GGC
Task Force on Climate-Related Financial Disclosures (TCFD) 2022

Global Green Chemicals Public Company Limited

The Integration of TCFD Framework to Address Climate Related Risks

GGC is aspired to be a leading green chemical company by creating sustainable value. As GGC's business is closely related to agricultural feedstocks and our market is mainly focused on green, bio-products, climate change is a crucial driver that affects GGC's operation and value chain. Therefore, GGC strives to operate our business in the ways that are responsible for the environment, enhancing the security in our supply chain, creating value for the community and society and providing customers with eco-friendly and sustainable products.

GGC integrated Task Force on Climate-Related Financial Disclosures (TCFD) into corporate-wide risk management process which guides the company towards a holistic management of climate topic. GGC recognizes the importance of having business strategy that are informed by climate risks and opportunities in order to progress towards the net zero future with resilience and sustain our competitive advantage in a low carbon society.

*"GGC has set the GHG emissions reduction target of 20 percent within 2030 and developing business towards **the Net Zero Target** within 2050."*

Core Elements of TCFD Disclosure

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

GGC TCFD Disclosure

TCFD Components	Documents
Governance	
a) Describe the board's oversight of climate related risks and opportunities.	This document page 4
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.	This document page 6-11
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.	This document page 4-5
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.	This document page 12-13
b) Disclose Scope 1, Scope 2, and, if appropriate, Scope 3 greenhouse gas (GHG) emissions, and the related risks.	This document page 12-13 and GGC Integrated Sustainability Report 2021 page 90-92
c) Describe the targets used by the organization to manage climate-related risks and opportunities and performance against targets.	

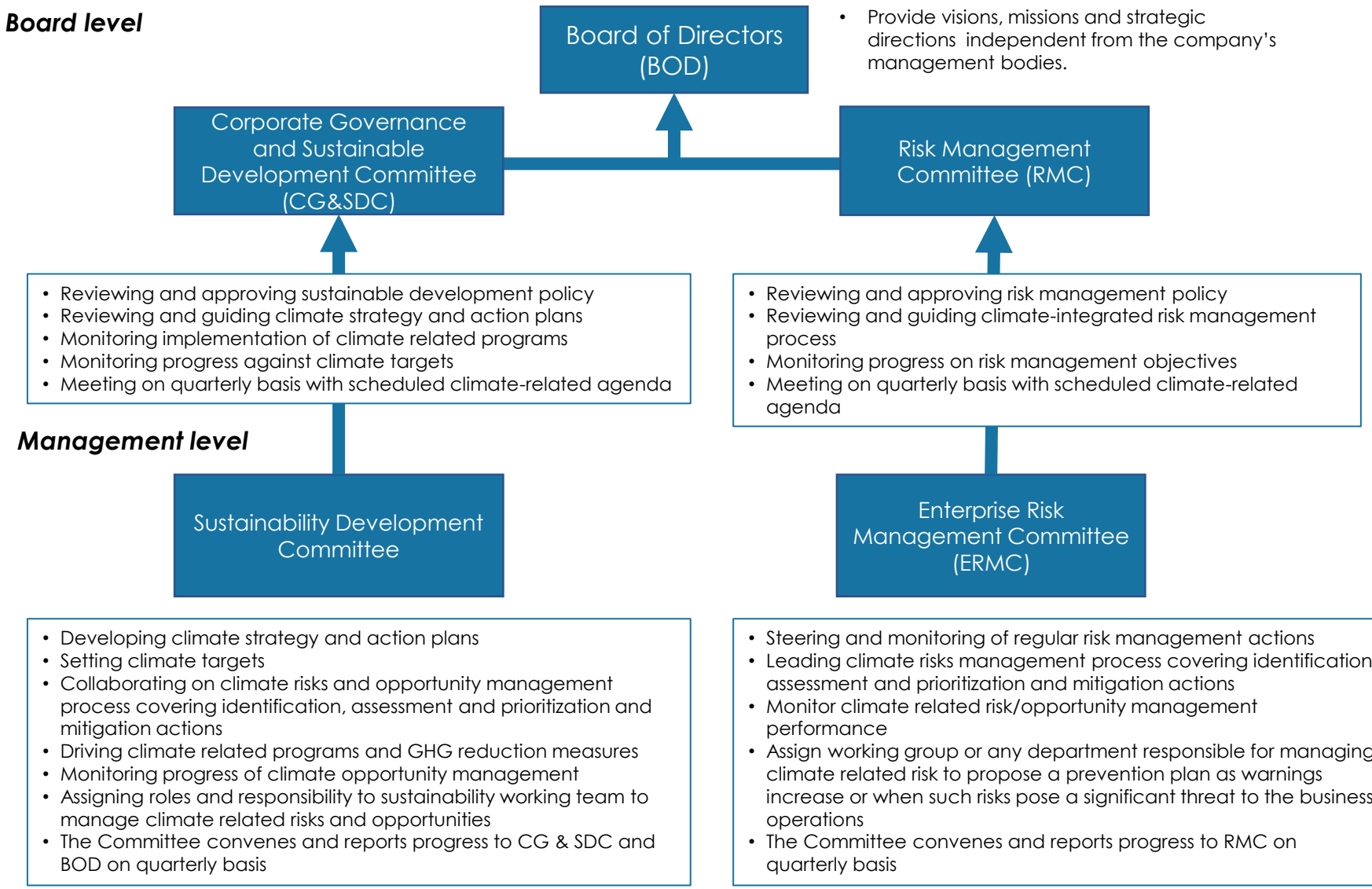
Roles and Responsibilities on Climate Change

To drive our business towards Net Zero target in 2050, GGC has in place the board level committees to oversee climate risks and opportunities process and performance as well as management-level committees to drive climate activities.

Sustainability Development Committee and Enterprise Risk Management Committee (ERMC)are key management level committees that are responsible for driving climate actions. Chaired by managing director, both committees consist of 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.

To drive the success in climate management, GGC provides climate-related monetary incentives for Managing Director, executives and employees on GHG reduction and energy efficiency.

GGC Climate Governance Structure



Integrated Climate Change Risks & Opportunities Management Process as part of Corporate-wide Risk Management

Identification of Climate Related Risks and Opportunities

- Climate related risks and opportunities identification from bottom-up and top-down approaches was conducted covering
  - Physical risks
  - Transition risks
  - Opportunities
- In bottom-up approach, cross-functional engagement was conducted in order to identify climate risks and opportunities in current operations and value chain
- In top-down approach, a review of sectoral climate related risks and opportunities as well as global and national trends were conducted to identify any strategic risks and opportunities for GGC.

Prioritization of Climate Related Risks and Opportunities

- Risks and opportunities were analyzed and prioritized through a cross-functional participatory process and approved by the management.
- Financial and non-financial impacts were evaluated and quantified for each risks and opportunities
- Management measures to capture opportunities and mitigate or adapt to risks were identified including the cost associated.

Company's Centralized Enterprise Risk/Opportunity Management Process

- Climate related risks and opportunities were considered alongside with other business risks and opportunities using the same risk assessment criteria, and reported through the Enterprise Risk Management Committee (ERMC), Risk Management Committee (RMC) and Board of Directors (BOD), respectively, in line with company's Enterprise Risk Management Process.
- Management and monitoring of progress are conducted in similar manner to other corporate risks.

Overview of Climate Risks and Opportunities

Criteria for identifying risks and opportunities with substantive impact:
The topics that can potentially cause significant impact on GGC's strategy in terms of (1) financial, (2) health, safety and environment, (3) partner/customer, (4) regulation, (5) brand/reputation/social, and (6) goal/achievement

Scope of assessment: Own operation, Upstream activities (Suppliers and other partners), and Downstream activities (Customers and other business partners)

Time horizon: Short term (0-5 years) Medium term (5-10 years) Long term (10-30 years)

Risks	Risk Type	Time Horizon	Risk Description & Financial Implications	Management Measures
Physical Impact on Agricultural Production (i.e. Drought, Flood and Increased Air temperature)	Physical Risk (Both Acute and Chronic)	Medium-term	• Change in weather patterns causing intensified flood and droughts as well as increased mean temperature negatively affects the production of agricultural feedstock (sugarcane and palm oil) resulting in supply shortage, price rise 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.
Implementation of Carbon Pricing	Transition Risk	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,. • Increasing of the operational expense proportional to the amount of GHG emission.	• Increase CAPEX directed for increasing renewable energy consumption, enhancing energy efficiency and investing in low carbon/decarbonization technology
Changing Customer Behavior (EV Expansion)	Transition Risk	Medium-term	• 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, • Shrinking revenue on 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.

Overview of Climate Risks and Opportunities

Criteria for identifying risks and opportunities with substantive impact:
The topics that can potentially cause significant impact on GGC's strategy in terms of (1) financial, (2) health, safety and environment, (3) partner/customer, (4) regulation, (5) brand/reputation/social, and (6) goal/achievement

Scope of assessment: Own operation, Upstream activities (Suppliers and other partners), and Downstream activities (Customers and other business partners)

Time horizon: Short term (0-5 years) Medium term (5-10 years) Long term (10-30 years)

Opportunities	Opportunity Type	Time Horizon	Opportunity Description & Financial Implications	Management Measures
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 toward 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.

Scenario Analysis of Climate-Related Risks

GGC conducts a set of context-specific, qualitative and quantitative climate scenario analysis for physical and transition risks across our value chain as follows;

Risk	Type	Scenario	Timeframe	Description
Drought	Physical risk	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 RCP1.9 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	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 RCP1.9 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	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	NDC IEA NZE 2050	2030, 2050	• The future projection of GHG emission was done for Business-As-Usual with 2020 as a base year topped with emissions from new investments in the future. Scenarios based on current GGC target as well as NDC and IEA NZE 2050 were also compared against. 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 Customer Behavior (EV Expansion)	Transition risk	1. High EV promotion policy 2. Promotional policy of both EV and biofuel	2040	• The future projection of EV adoption is based on two scenarios; (1) promotional policy on both EV and biofuel and (2) promotional policy on EV only. Both scenarios are influenced by climate commitment of Thailand. The analysis is context-specific for Thailand, the main market of GGC. The timeframe of analysis spans is up to 2040.

Source : CCKP. World Bank Group, Climate Change Knowledge Portal | Climate Analytics — Climate impact explorer. | TDRI (2022) | Sarkar, Md, et al. (2020)

Scenario Analysis of Physical Risks

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 max 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.*

Impact

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

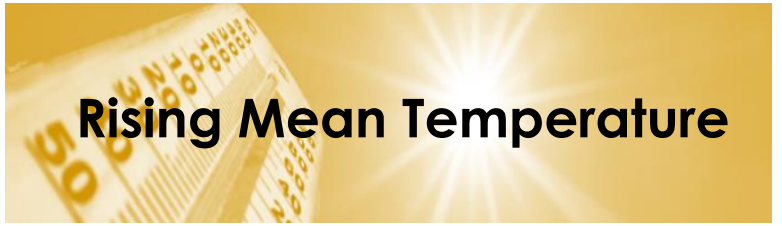
Result

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/ton.

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.*



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)*

Scenario Analysis of Transition Risks

Carbon Price 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

The carbon price could continuously potential rise. Note that achieving GGC 20% scope 1+2 GHG reduction by 2030 would keep the total carbon price in the lower estimate in all cases.

Carbon price

Carbon price	2030	2050
Carbon price for emerging market and developing economies with net zero pledges	1,333 THB/tCO2	5,334 THB/tCO2

Source: *Macro drivers – World Energy Model – Analysis - IEA*

Changing Customer Behavior (EV Adoption)

Impact

As a result of risk assessment throughout value chain, EV adoption is 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 2021 as a base case, the change in B100 demand due to the penetration of EV may result in 20% and 43.10% of revenue reduction in 2040.

Percentage of change in demand of biofuel[1] in 2040 compared to Business-As-Usual

Product	Business-As-Usual (BAU): No additional promotional policy of EV and biofuel	Scenario 1: Promotional policy on both EV and biofuel	Scenario 2: Promotional policy on EV only
Ethanol	0	-20%	-43.10%
Biodiesel	0	-7.60%	-41.70%

Source: *TDRI (2022)*

GGC Climate Strategy 2023-2030

To be a Global Sustainable Company with Net Zero Emissions by 2050

Efficiency Driven

Low carbon /renewable heat and power

Process efficiency measures

Advanced Technology

Portfolio Driven

Development of low carbon products & avoided emissions products with high value-added

- 1st Gen Biofuel
- Advanced Biofuel
- Specialty Oleochemicals
- Biochemicals
- Food & Nutraceuticals
- Others

Compensation Driven

Carbon Offset and Renewable Energy Certificates (REC)

Nature-based solution (Reafforestation)

Technology-based solution (CSS)

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 Engagement

- Value chain engagement with supplier and customer to promote GHG reduction and circularity
- Partnership with industry association and policy maker

Targets

Net Zero Emissions by 2050
20% reduction of scope 1+2 emission by 2030

GGC Climate Strategy 2023-2030 was formulated to capture key climate opportunities identified, mitigate physical and transitional risks and build business resilience towards the low carbon future consistent with a 2°C or lower scenario. The strategy is subject to the revision on regular basis to ensure effectiveness and alignment with the progress of national and global ambition.

Furthermore, GGC is also aspired 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 Paris Agreement.

GHG Emissions and Reduction Targets

Environmental Indicators	Unit	2018	2019	2020	2021
Direct GHG emissions (Scope 1)	tCO2e	6,415	4,128	27,714[2]	30,708[2]
Indirect GHG emissions from electricity (Scope 2) –Location Based	tCO2e	0	0	6,367[2]	8,362[2]
Indirect GHG emissions from electricity (Scope 2) –Market Based	tCO2e	66,747[1]	61,382[1]	65,607[2]	49,119[2]
Total Scope 3 GHG emissions	tCO2e	N/A	N/A	789,672	651,112
Scope 3: Purchased goods and services	tCO2e	N/A	N/A	785,798	647,987
Scope 3: Fuel and energy-related activities (not included in Scopes 1 or 2)	tCO2e	N/A	N/A	3,874[2]	3,125[2]
Scope 3: Use of sold products	tCO2e	0	0	0	0
Scope 3: End of life treatment of sold products	tCO2e	0	0	0	0
Targets	**20% reduction in the GHG emissions by 2030**				
	Net Zero emissions by 2050				

Remark

[1] In 2018-2019 GGC only purchased electricity from national grid

[2] Emission figure was verified by third-party verifier

- Data is based on calendar year
- Data in covers 100% of the operational control

Other Climate-Related Matrices and Targets

Environmental Indicators		Unit	2018	2019	2020	2021
Energy usage	Energy consumption	MWh/ Ton of products	2.1161	2.0949	2.1341	4.3916
	Reduction of energy consumption target	Reduction of energy consumption intensity per ton production by 3.25% by 2027 compared to 2020 baseline (0.65% per year between 2023-2027)				
Waste	Total amount of waste generation	tons	21,369.97	35,313.86	41,038.43	5,785.64
	Waste management target	Achieve Zero-Waste to Landfill*				
Low carbon and Avoided Emissions Products	Revenue from low carbon products	%	N/A	N/A	N/A	25
	Revenue from avoided emissions products	%	N/A	N/A	N/A	37

Remark
- Data is based on calendar year
- Data in covers 100% of the operational control

Contact

Corporate Affairs and Corporate Secretary
Global Green Chemicals Public Company Limited

555/1 Energy Complex Building A, 4th Floor,
Vibhavadi-Rangsit Road,
Chatuchak, Chatuchak,
Bangkok 10900 Thailand

TEL: +66 (0) 2558-7300
FAX: +66 (0) 2558-7301

TO BE A LEADING GREEN CHEMICAL COMPANY BY CREATING SUSTAINABLE VALUE

GGC
GLOBAL GREEN CHEMICALS