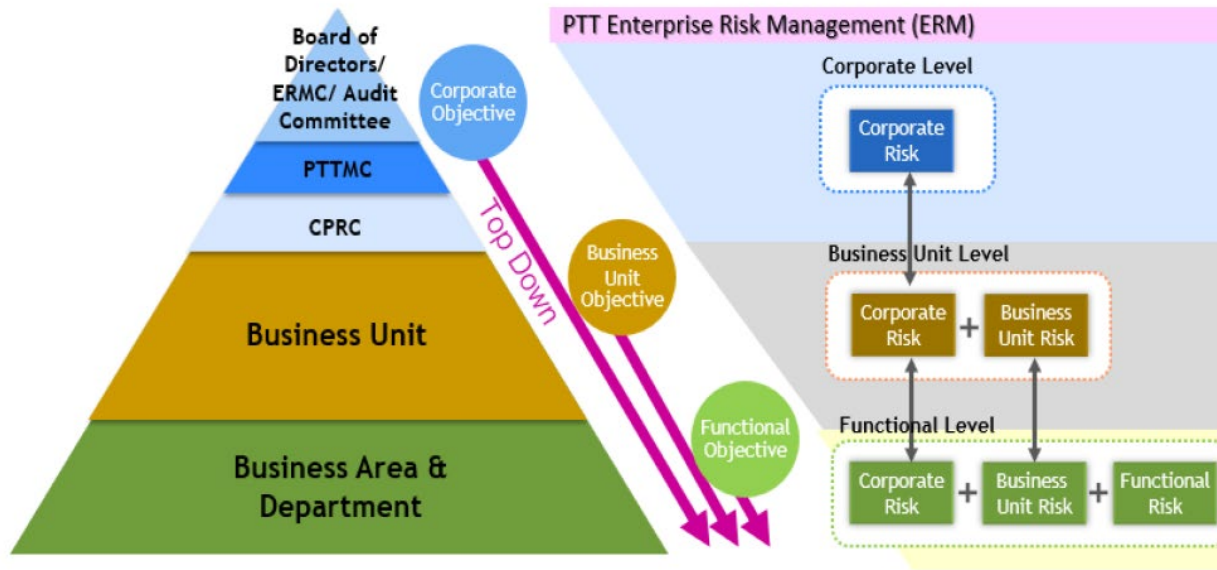


Business Plan & Action Plan

PTT's Enterprise Risk Management is a process by which the Board of Directors, executives and employees throughout the organization jointly define the organization strategy, identify risk events that may affect the organization and manage the risks to ensure the achievement of the organizational objectives.

PTT has applied the COSO ERM 2017 and ISO31000:2018 Risk Management to develop PTT ERM Framework and determine acceptable organization's risk level in each type of risk corresponding to the company's **Vision/ Mission** and align with the **strategic objective** and core business.

For the **Strategic Planning**, all potential risk factors from the Risk Universe are reviewed. Key risks that affect both short-term and long-term strategies are identified thoroughly. The result of the risk analysis becomes the input to determine the direction of the organization's strategy and related **master plans**.



PTT Enterprise Risk Management Structure Framework

PTT Enterprise Risk Management is divided into 3 levels as follow:

1. **Corporate Level:** manage risks that affect the achievement of Corporate Objectives.
2. **Business Unit Level:** Manage risks that affect business level objectives. Risks that have extreme impacts will be upgraded to Corporate Level Risk.
3. **Functional Level:** Manage risks that affect operational level objectives.

Risk Management Process

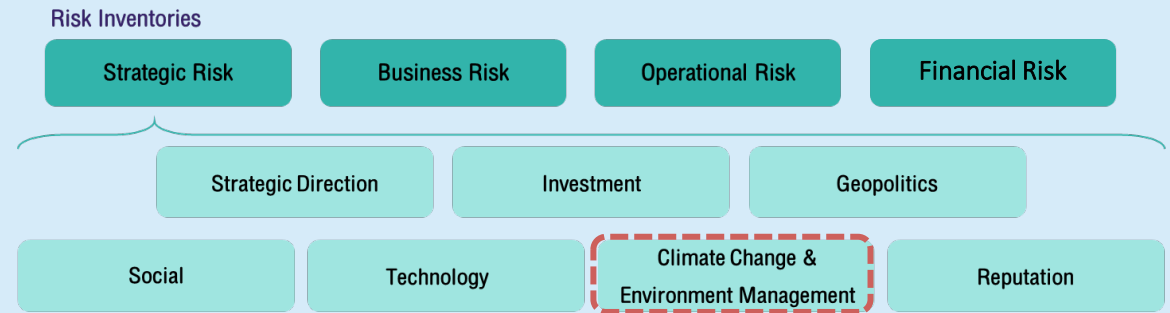




Analyze potential risks based on the source of risk.



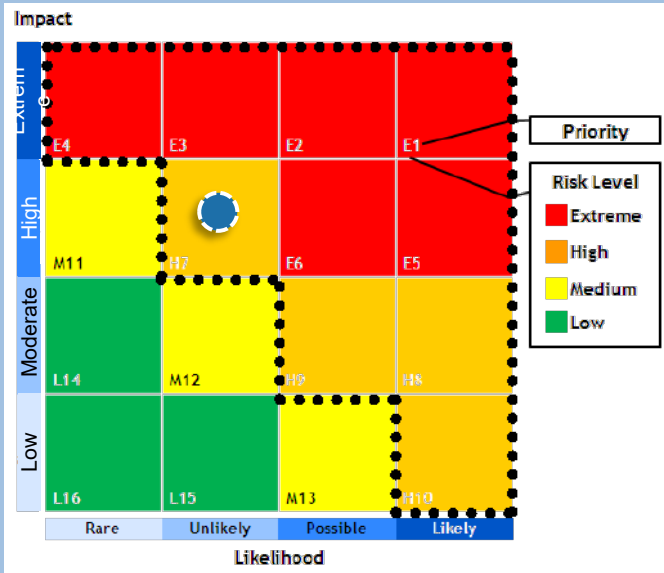
Categorize risk items into risk inventories



Risk items from the risk universe are categorized into the 4 categories of risk inventories as follows:

1. Strategic Risk
2. Business/ Support Function Risk
3. Operational Risk
4. Financial Risk

Climate-related risks are identified under the Strategic Risk.



Risk Analysis and Evaluation

Assess the impact and likelihood of each risk item and evaluate risk level into the risk matrix

Risk Prioritization

Prioritize risk item:

- Extreme and High risk levels are assessed to be corporate risk which must be implemented in accordance with the risk management process at corporate level
- Medium and Low risk levels are assessed to be Business unit level and functional level risk
- Climate-related Risk, Net Zero Target Achievement, is assessed as High Risk and selected to be Corporate Risk.



Risk Owner
set up a risk management plan
consisting of:

Control: manage to reduce the likelihood of risk item

Mitigation Plan: manage to reduce the impact that may affect the goals if such risk event occur

Cost & Benefit Analysis: Evaluate the worthiness of the benefits and operating costs

Leading KRI: Indicators established to track the likelihood of a risk occurring

Lagging KRI: Performance indicators of risk management

Corporate Plan and Risk Management Committee (CPRC)
endorses Corporate Risk Profile and risk management plan

Enterprise Risk Management Committee (ERMC)
approves Corporate Risk Profile and risk management plan



Monitor the progress and effectiveness of risk management plan, obstacles, event risks, and changes in risk levels when performing various activities to control the risk within the acceptable risk level and ensures the organization objectives achievement.

Situation/ Risk	PTT Group Performance	Leading/ Lagging KRIs	Risk Item Management Progress by Risk Owners
<p>Monitor changes in situations, trends and risks that have a significant impact.</p>	<p>Monitor PTT Group's performance to ensure that there are no significantly risk items affect the performance compared to the target.</p>	<ul style="list-style-type: none"> • Monitor the KRIs result. • Risk owner analyzes why KRIs do not meet targets, assess the trend of the situation and improve / add supportive measures. 	<ul style="list-style-type: none"> • Monitor the risk management plan progress. • Monitor and adjust the risk management plan align with the changing situation.

The risk owners must report the progress of risk management plans to the CPRC on a monthly basis and to the ERMC on a quarterly basis.

METRICS AND TARGET



2022 Key Performance Indicator (KPI):

Short-term Target	Long-term Target	Progress against Short-term Target	Indicators
PTT and PTT Group's greenhouse gas emissions (scope 1 and scope 2 including domestic and international operations) are less than 12 million tons of CO ₂ e and 52.5 million tons of CO ₂ e, respectively.	"Clean Growth" target: Reducing PTT's greenhouse gas emissions by 15% in 2030 compared to the base year 2020 to achieve carbon neutrality by 2040 and net zero emissions by 2050.	PTT and PTT Group's greenhouse gas emissions are 9.99 million tons of CO ₂ e and 45.40 million tons of CO ₂ e, respectively.	<ul style="list-style-type: none"> State Enterprise Assessment Model Key Performance Indicator (SE-AM KPI) and Corporate KPI* Functional KPI KPI for PTT Sustainability Management Masterplan for Social and Environmental Responsibilities 2022 – 2025 QSHE indicator in 2022 for PTT and PTT Group's performance <p>*SE-AM KPI and Corporate KPI for 'Climate Action' measures Eco-efficiency performance, calculates from greenhouse gas emission and PTT-specific product</p>

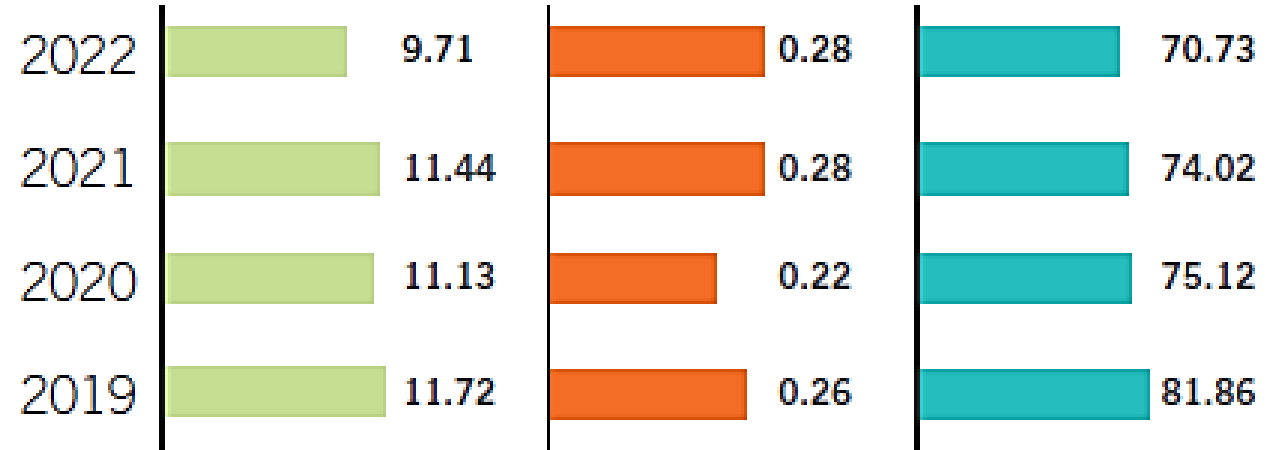
2022 Key Risk Indicator (KRI):

Leading KRI	Trigger	Lagging KRI	Target
Lower Emissions: PTT Group GHG Emissions Performance	> 52.5 million tons of CO ₂ e	Financial institution and investor withdrawal of investment as a result of climate-related issues	None

PTT's direct and indirect greenhouse gas emissions

Unit: million tons of CO₂ equivalent

- GHG Scope 1
- GHG Scope 2 (Market-based)
- GHG Scope 3



Remarks:

- PTT's greenhouse gas emissions (scope 1 and scope 2) include the emission from PTT's operated asset only.
- Scope 3 emission includes the combustion of fuel sold by PTT only.
- Scope 2 emission (market-based) includes electricity consumption from national grid, private producers, and Global Power Synergy Company Limited (GPSC).

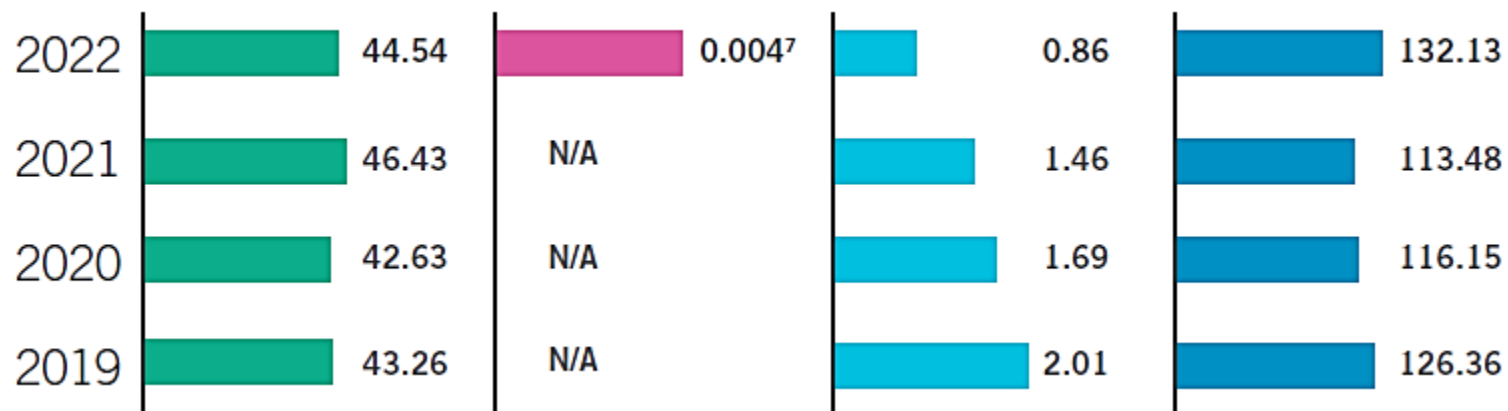
PTT Group Direct and Indirect GHG Emissions



PTT Group's direct and indirect greenhouse gas emissions^{1, 8}

Unit: million tons of CO₂ equivalent

- Direct GHG emissions (Scope 1)^{2, 3}
- Biogenic CO₂ emissions
- Indirect GHG emissions (Scope 2) (Market-based)
- GHG emission from PTT-distributed fuel products' combustion (Scope 3)^{4, 5, 6}



Remarks:

1 GHG report boundary based on the operational control approach, covers companies with exceeding 20% direct PTT shareholding and majority or 100% indirect PTT shareholding including joint ventures with equal shareholding.

2 The direct and indirect GHG emissions reporting covered the international company operations of PTT Global Chemical Public Company Limited (GC) were estimated to be 0.31 and 0.01 million tons of CO₂ equivalent, respectively (the estimated emissions based on the operational performances in 2020).

3 PTT Group's direct GHG emissions (2018-2022) were recalculated due to the following reasons:

- Expanding organization boundary from G2 operation of PTT Exploration and Production Public Company Limited (PTTEP) in 2022.
- Expanding reporting coverage of Thai Oil Public Company Limited (Thaioil), namely TLB, TOPSPP, TPX, LABIX) and GC, namely BPE, EOEG, GCL, GCME, GCMP, GCO, GCP, BPA, Phenol, GCS, ME I&I, NPS S&E, TPRC, TTT.
- In 2021, Merging between ThaiOil and ThaiOil Power in Thailand.
- In 2019, GPSC's acquisition of GLOW Group's electricity and stream.

- Expanding operational boundary from GHG emission reporting of GC (such as Olefins Reconfiguration Project (ORP), office at Energy Complex (EnCo), etc.), IRPC Public Company Limited (IRPC) (such as inventory and container yards), and PTT Oil and Retail Business Public Company Limited (OR) (such as Songkhla LPG cylinder and Bangpakong lubricant distribution center).
- Starting electricity generators of PTT LNG Company Limited in 2020

4 The indirect GHG emissions (scope 3) reporting covered PTT and OR distributed fuel products combustion including natural gas, benzene, diesel, aviation fuel, fuel oil, LPG, and kerosene. PTT has defined the State Enterprise Assessment Model Key Performance Indicator (SE-AM KPI) called "Eco-efficiency performance" for managing indirect GHG emissions (scope 3).

5 In 2019-2021, the indirect GHG emissions (scope 3) boundary in 2019 - 2021 covered PTT and OR.

6 In 2022, the indirect GHG emissions (scope 3) boundary covered PTT, GC, Thaioil, IRPC, and OR.

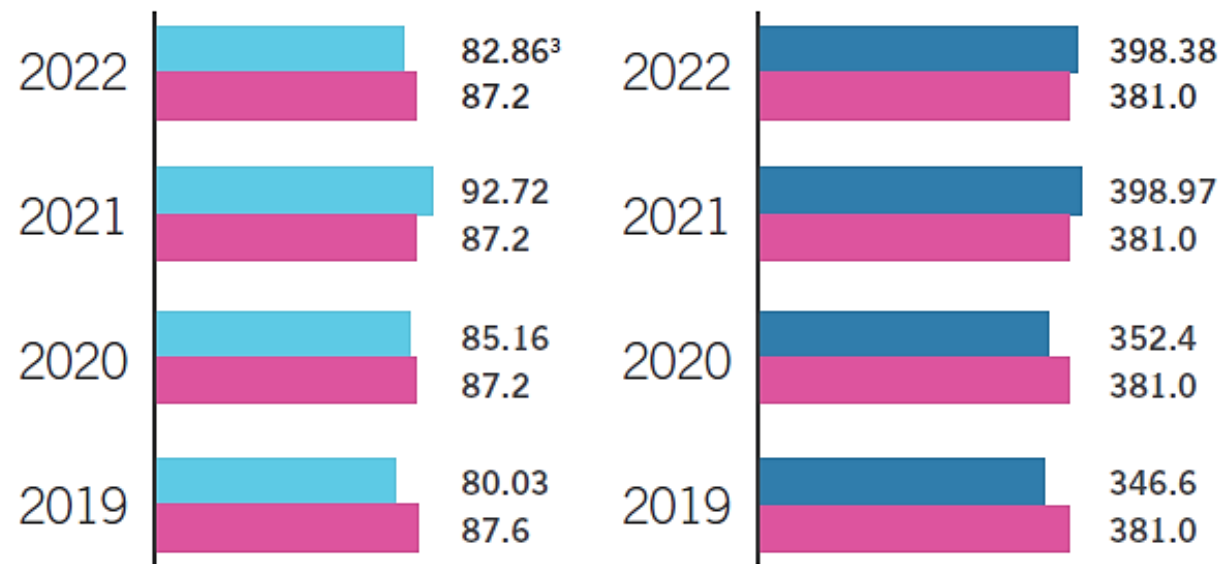
7 Started reporting on Biogenic CO₂ emission.

8 The organizational GHG emissions reporting is expanding data collection to ensure all operational coverages for forward improvement and disclosure.

GHG Emission Intensity^{1,5}

Unit: Kilogram CO₂ per barrel of crude oil equivalent

- Direct and indirect GHG emission from PTT activities (Scope 1 and 2)²
- Direct and indirect GHG emission from PTT activities, as well as combustible fuel products PTT distributed (Scope 1, 2 and 3)^{3,4}
- Targets



Remarks:

- 1 GHG report boundary based on the operational control approach, covers companies with exceeding 20% direct PTT shareholding and majority or 100% indirect PTT shareholding including joint ventures with equal shareholding.
- 2 Calculated from fuel product sales of PTT and OR.
- 3 Calculated from the organizational GHG emissions based on the boundary in the 2022 annual report.
- 4 Calculated from the direct and indirect GHG emissions (scope 1, 2, and 3) and fuel product sales of PTT and OR according to the organization boundary between 2019-2021.
- 5 The organizational GHG emissions intensity target and reporting are expanding data collection to ensure all operational coverages for forward improvement and disclosure.

