TCFD Report 2023

Task Force on Climate-related Financial Disclosures

Global Green Chemicals Public Company Limited

August 2023

The business of sustainability

Content

01
Introduction

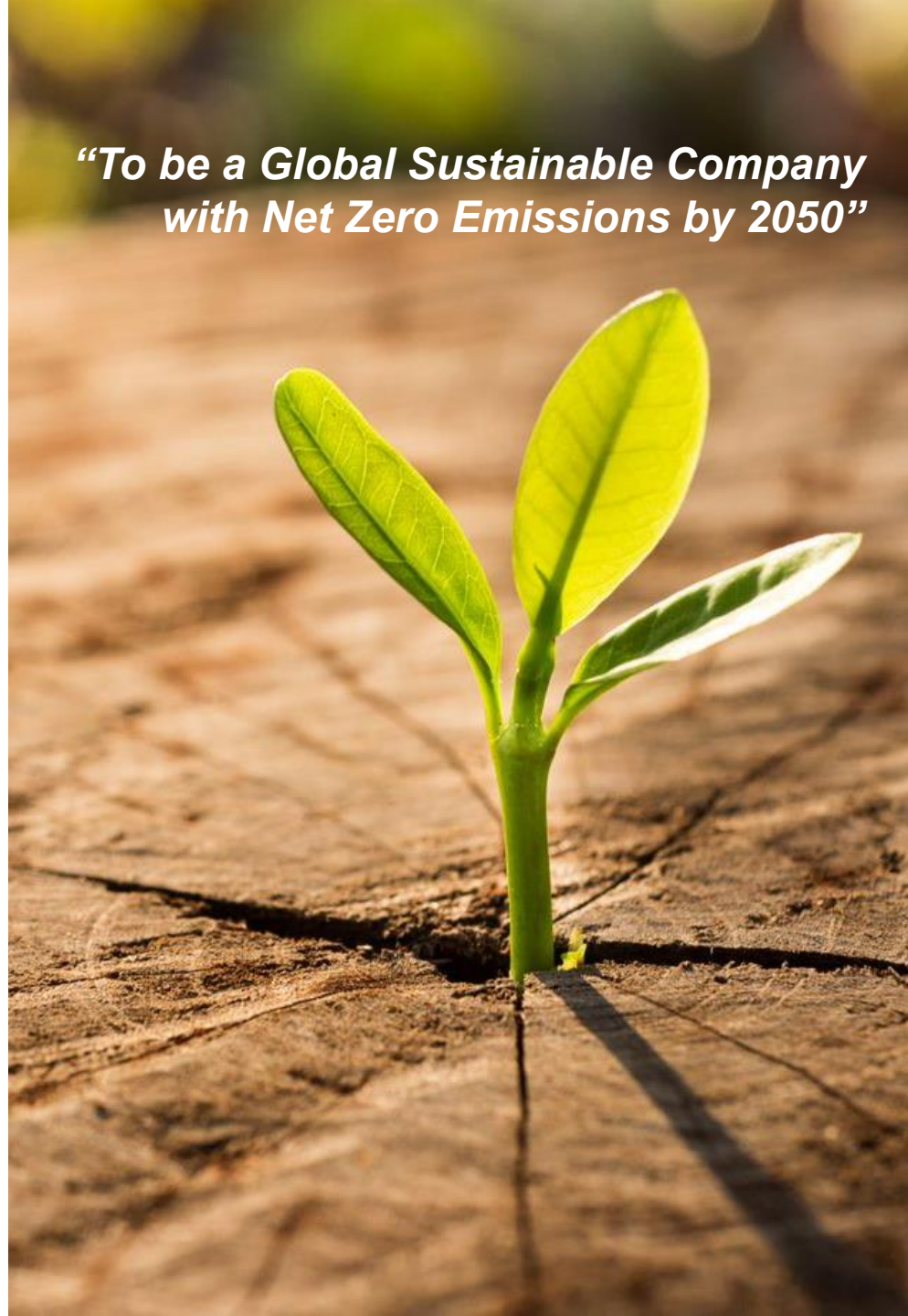
TCFD Framework Integration to Address Climate-related Risks and Opportunities

Global Green Chemicals Public Company Limited (“GGC”), in line with the Paris Agreement and our sustainability vision, recognizes the importance of limiting global temperature rise to 1.5°C. As a leading Oleochemical producer, GGC demonstrates our commitment towards tackling climate change through our ambition to achieve net zero emissions by 2050.

Across our value chain, GGC strives to sustainably operate our business through being responsible towards the environment while enhancing our supply chain security and creating community and social value through eco-friendly and sustainable products.

GGC integrates the TCFD framework into our corporate-wide enterprise risk management process to develop a holistic understanding of climate-related issues. In the development of our business strategy, climate-related risks and opportunities are regularly considered to drive progress towards achieving net zero emissions, maintain resilience towards climate change impacts, and sustain our competitive advantage in a low carbon society.

In this year’s TCFD disclosure, GGC has considered additional transition drivers that may potentially GGC’s operations and value chain and updated our transition scenario analysis. The scope of this year’s GHG inventory has also been expanded to capture additional scope 3 greenhouse gas (GHG) categories.



TCFD Content Index

Recommended Disclosures	Disclosure Source
Governance	
a) Describe the board's oversight of climate related risks and opportunities.	▪ TCFD Report 2023, PDF page 6 ▪ Climate Strategy
b) Describe management's role in assessing and managing climate-related risks and opportunities.	
Strategy	
a) Describe the climate-related risks and opportunities the organization has identified over the short, medium, and long term.	▪ TCFD Report 2023, PDF page 11-15, 18 ▪ Integrated Sustainability Report 2022, PDF page 74-78, 93-105
b) Describe the impact of climate-related risks and opportunities on the organization's businesses, strategy, and financial planning.	
c) Describe the resilience of the organization's strategy, taking into consideration different climate-related scenarios, including a 2°C or lower scenario.	
Risk Management	
a) Describe the organization's processes for identifying and assessing climate-related risks.	▪ TCFD Report 2023, PDF page 9-10 ▪ Integrated Sustainability Report 2022, PDF page 72-73 ▪ Climate Strategy ▪ Risk and Crisis Management ▪ Materiality Topics
b) Describe the organization's processes for managing climate-related risks.	
c) Describe how processes for identifying, assessing, and managing climate-related risks are integrated into the organization's overall risk management.	
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.	▪ TCFD Report 2023, PDF page 20-22 ▪ Integrated Sustainability Report 2022, PDF page 101-103 ▪ Performance Data 2022 ▪ Climate Strategy
b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.	
c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.	

02
Governance

Climate Governance Structure and Responsibilities

Board Level

Board of Directors

- Provide vision, mission, and strategic directions independent from the company's management bodies

Corporate Governance and Sustainable Development Committee

- Review and approve sustainable development policy
- Review and guide climate strategy and action plans
- Monitor the implementation of climate related programs
- Monitor progress against climate targets
- Meets quarterly with scheduled climate-related agenda

Risk Management Committee

- Review and approve risk management policy
- Review and guide climate-integrated risk management process
- Monitor progress on risk management objectives
- Meets quarterly with scheduled climate-related agenda

Management Level

Sustainability Development Committee

- Develop climate strategy and action plans
- Set climate targets
- Support climate risks and opportunity management processes covering identification, assessment and prioritization and mitigation actions
- Drive climate related programs and GHG reduction measures
- Monitor progress of climate opportunity management
- Assign roles and responsibility to sustainability working team to manage climate related risks and opportunities
- Report progress quarterly to CG&SDC and BOD

Enterprise Risk Management Committee

- Steer and monitor regular risk management actions
- Leads climate risks and opportunity management processes covering identification, assessment and prioritization and mitigation actions
- Monitor climate related risk/opportunity management performance
- Assign working groups or departments responsible for managing climate related risk to propose a prevention plan as warnings increase or when such risks pose a significant threat to the business operations
- Report progress quarterly to RMC

With the target of achieving net zero emissions by 2050, GGC's Board of Directors (BOD) and board level committees, comprising the Corporate Governance and Sustainable Development Committee (CG&SDC) and Risk Management Committee (RMC), are responsible for overseeing performance and processes related to climate risks and opportunities. Implementation of climate activities are driven by management-level committees.

The Sustainability Development Committee (SDC) and Enterprise Risk Management Committee (ERMC), reports to the CG&SDC and RMC at the board level and, are key management level committees responsible for driving climate actions. Chaired by the managing director, both committees comprise top executives across functions (e.g. strategy, operation, business development ,sourcing as well as Quality, Security, Safety, Occupational Health and Environment (QSE)) to ensure effective implementation of climate activities and monitoring of climate management outcomes.

GGC provides monetary incentives in the form of bonus for the managing director, executives, and employees related to the implementation of GHG reduction and energy efficiency measures to drive the success of GGC's climate strategy. Progress against targets and performance is assessed against corporate KPIs, one of which is directly linked to GGC's decarbonization pathway, and determines the annual bonus allocation for employees.

03
Risk Management and Strategy

Climate-related Risks and Opportunities Assessment Process

GGC's climate-related risks and opportunities assessment is integrated in GGC's overall risk management process. In line with the Enterprise Risk Management Process, climate-related risks and opportunities were considered alongside with other business risks and opportunities (including corporate, operational, and emerging risks) using the same risk assessment criteria and reported through the ERMC, RMC, and BOD. Management and monitoring of progress are conducted in a consistent manner across all corporate risks.

GGC assesses climate-related risks and opportunities across GGC's own operations and upstream and downstream value chains. GGC adopts the following process to assess climate-related risks and opportunities:

Identification of Climate-related Risks and Opportunities

- Climate-related risks and opportunities, covering physical risks, transition risks, and transition opportunities, identified using bottom-up and top-down approaches
- Bottom-up approach: cross-functional engagement conducted to identify climate risks and opportunities in current operations and value chain
- Top-down approach: strategic risks and opportunities for GGC identified through review of sectoral climate related risks and opportunities as well as global and national trends including changes in climate-related regulations.

Assessment of Climate-related Risks and Opportunities

- Risks and opportunities assessments are updated on an annual basis to reflect current climate trends and GGC's business context
- Scenario analysis covering financial and non-financial impacts were evaluated and quantified for risks and opportunities that are perceived to have substantial impact*
- Management measures to capture opportunities and mitigate or adapt to risks were identified including the cost associated.

Prioritization of Climate-related Risks and Opportunities

- Risks and opportunities were analyzed and prioritized through a cross-functional participatory process led by the ERMC and RMC and approved by the management.
- If the impacts from a risk or opportunity was identified as a "substantive impact*", implementation of mitigation and adaptation measures of the risk or opportunity is prioritized to minimize risks.

** "Substantive impact" defined in the next page.*

Identification of Risks and Opportunities with Substantive Impact

Climate change is important to the company's strategy and business growth. GGC defined substantive financial or strategic impact from the possibilities of risks ranging from business-related risks to climate-related risks that could interrupt our value chain and operations, affect the ability to achieve the company's strategy and business objectives, or materially impact the license to operate (including reputation issues).

GGC considers climate-related risks and opportunities to have substantive impact if they are expected to affect GGC's business strategy under the following areas:

Area	Threshold
Finance	Impacts on GGC's EBIDTA/cash flow or subsidiaries' EBITDA/cash flow above 10%
Health, Safety and Environment	Involvement in severe injury case and above environmental impact of magnitude but reversible with mitigation actions
Partner/Customer	Reduction of sales volume by 10-20% or loss of contract with suppliers and customers
Regulation	Violation of laws and regulations
Brand/reputation/social	Above concern/complaints of public groups/organizations, and impact on local communities, but reversible with long-term mitigation
Goal/achievement	Above business disruption and unachievable corporate goals

Climate-related Risks and Opportunities Overview

To develop a holistic understanding of potential climate-related risks and opportunities that may impact GGC's own business operations, upstream activities (suppliers and other partners), and downstream activities (customers and other business partners), GGC identified potential physical and transition drivers covering chronic and acute physical drivers as well as policy & legal, technology, market, and reputational transition drivers. Three assessment time horizons have been defined including short-term (0-5 years), medium-term (5-10 years), and long-term (10-30 years). For each driver identified, GGC developed short-term (less than 5 years) management measures to address potential impacts for all existing and new operations (100%).

Risks	Risk Type	Time Horizon	Risk Description & Financial Implications	Management Measures (2022-2027)
Physical Impact on Agricultural Production (i.e. Drought, Flood and Increased Air temperature)	Acute Chronic	Medium-term	• Change in weather patterns causing intensified floods and droughts as well as increased mean temperature negatively affects the production of agricultural feedstock (sugarcane and palm oil) resulting in supply shortage, price increase, and price volatility. • Loss of revenue, increased cost of feedstock, narrowed profit margin.	• Monitor water situation and prepare to diversify supply sources of feedstock. • Use derivatives on feedstock price to reduce financial risk from price volatility. • Construct rain harvesting and water storage system for its suppliers in order to handle water scarcity issues.
Nationally Determined Contributions (NDC)	Policy & Legal (Current Regulation)	Short-term	• Thailand's NDC target is to become carbon neutral by 2050 and achieve net zero emissions by 2065. Although not enforced, GGC is expected to align and contribute to this target. • Increase in operational expenses and capital expenditures to invest in new technologies that enable GHG reductions to achieve target.	• GGC developed GHG emission reduction targets for Scope 1 and 2 emissions and is in the process of developing a scope 3 reduction target. • Monitor GHG emissions and implement new and planned reduction strategies to meet targets.
Implementation of Carbon Pricing	Policy & Legal (Emerging Regulation)	Medium-term	• Policies and regulations are progressing towards more stringent control of GHG emission which could result in the implementation of carbon trading/ carbon tax scheme,. • Increase in operational expenses proportional to GHG emission.	• Increase CAPEX directed for increasing renewable energy consumption, enhancing energy efficiency and investing in low carbon/decarbonization technology.
Exposure to Climate Change-related Litigation	Policy & Legal (Legal Risk)	Short-term	• Increased scrutiny from the public sector, government agencies, and other stakeholders on climate-related issues increase GGC's exposure to potential climate change-related litigation.	• Develop and demonstrate clear climate strategy to support GGC's climate commitments. • Increase transparency and accuracy of climate change-related disclosures.

Climate-related Risks and Opportunities Overview

Risks	Risk Type	Time Horizon	Risk Description & Financial Implications	Management Measures (2022-2027)
Carbon Capture, Utilization, and Storage (CCUS)	Technology	Long-term	• CCUS may potentially enable large reductions in GHG emissions while allowing continued operations at low net emissions. • Deployment of CCUS technologies require large capital and investments as well as significant planning.	• Monitor potential opportunities from CCUS and consider conducting preliminary studies if appropriate.
Electrification of the Transport Sector	Market	Medium-term	• Short-term increase in biofuel demand due to increased uptake to meet GHG reduction targets. However, electricity demand is expected to gradually rise due to expansion of EV car which uses electricity can decarbonize the transportation sector but at the same time reduces the demand for biodiesel (B100) which is the main revenue stream for GGC, • Increase in revenue in the short-term but will gradually contract to reflect changes in demand over time of biofuel (B100) and bioethanol (E100).	• Closely monitor the Alternative Energy Development Plan (AEDP) for amendment to align with the national EV policy from AEDP 2018 (2018-2037) • Join hands with business partners in studying and developing the domestic market to sustain future investment and identify suitable technology for project investment in advanced biofuels • Study marketing data in conjunction with GC Group to identify marketing opportunities and seek suitable technology for the project on extension of ethanol's value • Jointly investigate with business partners and technology licensors the expansion to Bioplastics based on Biochemical feedstock • Study and expand the Oleochemical business toward downstream products with high-value i.e. Home and Personal Care (HPC) products.
Demand for Biofuels	Market	Short-term		
Stakeholder Perceptions	Reputation	Short-term	• GGC's reputation may be impacted if GGC does not have a clear climate strategy with sufficient action taken in line with the strategy. • Transparent and accurate climate disclosures will positively impact GGC's reputation enabling GGC's access to capital and business/investment opportunities.	• Engage with stakeholders on topics related to climate change and low carbon economy transition. • Continue to maintain and improve transparency and quality of sustainability and climate change-related disclosures. • Regularly revise climate strategy to maintain relevance to changing context.

Climate-related Risks and Opportunities Overview

Opportunities	Opportunity Type	Time Horizon	Risk Description & Financial Implications	Management Measures (2022-2027)
Green and Sustainable Products	Market	Medium-term	• GGC recognizes the opportunity to offer green and sustainable products to our customers. This us driven by the rise of eco- and sustainable consumerism. Furthermore, the rise of regulations such as EU's Carbon Border Adjustment Mechanism (CBAM) will also strengthen the competitive advantage for companies with low carbon value chain. Carbon Offsetting and Reduction Scheme in Aviation (CORSIA) will increase the demand of Sustainable Aviation Fuel (SAF) where GGC is developing advanced biofuel products to serve this growing market. • Increasing revenues from customers who are looking for low carbon and sustainable raw materials as well as aviation fuels. Enhancing access to capital from green business reputation.	• Invest on low carbon biochemical and bioplastic products plants including the utility provider and infrastructure • Invest in research and development with partners • Enhance value chain engagement through a collaboration with GIZ to promote and develop the caliber of small farmers up to the RSPO standard
Shift Towards Renewable Energy	Energy source	Medium-term	• GGC has an opportunity to utilize waste from the operation e.g. bagasse in bioethanol production to generate clean electricity and stream. Also, GGC has an opportunity to switch the fuel from carbon intensive sources such as fuel oil to other low carbon alternatives such as natural gas and biogas • Revenue generation form selling renewable utilities, Energy cost saving from less energy procurement, Lowering future costs related to GHG emissions i.e. carbon tax, carbon offset, carbon capture and storage. Reduced waste management cost. Good reputation from being the leader in renewable energy usage may enhance our access to capital.	• Invest on a biomass power plant with high-pressure steam production • Explore options in fuel switching from fuel oil to other low carbon alternatives
Efficiency Improvement in Production and distribution Processes	Resource efficiency	Medium-term	• GGC has a potential to improve the efficiency in operations and save energy and materials used in business activities which in turn reduce GHG emissions. • Energy cost saving, Lowering future costs related to GHG emissions i.e. carbon tax, carbon offset, carbon capture and storage	• Conduct energy conservation and efficiency improvement both by the enhanced energy management measures and hardware upgrades • Investment in low carbon process technologies.

Climate-related Risks and Opportunities Scenario Analysis

GGC conducted context-specific qualitative and quantitative scenario analyses of climate-related risks and opportunities including both physical and transition drivers across GGC's own operations and value chain including:

Risk	Type	Scenario	Timeframe	Description
Drought	Physical risk (Acute)	IPCC RCP 1.9, RCP 4.5, RCP 8.5	2030, 2050	• The future projection of drought is based on the number of consecutive dry days under RCP1.9, RCP4.5 and RCP8.5 scenarios. The analysis is made context-specific by considering the main sugarcane sourcing area in Nakhon Sawan, the location for Nakhon Sawan Biocomplex. The timeframe of analysis spans over 2030 and 2050 in alignment with the plant's potential to operate in long-term
Flood	Physical risk (Acute)	IPCC RCP 1.9, 4.5, 8.5	2030, 2050	• The future projection of flood is based on the number of days with precipitation >20 mm under RCP1.9, RCP4.5 and RCP8.5 scenarios. The analysis is made context-specific by considering the main location for palm oil sourcing in top 3 provinces in Thailand namely, Krabi, Surat Thani and Chumphon. The timeframe of analysis spans over 2030 and 2050 in alignment with the plant's potential to operate in long-term
Increased Air temperature	Physical risk (Chronic)	IPCC RCP 2.6, RCP 4.5, RCP 8.5	2030, 2050	• The future projection of air temperature is based on the number of consecutive dry days under RCP2.6, RCP4.5 and RCP8.5 scenarios. The analysis is made context-specific in Thailand. The timeframe of analysis spans over 2030 and 2050 in alignment with the GGC plants' potential to operate in long-term.
Carbon Price Mechanism	Transition risk (Policy & Legal)	IEA STEPS IEA NZE 2050	2030, 2050	• The future projection of GHG emissions (scope 1 and 2) was used to calculate potential costs from a carbon price mechanism under IEA STEPS and NZE. Future GHG emissions projection was estimated using 2022 data as the baseline and projected using forecasted growth in production volume. The analysis is context-specific for Thailand, where all operations and majority of market of GGC are located. The timeframe of analysis covers 2030 and 2050 in alignment with the GGC plants' potential to operate in long-term.
Changing Biofuel Demand	Transition risk (Market)	IEA STEPS IEA NZE 2050	2030, 2050	• The future projection of change in biofuel demand assessed potential opportunities derived from forecasted biofuel consumption data (sourced from the IEA). The analysis is context-specific for GGC as impacts are quantified based on GGC's current and forecasted production of methyl ester. The timeframe of analysis spans up to 2030 and 2050 in alignment with the GGC plants' potential to operate in long-term.

Physical Scenario Analysis

Drought

Impact

Drought is likely to have high impact on upstream activity, especially on the reduced production of sugarcane resulting in feedstock shortage and increased procurement cost.

Result

The maximum number of consecutive dry days in Nakhon Sawan is likely to increase the most under RCP 1.9 (8%) both in 2030 and 2050, as well as under RCP 8.5 (7%) in 2050. The financial impact proxy is based on the extreme drought event in 2021 driving up the mill gate price of sugarcane from 1,000 THB to 1,300 THB (30% increase).

Change in Max Number of Consecutive Dry Days
(from 1995-2014 baseline)

	Baseline	RCP1.9		RCP4.5		RCP8.5	
	1995-2014	2030	2050	2030	2050	2030	2050
Rayong	-	6%	1%	1%	2%	1%	5%
Chon Buri	-	10%	5%	2%	4%	3%	7%
Nakhon Sawan	-	8%	8%	2%	4%	3%	7%

Source: CCKP. *World Bank Group, Climate Change Knowledge Portal.*

Flood

Impact

Flood is likely to have high impact on upstream activity, especially on the reduced production of palm oil resulting in increased procurement cost.

Result

The southern part of Thailand is likely to experience growing number of days with heavy rainfall (>20 mm) particularly in RCP 1.9 and RCP 4.5 scenario. The financial impact proxy is based on the 2017 extreme flood event in the south which was reported to drive up the cost of Fresh Fruit Bunches (FFB) by 40% from 4.20 THB/kg to 7 THB/kg.

Change in Number of Heavy Rainfall Days (Days with precipitation >20mm)
(from 1995-2014 baseline)

	Baseline	RCP1.9		RCP4.5		RCP8.5	
	1995-2014	2030	2050	2030	2050	2030	2050
Krabi	-	22%	16%	13%	15%	4%	8%
Surat Thani	-	17%	8%	12%	13%	2%	8%
Chumphon	-	7%	-4%	10%	9%	-1%	7%
Average		15%	7%	12%	13%	2%	7%

Source: CCKP. *World Bank Group, Climate Change Knowledge Portal.*

Rising Mean Temperatures

Impact

As a result of risk assessment throughout value chain, increased air temperature is likely to have high impact on upstream activity, especially on the reduced production of palm oil resulting in increased procurement cost.

Result

Due to the increase in annual average air temperature in 2030, the overall palm oil production is likely to decrease by 13% - 14% under RCP 2.6 and RCP 8.5 respectively. This could escalate up to 15-22% reduction in 2050.

Reduction in palm oil production under various climate scenarios (°C)
(from 1980-2010 baseline)

	RCP 2.6		RCP 4.5		RCP 8.5	
	2030	2050	2030	2050	2030	2050
Change in air temperature in (°C)	+1.3	+1.5	+1.3	+1.8	+1.4	+2.2
Reduction in palm oil production (%)	-13%	-15%	-13%	-18%	-14%	-22%

Source: *Climate Analytics — Climate impact explorer, Sarkar, Md, et al. (2020)*

Transition Scenario Analysis

Qualitative Analysis

Opportunity ← Risk/Opportunity Score Color Key → Risk						
High ≥ 0.5	Moderate 0.26 to 0.49	Low > 0 to 0.25	Neutral 0	Low < 0 to -0.25	Moderate -0.26 to -0.49	High ≤ -0.5

The heat map demonstrates the overall risk and opportunity associated with each transition driver in 2030 and 2050 for GGC. The comparison between STEPS scenario and NZE scenario represents the climate-related risks and opportunities that may occur during a low-carbon economy transition. The average risk and opportunity across GGC's operations and value chain at both 2030 and 2050 are considered 'low risk'.

The risk or opportunity score reflects the potential size of the risk or opportunity and is determined by looking at changes in driver trajectory for each driver across 2030 and 2050 under the STEPS and NZE scenario. The influence of each driver on GGC's financial performance (i.e. degree of potential impacts) and risk/opportunity likelihood is also considered in determining the risk or opportunity score.

Carbon Tax: In 2030, there are 'low risks' from the impact of implementing a carbon tax mechanism on GGC's own operations and value chain. By 2050, the impact on GGC's own operation increases from 'low risk' to 'moderate risk'. However, impacts on the value chain remain at 'low risk'.

Biofuel Demand: In 2030, there is a 'low opportunity' that GGC can capture from biofuels. However, this is a short-term opportunity and by 2050, the opportunity becomes 'neutral'.

TCFD Category	Identified Transition Driver	Financial Impact	Risk/Opportunity Score			
			GGC		Value Chain	
			2030	2050		
Policy & Legal	Carbon Tax *Future national policies and regulations may introduce direct carbon tax mechanisms resulting in higher operating costs.*	REVENUE ↓ OPEX ↑				
Market	Biofuel Demand *Consumer demand shifts from carbon intensive products to low carbon products (e.g. biofuels) as consumers seek to reduce GHG emissions and decarbonize.*	REVENUE ↓ OPEX ↑				
Average Risk/Opportunity						

Transition Scenario Analysis

Quantitative Analysis

Carbon Pricing Mechanism

Impact

Carbon price may affect GGC by increasing the operational expense proportionate to the amount of GHG emission. Carbon price may come in various form i.e. carbon trading under cap & trade scheme, carbon tax or carbon offset price. The carbon price may be embedded in utility cost in upstream or GGC may have to pay directly. The cost may also be passed through to the customer.

Result

Under the implementation of a carbon price scheme, GGC would need to pay for excess emissions. Under the "worst-case" scenario where GGC would need to pay for 100% of its emissions every year, without any intervention or GHG reduction initiatives, the change in net profit between STEPS scenario and NZE scenario is -2.84% in 2030 and -4.65% in 2050 indicating larger impacts from carbon tax costs in NZE compared to STEPS.

Estimated carbon price per tonne CO_2 from the IEA WEO 2022.

Carbon Price (THB/tonne CO_2)	2030	2050
STEPs	416	928
NZE	800	5,763

Response Measure

Thailand's NDC target and future implementation of a carbon price mechanism triggered GGC to allocate capital expenditure to support low-carbon climate response projects such as increasing renewable energy usage in operations.

Changing Biofuel Demand

Impact

As a result of risk assessment throughout the value chain, change in biofuel demand due to EV adoption and increasing availability of alternative clean fuels are likely to have high direct impact on GGC operation in terms of shrinking revenue on biofuel (B100) for on-road vehicles.

Result

Assuming the revenue from methyl ester (B100) in 2022 as a base case, the change in biofuel demand may result in a revenue increase of 4.22% in 2030 and 1.32% in 2050 under STEPS. Under the NZE scenario, there is a revenue increase of 7.55% in 2030 and a decrease in revenue of 2.18% in 2050.

Change in revenue under each scenario compared to the base case.

Revenue (% Change)	2030	2050
STEPs	4.22%	1.32%
NZE	7.55%	-2.18%

Response Measure

In response to the potential decrease in biofuel demand from on-road vehicles, GGC plans to expand our portfolio to capture greater opportunities in the sustainable aviation fuel (SAF) market. GGC expects an increase in biofuel demands from the SAF market, in response to decarbonization efforts, as indicated by the IEA NZE scenario data. This demand will be further driven by the ICAO's Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) guidelines which require the use of low-carbon fuels and for the aviation industry to decarbonize and achieve net zero emissions by 2050.

GGC Climate Strategy 2023-2030

GGC Climate Strategy 2023-2030 was developed to capture key climate opportunities identified, mitigate physical and transitional risks, and build business resilience in a low carbon future consistent with a 2°C or lower scenario. The strategy is subject regular revisions to ensure relevance, effectiveness, and alignment with national and global ambitions. Furthermore, GGC also aspires to conduct engagement activities with suppliers, customers, business partners as well as other policy makers and business associations in order to collaboratively proceed towards the low carbon society and achieve the goals of the Paris Agreement.

Ambition	***To be a Global Sustainable Company with Net Zero Emissions by 2050.***
Targets	**Reduce GHG emissions (Scope 1 + 2) 20% by 2030 compared to 2020 baseline.** **Achieve net zero emissions (Scope 1 + 2) by 2050.** **Reduce Scope 3 emission by 50% from based year 2020 within 2050**

Efficiency Driven

Increase operational efficiency, reduce use of energy sources, reduce GHG emissions, and reduce other wastes from the production process.

Initiatives

- Low carbon/renewable heat and power
- Process efficiency measures
- Advanced technology
- Renewable Energy Certificates (RECs)

Portfolio Driven

Investments centered around low-carbon businesses and product portfolio management from upstream through calculation of GHG emissions by life cycle assessment and applying 3RS to develop low-carbon products.

Initiatives

- Development of low carbon products and avoided emissions products with high-value added
  - 1st Gen Biofuel, Advanced Biofuel, Specialty Oleochemicals, Biochemicals, Food & Nutraceuticals, and Others

Compensation Driven

Apply natural carbon absorption methods and find new technologies to capture and offset greenhouse gases that cannot be reduced from the production process.

Initiatives

- Nature-based solutions (reafforestation)
- Technology-based solutions (CCUS)
- Carbon offset

Internal Climate Management

- Climate Governance
- Incentive for climate-related performance at all levels
- Integration of climate risks management process in enterprise risk management
- Implementation of internal carbon pricing

External Climate Management

- Value chain engagement with suppliers and customers to promote GHG reduction and circularity
- Partnership with academics, star-ups, industry, associations and institutions, and policy makers to promote and develop GHG reduction technology

04
Metrics and Targets

Climate-related Metrics and Targets

GGC is committed to report its GHG inventory and progress against targets on an annual basis in alignment with the GHG Protocol and ISO 14064-1:2006 specification with guidance at the organizational level for quantification and reporting of GHG emissions and removals. The GHG inventory covers scope 1, 2, and 3 emissions and covers 100% of GGC's own operations (i.e. operational control) and emissions are reported based on the calendar year. In this year's GHG inventory, the coverage of our scope 3 GHG inventory has been expanded to cover additional scope 3 categories as defined in the GHG Protocol. GGC strives to continuously improve our climate-related performance and associated disclosures in line with best practices.

GHG Emissions Targets

Reduce GHG emissions (Scope 1 + 2) 20% by 2030 compared to 2020 baseline.
Achieve net zero emissions (Scope 1 + 2) by 2050.
Reduce Scope 3 emission by 50% from based year 2020 within 2050

Scope 1 and 2 Emissions

GHG Emissions Data	Unit	2020	2021	2022	2023
Direct GHG emissions (Scope 1)	tCO_2e	33,333	30,509	29,817	28,450
Indirect GHG emissions from electricity (Scope 2) –Location Based	tCO_2e	85,630	76,728	84,066	83,908
Indirect GHG emissions from electricity (Scope 2) –Market Based	tCO_2e	59,481	61,358	67,954	73,708
GHG intensity (Scope 1+2)	tCO_2e per tonne product	0.17	0.20	0.23	0.23
Percentage of data coverage	**% Of Production volume**	**100**	**100**	**100**	**100**

Remarks:
- Emission figure in 2020 received self verification
- Emission figure in 2021-2023 received third-party verification

Climate-related Metrics and Targets

GHG Emissions Targets

Reduce GHG emissions (Scope 1 + 2) 20% by 2030 compared to 2020 baseline.
Achieve net zero emissions (Scope 1 + 2) by 2050.
Reduce Scope 3 emission by 50% from based year 2020 within 2050

Scope 3 Emissions

GHG Emissions Data	Unit	2020	2021	2022	2023
Category 1: Purchased goods and services	tCO_2e	785,798	500,194.97	504,662.87	541,297.54
Category 3: Fuel- and energy-related activities (not included in Scopes 1 or 2)	tCO_2e	3,874	N/A	N/A	N/A
Category 4: Upstream transport and distribution	tCO_2e	N/A	11,167.9	11,831.37	10,624.89
Category 5: Waste generated	tCO_2e	N/A	676.17	10,456.85	14,597.15
Category 6: Business travel	tCO_2e	N/A	1.8	3.83	27.59
Category 7: Employee commuting	tCO_2e	N/A	370.43	415.87	427.24
Category 9: Downstream transport and distribution	tCO_2e	N/A	9,796.12	8,790.19	9,286.60
Category 11: Use of sold products	tCO_2e	0	0	0	0
Category 12: End-of-life treatment of sold products	tCO_2e	0	0	0	0
Total Scope 3 GHG emissions	**tCO_2e**	**789,672**	**522,208**	**536,161**	**576,262**
Percentage of data coverage	**% Of Production Volume**	**100**	**100**	**100**	**100**

Inventory Exclusions:

Category 2, 8, 10 – Excluded due to the category's perceived irrelevance to GGC's business activities, primarily because of its low proportion of emissions, approximately 5% of the total Scope 1 and 2 emissions.
Category 9 – Currently in the process of collecting data and verifying the final information.
Category 11, 12 – GGC does include the "Use of sold products“ and “End-of-life treatment of sold products” category in its Scope 3 emissions calculations. However, due to the nature of GGC's products such as Glycerin, Fatty Alcohol, and Methyl Ester, which are utilized in downstream processes, the emissions attributable to GGC in these categories are effectively zero. This outcome is based on the understanding that the emissions associated with the use and end-of-life treatment of these products fall under the responsibility of the downstream operators.
Category 13 – GGC does not have any downstream leased assets.
Category 14 – GGC operates without franchises.
Category 15 – Scope 3 emission from investments already included in scope 1 and 2 emissions from GGC’s operations.

Remarks:

- Emission figure in 2020 received self verification
- Emission figure in 2021-2023 received third-party verification

Climate-related Metrics and Targets

Energy Target Reduce energy consumption per ton production by 3.25% by 2027 compared to 2020 baseline (0.65% per year between 2023-2027).

Energy Metrics	Unit	2020	2021	2022	2023
Energy consumption	MWh/ Ton of products	0.80	0.83	0.97	0.93

Waste Target Strive towards zero-waste to landfill every year.

Waste Metrics	Unit	2020	2021	2022	2023
Total amount of waste generation	tonnes	6,929	5,786	14,033	7,363
Waste diverted from disposal	tonnes	456	448	1,186	1,252

Low Carbon Product Target Continue efforts in the development of low carbon products.

Low Carbon Product Metrics	Unit	2020	2021	2022	2023
Revenue from low carbon products	%	N/A	25	56	28
Revenue from avoided emissions products	%	N/A	37	34	65

*GGC's low carbon products include Fatty Alcohols and Bio-Methyl Ester.

Responsible Climate Lobbying

In addition to our internal climate-related targets, GGC also contributes to tackling climate change through our climate lobbying activities which are aimed to support achieving climate goals in line with Thailand's nationally determined contributions and the Paris Agreement. We regularly assess our climate lobbying activities against the Global Standard on Responsible Climate Lobbying (Annex 1).

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Annex 1

Responsible Climate Lobbying

Responsible Climate Lobbying

Global Green Chemical Public Company Limited, or GGC, is committed to responsible engagement and participation as we expand our business operations. We are mindful of our impact on the economy, society, and environment of Thailand, and we strive to maintain a balance that ensures sustainable growth in all three dimensions. As part of our commitment to driving improvements at the industrial and national level, we actively collaborate with national and international associations. Through these partnerships, we work towards achieving our goal of promoting economic, environmental, and social sustainability.

At GGC, we collaborate with associations and organizations to support them in achieving their objectives of formulating and promoting public policies and regulations. These entities work with policymakers by providing them with data from external sources, research, and perspectives on a range of critical topics, including sustainable development for Thailand, various industries, health, safety, environmental conservation, and the implementation of the United Nations Sustainable Development Goals (SDGs). Our commitment to partnering with these organizations and providing valuable insights underscores our dedication to advancing the greater good and facilitating meaningful progress in the areas that matter most.

GGC is committed to the Paris Agreement and strives to reach net zero emissions by 2050. Our decarbonization strategy has three pillars: efficiency-driven, portfolio-driven, and compensation. We have established robust governance and oversight procedures to ensure our efforts align with Thailand's NDC and the Paris Agreement. Our contribution management system is in place and conforms to United Nations Global Compact's Guide for Responsible Corporate Engagement in Climate Policy.

Policy and Commitment

No.	Framework Indicator	GGC Actions
1	Make a public commitment to align all climate change lobbying efforts with the objective of limiting global temperature increase to 1.5ºC above pre-industrial levels.	GGC commits to conducting initiatives related to climate change, including lobbying, in alignment with Thailand's NDC and the Paris Agreement. GGC also commits to achieving Net Zero emissions by 2050 to limit the global temperature rise to 1.5ºC above pre-industrial levels. We have communicated our net zero commitments both internally and externally, and it is also included in our QSHEB Policy.
2	Apply the scope of this commitment to all subsidiaries, business areas, and all operational jurisdictions.	GGC's climate-related policies and climate strategy is applied to all its subsidiaries, jurisdictions, and business areas.
3	Publicly commit to taking actions ensuring that the groups and organizations of which it is a member conduct their lobbying efforts regarding climate change in alignment with the goal of limiting the global temperature increase to only 1.5ºC above pre-industrial levels.	GGC supports various associations and organizations in their mission to develop and promote public policies and regulations. These groups aid policymakers by sharing external information, research, and visions on sustainable growth in Thailand, various industries, health and safety, minimizing environmental impact, and implementing the United Nations' Sustainable Development Goals (SDGs). These activities align with Thailand's NDC and the Paris Agreement, contributing to their achievement.

Governance

No.	Framework Indicator	GGC Actions
4	Assign a board-level responsibility for overseeing the company's approach and activities related to climate change lobbying.	The Corporate Governance and Sustainability Committee (CGS), overseen by the Board, is responsible for providing updates on the company's sustainable development progress reported by the Sustainability Development Committee (SDC). The CGS ensures that the company is making progress toward achieving its goals and targets related to climate issues. All climate change-related activities, including policy engagement activities, must be approved by the CGS. Therefore, the CGS is accountable for reviewing and implementing the management system for activities related to climate policy, including collaborating and supporting with trade association.
5	Assign a senior management level responsibility to oversee the day-to-day implementation of the company's policies and practices regarding climate change lobbying.	The SDC was formed at the management level to oversee the strategic direction for addressing climate change issues. One of the key responsibilities of the SDC is to ensure that the organization and its partners have aligned measures, policies, and strategies. This is to ensure that GGC's policy related activities under the topic of climate change are consistent with its overall vision and goal of achieving net zero emissions.
6	Establish an annual monitoring and review process to verify that all the company's direct and indirect climate change lobbying activities conducted across all geographies align with the goal of limiting global temperature rise to 1.5ºC above pre-industrial levels.	GGC conducts a monitoring and review process annually to ensure that our public policy engagements activities align with the Paris Agreement. This applies to all activities with trade associations that we are involved in. Our climate lobbying activities are subject to internal approval by the board, which conducts a comprehensive review to ensure consistency across all geographies with Thailand's NDC and the Paris Agreement. Additionally, we collaborate with each trade association and organization that we contribute to in developing a monitoring and evaluation system focused on ensuring alignment with Thailand's NDC and the Paris Agreement.

Governance

No.	Framework Indicator	GGC Actions
7	Establish a systematic approach for involving stakeholders in the development and evaluation of climate change lobbying policies, stances, and actions.	GGC consistently collaborate with our stakeholders, including suppliers, customers, government representatives, industry peers, and members of trade associations and organizations, who are involved in climate-related policies and activities to review and ensure alignment of our climate change policies, positions, and activities.
8	Establish a well-defined framework for addressing misalignments between the climate change related lobbying positions of associations, alliances, and coalitions and the objective of limiting global temperature increase to 1.5ºC above pre-industrial levels.	GGC strives to ensure that the objectives of trade associations and organizations align with Thailand's NDC and the Paris Agreement through regular engagements with other members to review activities. A clear framework is in place to address any misalignments identified. Misalignments and discrepancies are resolved through extensive discussions and engagements with involved parties. If necessary, we may distance ourselves from the misalignment to ensure alignment with Thailand's NDC and the Paris Agreement.

Actions

No.	Framework Indicator	GGC Actions
9	Publish an annual review of the company that includes a comprehensive assessment and action plan toward achieving the 1.5ºC climate change - alignment of (a) its own climate change lobbying activities; (b) the climate change lobbying activities of the associations, alliances, coalitions, or thinktanks of which it is a member or to which it provides support	GGC takes climate change lobbying seriously and reviews our activities at least once a year to ensure they align with Thailand's NDC and the Paris Agreement. During this process, we engage with stakeholders and members of trade associations and organizations to monitor policies and activities. Our review found no misalignments between these activities and the goals of Thailand's NDC or the Paris Agreement. All of our climate change-related actions, including lobbying, are approved by the board through the CGS.
10	Acknowledge any misalignments in its climate change lobbying efforts and take action to address them. This includes reporting on any misalignments between its climate change lobbying activities and/or the climate change lobbying activities of its trade associations, coalitions, alliances, or funded thinktanks, and ensuring that all efforts are aligned with the goal of limiting global temperature rise to 1.5 ºC above pre-industrial levels.	GGC has found no misalignments between our efforts to influence climate change policy and the actions of trade associations, in regards to Thailand's NDC or the Paris Agreement.
11	Form or participate in coalitions with the specific purpose of lobbying in support of the goal of restricting global temperature rise to 1.5ºC above pre-industrial levels.	GGC has been actively engaging in discussions with the government regarding environmental and climate change policies. The aim is to promote initiatives and projects that support Thailand's transition towards a low carbon economy in compliance with the Paris Agreement and Thailand's NDC. One of the projects being discussed is the Bio-Circular-Green Economy model, which emphasizes resource efficiency and circularity in the biochemicals sector. Going forward, GGC will keep seeking opportunities to join coalitions that are aligned with Thailand's NDC and the Paris Agreement.

Specific Disclosures

No.	Framework Indicator	GGC Actions
12	Publicly disclose, for all geographies, its membership of, support for and involvement in all associations, alliances and coalitions engaged in climate change-related lobbying.	GGC engages in climate change-related lobbying through our membership, support, and involvement in the following trade associations which cover three main topics: **1. Sustainable development and action to mitigate impacts of climate change in order to build a balance of sustainable business development** • Renewable Energy Industry Club • Thai Biodiesel Producer Association (TBA) • Thailand Business Council for Sustainable Development (TBCSD) GGC has joined and supported many trade associations that prioritize the environment in the business sector. Our commitment to sustainable development has three main focuses: developing sustainability policies in Thailand, promoting business competitiveness, and implementing sustainable practices. Additionally, we strive to educate the public on social and environmental issues. We are dedicated to mitigating the impact of climate change by advocating for policies that promote Net Zero greenhouse gas emissions and adhere to the principles of the circular economy in business operations. **2. Bioeconomy - Commit to grow the business that relates to agricultural raw materials** • The Federation of Thai Industries (F.T.I) • Roundtable on Sustainable Palm Oil (RSPO) • Member of BIOPLASTIC • Thai Bioplastics Industry Association GGC has clearly defined our role to be a leader in responsible operations and the sustainable use of raw materials. To achieve this, we actively support various trade associations and non-profit organizations that assist stakeholders involved in the palm oil industry. This includes palm farmers, consumer product manufacturers, palm oil retailers, financial institutions, and NGOs focused on environmental and social development. Our goal is to demonstrate our dedication to operating in a responsible manner that benefits both society and the environment.

Specific Disclosures

United Nations Global Compact

<table>
<tr><th>No.</th><th>Framework Indicator</th><th>GGC Actions</th></tr>
<tr><td>13</td><td>Publicly disclose, for each of these organizations::
(a) how much it pays to them on an annual basis;
(b) those organizations where it sits on the board or plays an active role in committees or other activities related to climate change.</td><td>
Contributions to Each Organization
<table>
<tr><th>Trade Association</th><th>Contributions 2023 - THB</th></tr>
<tr><td>Thailand Business Council for Sustainable Development (TBCSD)</td><td>250,000</td></tr>
<tr><td>Roundtable on Sustainable Palm Oil (RSPO)</td><td>120,000</td></tr>
<tr><td>The Federation of Thai Industries (FTI)</td><td>30,000</td></tr>
<tr><td>Thai Bioplastics Industry Association</td><td>10,000</td></tr>
<tr><td>Thai Biodiesel Producer Association (TBA)</td><td>8,000</td></tr>
<tr><td>Renewable Energy Industry Club</td><td>5,000</td></tr>
<tr><td>Member of BIOPLASTIC</td><td>2,000</td></tr>
<tr><td>Total</td><td>425,000</td></tr>
</table>
Active roles and activities related to Climate Change
GGC has recently joined the Renewable Energy Industry Club, facilitated by the Federation of Thai Industries (FTI). The primary objective of this club is to enhance and advance the renewable energy industry in Thailand towards sustainability, through promoting collaboration between the government, private sector, and local communities. The ultimate goal is to reduce greenhouse gas emissions, aligning with the objectives of the Paris Agreement.
</td></tr>
</table>

Specific Disclosures

No.	Framework Indicator	GGC Actions
14	Publicly disclose its overall assessment of the influence that its climate lobbying has had on: (a) supporting ambitious public climate change policy; (b) the company's ability to deliver its own corporate transition strategy.	At GGC, we are committed to supporting public policies that tackle climate change. To achieve this, we contribute to trade associations and organizations that align with Thailand's NDC and the Paris Agreement. Our aim is to achieve net zero emissions by 2050, which is crucial in limiting global temperature rise to 1.5ºC above pre-industrial levels. Our contributions mainly focus on three areas: (1) Support mitigation actions for climate change; (2) Developing sustainable petroleum and petrochemical industries; and (3) Promoting socially and environmentally responsible business practices. Supporting initiatives and projects that align with Thailand's NDC and Paris Agreement and promoting the country's transition to a low carbon economy through our climate lobbying activities allow GGC to influence the development of climate-related policies and initiatives at both the national and sectoral levels. Ultimately, this helps GGC achieve our own net zero emissions goal by 2050 through our corporate transition strategy.

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Annex 2

Transition Scenario Analysis

Quantitative Assessment Approach

The impacts of carbon tax and biofuel demand which were identified as a risk and an opportunity in the qualitative assessment was further studied to understand the potential financial impacts that may occur to GGC. Quantification of financial impacts utilize both GGC's input and IEA scenario data (STEPS and NZE). The quantification of potential impacts from carbon tax looks at GGC's operations (across all product portfolios) whereas the quantification of potential impacts from change in biofuel demand focuses on GGC's methyl ester (ME) production.

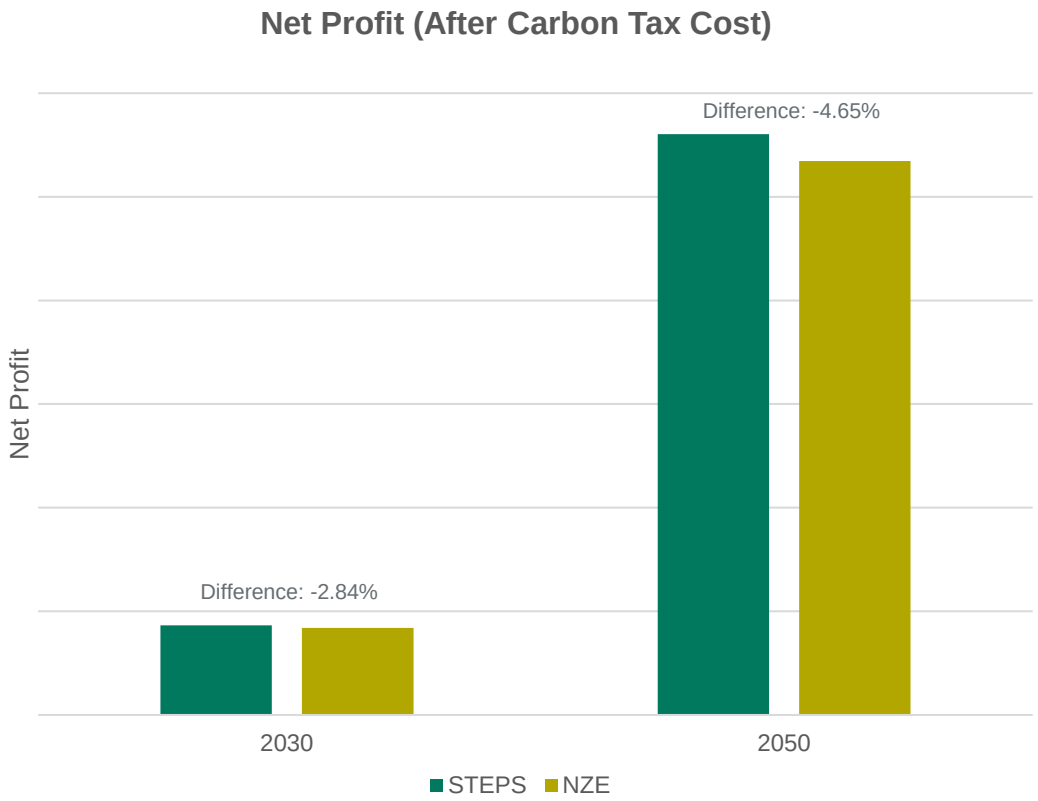
Refer to Appendix 1 for calculation approach and assumptions.

Driver	Input Variables	Financial Impact (Output)
Risk Driver: **Carbon tax**	• Scope 1 and 2 GHG emissions • Total sales revenue • Total net profit • Total production volume • Potential carbon price (STEPS, NZE)	→ Potential carbon price impacts on net profit
Opportunity Driver: **Biofuel Demand**	• ME sales revenue • ME production volume • Total final consumption – modern bioenergy: liquid (STEPS, NZE)	→ Potential revenue from biofuels

= GGC's Data = IEA Scenario Data

Transition Risk

Potential Risks from the Implementation of a Carbon Tax Mechanism



Thailand is expected to have a carbon tax mechanism in the future. However, it is still under development. Therefore, each scenario has been defined as the following:

- STEPS: "business-as-usual" scenario
- NZE: "low carbon" scenario

Refer to Appendix 1 for all assumptions underlying calculations.

Under the implementation of a carbon tax mechanism, GGC would need to pay for excess emissions. Under the "worst-case" scenario where GGC would need to pay for 100% of its emissions every year, without any intervention or GHG reduction initiatives, the carbon tax cost in 2030 is 53 million THB under STEPS and 102 million THB under NZE. By 2050, carbon tax costs are 102 million THB under STEPS and 622 million THB under NZE.

The change in net profit between STEPS scenario and NZE scenario is -2.84% in 2030 and -4.65% in 2050 indicating larger impacts from carbon tax costs in NZE compared to STEPS.

Results indicate that:

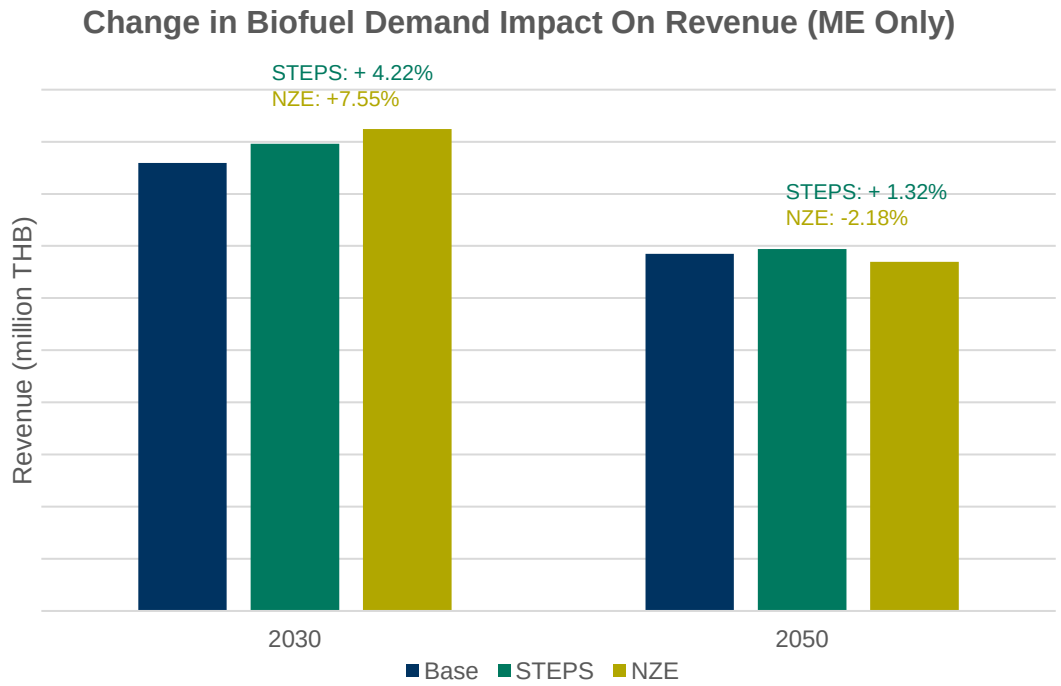
- Impacts are largest in 2050 under the NZE scenario due to high carbon price per tonne CO_2.
- However, the overall impacts from the implementation of a carbon tax mechanism is limited and may not have significant financial implications for GGC. This is due to GGC's scope 1 and 2 emissions being relatively low.

Estimated carbon price per tonne CO_2 from the IEA WEO 2022.

Carbon Price (THB/tonne CO_2)	2030	2050
STEPs	416	928
NZE	800	5,763

Transition Opportunity

Change in Biofuel Demand Results in Near-term Opportunities in 2030 under both STEPS and NZE



The quantification of this opportunity is based on GGC's main revenue stream which is methyl ester (ME). Each scenario has been defined as the following:

- Base: GGC's current operations and forecasted ME production (with no additional capacity)
- STEPS: "business-as-usual" scenario that considers additional ME production as suggested by scenario data
- NZE: "low carbon" scenario that considers additional ME production as suggested by scenario data

Refer to Appendix 1 for all assumptions underlying calculations.

Biofuels present a potential opportunity for GGC where additional production of biofuels can be considered to meet the biofuel market demand. The potential revenue from additional production of biofuels in 2030 is 725 million THB under STEPS (estimated annual revenue is 90 million THB) and 1,298 million THB under NZE (estimated annual revenue is 162.25 million THB). By 2050, the potential revenue from additional production of biofuels is 181 million THB under STEPS and -298 million THB under NZE.

Change in revenue under each scenario compared to the base case.

Revenue (% Change)	2030	2050
STEPS	4.22%	1.32%
NZE	7.55%	-2.18%

Results indicate that:

- There are near-term opportunities from additional biofuel production in both STEPS and NZE. This reflects the biofuel market demand trend where demand increases until peaking in 2030.
- In the long-term (i.e. 2050), opportunities will decline as reflected in STEPS and NZE due to decreased biofuel market demand. The decreased biofuel market demand is due to electrification and adoption of alternative fuels such as green hydrogen. This trend will be observed first under NZE followed by STEPS resulting in decreased revenue in NZE and minimal revenue growth in STEPS.

Thank You

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