

GC Greenhouse Gas Report (Y2023)



PTT Global Chemical Public Company Limited
(31 May 2024)

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GHG REPORT FOR GC GROUP IN Y2023

1. General

1.1. Background

PTT Global Chemical Public Company Limited (GC) has developed a corporate Greenhouse Gas (GHG) management program as a proactive initiative to respond to international and domestic pressures and to help the world in combating climate change.

1.2. Standards for GHG Inventory Preparation

GC prepared a GHG inventory that takes account of the international standards based on international GHG estimation standards such as, ISO 14064-1:2018, Greenhouse Gas Protocol (developed by WBCSD/WRI, 2004), Compendium of Greenhouse Gas Emission Methodologies for the Oil and Natural Gas Industry (developed by API, 2009), IPCC Guidelines for National Greenhouse Gas Inventories (developed by IPCC, 2006) and Thailand Greenhouse Gas Management Organization (Public Organization).

1.3 Responsible for GHG Inventory

- 1) The corporate GHG accounting team responsible for consolidating GHG data provided by the facilities will want to explore.
- 2) Facility staff responsible for reporting facility-level data to corporate should read the following sections.

1.4 Reporting Period

This inventory report contains information related to GC GHG emissions the period 1st January to 31st December 2023 the total GHG emissions by scope, within our organizational boundary.

2. Organizational boundary

2.1. General

GC consists of a number of companies with differentiated business activities. Therefore, there is need in a standardized and systematic procedure for compiling GHG emission data for the GC group that can be sustained over the long term and that will improve data quality for the group.

GC Greenhouse Gas Emission Accounting and Reporting Manual is an all-encompassing organizational GHG accounting manual for reference by all facilities under GC corporate GHG management program.

2.2. Setting the organizational boundary

GC Manual uses the Operational Control approach for GHG accounting. Under the Operational Control approach, an organization accounts for GHG emissions from operations where it has full control over (all or nothing). The Operational Control gets by:

- 1) GC owns 100 % in equity share of the Company; or
 - 2) GC has the full authority to introduce and implement its operating policies at the operational level.
- Joint Venture as well as oversea facilities are not covered.

For the purpose of reporting up to the Global Reporting Initiative (GRI), Dow Jones Sustainability Index (DJSI), Carbon Disclosure Project (CDP) and GC using the Operational Control approach.

2.3. Greenhouse Gas Selection

Under the Kyoto Protocol, six greenhouse gases have been selected based on the significant estimated volume in the atmosphere due to anthropogenic activities, and the significant potential for reduction. Countries which ratified the Protocol have committed to reduce the “basket-of-six” greenhouse gases, which include; Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF₆).

At the time of this report no official decision had been made yet by IPCC on what source of global warming potentials (GWP) values should be used in the second commitment period. This manual adopts the American Petroleum Institute (API 2009, p.3-6) guidance on GWP selection. The API (2009) prescribes the use of IPCC Second Assessment Report (SAR) until the end of the Kyoto Protocol 1st Commitment Period (31st December 2012), and the use of IPCC AR6 GWP values beyond 2020.

This report accounts for GHGs considered under the Kyoto Protocol, and the following Non-Kyoto GHG: Hydrofluorocarbons (HFCs) and CFC use in refrigeration. These compounds are to be phased out under the Montreal Protocol, and GC will account for its use and report any reduction initiatives. However, GWP of these GHGs will not be accounted for in the GHG Inventory.

3. GHG Inventory Component and List of Facility

3.1 General

In line with ISO 14064-1, the organization shall document the following, where quantified, separately at facility and organization levels:

- Direct GHG emissions for each GHG;
- GHG removals;
- Energy indirect GHG emissions;
- Other indirect GHG emissions; and
- Direct CO₂ emissions from the combustion of biomass (biogenic emissions).

The organization should document separately at facility and organization levels other categories of GHG emissions and removals as appropriate.

3.2 Identification and Categorization of GHG Sources and Sinks

The organization shall, as appropriate, categorize the identified GHG sources following the categorization published by the GHG Protocol / ISO 14064:1 as follows:

3.2.1 Scope 1: Direct GHG Emissions

- Any fossil fuel combustion activity at stationary sources (captive power plants, process heaters, engines, turbines, flares, incinerators, oxidizers). This is normally for the generation of energy – e.g., Electricity, heat or steam.
- Process and vented emissions (process vents, equipment vents, maintenance /turnaround activities, non-routine activities).
- Any fossil fuel combustion of fuels in company owned or controlled vehicles (transportation of raw materials/products/waste; company owned vehicles);
- Fugitive emissions from pressurized equipment – e.g., Refrigeration chillers and SF₆ containing electrical switchgears, wastewater treatment etc.); and
- Accidental releases of GHG from equipment failure include those attributed to acts of nature or sabotage.

3.2.2 Scope 2: Energy Indirect GHG Emissions

- Consumption of purchased electricity, heat or steam supplied to the group by an external entity outside of the Organizational Boundary.

3.2.3 Scope 3: Other Indirect GHG Emissions

- Scope 3 emissions are any type of emissions which occur outside of the Organizational Boundary of GC.
- GC refer calculated to the Scope 3 Standard for requirements and guidance related to Technical Guidance for Calculating Scope 3 Emissions by GHG Protocol.

3.3 List of Facility

No.	Name	Business Unit	Location
1	GC 1 (RO)	Office building	59, Ratniyom Road, Noenphra, Mueang Rayong, Rayong 21150, Thailand.
2	GC 2 (OLE 1)	Olefins	14, I-1 Road, Tambol Maptaphut, Amphur Mueang Rayong, Rayong 21150, Thailand.
3	GC 2 (UT)	Utilities	
4	GC 2 (HDPE 1)	Polymers	
5	GC 2 (OLE 4)	Olefins	
6	GC 2 (HGP)	Olefins	
7	GC 3 (OLE 2)	Olefins	9, I-4 Road, Map Ta Phut Industrial Estate, Map Ta Phut, Mueang Rayong, Rayong 21150, Thailand.
8	GC 4 (ARO 1)	Aromatics	4, I-2 Road, Map Ta Phut Industrial Estate, Map Ta Phut, Mueang Rayong, Rayong 21150, Thailand.
9	GC 5 (ARO 2)	Aromatics	98/9, Rayong Highway 3191, RIL Industrial Estate, Maptaphut District, Rayong 21150, Thailand.
10	GC 6 (REF)	Refinery	8, I-8 Road, Map Ta Phut Industrial Estate, Map Ta Phut, Mueang Rayong, Rayong 21150, Thailand.
11	GC 7 (BTF)	Jetty & Buffer Tank Farm	19 Rong Pui Road, Map Ta Phut, Mueang Rayong, Rayong 21150, Thailand.
12	GC 8 (ATF)	Tank Farm	11, I-4 Road, Map Ta Phut Industrial Estate,

No.	Name	Business Unit	Location
			Map Ta Phut, Mueang Rayong, Rayong 21150, Thailand.
13	GC 9 (LAB)	Lab Center	24/9, Pakorn Songkrorat Road, Map Ta Phut, Mueang Rayong, Rayong 21150, Thailand
14	GC 11 (OLE 3)	Olefins	8 Padaeng Road, Maptaphut Amphur Mueng Rayong, Rayong 21150, Thailand.
15	GC 11 (LDPE)	Polymers	
16	GC 11 (LLDPE)	Polymers	
17	GC 12 (HDPE2)	Polymers	8, I-10 Road, Map Ta Phut Industrial Estate, Map Ta Phut, Muang Rayong, Rayong 21150, Thailand.
18	GC 16 (EO/EG)	EO-Based	9 Soi G-12 Pakorn Songkhraorat Road, Tambon Map Ta Phut Amphur Muang Rayong, Rayong 21150, Thailand.
19	GC 16 (EA)	EO-Based	
20	GGC (Plant I)	Green Chemicals	8, Pakornsongkhorat Road, Map Ta Phut, Muang Rayong, Rayong 21150, Thailand.
21	GCME	Office building	22/2 Pakornsongkoraj Rd. T.Maptaput, A.Mueang, Rayong 21150, Thailand.
22	NPC S&E	Office building	20/9 Pakorn Songkhraorat Road, Tambon Map Ta Phut Amphur Muang Rayong, Rayong 21150, Thailand.
23	GC 17 (GC Stryrenics)	Polymers	7 I-1 Rd., Map Ta Phut Industrial Estate, Map Ta Phut, Muang Rayong, Rayong 21150, Thailand.
24	ENCO (Head Office)	Office building	555/1 Energy Complex, Building A, 14th-18th Floor, Vibhavadi Rangsit Road, Chatuchak, Chatuchak, Bangkok 10900, Thailand.
25	GC 18 (Phenol I & II)	Phenol	9 Soi G9 Hemaraj eastern Industrail Eastern Pakornsongkrohraj,Rd Map Ta Phut Rayong 21150, Thailand.
26	GC 18 (BPA)	Phenol	
27	GC 13 (INNO)	Innovation building	83/9-10 Moo 5, Tambon Thap Ma, Muang Rayong, Rayong 21000 Thailand.
28	GC Corporate (Scope 1)	Corporate	Bangkok and Rayong
29	GC14 (Maintenance)	Office building	32 Rong Pui Road, Map Ta Phut, Mueang Rayong, Rayong 21150 Thailand.
30	GCMTPA	Polymers	8 Pakorn Songkhraorat Road, Tambon Map Ta Phut Amphur Muang Rayong, Rayong 21150, Thailand
31	TPRC	Polymers	18, Soi G-2 Pakorn Songkhraorat Road, Tambon Map Ta Phut Amphur Muang Rayong, Rayong 21150, Thailand
32	GGC (Plant II)	Green Chemicals	199/1 Moo 2, Khao Sok, Nong Yai, Chon Buri 20190, Thailand
33	GC 19 (GC Oxirane)	EO-Based	12 Soi G-4 Pakorn Songkhraorat Road, Tambon Map Ta Phut Amphur Muang Rayong, Rayong 21150, Thailand
34	GCP (GC Polyols)	Polymers	9 Soi G-14 Pakorn Songkhraorat Road, Tambon Map Ta Phut Amphur Muang Rayong, Rayong 21150, Thailand
35	GC Estate	Office building	888 Sukhumvit Road 20, Huai Pong, Amphur Muang Rayong 21150, Thailand

No.	Name	Business Unit	Location
36	Envicco	PCR Polymers	P433+XQ7 GC Estate Rd, Ban Chang, Ban Chang District, Rayong 21130, Thailand
37	GC 15 (GC Campus)	Office building	66 National Highway 363 Road, Nernpra Sub-District, Muang Rayong District, Rayong, Thailand 21150

4. GHG Reporting and Accounting

4.1. General

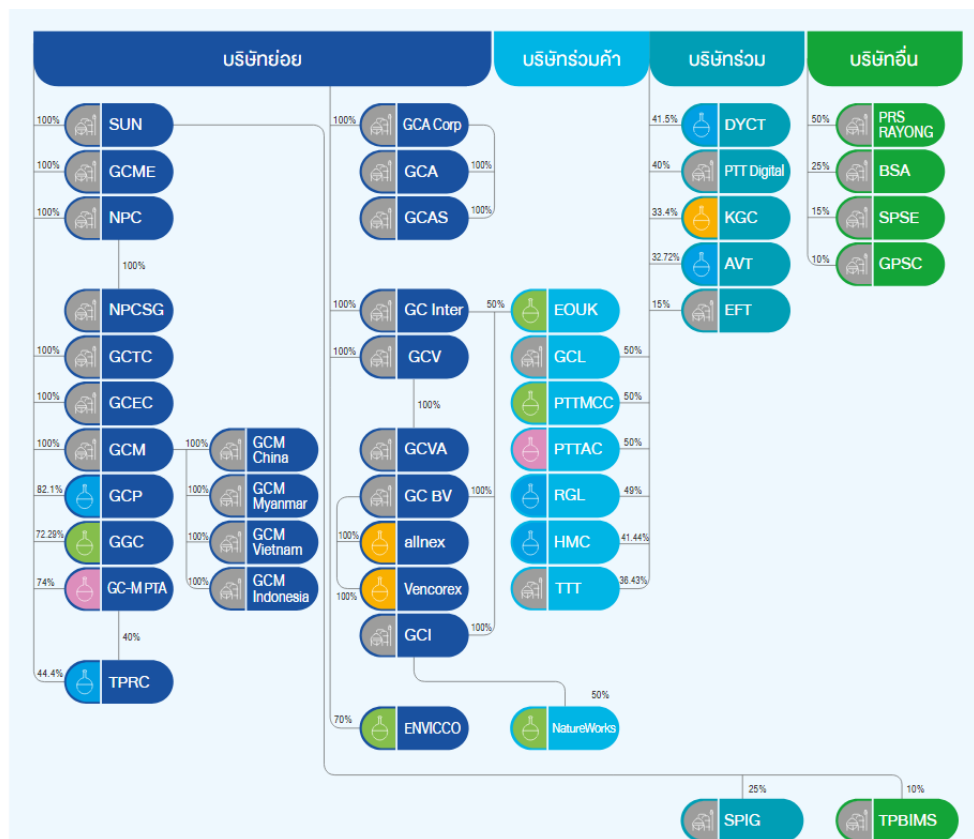
GC uses the Operational Control approach for GHG accounting. Under the Operational Control approach, an organization accounts for GHG emissions from operations where it has full control over (all or nothing). For GHG accounting will be reported the site location within Thailand only. The Operational Control gets by:

- 1) GC owns 100% in equity share of the Company; or
- 2) GC has the full authority to introduce and implement its operating policies at the operational level.

For GPSC, combined GHG Emission in the PTT, Not including in operational control approach for GHG accounting in GC Group.

For GGC owns 100% in equity share of the TEX Company. It's not included in the operational control approach for GHG accounting in GC Group.

For GCL and TTT, Not including in operational control approach for GHG accounting in GC Group



Pic 1) Organizational Structure of GHG Reporting and Accounting



Pic 2) Structure Business of GC Group

4.2. De Minimis of GHG Sources

GC applies the following De Minimis provision:

- 1) De Minimis represents GHG emitting activities which in aggregate forms less than 5% of the company's total aggregated GHG emissions. De Minimis emissions may be quantified once at the start of the GHG accounting exercise, and the value may be used for GHG reporting in subsequent years. A recalculation of the GHG emissions for these De Minimis sources should be repeated at least once in 7 years, or when changes to the system which significantly affects the GHG emitting characteristics of the activity is implemented.
- 2) GC De Minimis includes the GHG emitting activities that required huge effort and insignificant impact to GHG emission as follows:
 - **Welding and cutting in Workshop area:** Welding and cutting activity occasionally taken place in workshop area, approximately 0.0001% of total GHG emission. Electricity consumption in Workshop is already included in scope 2 (Energy indirect greenhouse gas emission), while the use of acetylene is omitted.
 - **Afforestation & Reforestation:** GHG reduction approach due to afforestation and reforestation activity is now being reviewed and will be evaluated as soon as possible.
 - **Fertilizer used:** Fertilizer is mainly used for plantation in factories within GC group. However, the group gardening is serviced by external contractors, as well as fertilizing is controlled in their scopes of work, approximately 0.0002% of total GHG emission.
 - **CH₄ Generated from toilet:** CH₄ generated from toilet is not practically measurable. Though, approximately 0.0001% of total GHG emission could be calculated following: 6.2.2 Domestic wastewater, Chapter 6, IPCC 2006 Vol 5. The quantification shows a very slightly significant impact to the total GHG.
 - **LPG using to start-up flare:** Flare system commonly uses LPG for starting up the system, after that natural gas and flare gas are continuously consumed for pilot flare. Thus, LPG used to start-up flare is ignored since very less consumption, approximately 0.0001% of total GHG emission.

4.3. Biogenic CO₂ Emissions

Biogenic emissions are direct CO₂ emissions from biologically sequestered carbon (e.g., CO₂ from burning biomass/biofuels). These emissions shall be quantified and reported separately from the Scopes. Biogenic emissions occur in all types of biomasses, biofuels, and biogas. Biogenic CO₂ should only contain that part of the fuel that relates to the quantities of biofuel and not to the total volume of liquids into which the biofuels are blended (if blended).

5. GHG Emissions Sources

5.1. General

GC Group estimated the GHG emissions based on direct GHG emissions, energy indirect GHG emissions, and other indirect GHG emissions as the operational boundaries.

- **Direct GHG emissions (Scope 1)** refer to the GHG generated from the emission sources possessed or controlled by GC Group. They include emissions from
 - Process and vented emissions from: CO₂ Separation, Ethylene production, other process and Vent emission.
 - Fugitive emission from: Use of HFCs and SF₆, Wastewater Treatment Plant and Other facilities.
 - Emission from combustion: Flare combustion, Coke combustion, Mobile fuel combustion and Stationary fuel combustion.
- **Energy indirect GHG emissions (Scope 2)** refer to the amount emitted as a result of GC Group activities, although their emission sources are possessed or controlled by other companies. GC Group use Energy Indirect GHG Emissions (Scope2) (Market-based) as a target. Generally, they include emissions from
 - Electricity purchased.
 - Steam purchased.
- **Other indirect GHG emissions (Scope 3)** refer to the amount indirect emissions which are a consequence of the activities of the GC Group, the significant emission is identified. The method of identification is considered by sizing, level of influence, risk, opportunity, sector guidance, outsourcing, and employee engagement. If the result of evaluation is more than 2.5 points, it is identified to be significant emission to report as following.
 - Categories 1- Purchased goods and service; Raw material, Chemical, Catalyst, Packaging, and Service
 - Categories 2- Capital goods
 - Categories 3- Fuel-and-energy-related activities (not included in scope 1 or scope 2)
 - Categories 4- Upstream transportation and distribution
 - Categories 9- Downstream transportation and distribution; Polymer product
 - Categories 10- Processing of sold products; Polymer product.
 - Categories 11- Use of sold product.
 - Categories 12- End-of-life treatment of sold product; Polymer product.
 - Categories 15- Investment; Thailand business

5.2 Break down of GHG emissions.

1) Breakdown of GHG emissions by facility

Facility Name	Scope 1 (t-CO ₂ eq)	Scope 2 (Location based) (t-CO ₂ eq)	Scope 2 (Market based) (t-CO ₂ eq)	Scope 3 (t-CO ₂ eq)	Total (t-CO ₂ eq)
(A)	(B)	(C)	(D)	(A+C+D)	
GC 1 (RO)	1,136	3,879	3,879	0	5,015
GC 2 (OLE1) *	173,286	0	0	0	173,286
GC 2 (UT)	1,612,454	7,698	6,994	0	1,619,447
GC 2 (HDPE2)	5,099	0	0	0	5,099
GC 2 (OLE4)	510,682	0	0	0	510,682
GC 2 (HGP)	6,542	0	0	0	6,542
GC 3 (OLE2) *	802,403	154,087	188,549	0	990,952
GC 4 (ARO 1)	168,123	274,617	311,361	0	479,484
GC 5 (ARO2) *	583,920	237,468	244,371	0	828,291
GC 6 (REF)	1,013,030	2,699	2,699	0	1,015,729
GC 7 (BTF)	1,300	0	0	0	1,300
GC 8 (ATF)	1,661	4,325	5,469	0	7,130
GC 9 (LAB)	0	2,685	2,348	0	2,348
GC 11 (OLE3)	829,425	96,400	86,190	0	915,615
GC 11 (LDPE)	9,595	102,437	89,684	0	99,280
GC 11 (LLDPE)	18,093	100,437	88,136	0	106,230
GC 12 (HDPE1)	734	8,323	14,178	0	14,912
GC 13 (INNO2)	1	1,607	1,607	0	1,608
GC 14 (Workshop)	0	79	79	0	79
GC 15 (GC Campus)	0	401	401	0	402
GC 16 (EOEG)	20,583	74,106	66,355	0	86,938
GC 16 (EA)	0	11,677	10,553	0	10,553
GC 17 (GCS)	1,961	0	0	0	1,961
GC 18 (Phenol) *	12,513	341,142	307,779	0	320,292
GC 18 (BPA)	0	81,043	90,496	0	90,496
GC 19 (GCO)	86,905	111,621	99,820	0	186,725
GGC#1	180	72,354	65,239	0	65,420
GGC#2	26,747	6,967	6,967	0	33,713
GCM-PTA	203,415	84,515	102,542	0	305,957
TPRC	28,932	11,920	15,070	0	44,002
GCME (PTTME)	1,061	607	607	0	1,668
NPC S&E	756	398	398	0	1,154
ENCO (Head Office)	0	328	328	0	328
GCP	5,163	8,373	9,484	0	14,647
GC Estate	3	393	393	0	396
Envicco	0	6,472	5,704	0	5,704
GC Corporate (Scope 1)	3,734	0	0	0	3,734
GC Scope 3	0	0	0	41,485,517	41,485,517
GC Group	6,129,439	1,809,055	1,827,679	41,485,517	49,442,635

Remarks: * Facility that have Turnaround activity in 2023

2) Break down GHG emissions by Activity.

Activity	GHG Emissions (t-CO ₂ eq)	%
Scope 1		
CO2 Separation	11,515	0.02%
Ethylene Production	318,384	0.64%
Other Process and Vented Emissions	153,234	0.31%
Fugitive emissions of SF6 and HFCs	8,321	0.02%
Fugitive Emissions from Wastewater Treatment Plants	-	0.00%
Fugitive Emissions from Facilities	2,728	0.01%
Flare Combustion	211,482	0.43%
Mobile Fuel Combustion	5,470	0.01%
Stationary Fuel Combustion	5,414,325	10.95%
Coke Combustion	3,980	0.01%
Total Scope 1	6,129,439	12.40%
Scope 2		
Location-based	1,809,055	-
Market-based	1,827,679	3.70%
Total Scope 2	1,827,679	3.70%
Scope 3		
Categories 1- Purchased goods and services (Raw material, Chemical, Catalyst, Packaging, and Service)	7,372,455	14.91%
Categories 2- Capital goods	181,796	0.37%
Categories 3- Fuel- and energy-related activities	1,174,140	2.37%
Categories 4- Upstream transportation and distribution	635,699	1.29%
Categories 9- Downstream transportation and distribution (Polymer product)	36,873	0.07%
Categories 10- Processing of sold products (Polymer product)	2,532,062	5.12%
Categories 11- Use of sold product	26,904,998	54.42%
Categories 12- End-of-life treatment of sold product (Polymer product)	1,022,415	2.07%
Categories 15- Investments (Thailand business)	1,625,081	3.29%
Total Scope 3	41,485,517	83.91%

5.3 GHG Emissions Summary

GC Group's total Scope 1 GHG Emission including GHG emitted within the organizational boundary is **6,129,439 tCO₂eq**, accounting for **12.40%** of the company's total emissions.

For GC Group's total Scope 2 (Market-Based) GHG Emission are GHG emitted in the course of purchasing electricity and steam to GC Group is **1,827,679 tCO₂eq**, accounting for **3.70%** of the company's total emissions.

For GC Group's total Scope 3 GHG Emission excluding GHG emitted from activities accounted as Scope 1 & 2 emissions in other companies within the GC Group is **41,485,517tCO₂eq**, accounted for **83.91%** of the company's total emissions.

Anthropogenic biogenic emissions are **174.79 tons**.

6. Base year

The year 2021 is nominated as a fixed base year, as it is the year where sufficiently reliable GHG data for GC is available verification. This baseline is used to compare a current year's GHG emissions. GC may decide to participate in may have a definition on what is considered significant change to the GHG inventory which trigger base year recalculation.

7. Data Quality Management Procedure

A data quality management program is essential to ensure that a GHG accounting and reporting system meets the five principles of the GHG accounting manual. In order to maintain the quality of the GC GHG Inventory, the following considerations shall be implemented in the GC GHG accounting and reporting program:

7.1 Organizational Structure

A GHG reporting organizational structure shall be developed and communicated to all employees involved in the program. All involved shall understand which department/ individual are responsible for which task, and who shall the results/ data be communicated to. The organizational structure shall include owners (department/ individual) for all activities within this program which includes but not limited to data collection, verification, consolidation, and reporting.

7.2 Data management Procedures

The four key items necessary to ensure quality of data are:

- 1) Data collection.
- 2) Data recording and retention system.
- 3) QA/QC procedure; and
- 4) Emergency procedures

The procedures for the above four items shall be outlined in more detail in each company's customized data management manual. Companies may reference ISO 14001 in developing its Data Management Manual.

7.3 Uncertainty Analysis

Uncertainty investigations can be part of a broader learning and quality feedback process. They can support a company's efforts to understand the causes of uncertainty and help identify ways of improving inventory quality. These investigations establish lines of communication and feedback with data suppliers to identify specific opportunities to improve the quality of the data and methods used.

Estimation uncertainty arises any time greenhouse gas emissions are quantified. Therefore, all emission or removal estimates are associated with estimation uncertainty. Estimation uncertainty can be further classified into two types: model uncertainty, and parameter uncertainty.

Model uncertainty relates to any type of modeling conducted to estimate any amount of release, for example accidental release, fugitive emissions etc. Manual estimation using professional judgment also counts within this category. If an accidental release occurred, and the site engineer estimated the release amount by considering the time when the release occurred, stopped and flow rate, then the accuracy of the estimated time and flow of release shall be considered.

Parameter uncertainty relates to activity data, emissions factor, meter, and/or measurement accuracy. For activity data and emission factor data, the log-normal distribution is often determined to be a reasonable fit. This report focuses on quantifying parameter uncertainty from activity data and emission factors; however, the pedigree matrix approach and many of the propagation techniques discussed below may also apply for direct emissions data. For meter and measurement, if a flow rate meter has an accuracy of $\pm 5\%$, then data read from it will have uncertainty of $\pm 5\%$. GC may combine its parameter uncertainty information using either of the following approaches by order of preference:

First Preference: A Full Quantitative Approach

Second Preference: Simplified Quantitative Approach; and

Third Preference: A Qualitative Approach.

7.4 Emergency Procedure

An emergency procedure is related to data collection issues with respect to metering failure or human error. Procedures should be applied, in line with ISO 14001 requirement to eliminate or reduce the risk of data loss/ incomplete data collection. Compliance with ISO 14001 procedural methods is encouraged, but not mandatory.

8. GC Greenhouse Gas Statement 2023

GC hereby confirms that our 2023 GHG emissions calculations have been conducted as per the GC GHG accounting and reporting manual using the corresponding GHG accounting tool version 1. Any diversions to the manual or exclusions are outlined in this assertion. This has been prepared according to ISO 14064-1:2018.

We assert that for the period 1st January to 31st December 2023 the total GHG emissions by scope, within our organizational boundary are as follows:

Scope	GHG emissions (tons CO ₂ equivalent)			
	2020 (recalculated)	2021** (recalculated)	2022** (recalculated)	2023**
Direct GHG Emissions	5,787,067	6,522,577	6,142,594	6,129,439
Energy Indirect GHG Emissions (Market-based) *	1,781,824	2,029,650	2,039,063	1,827,679
Energy Indirect GHG Emissions (Location-based)	1,973,127	2,063,605	2,038,803	1,809,055
Other indirect GHG emissions	38,446,123	37,246,702	35,356,123	41,485,517
Categories 1- Purchased goods and service	5,707,398	6,087,267	5,642,268	7,372,455
Categories 2- Capital goods	-	581,050	98,815	181,796
Categories 3- Fuel-and-energy-related activities (not included in Scope 1 or 2)	1,148,852	1,031,996	978,957	1,174,140
Categories 4- Upstream transportation and distribution	588,896	560,586	540,983	635,699
Categories 9- Downstream transportation and distribution	31,904	40,138	22,314	36,873
Categories 10- Processing of sold products	2,404,437	2,501,051	2,475,156	2,532,062
Categories 11- Use of sold product	25,069,677	24,266,496	22,798,563	26,904,998
Categories 12- End-of-life treatment of sold product	589,289	604,053	990,880	1,022,415
Categories 15- Investment	2,905,669	1,574,065	1,808,187	1,625,081

Remarks: * GC Group use Energy Indirect GHG Emissions (Scope2) (Market-based) as a target

** In Y2021-2023, Scope 3 calculation in categories 2 capital goods was added.

Other indirect GHG emissions (Scope 3) included Purchased goods and service (Raw material, Chemical, Catalyst, Packaging, and Service), Capital goods, Fuel-and-energy-related activities (not included in scope 1 or scope 2), Upstream transportation and distribution, Downstream transportation and distribution (Polymer product), Processing of sold products (Polymer product), Use of sold product, End-of-life treatment of sold product (Polymer product), Investment (Thailand business)

Scope (as defined within ISO 14064-1:2018)	GHG emissions (tons CO ₂ equivalent)			
	2020* (recalculated)	2021* (recalculated)	2022 (recalculated)	2023
Direct GHG Emissions and removals (Category 1)	5,787,067	6,522,577	6,142,594	6,129,439
Indirect GHG Emissions from imported energy (Category 2, Location-based)	1,973,127	2,063,605	2,038,803	1,809,055
Indirect GHG Emissions from imported energy (Category 2, Market-based without attribute bundle)	1,781,824	2,029,650	2,039,063	1,827,679
Indirect GHG Emissions from transportation (Category 3, Upstream transportation and distribution)	588,896	560,586	540,983	635,699
Indirect GHG Emissions from transportation (Category 3, Downstream transportation and distribution)	31,904	40,138	22,314	36,873
Indirect GHG Emissions from products used by organization (Category 4, Purchased goods and services)	5,707,398	6,087,267	5,642,268	7,372,455
Indirect GHG Emissions from products used by organization (Category 4, Capital goods)	-	581,050	98,815	181,796
Indirect GHG Emissions from products used by organization (Category 4, Fuel-and energy-related activities)	1,148,852	1,031,996	978,957	1,174,140
Indirect GHG Emissions associated with the use of products from the organization. (Category 5, Processing of sold products)	2,404,437	2,501,051	2,475,156	2,532,062
Indirect GHG Emissions associated with the use of products from the organization. (Category 5, Use of sold products)	25,069,677	24,266,496	22,798,563	26,904,998
Indirect GHG Emissions associated with the use of products from the organization. (Category 5, End of life treatment of sold products)	589,289	604,053	990,880	1,022,415
Indirect GHG Emissions associated with the use of products from the organization. (Category 5, Investment)	2,905,669	1,574,065	1,808,187	1,625,081

Anthropogenic biogenic emissions are **174.79 tons**.

Due to the calculation of GHG in 2023 has updated in several areas such as boundary, GHG quantification methodologies, changing fixed based year to 2021. Therefore, GHG recalculation of the base year of 2021 and year 2023 has been recalculated as follows:

- 1) Quantification methodologies updated, the changing the calculation concept of Energy Indirect GHG Emissions (Scope2) for Location-based and Market-based for all facilities of GC group in both 2021 and 2022.
- 2) Quantification methodologies updated, the changing the Emission Factor from GPSC and Glow supplier then calculation approach updated for all facilities of GC group that use energy from GPSC and Glow supplier in both 2021 and 2022.
- 3) Quantification methodologies updated, change the heating value of steam method, then calculation approach updated for GC 18 (BPA), GC 11 (OLE3), in both 2021 and 2022.
- 4) Any error and omission of data for Flare Combustion has been addressed for GC 2 (HGP), and GC 18 (Phenol) in 2021 and 2022.
- 5) Any error and omission of data for Stationary Fuel Combustion has been addressed for GC 2 (OLE1), GC 11 (OLE3), and GCM-PTA in 2021 and 2022.
- 6) Any error and omission of data for Energy Indirect GHG Emissions (Scope2) has been corrected for GC 1 (RO), GC 7 (BTF), GC13 (Inno2), and GC14 (Workshop) in 2021 and 2022.
- 7) Quantification methodologies updated; the changing the Emission Factor of Cat 2 (Capital goods) in 2021 and 2022.
- 8) Organizational boundaries updated; GCL and TTT are removed from GC operational control boundaries in 2021 and 2022, and new operating sites such as GC 15 (GC Campus), are added in 2023.

In 2023, Examples of performance enhancement projects include activities on energy conservation projects as follows:

- Stripper Column Optimization to improve process efficiency and reduce CO₂ Emissions 6,695 tons CO₂ equivalent per year.
- Advance Membrane Separation Technology to Streamline Separation Efficiency in Production Process. This project can reduce CO₂ Emissions 10,000 tons CO₂ equivalent per year.
- Renewable Energy by installing Solar Rooftop and Floating Solar systems to reduce CO₂ Emissions 4,364 tons CO₂ equivalent per year.

These projects were leading to the GHG reduction of 54,043 tons CO₂ equivalent with 605 million Thai Baht investment and 365 million Thai Baht cost saving (estimate).

GC has set target of GHG emissions reduction (Greenhouse gas emission reduction): 1) greenhouse gas emissions reduction (scope 1 and 2 (Market-Based)) by 20 percent within 2030 compared to base year (2021), and 2) net zero emission (scope 1 and 2 (Market-Based)) within 2050 based on net zero commitment.

In 2023, which represents are emit greenhouse gases emission (scope 1 and 2(Market-Based)) by 7.96 million tons CO₂ equivalent and it achieve the target, and emit greenhouse gases emission intensity (scope 1 and 2(Market-Based)) by 366 kgCO₂ equivalent per ton productions,

GC ensures the selection of appropriate methodology for data collection. The outcomes of all submitted information are in accordance with the global standard, which is also reviewed internally by senior management and externally reviewed by credible third parties to ensure that applied approach is rigorous and transparent.