GPSC Climate Strategy & Disclosure

2021-2022

GPSC

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Climate Risk Management and TCFD Framework

GPSC Group fully Integrates TCFD framework to address climate risks and opportunities

“ With the effort for increasing transparency on the resiliency of GPSC climate change strategies, GPSC produces climate risks and opportunities report in response to TCFD to fulfil our ambitious target, which is NET- ZERO”.

TCFD Disclosure Pillars

Governance
The organization’s governance around climate-related risks and opportunities

Strategy
The actual and potential impacts of climate-related risks and opportunities on the organization’s businesses, strategy, and financial planning

Risk Management
The processes used by the organization to identify, assess, and manage climate-related risks

Metrics and Targets
The metrics and targets used to assess and manage relevant climate-related risks and opportunities

Disclosure of climate risks in line with TCFD framework is an opportunity for GPSC to:

- Demonstrate **climate leadership** and alignment with the best international climate reporting practice to stakeholders
- Show **readiness** of GPSC to respond to climate challenges in a timely manger and process and achievements to date
- Have better **access to capital** by increasing investors’ and lenders’ **confidence** that the company’s climate-related risks are appropriately assessed and are being integrated in the risk management processes
- Meet increasing requirements for climate-related financial disclosures by **investors and regulators**

TCFD | TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

GPSC group applies the TCFD reporting guidance and illustrates Physical and Transition risks as follows.

Figure 2

Major Categories of Financial Impact

Income Statement	Balance Sheet
Revenues. Transition and physical risks may affect demand for products and services. Organizations should consider the potential impact on revenues and identify potential opportunities for enhancing or developing new revenues. In particular, given the emergence and likely growth of carbon pricing as a mechanism to regulate emissions, it is important for affected industries to consider the potential impacts of such pricing on business revenues. **Expenditures.** An organization's response to climate-related risks and opportunities may depend, in part, on the organization's cost structure. Lower-cost suppliers may be more resilient to changes in cost resulting from climate-related issues and more flexible in their ability to address such issues. By providing an indication of their cost structure and flexibility to adapt, organizations can better inform investors about their investment potential. It is also helpful for investors to understand capital expenditure plans and the level of debt or equity needed to fund these plans. The resilience of such plans should be considered bearing in mind organizations' flexibility to shift capital and the willingness of capital markets to fund organizations exposed to significant levels of climate-related risks. Transparency of these plans may provide greater access to capital markets or improved financing terms.	**Assets and Liabilities.** Supply and demand changes from changes in policies, technology, and market dynamics related to climate change could affect the valuation of organizations' assets and liabilities. Use of long-lived assets and, where relevant, reserves may be particularly affected by climate-related issues. It is important for organizations to provide an indication of the potential climate-related impact on their assets and liabilities, particularly long-lived assets. This should focus on existing and committed future activities and decisions requiring new investment, restructuring, write-downs, or impairment. **Capital and Financing.** Climate-related risks and opportunities may change the profile of an organization's debt and equity structure, either by increasing debt levels to compensate for reduced operating cash flows or for new capital expenditures or R&D. It may also affect the ability to raise new debt or refinance existing debt, or reduce the tenor of borrowing available to the organization. There could also be changes to capital and reserves from operating losses, asset write-downs, or the need to raise new equity to meet investment.

The Task Force encourages organizations to undertake both historical and forward-looking analyses when considering the potential financial impacts of climate change, with greater focus on forward-looking analyses as the efforts to mitigate and adapt to climate change are without historical precedent. This is one of the reasons the Task Force believes scenario analysis is important for organizations to consider incorporating into their strategic planning or risk management practices.

Source: https://www.fsb-tcfd.org/publications/finalrecommendations-report

Table 1

Examples of Climate-Related Risks and Potential Financial Impacts

Type	Climate-Related Risks[32]	Potential Financial Impacts
Transition Risks	**Policy and Legal**	
	– Increased pricing of GHG emissions – Enhanced emissions-reporting obligations – Mandates on and regulation of existing products and services – Exposure to litigation	– Increased operating costs (e.g., higher compliance costs, increased insurance premiums) – Write-offs, asset impairment, and early retirement of existing assets due to policy changes – Increased costs and/or reduced demand for products and services resulting from fines and judgments
	Technology	
	– Substitution of existing products and services with lower emissions options – Unsuccessful investment in new technologies – Costs to transition to lower emissions technology	– Write-offs and early retirement of existing assets – Reduced demand for products and services – Research and development (R&D) expenditures in new and alternative technologies – Capital investments in technology development – Costs to adopt/deploy new practices and processes
	Market	
	– Changing customer behavior – Uncertainty in market signals – Increased cost of raw materials	– Reduced demand for goods and services due to shift in consumer preferences – Increased production costs due to changing input prices (e.g., energy, water) and output requirements (e.g., waste treatment) – Abrupt and unexpected shifts in energy costs – Change in revenue mix and sources, resulting in decreased revenues – Re-pricing of assets (e.g., fossil fuel reserves, land valuations, securities valuations)
	Reputation	
	– Shifts in consumer preferences – Stigmatization of sector – Increased stakeholder concern or negative stakeholder feedback	– Reduced revenue from decreased demand for goods/services – Reduced revenue from decreased production capacity (e.g., delayed planning approvals, supply chain interruptions) – Reduced revenue from negative impacts on workforce management and planning (e.g., employee attraction and retention) – Reduction in capital availability
Physical Risks	**Acute**	– Reduced revenue from decreased production capacity (e.g., transport difficulties, supply chain interruptions) – Reduced revenue and higher costs from negative impacts on workforce (e.g., health, safety, absenteeism) – Write-offs and early retirement of existing assets (e.g., damage to property and assets in "high-risk" locations) – Increased operating costs (e.g., inadequate water supply for hydroelectric plants or to cool nuclear and fossil fuel plants) – Increased capital costs (e.g., damage to facilities) – Reduced revenues from lower sales/output – Increased insurance premiums and potential for reduced availability of insurance on assets in "high-risk" locations
	– Increased severity of extreme weather events such as cyclones and floods	
	Chronic	
	– Changes in precipitation patterns and extreme variability in weather patterns – Rising mean temperatures – Rising sea levels	

Disclosure Aligned with Force on Climate Related Financial Disclosure (TCFD) Framework (1/4)

Recommendation Disclosure	GPSC Status	Disclosure Source
Governance		
a) Describe the board's oversight of climate-related risks and opportunities.	Management of risks and opportunities of climate change, including GHG reduction, business adjustment, and strategies on climate change, is the responsibility of the Board of Directors (including Corporate Governance and Risk Management Committee) and the President & CEO. Overall roles and responsibilities are as follow: • Review and approve solutions strategies, risk factors, opportunities arising from climate change • Track implementation and projects related to climate change in accordance with the procedure, including business decision-making processes and assigning budget to relevant departments in accordance with the established structure • Set the organization's performance objectives, monitoring implementation and performance, and overseeing major capital expenditures, acquisitions, and divestitures In addition, the Corporate Risk Management Division, under the Corporate Strategy and Risk Management Department, is assigned to be responsible for assessing the risks and opportunities of the business in the field of climate change and report back to management team every 6 months in order to monitor and obtain a clear and comprehensive management of climate change in all aspects of business operations. Climate Change performance is linked with the President & CEO and relevant functions as an monetary incentives.	• GPSC website
b) Describe management's role in assessing and managing climate-related risks and opportunities.		

Disclosure Aligned with Force on Climate Related Financial Disclosure (TCFD) Framework (2/4)

Recommendation Disclosure	GPSC Status	Disclosure Source
Strategy		
a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long Term	GPSC identifies risk and probability caused by climate change seen as material to business over the short, medium, and long terms as follows: • **Physical risks** including floods, drought, lightning strikes, and tropical storms, and rises in temperature at the earth's surface from projections, with reference to a summary of the IPCC's Sixth Assessment Report (AR6). The assessment include RCP 2.6, 4.5, 6.0 and 8.5 • **Transition risks** and opportunities, including changes in policies, laws, requirements, technological shifts, and consumers' behavioral shift, with reference to scenarios from IEA NZE 2050, IEA B2DS, IEA SDS and NDC.	• Page 14-59 • GPSC website
b) Describe the impact of climate related risks and opportunities on the organization's businesses, strategy, and financial planning.	GPSC sets out strategies for handling climate change through plans and mitigation plans (operating and under activities across the supply chain) with reference to the impacts of climate change on GPSC	• Page 14-59 • ISR page 4-5,12-13, 28 • GPSC website
c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	GPSC examines risks concerning climate from undertaking scenario planning, including RCP2.6, 4.5, 6.0 and RCP8.5, and define business resilience in its strategy on climate change.	• Page 60-63 • GPSC website

Disclosure Aligned with Force on Climate Related Financial Disclosure (TCFD) Framework (3/4)

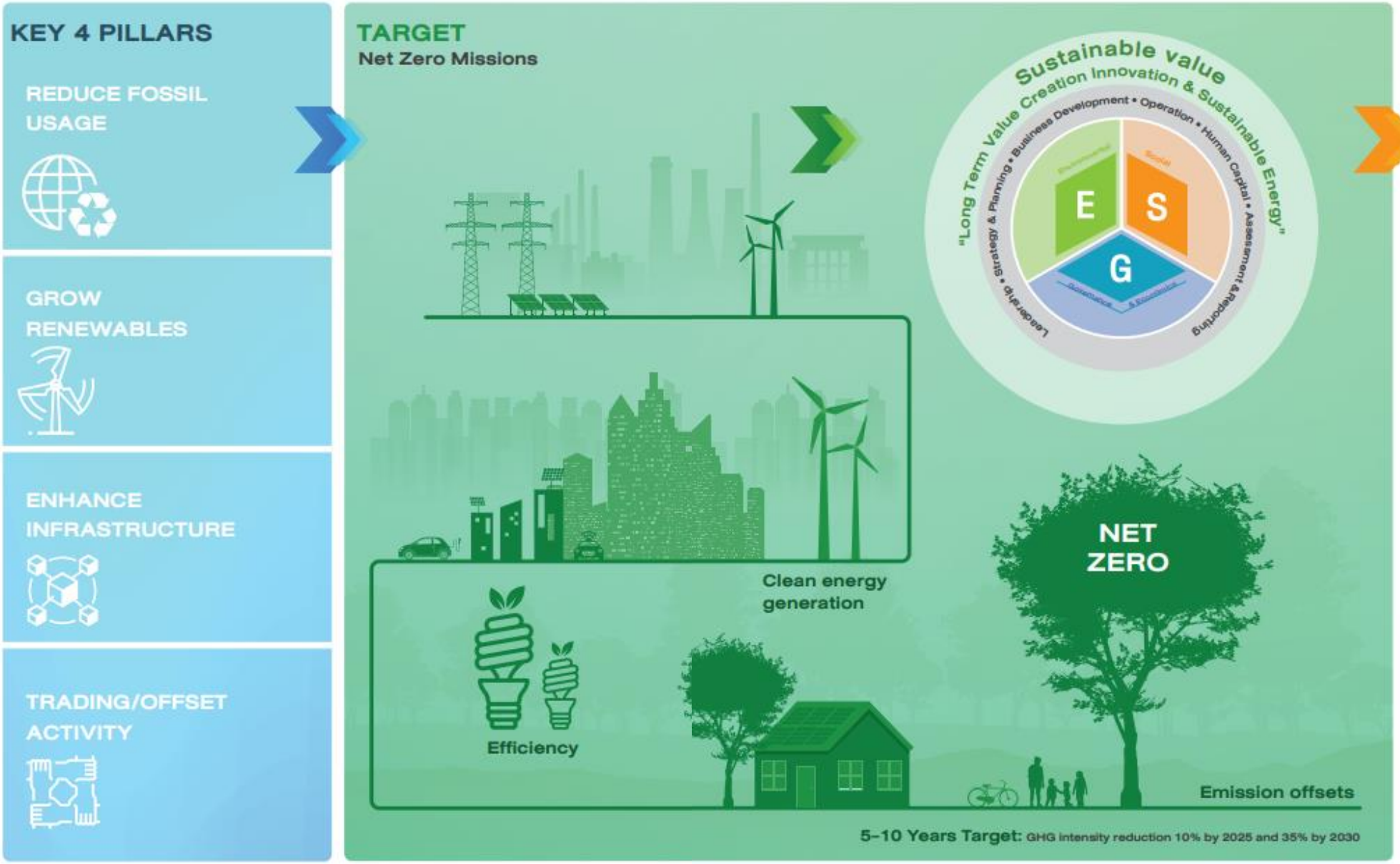
Recommendation Disclosure	GPSC Status	Disclosure Source
Risk Management		
a) Describe the organization's processes for identifying and assessing climate-related risks.	GPSC identifies, ranks, analyzes, and assesses levels of climate change risk impacts at the annual workshop attended by various units, including planning, risk, and corporate sustainability departments, whereby GPSC is aware of risks and financial impacts potentially affecting its business.	• GPSC website
b) Describe the organization's processes for managing climate-related risks.	GPSC manages climate change risks by formulating climate change strategies embracing GHG reduction and future handling. It also monitors performances and reports them to the Board of Directors and the President & CEO at least every 6 months.	• ISR page 4-5, 28-29 • GPSC website
c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	The outcomes of annual risk assessment identified, assessed, and managed climate risks and are integrated with GPSC's overall risk management to: • Review them during the formulation of the corporate strategic plan • Develop mitigation plans and cope with climate change for supporting GPSC's new-project investment decision-making.	• Page 14 • GPSC website

Disclosure Aligned with Force on Climate Related Financial Disclosure (TCFD) Framework (4/4)

Recommendation Disclosure	GPSC Status	Disclosure Source
Metrics and Targets		
a) Disclose the metrics used by the organization to assess climate related risks and opportunities in line with its strategy and risk management process.	GPSC discloses indicators from its examination of risks aligning with corporate strategies and the risk management process, including GHG reduction, the increase in proportion of corporate renewable energy, and expansion of services under new businesses. This is to align with corporate 4S strategy having 4 key strategy area as follows: • **S1** Strengthen and Expand the Core • **S2** Scale-up Green Energy • **S3** S-Curve & Batteries • **S4** Shift to Customer Centric Solutions These are reported in the ISR and on the company's website	• ISR page 28-29 • GPSC website • Performance data
b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.	GPSC discloses GHG emissions in the ISR.	• ISR page 10-11, 28-29 • GPSC website • Performance data
c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.	GPSC sets a goal for GHG emissions reduction in line with the targets of PTT Group and Thailand's policy together with its application of low-carbon technology in operations, apart from raising the proportion of renewable energy for power Generation	• ISR page 27-33, 36-42 • GPSC website • Performance data

Net Zero Commitment

GPSC | GPSC Group Net Zero Roadmap

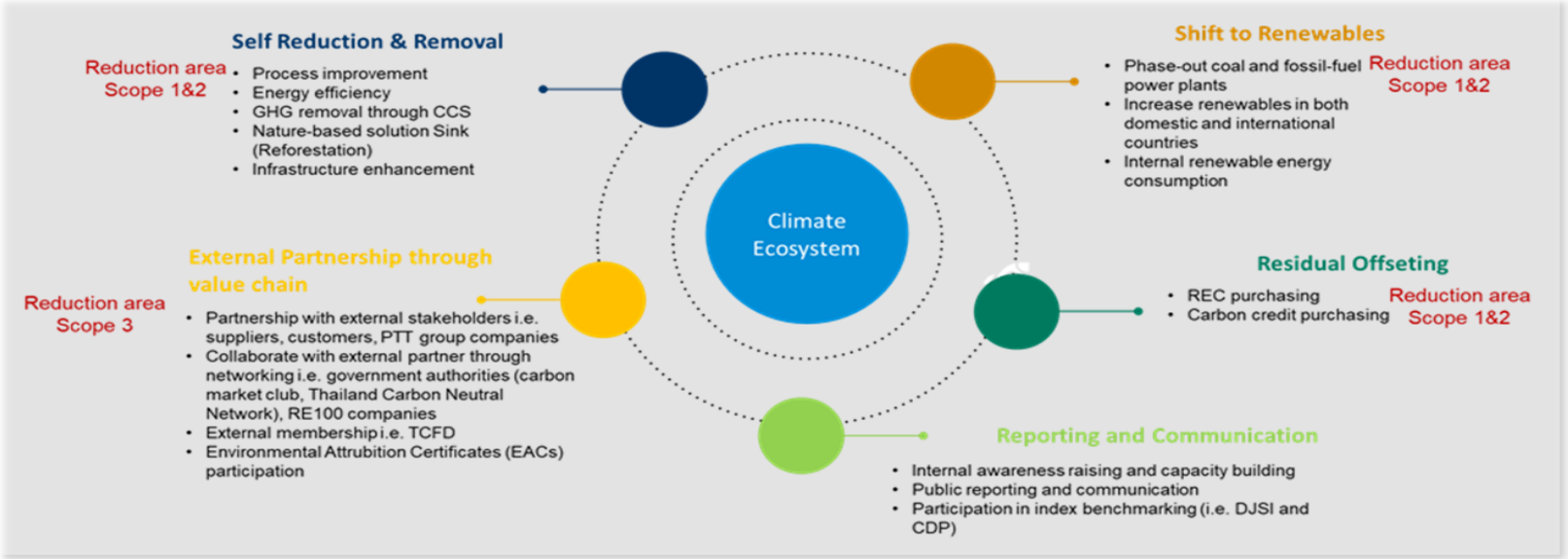


Target*

- **Carbon Intensity Reduction**
- **10% by 2025**
- **35% by 2030**
- To Achieve
- **Carbon Neutrality within 2050**
- **Net Zero within 2060**

*GPSC is considering SBTi for target setting in the future

GPSC | GPSC Group Net Zero Roadmap



Net Zero GHG Emission within 2060

Carbon Neutrality within 2050

Carbon intensity reduction -10% by 2025 & -35% by 2030

The route to net zero for utilities → Net Zero Ambition

Reduce Fossil Fuel Usage

Energy Efficiency

According to GHG Emission Reduction plan 1 % within 2023

Continuously implement process improvement & optimization to existing fossil-fuel power plants, reduce fuel and energy consumption.

- Adopt best practice operational excellence
- Retrofit fossil-fuel plants
- Fuel & Energy consumption reduction
- Internal renewable energy consumption

Grow Renewables

Grow Renewables

According to business plan 50 % within 2030

Phase out fossil-fuel power plant and grow renewable in both domestic and international

- *Phase out fossil-fuel based power plant (priority on coal)*
- *Invest renewables through new, M&A projects focusing on solar and wind energy*
- *Fuel switching from fossil fuel into renewables*
- *Green hydrogen (new plants)*
- *Biomass with and W/O CCUS*

Enhance infrastructure

CCUS & Hydrogen Technology

According to CCUS Roadmap within 2030

Facilitate direct GHG sink and removal from fossil-based operations

- *Blue and Green Hydrogen (existing plants) (with CCUS)*
- *CCUS integration (Coal/natural gas with post combustion carbon capture)*

Trading & Offset

Initiate nature-based solution and generate additional values through EAC participation

- Carbon sink through nature-based solution
- Environmental Attribution Certificates (EACs) participation
  - Renewable Energy Certificates (RECs) trading
  - Carbon credit trading
- Internal Carbon Pricing

Climate-related
Risks & Opportunities Assessment

Integration Process of Climate Change Risks & Opportunities into Company-Wide Risk Management Process

Identification of Climate Related Risks and Opportunities Assessment

- Climate related risks and opportunities identification in
  - Physical risks
  - Transition risks
  - Opportunities
- Screening of the identified risks and opportunities

Involvement Level– Functional levels

Prioritization of Climate Related Risks and Opportunities

- Input gathering of the identified risks and opportunities in term of level of impact and likelihood including both financial and non-financial impact
- Risks and opportunities prioritization and analysis

Involvement Level – Functional and Corporate levels

Company's Centralized Enterprise Risk/Opportunity Management Process

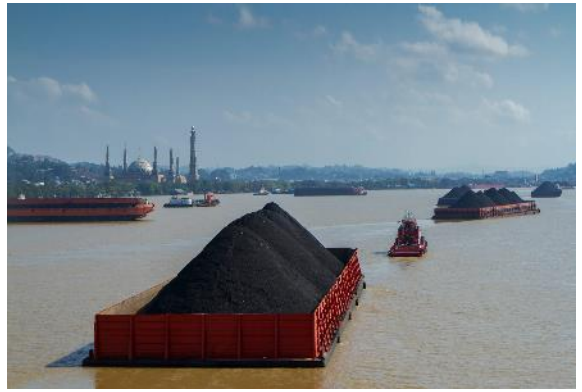
- Results from the prioritization are integrated into the centralized enterprise risk/opportunity management process and reporting to relevant executive-levels
- The consolidation of the corporate risks and opportunities results as parts of executive strategic thinking session and contribution to GPSC Group Business Strategy
- Executive-level has own sponsorship on the scenario analysis

Involvement Level– Functional and Corporate levels (Executive-level)

Scope of Assessment

- GPSC Group Own Operation, Upstream (Raw material – Natural Gas, Coal), Downstream (Key Customers)
- The assessment have been done in both semi-quantitative using climatic modeling tool and literature assessment/review

Own Operation and Downstream
(Key Customers)



Upstream (Raw Material – Natural Gas, Coal)

Scope of Assessment

Location	Fossil Fuel Power Plant & Downstream
Rayong	• GPSC CUP1 • GPSC CUP2 • GPSC CUP3 • GPSC CUP4 • GHECO-One • Glow Energy Phase 1 • Glow Energy Phase 2 • Glow Energy Phase 4 • Glow Energy Phase 5 • Glow SPP2 • Glow Energy CFB • Glow SPP3 • Glow IPP • Glow SPP 11 Phase 1,2,3 area
Chonburi	• GPSC Sriracha

Location	Own Operation (Solar & RDF Power Plant)
Pichit	• Sak lek plant 1 • Ta parn hin plant1 • Sak lek plant 2 • Ta parn hin plant2
Suphanburi	• Suphanburi, Dan Chang
Lopburi	• Lopburi, Ban mi
Khon kaen	• PPS1 • PPS2 • PPS3
Saraburi	• WHA industrial estate
Rayong	• Pluack dang PV • RDF plant
Chanthaburi	• Chanthaburi shimp farm solar

Location	Upstream (Raw Material Suppliers)
Thailand	• PTT (Tier-1 raw material provider) • PTTEP (Non-Tier 1)
Indonesia	• KPC (Coal Supplier)
Thailand	• Banpu (Coal Supplier)

Remarks: GPSC applies the assessment into the future operations, mergers & acquisition to evaluate impact on their businesses, strategy, and financial planning.

Physical Risk Assessment

Summary of physical risk assessment

Risk	Indicator	IPCC Scenario	Timeframe	Description / Criteria	Tool
Drought	Rainfall	**RCP** 2.6, 4.5, 6.0, 8.5 **SSP** 126,245,370,585	Short 1 y Medium 3-5 y Long > 5y	• The projection of rainfall data conducted by both climate model CMIP 5 and 6 have been generated over Thailand • Standard Precipitation Index (SPI) has been calculated and use as the factor to indicate drought and flood year	AQUEDUCT THE CLIMATE EXPLORER
Flood	Rainfall	**RCP** 2.6, 4.5, 6.0, 8.5 **SSP** 126,245,370,585	Short 1 y Medium 3-5 y Long > 5y		
Tropical Cyclone	Rainfall Wind speed	**RCP** 2.6, 4.5, 6.0, 8.5	Short 1 y Medium 3-5 y Long > 5y	• The projection of rainfall data conducted by both climate model CMIP 5 and 6 have been generated over Thailand and Indonesia (Upstream) • The frequency of tropical cyclone categories 1-5 have been counted and projected	THE CLIMATE EXPLORER ScienceDirect ELSEVIER ResearchGate
Lighting & Hail	Convective Available Potential Energy (CAPE)	**RCP** 2.6, 4.5, 6.0, 8.5	Short 1 y Medium 3-5 y Long > 5y	• The utilization of CAPE as the indicator and reviewed over related literature showing the projection of frequency and intensity of lighting/hail over Thailand	NASA GHRC Global Hydrology Resource Center
Increasing temperature	Temperature	**RCP** 2.6, 4.5, 6.0, 8.5 **SSP** 126,245,370,585	Short 1 y Medium 3-5 y Long > 5y	• The projection of surface temperature data conducted by both climate model CMIP 5 and 6 have been generated over Thailand and Indonesia (Upstream)	THE CLIMATE EXPLORER ScienceDirect ELSEVIER ResearchGate

*RCP – representative concentration pathway, SSP– Shared Socioeconomic Pathways Socioeconomic, CMIP- Coupled Model Intercomparison Project

Drought and Flood Assessment Methodology

AQUEDUCT THE CLIMATE EXPLORER ScienceDirect ELSEVIER

SPI	Flood Impact
2.00 and above	Very high
1.50 to 1.99	High
1.00 to 1.49	Medium
0.00 to 0.99	Low

Likelihood	Flood Impact
Very High risk = >2 severe drought/flood year within 10 years	Very high
High risk = 2 severe drought/flood year within 10 years	High
Medium risk = 1 severe drought/flood within 10 years	Medium
Low risk = No severe drought or flood year with in 10 years	Low

SPI	Drought Impact
- 2.00 and less	Very high
-1.50 to -1.99	High
-1.00 to -1.49	Medium
0.00 to -0.99	Low

Category	SPI	Probability (%)
Extremely wet	2.00 and above	2.3
Severely wet	1.50–1.99	4.4
Moderately wet	1.00–1.49	9.2
Near normal	−0.99–0.99	68.2
Moderate drought	−1.00 to −1.49	9.2
Severe drought	−1.50 to −1.99	4.4
Extreme drought	−2.00 and less	2.3

SPI – Standard Precipitation Index

Overview: Share Socioeconomic Concentration Pathway

Scenarios	Description
SSP 1: Sustainability - Taking the green road	• This future poses low challenges to mitigation and low challenges to adaptation • Global population peaks mid-century • Emphasis on human well-being • Environmentally friendly technologies and renewable energy • Strong and flexible institutions on global, regional, and national level
SSP 2: Middle of the road	• This future poses moderate challenges to mitigation and moderate challenges to adaptation • Population growth stabilizes toward the end of the century • Current social, economic, and technological trends continue • Global and national institutions make slow progress toward achieving sustainable development goals
SSP 3: Regional rivalry - A rocky road	• This future poses high challenges to mitigation and high challenges to adaptation • Population growth continues with high growth in developing countries • Emphasis on national issues due to regional conflicts and nationalism • Economical development is slow and fossil fuel dependent • Weak global institutions and little international trade
SSP 4: Inequality - A road divided	• This future poses low challenges to mitigation and high challenges to adaptation • Population growth stabilizes toward the end of the century • Growing divide between globally-connected, well educated society and fragmented lower income societies • Unrest and conflict becomes more common • Global, regional, and national institutions are ineffective
SSP 5: Fossil-fueled development - Taking the highway	• This future poses high challenges to mitigation and low challenges to adaptation • Global population peaks mid-century • Emphasis on economic growth and technological progress • Global adoption of resource and energy intensive lifestyles • Lack of environmental awareness

https://climatescenarios.org/primer/socioeconomic-development/

Representative Concentration Pathway (RCP)

Scenarios	Description	Global mean temperature Change	Maintain at 2.0 C by 2050
RCP 2.6	• Mean Radiative forcing at earth surface is 2.6 W/m2; • High effort on the implementation of decarbonization • Medium intensity & low frequency in extreme weather	1.6 C in 2050	Possible
RCP 4.5	• Mean Radiative forcing at earth surface is 4.0 W/m2; • Medium effort on the implementation of decarbonization • Medium intensity & medium frequency in extreme weather	2.4 C in 2050	Possible, with high uncertainty
RCP 6.0	• Mean Radiative forcing at earth surface is 6.0 W/m2; • Medium effort on the implementation of decarbonization • High intensity & medium frequency in extreme weather	3.6 C in 2050	Impossible
RCP 8.5	• Mean Radiative forcing at earth surface is 8.5 W/m2; • Low effort on the implementation of decarbonization • High intensity & high frequency in extreme weather	4.3 C in 2050	Impossible

AQUEDUCT

Scenarios

Baseline:
The observational data since 2011 – present have been used as the baseline for comparison through the change in future projection

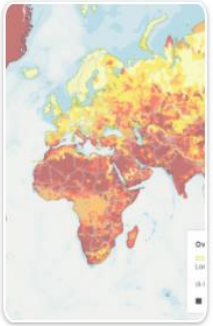
Optimistic:
The "optimistic" scenario (SSP2 RCP4.5) represents a world with stable economic development and carbon emissions peaking and declining by 2040, with emissions constrained to stabilize **at ~650 ppm CO2 and temperatures to 1.1–2.6°C by 2100.**

Business as usual
The "business as usual" scenario **(SSP2 RCP8.5)** represents a world with stable economic development and steadily rising global carbon emissions, with **CO2 concentrations reaching ~1370 ppm by 2100** and global mean **temperatures increasing by 2.6–4.8°C** relative to 1986–2005 levels.

Pessimistic
The "pessimistic" scenario (SSP3 RCP8.5) represents a fragmented world with **uneven economic development, higher population growth, lower GDP growth, and a lower rate of urbanization,** all of which potentially affect water usage; and steadily rising global carbon emissions, with CO2 concentrations **reaching ~1370 ppm by 2100 and global mean temperatures increasing by 2.6–4.8°C relative to 1986–2005 levels**

https://www.wri.org/aqueduct

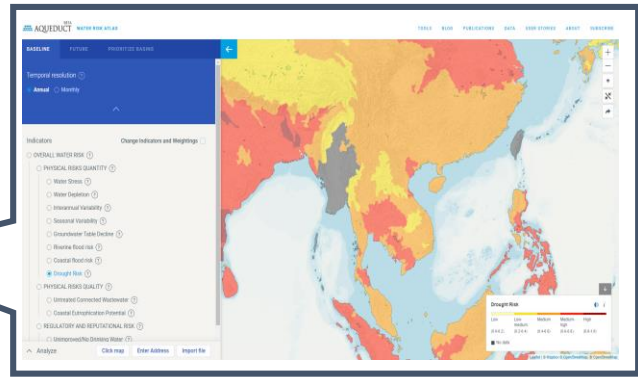
Aqueduct tools

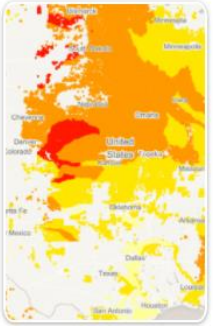


Aqueduct Water Risk Atlas

Map and analyze current and future water risks across locations.

Launch Tool

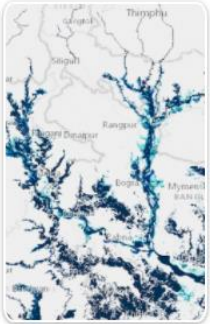




Aqueduct Food

Understand and identify current and future water risks to agriculture and food security.

Launch Tool



Aqueduct Floods

Identify coastal and riverine flood risks, and analyze the costs and benefits of investing in flood protection.

Launch Tool

GPSC

Transition Risk Assessment

Summary of Transition risk assessment

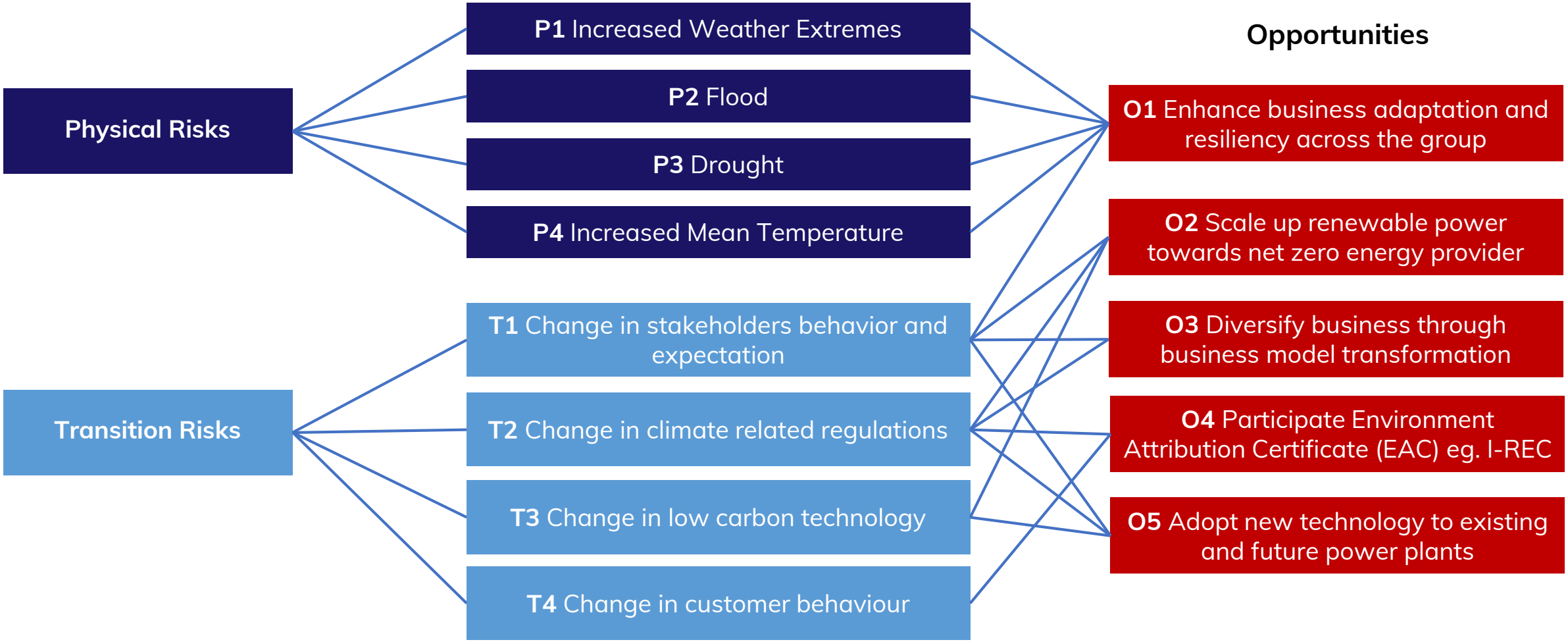
Risk	Timeframe	Source/Reference
T1 Stakeholder concern and negative feedback	Short 1 y Medium 3-5 y Long > 5y	• News publishers play an important role in transition risk assessment as well. The stakeholders concern/feedback can be found in the worldwide and domestic news.
T2 Increased Technological Competition	Short 1 y Medium 3-5 y Long > 5y	• World energy outlook provide the overall trend of global energy demand breaking down in each type of energy sources and explained the energy transition through different scenarios including net zero emission as the latest update one.
T3 Changing in customer behavior	Short 1 y Medium 3-5 y Long > 5y	
T4 Changing in climate related regulation	Short 1 y Medium 3-5 y Long > 5y	• International energy agency has very useful research that related to the scenario of the establishment of cap and trade regulation over Thailand; moreover, IEA have provide scenario analysis for the increasing of carbon pricing and the impact to electric & utilities sector. The scenario includes IEA B2DS, NZE2050 and Thailand Nationally determined contributions (NDCs).

wbcsd

The Guardian Bangkok Post

United Nations Climate Change

Risks and Opportunities for GPSC 2022



Overview: How Corporate Strategy Relate to Climate change Strategy

Corporate Strategy	Description	Identified Climate Actions
S1: Strengthen and Expand the Core	strengthening the company's core businesses, with an emphasis on ensuring stable world-class production capacity to meet clients' demand and expand to other related businesses.	• Enhance business adaptation and resiliency across the group
S2: Scale-Up Green Energy	scaling up green energy development projects including solar and wind energy as well as an integration of renewable energy into an energy storage system.	• Scale up renewable power towards net zero energy provider
S3: S-Curve and Batteries	continuously developing energy innovation and businesses of the future including an energy storage system and batteries for electric cars and other electric vehicles and creating an added-value chain with innovation.	• Diversify business through business model transformation • Adopt new technology to existing and future power plants • Participate Environment Attribution Certificate (EAC) eg. I-REC
S4: Shift to Customer-Centric Solutions	using energy innovations such as the energy storage system at both the baseload power plants and renewable power plants and providing optimum energy efficiency solutions employing platforms that ensure environmentally friendly power generation for clients	

Opportunities: Impact to business

Identified Climate Actions	Impact to Businesses
• Enhance business adaptation and resiliency across the group	• Minimize acute climate physical risks arising from climate change (e.g. flood and drought) • Increase tolerance to chronic climate physical risks arising from climate change (e.g. increase surface temperature) • Be able to continuously supply products & services to customers without interruption • Increase business competitiveness and advantages across the sector
• Scale up renewable power towards net zero energy provider	• Build system reliability and confidentiality • Increase stakeholder trust and brand
• Diversify business through business model transformation • Adopt new technology to existing and future power plants • Participate Environment Attribution Certificate (EAC) e.g. I-REC	• Be able to maintain (or potentiality increase) revenue without getting palatalize from national authorities, regulators • Capture new market from customers who demand low-carbon energy • Increase business competitiveness and advantages across the sector • Increase stakeholder trust and brand • Increase revenue from new products & services • Increase revenue from carbon credit & RECs • Increase resiliency to market change and be able to generate revenue overtime

Risk Assessment and Scenario Analysis on Physical Risks

2021-2022 Climate Related Risks & Opportunities Reporting Based on TCFD Reporting Guidance: Physical Risks (1/2)

Potential Impacts	Potential Financial Risks	Level of Financial Impact /Timeframe	
		2022	2027
P1- Increased Weather Extremes including hail, lighting, wind/ clyclones • Weather extremes (i.e., thunderstorm, hail storm and typhoon) can damage infrastructure or machinery and equipment, resulting in higher maintenance cost and discontinuity of power generation. If the plant shut down, GPSC Group might be penalized and the revenue will be affected. For hailing, the falling hail have very high change to cause damage to the solar panel leading to the increased cost toward repair and replacement • Increased cost toward repair/restoration/ replacement. • Injury due to airborne objects • The logistics between producers, suppliers and consumers along the supply chain can be interrupted by storm, heavy rainfall . There is a potential that weather can damage natural gas transporting pipe.	• Increased cost toward repair/restoration/ replacement. • Storm & lighting causes financial impacts to company's operations from system interruption and damage which also causes financial impacts as a results of customer trust and reputation of GPSC		
P2- Flood • Flooding can damage infrastructure or machinery and equipment, resulting in higher maintenance cost and discontinuity of power generation . If the plant shut down, GPSC might be penalized and the revenue will be affected. • Flooding can cause landslide or mudslide, employees might be injured or even death. This can affect company productivity and reputation. • Flooding can obstruct employees from coming to work in company's operating areas or even cause life threatening harm to employees. If many employees can not come to work, resulting in lower company productivity. • Flooding can cause sediments load, which can reduce the capacity of dams and reservoirs and can damage turbines. GPSC's maintenance costs might increase as turbines suffer from higher sediment loads. • Increased cost toward repair/ restoration/ replacement. • Increased insurance costs. • Loss of revenue due to suspension of operations. • The logistics between producers, suppliers and consumers along the supply chain can be interrupted by flooding.	- Increased cost toward repair/ restoration/ replacement. - Increased insurance costs. - Loss of revenue due to suspension of operations. - Flood causes financial impacts to company's operations from system interruption and damage. Flooding also causes financial impacts as a results of customer trust and reputation of GPSC		

Low Medium High Critical

2021-2022 Climate Related Risks & Opportunities Reporting Based on TCFD Reporting Guidance: Physical Risks (2/2)

Potential Impacts	Potential Financial Risks	Level of Financial Impact /Timeframe	
		2022	2027
P3- Drought • Low water supply affect generating capacity and the plant's ability to deliver reliable power supply. • The drought can disrupt the operation unable the plant to run cooling process leading the plant to shutdown • During drought, water resource can become scarce, which affect Eastwater group business (GPSC's water supplier). Eastwater might have low water resource to provide for GPSC to generate electricity. This can increase the risk of operational discontinuity and GPSC's revenue will be affected. • Increased operating costs (e.g., inadequate water supply to cool fossil fuel plants) • If GPSC has sufficient water resources, the company might have an opportunity to sell water to customers, which can generate revenue. • Community may have bad perception to GPSC when they receive insufficient water • If GPSC has mitigation measure by finding or building pond for water storage and rain harvesting system, utilizing in the operation and providing water to community. GPSC might receive good perception from community.	• Low water supply affect generating capacity and the plant's ability to deliver reliable power supply. • The drought can disrupt the operation unable the plant to run cooling process leading the plant to shutdown • Drought causes financial impacts to company's operations from system interruption and lacking or resources. Drought also causes financial impacts as a results of customer trust and reputation of GPSC		
P4- Increased Mean Temperature • Extreme heat decrease the efficiency of power plant. Higher temperatures lower the ability of transmission lines to carry power, possibly leading to electricity reliability issues during heat waves. In addition, as rivers and lakes warm, their capacity for absorbing waste heat from power plants declines. This can reduce the thermal efficiency of power production because the increase in ambient air temperature leading power output from steam turbine to decrease by 9% • Solar PV modules are tested for their efficiency at 25°C, which is the cell temperature of Standard Test Conditions (STC). And with any temperature increase above 25°C must consider power losses of 1% for every 2°C increase.	• The increase of mean temperature causes financial impacts to company's operations from system deficiency and resource consumption which also resulted in increasing cost of operations as compared to normal condition.		

Low Medium High Critical

P1: Increased Weather Extremes including hail, lighting, wind/cyclones

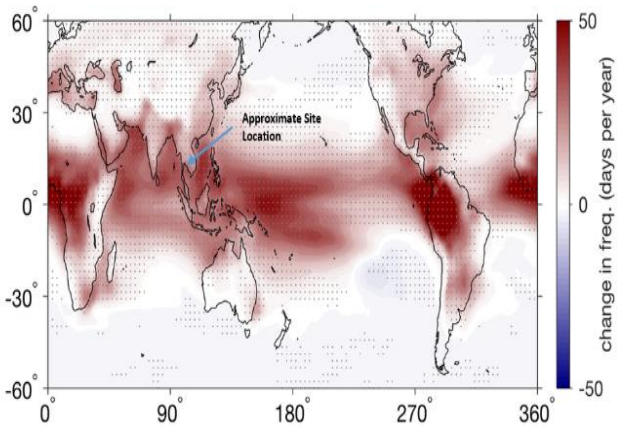
P1: Increased Weather Extremes (Lightning)

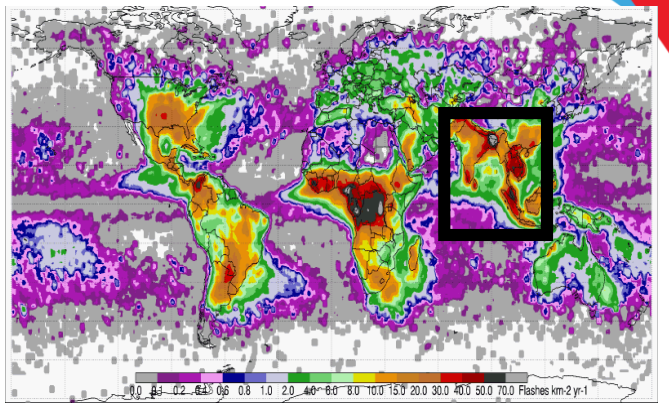
Baseline

According to observation data the frequency of light detected to satellite imagery **over Thailand is range of 30 to 50 times per year** which is **very high** compared to the occurrence globally.

Future Projection

Accordingly, the increase in number of favourable days (frequency) at Site are likely to be 0-10 days/year. Assuming the linear change in the **increase the change in 2050 is likely to be 0-5 more days.**





- **One such factor is Convective Available Potential Energy (CAPE),** which is a measure of maximum kinetic energy obtainable by an air parcel lifted adiabatically from near surface. CAPE is also reported to be important large scale indicator for the potential lightning.

Lighting	Baseline		2021-2025		2021-2030	
	Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood
Own operation (Renewable power plant)	Low	High	Low	High	Low	High
Own Operation (Fossil fuel plant) and Downstream (Customers)	Med	High	Med	High	High	High
Upstream (Raw material – Natural, Coal)	Low	High	Low	High	Low	High

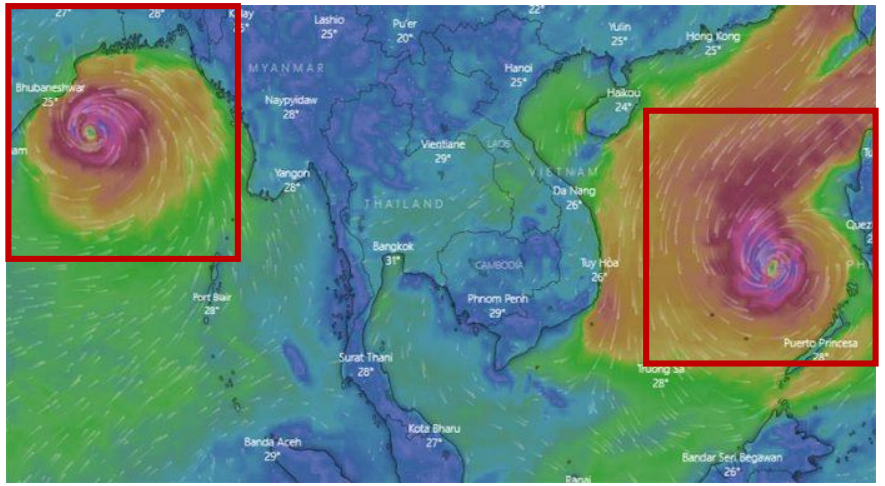
Source: *NASA-GHRC*

Source: *martin Singh et al. (2017)*

Baseline: 2011-2020
Future projection: 2021-2030

P1: Increased Weather Extremes (Tropical Cyclone)

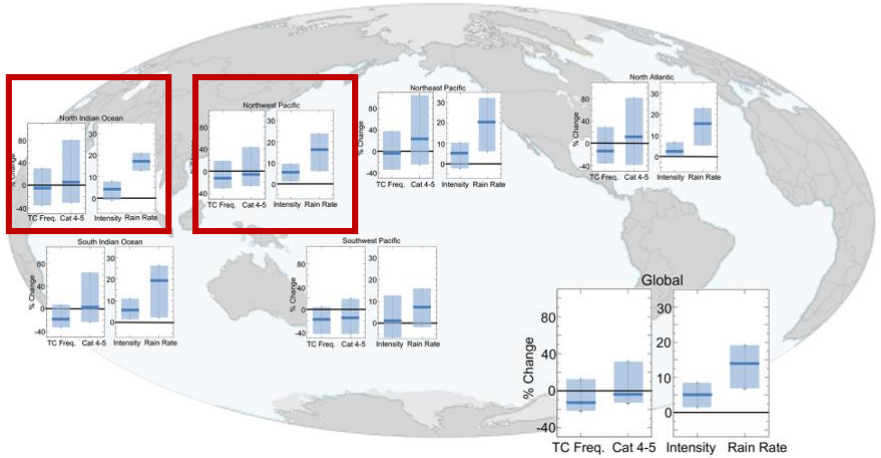
Tropical cyclone observation



The recent study by Knuston et. al. (2020)[1] indicated a likely changes for occurrences of tropical cyclone over north-west Pacific ocean as following

- Overall frequency of tropical cyclone by -30 to 20% with median change of -12%,
- Changes in frequency of category 4-5 cyclone between -25 to 40% with median change of -5%
- However intensity of cyclone indicated likely increase of 1 to 9% with median of 5% increase
- Increase in precipitation is likely to be in the range of 5-25% with a median of 15% under 2°C scenario by end of century

Tropical Cyclone Projections (2°C Global Warming)



Region	Frequency of TC	TC Categories 4-5	Intensity (Mean wind speed)	Rain rate
Global	**Decrease**	**Decrease**	**Increase**	**Increase**
North West Pacific	Decrease	Decrease	Increase	Increase
North Indian	Decrease	Increase	Increase	Increase

Source: *Knuston et al (2020)*

Baseline: 2011-2020
Future projection: 2021-2030

P1: Increased Weather Extremes (Tropical Cyclone)

- Wind speed projections for maximum wind speed and gust speeds from Regional Climate Model (RCM) - REMO 2009 were evaluated.

Statistic	Maximum Wind Speed (m/s)		Gust Speed (m/s)	
	2030	2050	2030	2050
Min	1.6	1.4	3.4	2.8
Max	18.2	18.0	33.4	33.0
Average	5.9	6.0	10.9	11.1

- Gust speeds exceeding 21 m/s of wind speed indicate high hazard.

- The climate models for wind speed indicate a high degree of uncertainty with models projecting increase, decrease, or no change in the future. **However, a recent study indicated rapid increases in wind speed across the globe since 2010 (Zeng et al., 2019, https://doi.org/10.1038/s41558-019-0622-6**
- Considering the limited information available on wind speed projections and high uncertainty, the wind hazard under a climate change scenario is considered to be same as the baseline i.e. 'High'.

Tropical Cyclone	Baseline		2021-2025		2021-2030	
	Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood
Own operation (Renewable power plant)	Low	Low	Low	Low	Low	Med
Own Operation (Fossil fuel plant) and Downstream (Customers)	Med	Low	Med	Low	Med	Med
Upstream (Raw material – Natural Gas, Coal)	Med	Med	Med	Med	High	High

Source: *https://thethaiger.com/news/bangkok/summer-storm-cell-hits-bangkok*

Baseline: 2011-2020
Future projection: 2021-2030

P1: Increased Weather Extremes (Hail Storm)

Baseline

The observation data presented the physical character of summer hailstorms, at peak or **all 2012-twelve incidents**, over northern Thailand. Most incidents occur in North of Thailand.

The results are shown briefly below

- The high value of CAPE reached the extreme instability **(CAPE > 2500 J/kg) in high precipitation day triggering hail formation**

Future Projection

- According to CMIP 5 projection result, **CAPE index have medium – high confidence to increase over Mekong regions** between 2030-2050

Hail	Baseline		2021-2025		2021-2030	
	Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood
Own operation (Renewable power plant)	High	Medium	High	Medium	High	High
Own Operation (Fossil fuel plant) and Downstream (Customers)	Low	Low	Low	Low	Low	Low
Upstream (Raw material – Natural Gas, Coal)	Low	Low	Low	Low	Low	Low

Source: https://www.tshe.org/ea/pdf/vol8no1-13.pdf

Baseline: 2011-2020
Future projection: 2021-2030

P2: Flood

P3: Drought

Drought and Flood Assessment Methodology

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Category	SPI	Probability (%)
Extremely wet	2.00 and above	2.3
Severely wet	1.50–1.99	4.4
Moderately wet	1.00–1.49	9.2
Near normal	−0.99–0.99	68.2
Moderate drought	−1.00 to −1.49	9.2
Severe drought	−1.50 to −1.99	4.4
Extreme drought	−2.00 and less	2.3

SPI	Flood Impact
2.00 and above	Very high
1.50 to 1.99	High
1.00 to 1.49	Medium
0.00 to 0.99	Low

SPI	Drought Impact
- 2.00 and less	Very high
-1.50 to -1.99	High
-1.00 to -1.49	Medium
0.00 to -0.99	Low

*This figure have been used to categorize the magnitude of drought and flood impact over the study area

Likelihood	Flood Impact
Very High risk = >2 severe drought/flood year within 10 years	Very high
High risk = 2 severe drought/flood year within 10 years	High
Medium risk = 1 severe drought/flood within 10 years	Medium
Low risk = No severe drought or flood year with in 10 years	Low

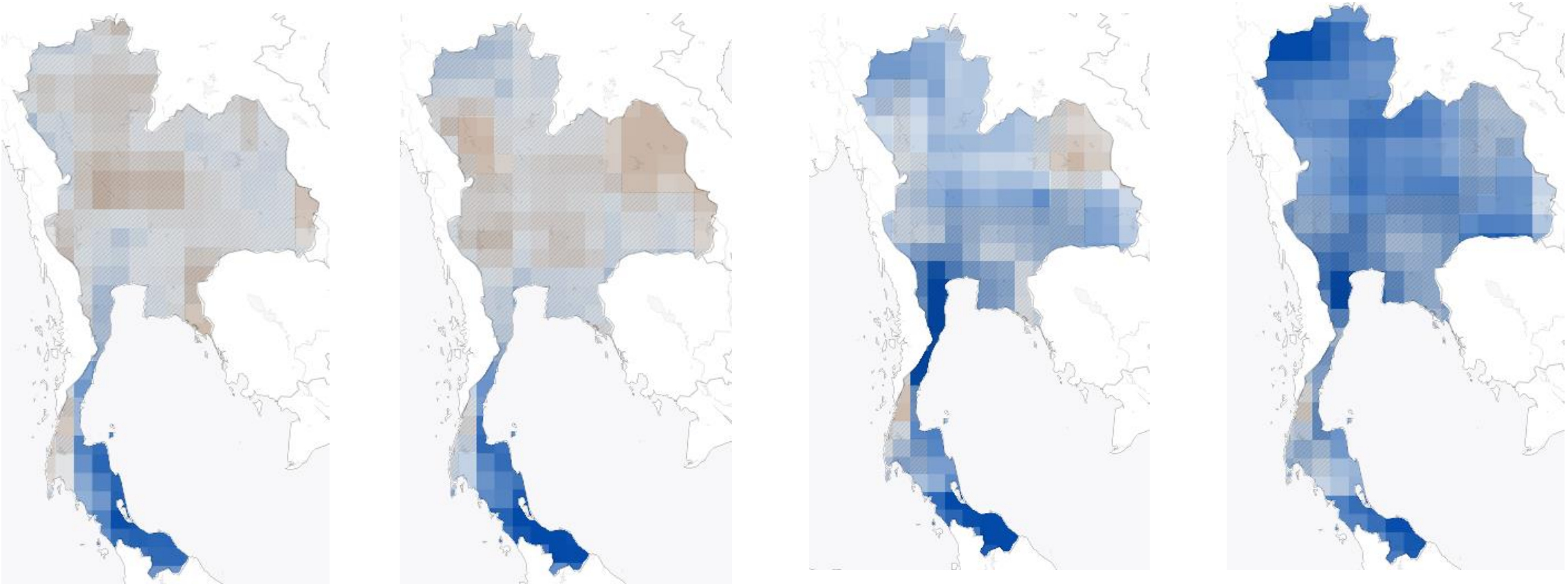
SPI – Standard Precipitation Index

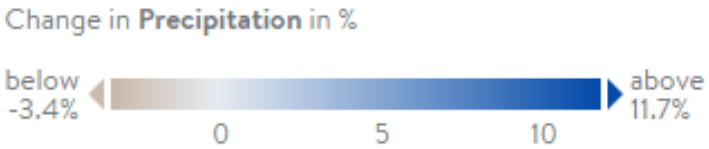
Zhang, Qiang & Xu, Chong-Yu & Zhang, Zengxin. (2009). Observed changes of drought/wetness episodes in the Pearl River basin, China, using the Standardized Precipitation Index and Aridity Index. Theoretical and Applied Climatology. 98. 89-99. 10.1007/s00704-008-0095-4.

P2 – Flood (Thailand)

The % change in precipitation over Thailand

1.5 C **2.0 C** **2.5 C** **3.0 C**





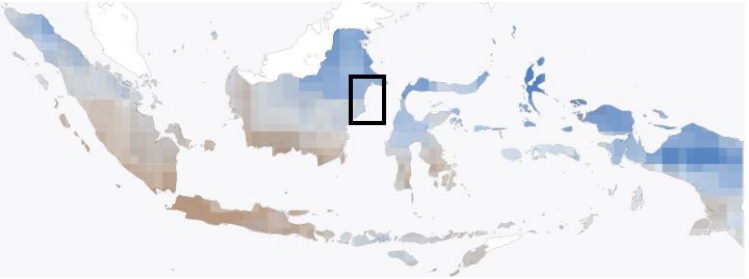
- **Thailand** will have **higher rainfall pattern** due to the increased temperature & CO2 concentration in atmosphere
- At **2.0** temperature change **upper middle part of Thailand have medium probability to face drought**
- At **3.0** temperature change **the north, middle and upper-south of Thailand have high chance to face flood**

https://climateanalytics.org/tools/

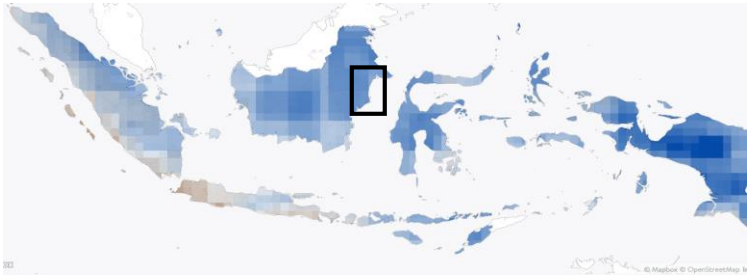
P2 – Flood (Upstream)

The % change in precipitation over Indonesia

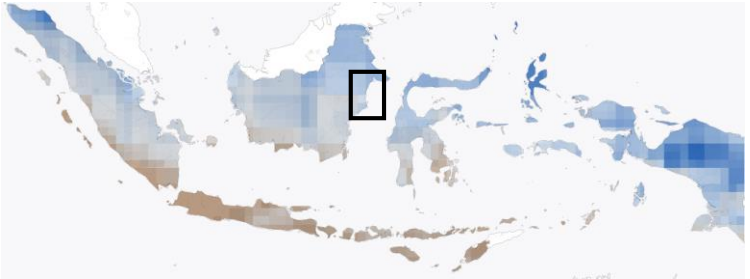
1.5 C, RCP 2.6



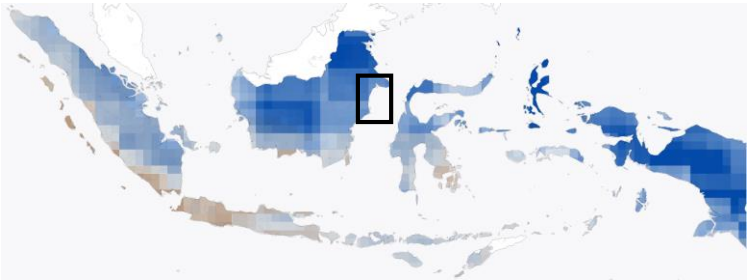
2.5 C, RCP 6.0

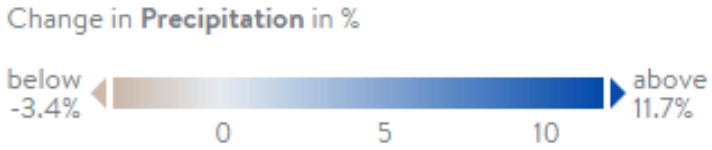


2.0 C, RCP 4.5



3.0 C, RCP 8.5





The rate of rainfall in study area have measured to **be slightly decrease between 2020-2022**; however, the projection in higher temperature change leading the rainfall pattern in study area to dramatically increase. Moreover, this area is considered as **flood vulnerable area.**

https://climateanalytics.org/tools/

Supporting Information - P2: Flood
Fossil Fuel Plant and Downstream Activities

Location	Type	RCP 2.6						RCP 4.5					
		Baseline		2021-2025		2021-2030		Baseline		2021-2025		2021-2030	
		Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood	Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood
Pichit	Solar	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Med
Suphanburi		Med	Low	Med	Low	Med	Med	Med	Low	Med	Low	Med	High
Lopburi		Med	Low	Med	Low	Med	Low	Med	Low	Med	Low	Med	Med
Khon Kaen		Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Med
Saraburi (Roof)		Low	Low	Low	Low	Low	Med	Low	Low	Low	Low	Low	Med
Chanthaburi		Low	Med	Low	Med	Med	Med	Low	Med	Low	Med	Med	High
Rayong	Solar	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Med	Med
	Fossil	Med	Low	Med	Low	Med	Low	Med	Low	Med	Low	Med	Med
	Downstream	Med	Low	Med	Low	Med	Low	Med	Low	Med	Low	Med	Med
Chonburi	Fossil	Med	Low	Med	Low	Med	Low	Med	Low	Med	Low	Med	Med
Bontang	Raw mat (coal)	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med	Med

- >2 severe flood year within 10 years, SPI 2.00 and above
- 2 severe flood year within 10 years, SPI 1.50 to 1.99
- 1 severe flood year within 10 years, SPI 1.00 to 1.49
- no severe flood year within 10 years, SPI 0.00 to 0.99

Baseline – 2011- 2020
Future Projection – 2021 - 2030

Supporting Information - P2: Flood
Fossil Fuel Plant and Downstream Activities

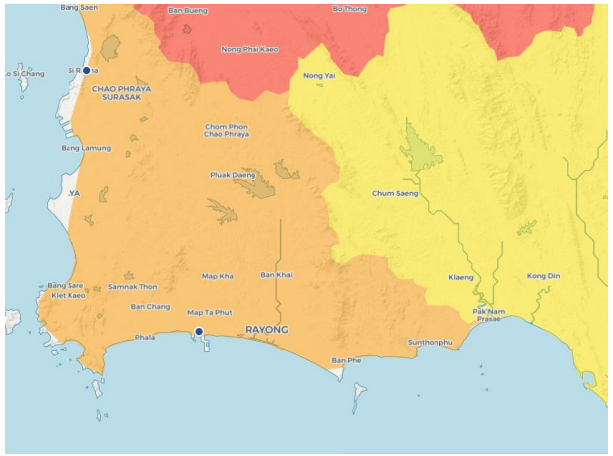
Location	Type	RCP 6.0						RCP 8.5					
		Baseline		2021-2025		2021-2030		Baseline		2021-2025		2021-2030	
		Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood	Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood
Pichit	Solar	Low	Low	Low	Low	Low	Med	Low	Low	Low	Med	Low	Med
Suphanburi		Med	Low	Med	Med	Med	High	Med	Low	Med	High	Med	High
Lopburi		Med	Low	Med	Low	Med	Med	Med	Low	Med	Med	Med	Med
Khon Kaen		Low	Low	Low	Low	Low	Med	Low	Low	Low	Med	Low	Med
Saraburi (Roof)		Low	Low	Low	Med	Low	Med	Low	Low	Low	Med	Low	Med
Chanthaburi		Low	Med	Med	Med	Med	High	Low	Med	Med	High	Med	High
Rayong	Solar	Low	Low	Low	Low	Med	Med	Low	Low	Med	Med	Med	Med
	Fossil	Med	Low	Med	Low	Med	Med	Med	Low	Med	Med	Med	Med
	Downstream	Med	Low	Med	Low	Med	Med	Med	Low	Med	Med	Med	Med
Chonburi	Fossil	Med	Low	Med	Low	Med	Med	Med	Low	Med	Med	Med	Med
Bontang	Raw mat (coal)	Med	Med	Med	High	Med	High	Med	Med	Med	High	High	High

- >2 severe flood year within 10 years, SPI 2.00 and above
- 2 severe flood year within 10 years, SPI 1.50 to 1.99
- 1 severe flood year within 10 years, SPI 1.00 to 1.49
- no severe flood year within 10 years, SPI 0.00 to 0.99

Baseline – 2011- 2020
Future Projection – 2021 - 2030

P3: Drought
(Own operation and downstream - Chonburi & Rayong)

Baseline: Drought risk

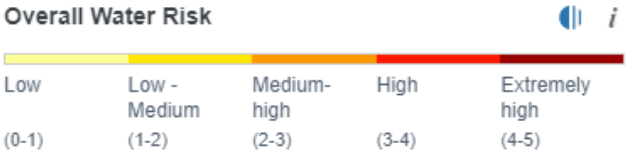


SSP 2, RCP 4.5 Drought

SSP 2, RCP 8.5 Drought

SSP 3, RCP 8.5 Drought

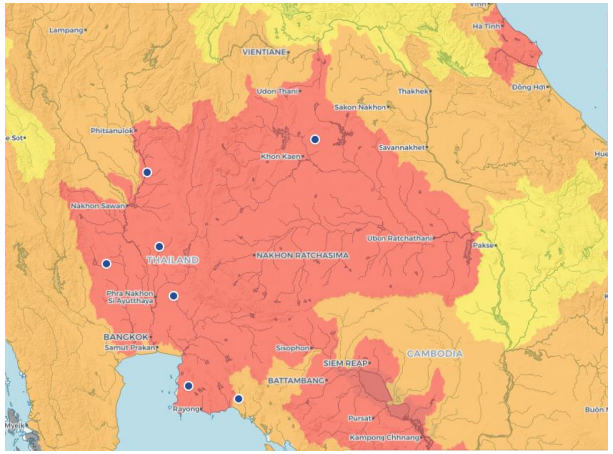
Location	Baseline	SSP 2, RCP 4.5	SSP 2, RCP 8.5	SSP 3, RCP 8.5
Rayong	High	Low - Medium	Low - Medium	Low - Medium
Chonburi	High	Low - Medium	Low - Medium	Low - Medium



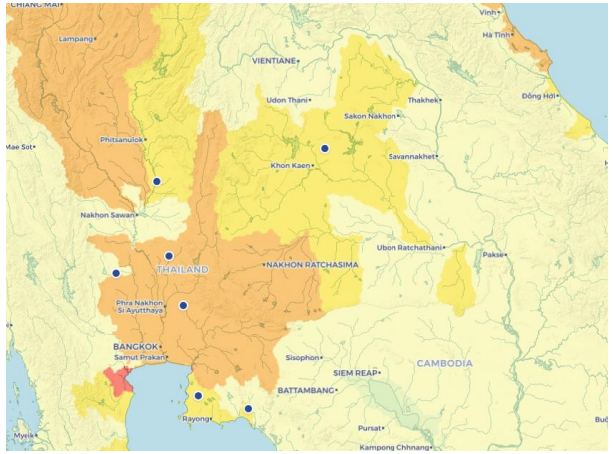
Baseline – 2011- 2020
Future Projection – 2021 - 2030

P3: Drought
(Own Operation - Renewable Plants)

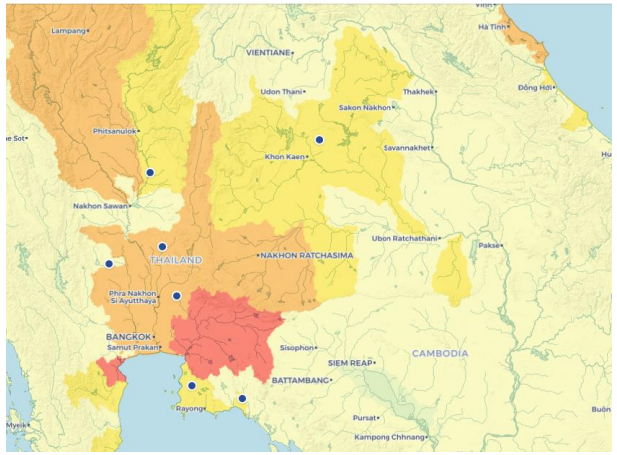
Baseline: Drought risk



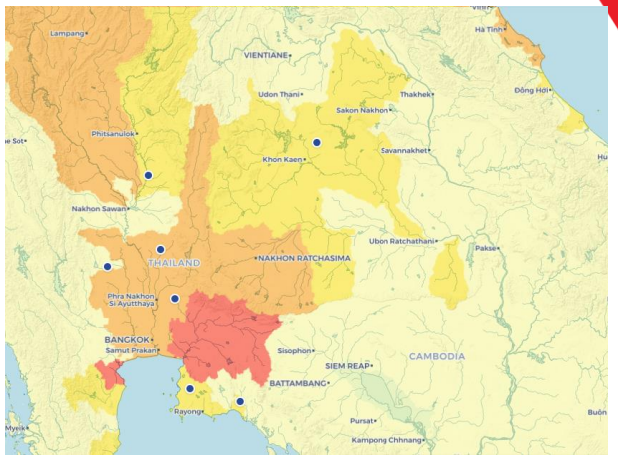
SSP 2, RCP 4.5 Drought



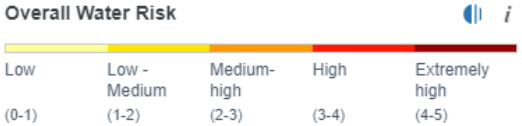
SSP 2, RCP 8.5 Drought



SSP 3, RCP 8.5 Drought



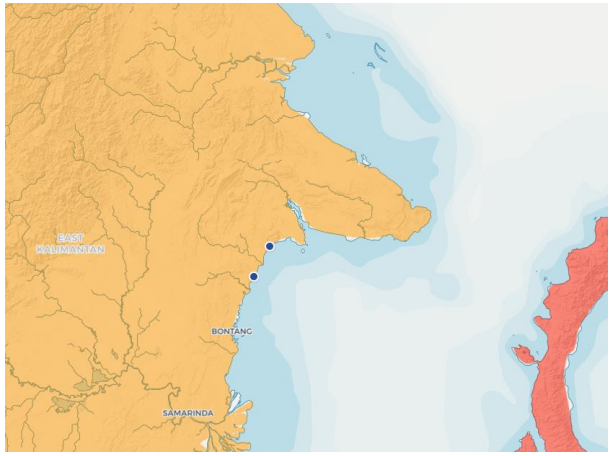
Location	Baseline	SSP 2, RCP 4.5	SSP 2, RCP 8.5	SSP 3, RCP 8.5
Pichit	High	Low - Medium	Low - Medium	Low - Medium
Suphanburi	High	Low	Low	Low
Lopburi	High	Medium-High	Medium-High	Medium-High
Khon Kaen	High	Low - Medium	Low - Medium	Low - Medium
Saraburi	High	Medium-High	Medium-High	Medium-High
Rayong	High	Low - Medium	Low - Medium	Low - Medium
Chanthaburi	Medium-High	Low	Low	Low



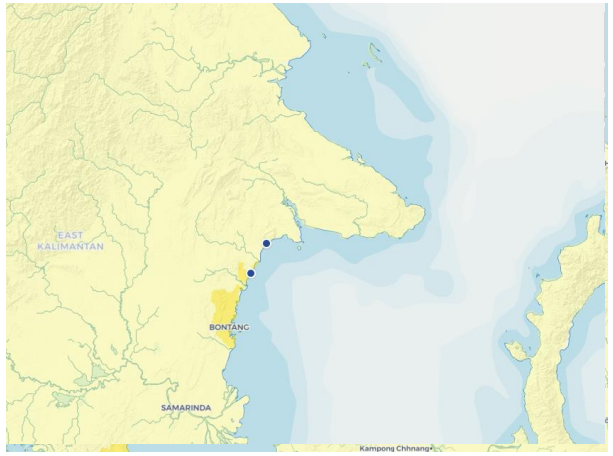
Baseline – 2011- 2020
Future Projection – 2021 - 2030

P3: Drought (Upstream – Raw Material)

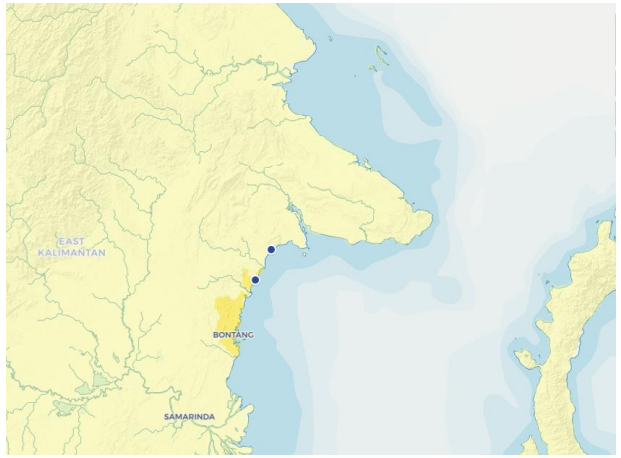
Baseline: Drought risk



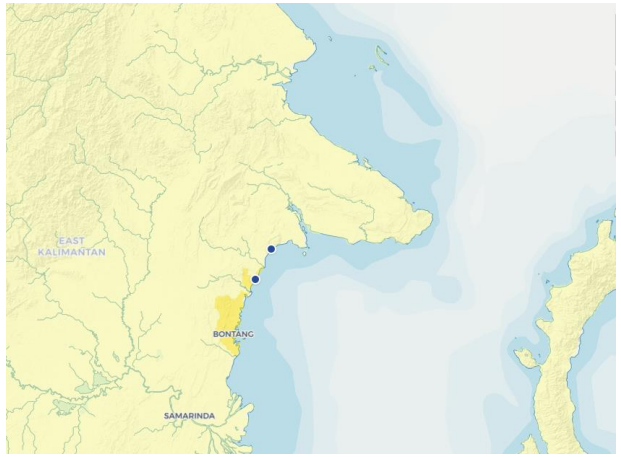
SSP 2, RCP 4.5 Drought



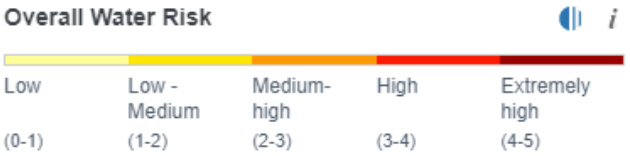
SSP 2, RCP 8.5 Drought



SSP 3, RCP 8.5 Drought



Location	Baseline	SSP 2, RCP 4.5	SSP 2, RCP 8.5	SSP3, RCP 8.5
KPC Tanjung Bara Coal Terminal	Medium-High	Low - Medium	Low - Medium	Low - Medium
KPC Lubuktutung	Medium-High	Low	Low	Low

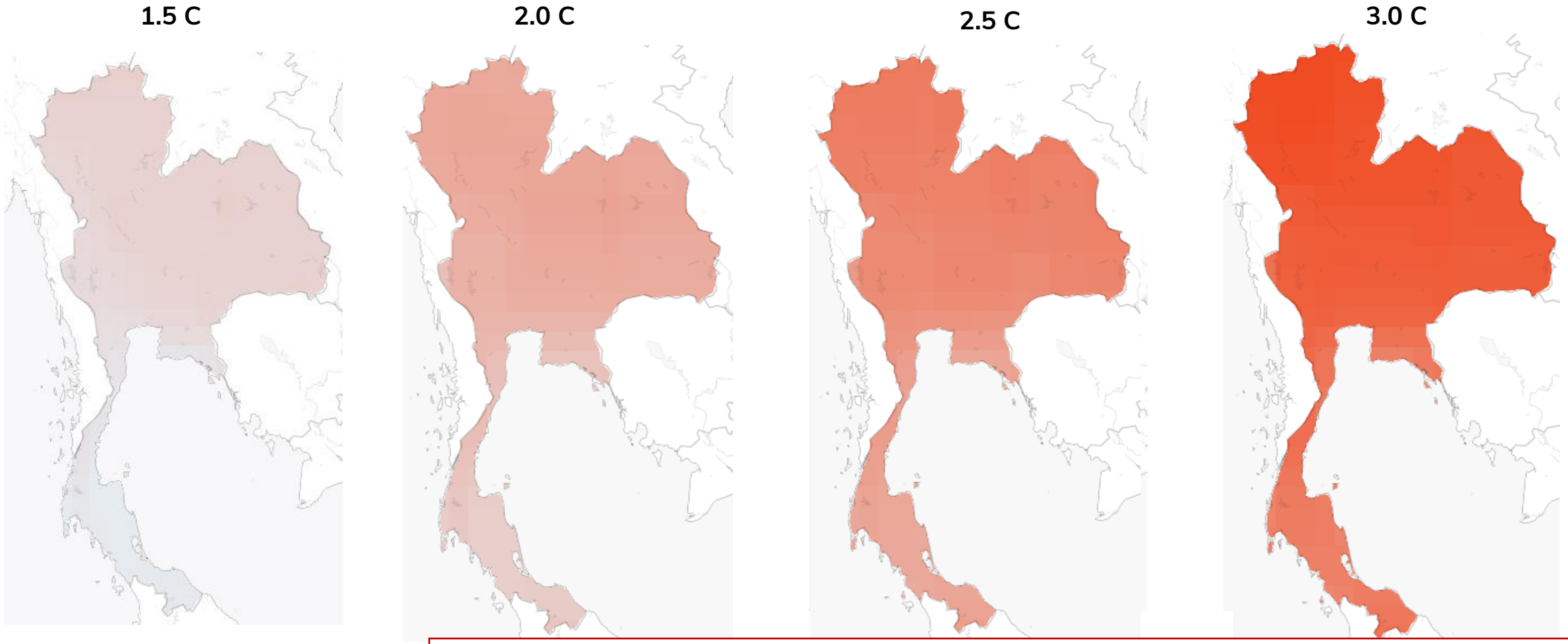


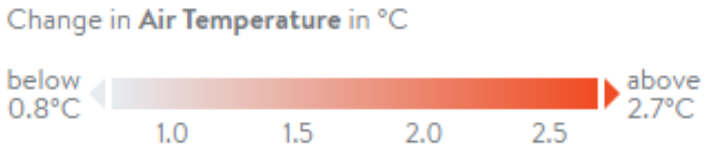
Baseline – 2011- 2020
Future Projection – 2021 - 2030

P4: Increased Mean Temperature

Air Temperature Projection over Thailand

The % change in air temperature over Thailand





- Thailand will have higher Temperature due to the increased temperature (T)
- At 2.0 temperature change **north, middle and northeast part** of Thailand have **medium probability to face high** air surface T
- At 3.0 temperature change **the north, middle and upper-south** of Thailand have high chance to **extremely high** air surface T

https://climateanalytics.org/tools/

P4: Increased Mean Temperature (Effect on solar power plants)

The temperature of the solar PV module has a direct effect on its ability to generate electricity. This impact is reflected through the temperature coefficient, which is expressed as the percentage decrease in output for every 1-degree Celsius (°C) increase in temperature from 25°C. Solar PV modules are tested for their efficiency at 25°C, which is the cell temperature of Standard Test Conditions (STC). And with any temperature increase above 25°C must consider **power losses of 1% for every 2°C increase.**

TEMPERATURE CHARACTERISTICS	
NMOT	41 °C ±3 °C
Temperature coefficient of Pmax	-0.35%/°C
Temperature coefficient of Voc	-0.30%/°C
Temperature coefficient of Isc	+0.05%/°C

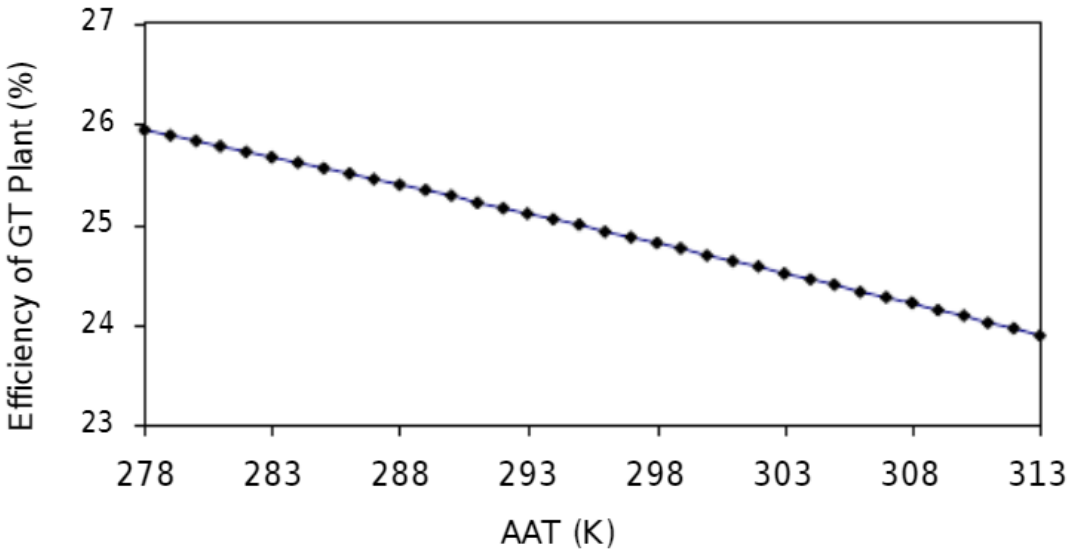
(Eco Green Energy Helios Plus 440-455W panels temperature characteristics)

*NMOT - Nominal Module Operating Temperature or temperature under operation
*Temperature coefficient of Pmax – the change in Maximum power output vary based on the temperature that go over standard test condition (STC)

https://www.eco-greenenergy.com/temperature-coefficient-of-solar-pv-module/

P4: Increased Mean Temperature (Effect on cogeneration power plants)

The decreasing of efficiency of gas turbine plant can be affected by the **increase in ambient air temperature leading power output from steam turbine to decrease by 9%**



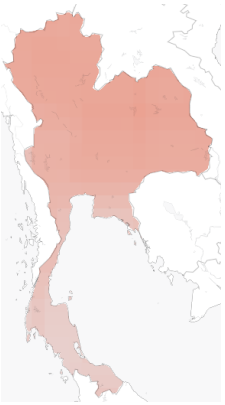
*AAT – Ambient air temperature (air temperature around the plants)

(PDF) Ambient air temperature effect on power plant performance (researchgate.net)

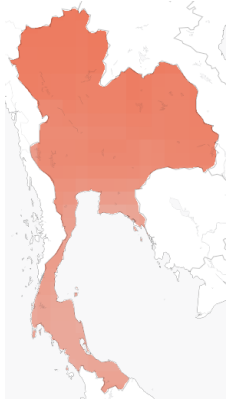
P4: Increased Mean Temperature

1.5 C

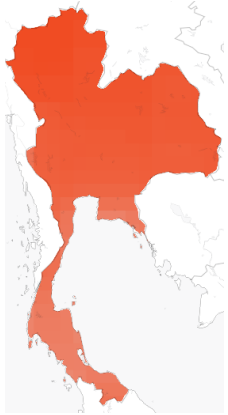
2.0 C



2.5 C



3.0 C



Negative impact

Minor

Major

Increasing Mean Temperature	Baseline		2021-2025		2021-2030	
	Current Magnitude	Likelihood	Level of Magnitude	Likelihood	Level of Magnitude	Likelihood
Own operation (Renewable power plant)	Medium	Medium	Medium	Medium	Medium	High
Own Operation (Fossil fuel plant) and Downstream (Customers)	Low	Medium	Low	Medium	Medium	High
Upstream (Raw material – Natural Gas, Coal)	Low	Medium	Low	Medium	Low	High

Baseline – 2011- 2020
Future Projection – 2021 - 2030

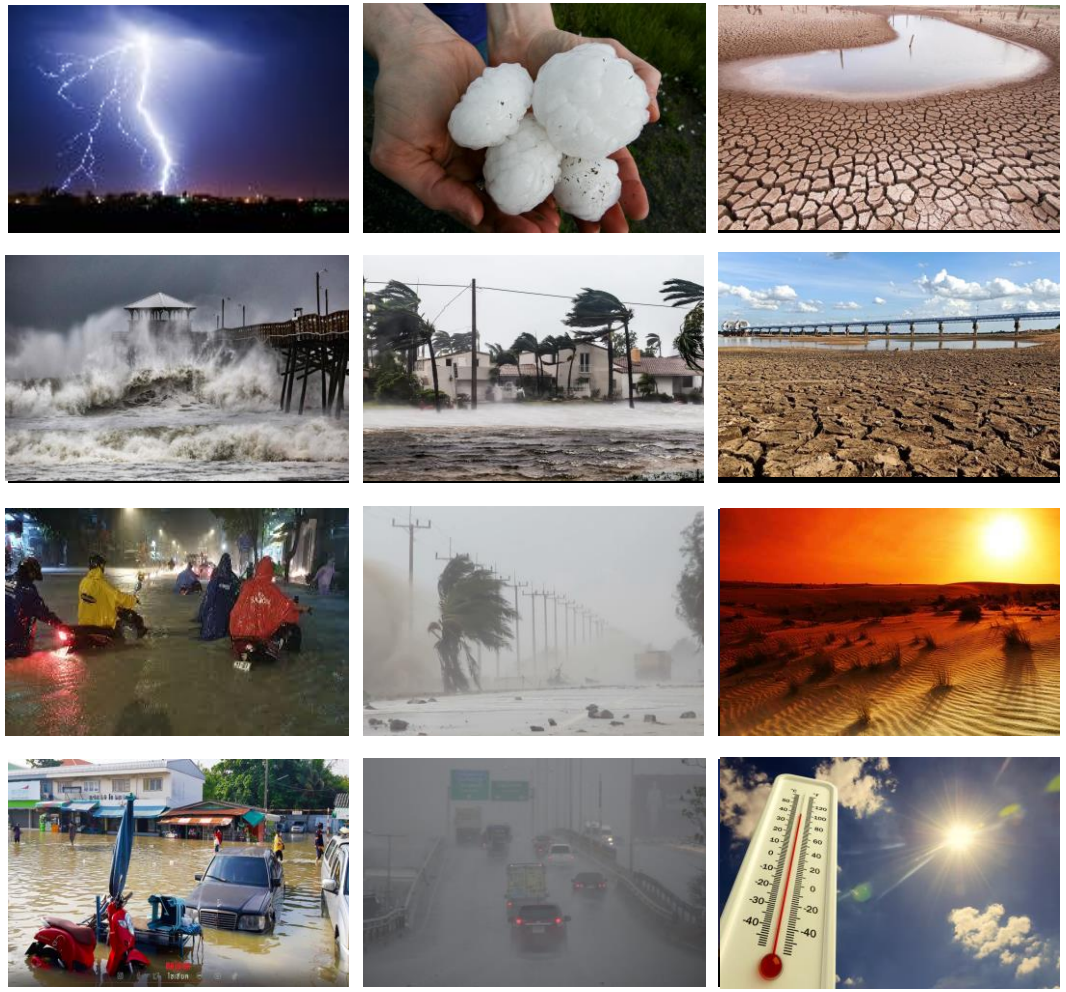
Physical Risks Impact Implication

P1 Increased Extreme Weather*

- **Solar power plants** can be impacted by hail storm which has higher to occur in the middle of Thailand leading the plant to have direct damage on solar panels
- Lighting strike has higher potential to occur and may cause the electricity disruption over **Map Tha- Put Industrial area**

P2 Flood

- The rate of annual average rainfall over **Thailand** will be higher if there is an increasing of global mean temperature
- **Rayong and Chonburi** which are the key location for GPSC operation are not located in vulnerable area leading the magnitude to be low-medium



P3 Drought

- Since the rate of rainfall through 2 previous years showed 2 drought year in a row, the **middle of Thailand** was more likely to face drought; however, with an increase mean temperature trigger the rate of rainfall over Thailand to increase and mitigate the drought risk magnitude to be lower (vary to the average temperature change)

P4 Increased Temperature

- Increasing surface temperature over **solar power plant** area results in the decreasing of electricity generation
- Maximum surface temperature over **Thailand** are more likely to increase > 50 C during summer/El- nino condition in the middle of Thailand
- **Fossil fuel plant** have minor negative change in energy efficiency due to increasing surface temperature around the plant

Baseline – 2011- 2020
Future Projection – 2021 - 2030

*P1 Increased Extreme Weather include cyclone, hailing, lighting, and thunder storm

Scenario Analysis on Transition Risks

2021-2022 Climate Related Risks & Opportunities Reporting Based on TCFD Reporting Guidance: Transition Risks (1/2)

Potential Impacts	Potential Financial Risks	Level of Financial Impact /Timeframe	
		2022	2027
T1- Change in stakeholders behavior and expectation (Stakeholder concern and negative feedback) • Stakeholder groups are becoming aware and concerned of the pollution generating GHG from fossil fuel and its negative impacts to climate change. • Renewable plant (i.e. Hydropower plant) is a renewable energy that can contribute to emissions reductions but requires a large area to cover for construction of dams and re-channeling water flow, this will disrupt ecosystems and community displacement. Communities and affected stakeholders might protest against the company.	• The rise of stakeholder concern and negative feedback forces GPSC Group to limit GHG emissions from operation, thus, increasing operating cost. The concerns of conventional power plants (fossil-fired power plants) leading to opportunities in investing of low-carbon products.		
T2: Increased technological competition • If GPSC adopt the use of CCS technology and blue hydrogen, this will dramatically reduce the corporate GHG emission and reach net zero emission target much more easier • In case of EU union allow blue hydrogen to be listed as the renewable energy sources, GPSC will have 100% renewable energy in its energy generation portfolio. • The lack of new energy management services such as the installation of renewable and smart grid - microgrid can lead the comapny to loose the opportunities in new customer demand • In the future, Thailand electricity distribution system will have dramatic change. In order to track the sources of electricity genereation, the company required blockchain technology to verified and tracking electricity generation. The lack of blockchain technology may cause negative impact to customer satisfaction and fall behind other compettitors	• Increasing of technological competition lead GPSC to increase competitiveness among peers and attract more customer who demand advanced technology and low carbon energy. If GPSC does not adopt well to increase technology within operation, the company might lose revenue from customer who change to other energy providers.		

Low Medium High Critical

2021-2022 Climate Related Risks & Opportunities Reporting Based on TCFD Reporting Guidance: Transition Risks (2/2)

Potential Impacts	Potential Financial Risks	Level of Financial Impact /Timeframe	
		2022	2027
T3- Changing Customer Behavior • Shifting customer preference towards electricity generated with lower emission technology will negatively affect GPSC revenue. The affect will increase if the company continue to generate electricity with fossil fuel, as customers may choose other power generators, who utilize low carbon generation methods instead. • Climate change trend cause increasing the use of renewable energy. Customers (EGAT) will be forces to increase in purchasing or investing in renewable energy in order to offset their green house gas emissions. Increased investment in renewable energy might be a great opportunity in the future.	• Changing of customer behaviors cause financial impacts to GPSC Group from losing of revenue from main products & services as well as losing financial opportunities from new business provided to customers if GPSC Group do not adapt the business model.		
T4- Change in climate related regulations • GPSC is generally subjected to the cap and trade scheme in the countries that the scheme existing. As mentioned, although only Thailand in this group that has fully implemented the scheme, other countries in this group are developing Emissions trading schemes (ETS) in which GPSC should be prepared for adaptation or compliance. Failing to comply with regulation could lead to the loss of investment privilege received by the investment promotion agency. • Future of cap and trade which might be implemented in operating regions e.g. Thailand will pressure corporates like GPSC to seek for alternatives to avoid increasing cost of operations and price of electricity. • Provides an opportunity for GPSC to increase renewable technology operating sites to maintain stability of operation or enhance without operation costs and effects from the cap and trade scheme. • GPSC might be impacted by carbon taxes due to power sector defined as the GHG emitter that will increase operating cost of GPSC e.g., higher compliance costs, increased insurance premiums etc.. • Encourage investments in alternative source of lower emissions technology to lower overall emissions of power plant	• The increase of carbon price causes financial impacts to GPSC Group from carbon price paid to government, fees, as well as fines raised from non-compliance or regulation violation. There are financial impacts rise from investment cost of low carbon products/initiative in order to avoid and minimize GHG emissions. • The increase of renewable energy and climate related regulation and carbon tax causes financial impacts to GPSC Group from carbon price paid to government, fees, as well as fines raised from non-compliance or regulation violation. There are financial impacts rise from investment cost of low carbon products/initiative in order to avoid and minimize GHG emissions.		

Low Medium High Critical

Transition Risks & Opportunities

TCFD TASK FORCE ON CLIMATE-RELATED FINANCIAL DISCLOSURES

"Transitioning to a lower-carbon economy may entail extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change.

Reputation

- Changing customer or community perceptions of an organization's contribution to or detraction from the transition to a lower-carbon economy

Technology

- Technological improvements or innovations that support the transition to lower-carbon, energy-efficiency
- The disruption caused by the displacement of old systems by new technology

Market

- Shifts in supply and demand for certain commodities, products and services as climate-related risks and opportunities are increasingly taken into account.

Policy and Legal

- Policy actions that attempt to constrain actions that contribute to the adverse effects of climate change
- Policy actions that seek to promote adaptation to climate change

T1 Change in stakeholders behavior and expectation (Stakeholder concern and negative feedback)

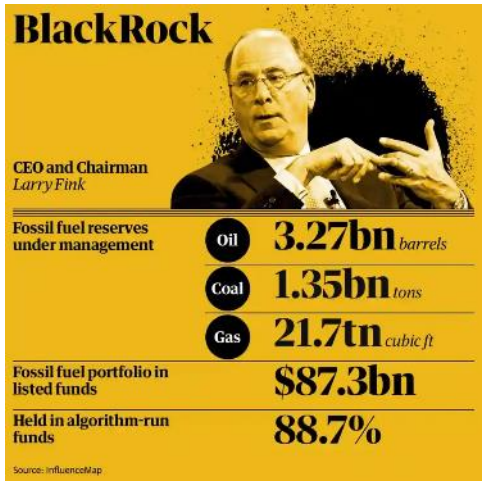
Description

Stakeholder groups are becoming aware and concerned of the pollution generating GHG from fossil fuel and its negative impacts to climate change.

- An increasing number of stakeholders who focus on Climate mitigation actions of organization
- More and more investor or international supports will look for the corporate climate management and ambitious commitment on climate change as one of the compulsory criteria
- **Reputational issues** - a strong focus on climate change has emerged across a wide range of stakeholders resulting in many initiatives to align the corporate and finance sectors towards a low-carbonfuture

Opportunities

- O1 Enhance business adaptation and resiliency across the group
- O2 Scale up renewable power towards net zero energy provider
- O3 Diversify business through business model transformation
- O4 Participate Environment Attribution Certificate (EAC) e.g. I-REC
- O5 Adopt new technology to existing and future power plants



T2 Increased technological competition

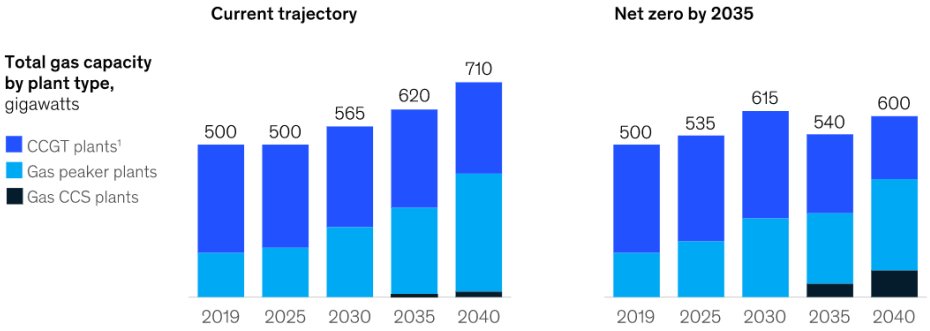
McKinsey & Company

Description

The lack of new technologies in the energy industry such as the installation of renewable, energy storage system, and technological enhanced innovation can lead the company to decrease competitiveness and loose the opportunities in new customer demand

- The **ongoing physical and digital transformations** require the development of additional flexibility options. Solution developers are now turning to innovative **energy storage solutions**.
- **Energy storage** is vital for the cost-effective transition towards decarbonized electricity systems. Battery storage installations are expected to become standard components of energy infrastructures.
- **CCUS and Hydrogen-blend technologies** will play roles in energy generation to facilitate net zero emission.

Gas would continue to support reliability, assuming carbon capture and storage (CCS) and hydrogen blending can enable low-emissions generation.



Opportunities

- O5 Adopt new technology to existing and future power plants

(e.g. CCS, Blue/Green hydrogen)

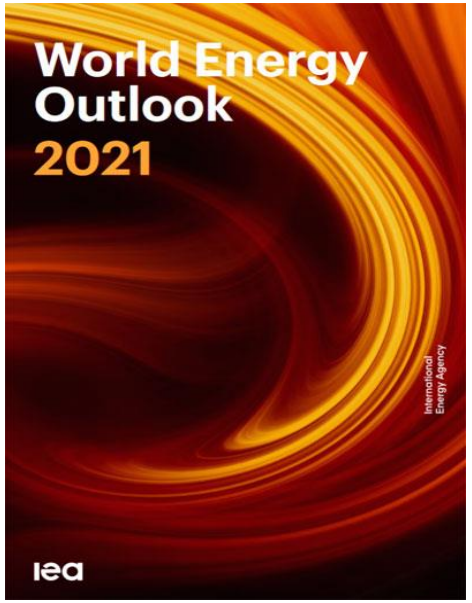
Source: https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/net-zero-by-2035-a-pathway-to-rapidly-decarbonize-the-us-power-system
https://www.iaea.org/sites/default/files/21/06/transitions-to-low-carbon-electricity-systems-changing-course-in-a-post-pandemic-world.pdf

T3 Change in customer behaviour

Description

The impact of climate change raise awareness on the climate action in all business Sectors leading mostly customers of electric utilities sector switching from the use of conventional to renewable energy

- Demand of Solar PV and wind power rise dramatically by 2030, driven upward by increased policy support (WEO, 2021).
- Since 2004, Thailand has been among the forerunners in Asia in promoting alternative energy development via government policies and investment incentives. In early 2019, the national Power Development Plan (PDP) and the Alternative Energy Development Plan (AEDP) were approved
- Renewable energy in Thailand is projected to be 30% of the total energy production by 2037, jumping from the current 14.5%, with big Thailand state-owned and private-sector conglomerates taking the lead.
- The new energy management services must be applied to customer in order to present the importance and the advancement of technology which enable GPSC to perform decentralization in developing countries as the pilot projects



Opportunities

O2 Scale up renewable power towards net zero energy provider
O3 Diversify business through business model transformation
O4 Participate Environment Attribution Certificate (EAC) e.g. I-REC

T4 Change in climate related regulations (1/2)

Description

Under regulation related **carbon prices/tax** are getting higher and become close to enforcement in the near future, which will affect power sector. The company need to control and limit GHG emissions to comply with the regulations.

- Thailand plans to announce climate change act. to **enforce polluters in managing GHG emission** in compliance with national regulation.
- When a carbon price/tax is applied, the overall electricity generation cost increases due to an increase in operating costs and carbon pricing liability. **With a USD 40 carbon price**, the PDP scenario's operating cost and **carbon price liability combined reach THB 1.33/kWh by 2030**. **The operating cost increases THB 0.06/kWh** from the PDP scenario without a carbon price as a result of the shift from coal to more expensive natural gas generation.
- **Singapore** is the first country in Southeast Asia to introduce a carbon price. **The carbon tax, at S$5 per tonne of greenhouse gas emissions (tCO2e), was introduced in 2019** through the Carbon Pricing Act (CPA).

Opportunities

- O1 Enhance business adaptation and resiliency across the group
- O2 Scale up renewable power towards net zero energy provider
- O5 Adopt new technology to existing and future power plants

https://www.iea.org/reports/the-potential-role-of-carbon-pricing-in-thailands-power-sector

หลักการ

ให้มีกฎหมายว่าด้วยการเปลี่ยนแปลงสภาพภูมิอากาศ

เหตุผล

โดยที่ภาวะการสะสมก๊าซเรือนกระจกในชั้นบรรยากาศของโลกส่งผลให้เกิดปัญหาการเปลี่ยนแปลงสภาพภูมิอากาศ และนับวันจะทวีความรุนแรงขึ้น โดยประเทศไทยต้องเผชิญและรับมือกับปัญหาดังกล่าว ได้แก่ การเปลี่ยนแปลงรูปแบบของฤดูกาล การเกิดภัยพิบัติ สิ่งมีชีวิตสูญพันธุ์ การเปลี่ยนแปลงรูปแบบการกระจายของเชื้อโรคและพาหะนำโรค เป็นต้น ประกอบกับประเทศไทยได้ให้สัตยาบันเข้าร่วมเป็นภาคีความตกลงปารีสตามกรอบอนุสัญญาสหประชาชาติว่าด้วยการเปลี่ยนแปลงสภาพภูมิอากาศ เมื่อวันที่ ๒๑ กันยายน พ.ศ. ๒๕๕๙ ซึ่งตามอนุสัญญาดังกล่าวกำหนดพันธกรณีให้รัฐภาคีจะต้องรายงานบัญชีปริมาณการปล่อยก๊าซเรือนกระจกจากแหล่งกำเนิดต่าง ๆ และปริมาณการกักเก็บก๊าซเรือนกระจกจากแหล่งดูดซับ และต้องมีแผนรองรับเพื่อยกระดับความสามารถในการปรับตัวและฟื้นตัวจากการเปลี่ยนแปลงสภาพภูมิอากาศ ตลอดจนให้รัฐภาคีกำหนดเป้าหมายในการลดปริมาณการปล่อยก๊าซเรือนกระจก รวมทั้งจะต้องดำเนินมาตรการเพื่อลดปริมาณก๊าซเรือนกระจกในประเทศให้ได้ตามเป้าหมายที่กำหนดไว้ เพื่อให้ความร่วมมือกับนานาประเทศในการลดปริมาณการสะสมของก๊าซเรือนกระจกในชั้นบรรยากาศของโลกและแก้ไขปัญหาด้านผลกระทบจากการเปลี่ยนแปลงสภาพภูมิอากาศในประเทศไทย จึงจำเป็นต้องตราพระราชบัญญัตินี้

T4 Change in climate related regulations (2/2)

Description

Cap and trade is one mechanism planned to become enforcement as a result from National Commitment through COP26 and National GHG reduction target. Numbers of GHG emission reduction target have been elaborate through the official letter of each Country submitted to UNFCCC including Thailand.

- Currently Thailand Greenhouse Gas Organization and IEA have studied the implementation of Cap and Trade policy which will limit the GHG emission in energy sector. **The IEA predicted that Thailand with legislate cap and trade regulation within less than 5 years**
- Thailand recently annouced the ambition on COP 26 to **shift National Determine Contribution from 20-25 to 40 % by 2030**
- International No Deforestation Commitment in COP 26; however, Thailand has not signed the commitment
- Thailand pledge to achieve **carbon neutrality by 2050, net zero GHG by 2065 and to cut GHG emissions by 40% within 2030.**
- The commitment has come with strategic plan with potential changes in national policy and regulation on climate change.

Opportunities

- O1 Enhance business adaptation and resiliency across the group
- O2 Scale up renewable power towards net zero energy provider
- O5 Adopt new technology to existing and future power plants

นโยบาย/กฎหมาย	การมีส่วนร่วมทุกภาคส่วน	เทคโนโลยี/วัตกรรม	งบประมาณ/การลงทุน
- NET ZERO COMMITMENTS - ยุทธศาสตร์ชาติ/แผนการปฏิรูปประเทศ/แผนพัฒนาเศรษฐกิจและสังคมแห่งชาติ ฉบับที่ 13 - พ.ร.บ. การเปลี่ยนแปลงสภาพภูมิอากาศ - แผนที่นำทางการลดก๊าซเรือนกระจก/แผนรายสาขา - การขับเคลื่อน BCG MODEL - การปฏิรูปภาคอุตสาหกรรม/พลังงาน/เกษตร/คมนาคม - การอนุรักษ์ทรัพยากรธรรมชาติและสิ่งแวดล้อม	- PUBLIC–PRIVATE PARTNERSHIP - CARBON TRADING/ CARBON MARKET MECHANISM - CLIMATE ACTION NETWORK: สร้างการรับรู้/การมีส่วนร่วมภาคประชาชน - การผลิตและบริโภคที่เป็นมิตรกับสิ่งแวดล้อม - แผนปฏิบัติการลดก๊าซเรือนกระจกระดับจังหวัด - ความร่วมมือระหว่างประเทศ (REGIONAL/GLOBAL COOPERATION)	- BIG DATA: CARBON EMISSION SOURCES/SINK - GEO-ENGINEERING: SMART FARMING, GHGS REMOVAL TECHNOLOGY, TECHNOLOGY FOR FOOD SECURITY - CARBON CAPTURE UTILIZATION AND STORAGE - CLEAN/GREEN/RENEWABLE ENERGY: SOLAR FARM - ELECTRIC VEHICLES (EV), HYDROGEN VEHICLES - SMART & LOW CARBON CITIES	- GREEN CLIMATE FUND - CLEAN TECHNOLOGY FUND - GLOBAL ENVIRONMENT FACILITY: GEF - ธนาคารแห่งประเทศไทย/ธนาคารพาณิชย์: เงินกู้/สินเชื่อสีเขียวเพื่อการอนุรักษ์และแก้ไขปัญหาเปลี่ยนแปลงสภาพภูมิอากาศ - งบประมาณภาครัฐด้าน GREEN INFRASTRUCTURE และด้านสิ่งแวดล้อม - ภาคเอกชน/ CSR

T4 Change in climate related regulations (3/4)

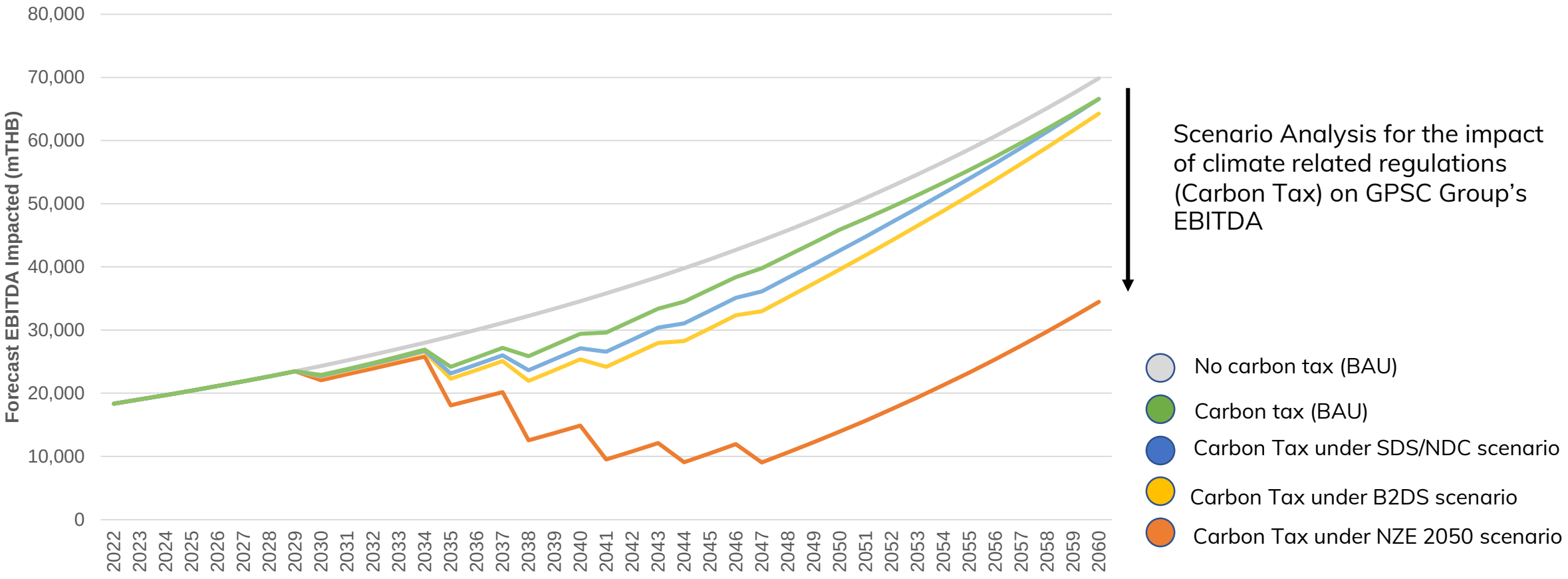
Key Assumptions and Sources

Issue	Assumptions	Sources
Baseline EBITDA growth rate (from 2022 onwards)	4% from average annual growth rate over 2019-2021	Assumed based on calculation
Carbon tax	Referring to Singapore tax rate (short-, medium-, and long-term), its future plan and assumption beyond, the values used are: • SG$5/tCO2e for 5 years (from 2030) • Increase to $25, $45, $60, $70 for every 3 years • End value of $80 at year 2047	https://www.nea.gov.sg/our-services/climate-change-energy-efficiency/climate-change/carbon-tax#:~:text=The%20carbon%20tax%20is%20set,tCO2e)%20from%202019%20to%202023
	The International Monetary Fund has recommended a global average carbon price of US$75 per tonne by the end of the decade.	https://www.imf.org/en/News/Articles/2021/06/18/sp061821-launch-of-imf-staff-climate-note
Scenarios	IEA's Sustainable Development Scenario (SDS) suggests advanced economies reach net zero emissions by 2050, China around 2060, and all other countries by 2070. This scenario is aligned with Thailand NDC target to reach net zero by 2065.	https://www.iea.org/reports/world-energy-model/sustainable-development-scenario-sds
	Beyond 2°C Scenario (B2DS) sims to limit global temperature rise to 1.75°C above pre-industrial levels. The energy sector emission reach net zero around 2060.	https://iea.blob.core.windows.net/assets/a6587f9f-e56c-4b1d-96e4-5a4da78f12fa/Energy_Technology_Perspectives_2017-PDF.pdf
	Net Zero Emissions by 2050 Scenario (NZE) shows a narrow but achievable pathway for the global energy sector to achieve net zero CO2 emissions by 2050.	https://www.iea.org/reports/world-energy-model/net-zero-emissions-by-2050-scenario-nze
Emission Pathway	Followed SBTI CORPORATE NET-ZERO STANDARD (2021): • Short-term target annual reduction at 205%, 3.3% and 4.2% used for the above scenarios, SDS, B2DS and NZE, respectively. • And to reach 90% reduction in the long-term (end year target).	https://sciencebasedtargets.org/resources/files/Net-Zero-Standard.pdf

T4 Change in climate related regulations (4/4)

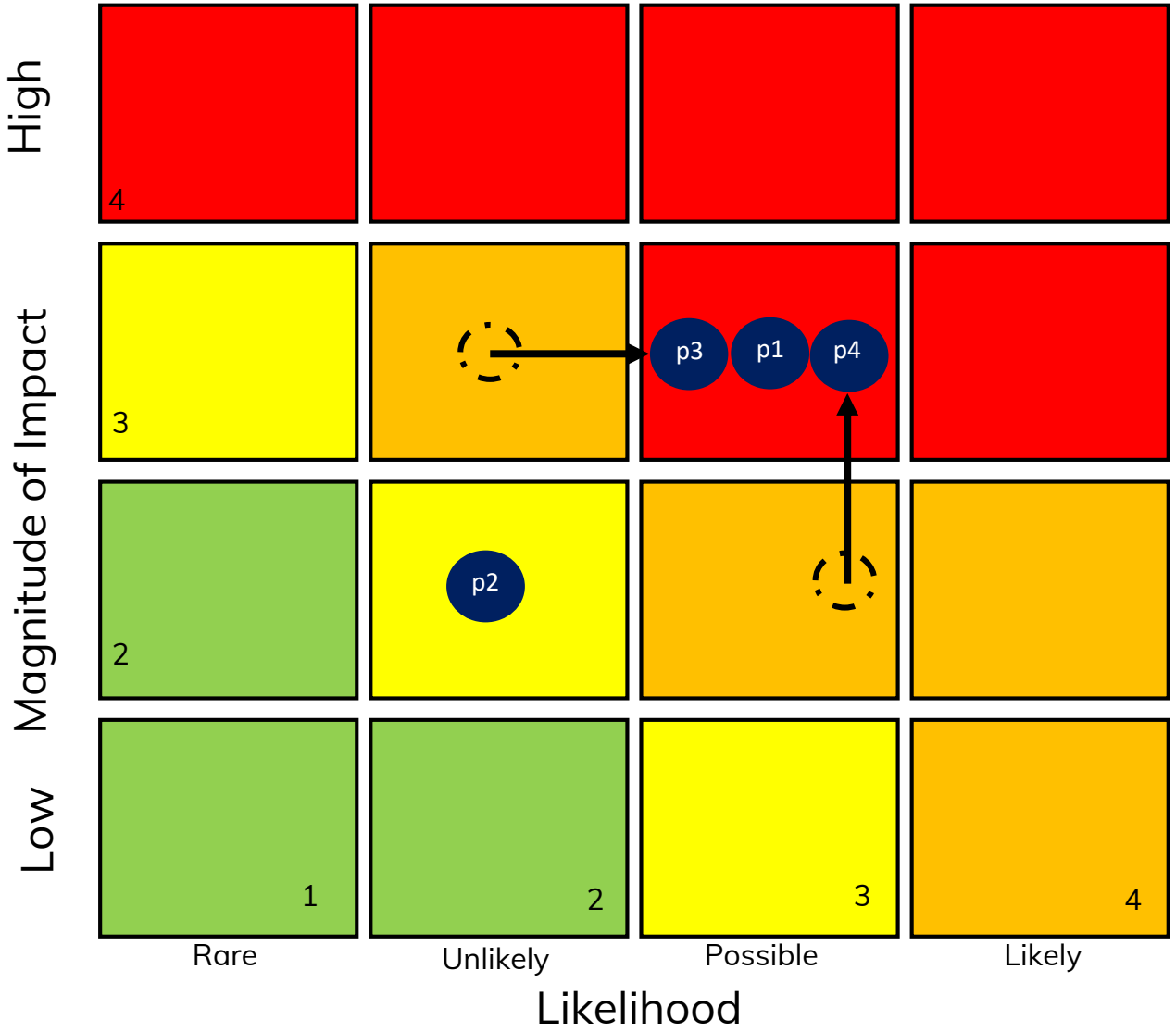
Scenario analysis on the EBITDA on climate related regulations

If GPSC is unable to reduce GHG from different level, the highest financial impact caused by carbon tax are from NZE 2050 scenario followed by B2DS, SDS/NDC and BAU.



Physical Climate Risk Adaptation Plan

Physical Risk Matrix 2027



Physical Risks:

- ❑ P1 Increased Weather Extremes (acute)
- ❑ P2 Flood (acute)
- ❑ P3 Drought (chronic)
- ❑ P4 Increased Mean Temperature (chronic)

Since GPSC physical climate risk analysis in 2027 show that the likelihood percentage of drought (P3) and the magnitude of impact of increasing temperature (P4) will increase respectively. This situation leads GPSC to develop adaptation plans for responding to all identified physical risks

Remark: The risk matrix & risk assessment was conducted in 2022

Physical Climate Risk: Adaptation Plan

Climate Related Risks	Adaptation Plan (less than 5 years implementation) (Existing and New Operations)
P1: Increased Weather Extremes including hail, lighting, wind/cyclones	• Implemented back-up procedure in order to response to the emergency incidents. • Study case to install and improve lightning protection systems (e.g. surge protector). • Employees are trained for Plant Crisis Plan in order to prepare for crisis situation and to limit the consequences of an emergency incidents from getting out of control. • Takes a proactive approach to handling potential crisis by developing a business continuity management (BCM) system which covers major operations. • Raise lighting strike issue to management of change (MOC) and check the detail for improvement • Installed lighting protection system • Research on the installation of technology for reducing Convective Available Potential Energy (CAPE) over surrounding area
P2- Flood	• Monitors water conditions closely with the representatives from PTT Group's water resource management committee • Setting up the business continuity management (BCM) to ensure its effective response to the problems and to maintain operational continuity • Electricity back up from PEA/EGAT • Conducted environmental impact assessment • Manages by monitoring and mitigation controls in accordance to the EIA and other regulations that applied to the country of operation in oversea. • Review vulnerability area and assets on flooding and implement adaptive measures such as increase floor elevation • Implement flood barrier (Temporary / Permanent) • Water drainage installation

Physical Climate Risk: Adaptation Plan

Climate Related Risks	Adaptation Plan (less than 5 years implementation) (Existing and New Operations)
P3- Drought	• Have back-up emergency storage for 3 days of operations. • Creates a water management plan to prepare for risky events related to water resource such as secure contract of demineralized water from other supplier • Construct water storage e.g. Pond, Rain harvesting system • Reduce water consumption/Reduce productivity • Increase water circularity (reuse/recycle) • Installed sea water RO • Monitor from available water supply nearby the site • Expand water supply nearby the site (collaboration with government) • Consider another water supply expansion initiative (collaboration with others in Map Tha Put Industrial Area) • Obtain wastewater from others to treat and use for cooling process
P4- Increased Mean Temperature	• Improve and strengthen infrastructure and machine to endure high temperature • Concentrate investment in locations where temperatures are likely to be cooler • Installation of water spray to reduce temp during electricity production leading to the increase in energy efficiency • Modified plant based on situation

THANK YOU

Annex: GHG Emissions Performance

(based on GPSC, Glow and Subsidiary boundaries)

	Unit	2018	2019	2020 (Base year)	2021
Absolute GHG Emission (Scope 1 and 2)	tCO2e	13,063,896.72	12,347,950.47	12,337,049.88	12,839,351.16
Net Generation	MWh	29,922,053.58	31,537,370.69	28,382,232.67	32,383,659.27
GHG Intensity	tCO2e/MWh	0.437	0.392	0.435	0.396

- To Achieve Net Zero within 2060 (Base year 2020)
- Carbon Intensity Reduction
  - 10% by 2025
  - 35% by 2030