Hokkaido University GHG Inventory 2022

Summary

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ES.1. Objective

Hokkaido University has incorporated its carbon neutrality strategy as a key component of its climate change initiatives under the *"Fourth Mid-Term Goals and Mid-Term Plan (FY2022–FY2027)*[*1]." The Hokkaido University Greenhouse Gas Inventory 2022 presents comprehensive data on the University's greenhouse gas (GHG) emissions, aiming to accurately assess the current status of emissions. This inventory serves as a fundamental dataset for the development, evaluation, and verification of policies, targets, and strategies related to achieving carbon neutrality at Hokkaido University.

ES.2. Methodology

2.1. Standards and Guidelines for Estimation of GHG Emissions

This inventory was developed in accordance with the following standards and guidelines.

- WBCSD, WRI. Greenhouse Gas Protocol: Standards.
- Manual for Calculating and Reporting Greenhouse Gas Emissions. Ver.4.9, 2023. Ministry of the Environment, Japan.
- Basic Guidelines for Calculating Greenhouse Gas Emissions through Supply Chains, Ver.2.5, 2023. Ministry of Environment, and Ministry of Economy, Trade and Industry, Japan.

2.2. Outline of Estimation Method

This inventory was designed to provide a comprehensive understanding of the University's GHG emissions by quantifying and aggregating emissions across the three categories defined under the GHG Protocol—Scope 1, Scope 2, and Scope 3[*2]. The calculation of emissions for each source is based on the standard formula: "Activity Data × Emission Factor."

2.3. Boundaries

(Target GHGs for Calculation)

This inventory covers seven types of GHGs: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs), Sulfur hexafluoride (SF_6), and Nitrogen trifluoride (NF_3).

(Organizational Boundaries)[*3]

This inventory adopted the "operational control approach" [*4] to define the organizational boundary. It covers all business activities under the University's operational control, including off-campus facilities, regardless of whether they are owned or leased.

(Operational Boundaries)[*5]

This inventory covered all three scopes — Scope 1, Scope 2, and Scope 3. In the case of Scope 3, all applicable categories were assessed in the estimation, with the exception of those for which the University has no associated emissions.

2.4. Base Year

To enable year-to-year comparisons of the University's GHG emissions, it is necessary to establish a base year. In determining this base year, international agreements and national policies should be taken into consideration. The following are potential candidates for the base year of the University.

- FY2013（the Paris Agreement / the Act on Promotion of Global Warming Countermeasure）
- FY2019（IPCC 6th Assessment Report）
- FY2022（the most recent fiscal year）

This inventory included all of the above years in the estimation period, while the base year will be formally established later when determining GHG reduction targets of the University.

2.5. Estimation Period

Based on 2.4 above, the estimation period was set from FY2013 to FY2022, and GHG emissions were estimated for each fiscal year.

2.6. GHG Emissions Intensity (Indicator)

To enable comparison and analysis of the University's total GHG emissions with those of other universities and businesses, GHG emissions intensity per total floor area of a building was calculated and used as a key indicator. The total floor area of a building is closely correlated with the scale of University's activities and is one of the most widely adopted metrics for estimating GHG emissions intensity in Japanese regulatory reports.

- GHG Emissions Intensity（Indicator）= GHG emission / total floor area of a building

2.7. Constraints and Challenges

While it is ideal for a GHG inventory to ensure both comprehensiveness and accuracy in data collection, achieving both to a high degree is often challenging due to limitations in time and resources. In this inventory, data collection efforts were prioritized by maximizing coverage, aiming to provide a comprehensive understanding of the overall GHG emissions and their sources within the University. The following outlines constraints and data coverage of this inventory.

（Constraints of Data Coverage）

This inventory did not include the GHG emissions from certain cases, which are listed below.

- In cases where the corresponding activities do not exist.
- In cases where the corresponding activities exist, however, do not generate GHG.
- In cases where the emissions are minor and insignificant to total emissions.
- In cases where calculating the emissions is currently difficult.
- In cases where identifying the emissions is difficult
- In cases where the methodology for calculating these emissions does not exist.

The specific emission sources are indicated with the following symbols.

Table 1 Symbols for Non-Calculated Emission Sources

Symbol	Note
NO（Not Occurring）	In cases where the corresponding activities do not exist.
NA（Not Applicable）	In cases where the corresponding activities exist but do not generate GHG emissions.
NE（Not Estimated）	In cases where the University engages in activities that may generate GHG emissions, but data collection and analysis are difficult.
IE（Included Elsewhere）	In cases where the University engages in activities that may generate GHG emissions, but these emissions are already included under other emission sources.
C（Confidential）	In cases where the data could compromise sensitive or confidential information.

(Constraints of Data Accuracy)

For this inventory, secondary data sources—including emission factor databases[*6]—were used to estimate GHG emissions from each source. In addition, monetary data was utilized as activity data where material quantity data would have been more appropriate but was unavailable. As a result, the estimation outcomes contain a certain degree of uncertainty.

ES.3. Results

3.1. Trends in GHG Emissions

The estimated GHG emissions—covering the total of Scope 1, Scope 2 (market-based[*7]), and Scope 3—for the reporting period are presented in Figures 1 through 3 and Tables 2 through 4.
In the most recent year, FY2022, total emissions amounted to 275,820 tons of CO_2 equivalent, representing a 17.3% reduction compared to FY2013. The primary factors contributing to this reduction are considered to be as follows:

- A decrease in Scope 2 emissions, primarily due to a reduction in the emission factors of electricity providers
- A decrease in Scope 3 Category 2 emissions, resulting from a decline in facility construction and the installation of large-scale equipment
- Improvements in energy efficiency through the implementation of energy-saving measures

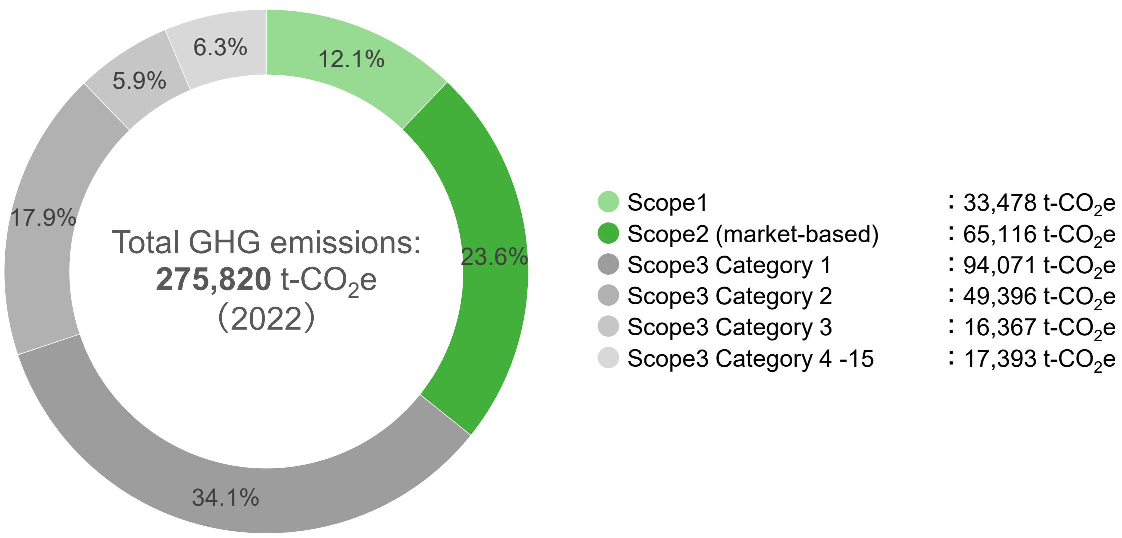


Figure 1. GHG emissions of Hokkaido University in FY2022

Table 2.　GHG emissions of Hokkaido University in FY2022

List of Scopes and categories	Unit	FY2022	%
Scope1	**t-CO_2e**	**33,478**	**12.1%**
Scope2（market-based）	**t-CO_2e**	**65,116**	**23.6%**
Scope3	**t-CO_2e**	**177,226**	**64.3%**
Scope3 Category 1 (Purchased goods and services)	t-CO_2e	94,071	34.1%
Scope3 Category 2 (Capital goods)	t-CO_2e	49,396	17.9%
Scope3 Category 3 (Fuel- and energy-related activities (not included in scope 1 or scope 2))	t-CO_2e	16,367	5.9%
Scope3 Category 4-15	t-CO_2e	17,393	6.3%
Total GHG emissions	**t-CO_2e**	**275,820**	**100.0%**

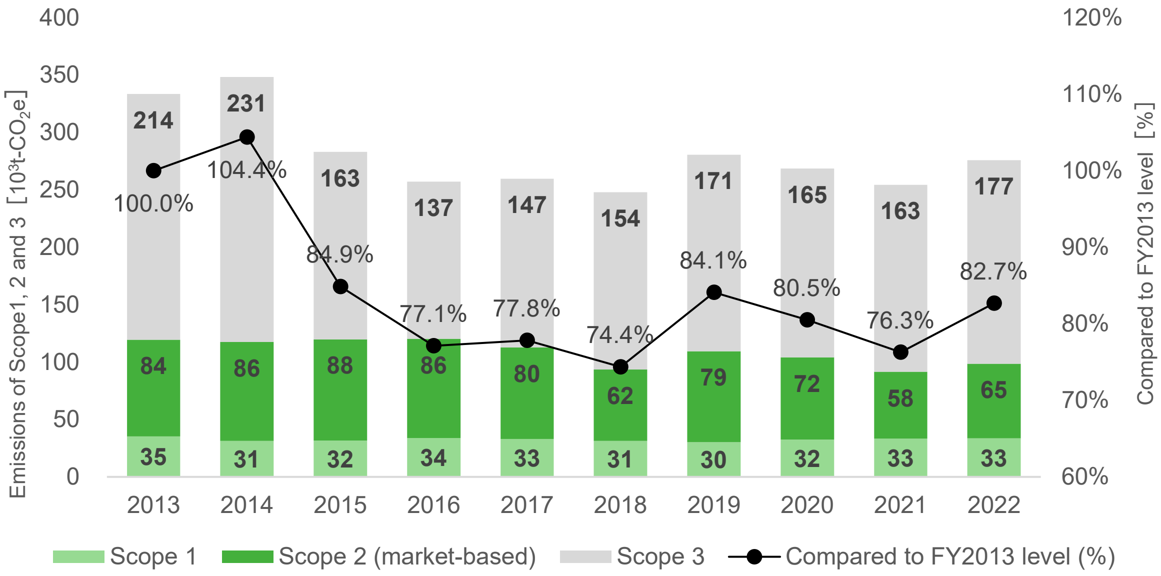


Figure 2. Trends in GHG Emissions of Hokkaido University (Scope 1, 2 and 3, FY2013 - 2022)

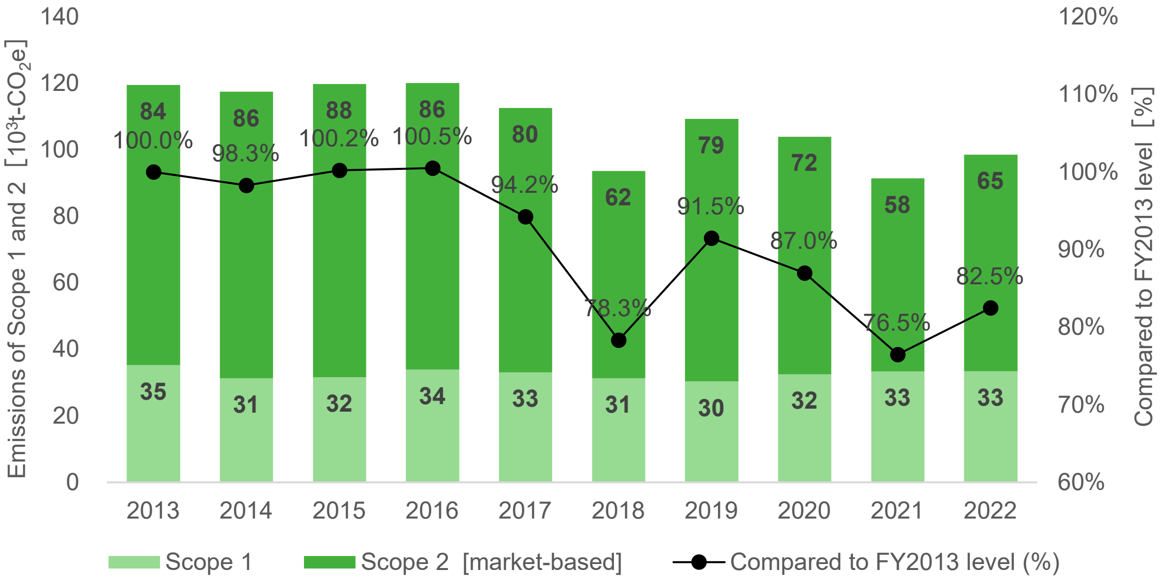


Figure 3.　Trends in GHG Emissions of Hokkaido University (Scope 1 and 2, FY2013～2022)

Table 3. Trends in GHG Emissions of Hokkaido University (FY2013 – 2022)

List of Scopes and categories	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Scope 1	**t-CO_2e**	**35,256**	**31,295**	**31,633**	**33,917**	**33,027**	**31,286**	**30,316**	**32,458**	**33,374**	**33,478**
Scope 2 [market-based]	**t-CO_2e**	**84,265**	**86,170**	**88,147**	**86,214**	**79,593**	**62,333**	**79,004**	**71,528**	**58,049**	**65,116**
Scope 2 [location-based] *7	t-CO_2e	70,794	72,156	70,761	68,151	64,717	60,126	55,388	53,014	52,797	52,744
Scope 3	**t-CO_2e**	**214,006**	**230,686**	**163,266**	**137,094**	**147,028**	**154,420**	**171,156**	**164,500**	**162,968**	**177,226**
Category 1 (Purchased Goods and Services)	t-CO_2e	78,696	76,319	78,719	76,797	78,325	80,054	86,310	86,979	90,480	94,071
Category 2 (Capital Goods)	t-CO_2e	94,943	112,337	43,433	20,033	28,653	35,230	47,313	55,326	48,467	49,396
Category 3 (Fuel- and Energy-Related Activities Not Included in Scope 1 or Scope 2)	t-CO_2e	17,245	16,488	16,697	17,208	16,717	16,085	15,818	16,186	16,509	16,367
Category 4 (Upstream Transportation and Distribution)	t-CO_2e	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Category 5 (Waste Generated in Operations)	t-CO_2e	2,825	3,223	2,473	2,123	2,298	1,851	1,596	1,469	1,454	1,798
Category 6 (Business Travel)	t-CO_2e	18,272	20,224	19,883	18,793	18,889	19,054	17,934	2,364	3,837	13,287
Category 7 (Employee Commuting)	t-CO_2e	1,815	1,904	1,946	1,969	1,944	1,957	2,002	2,012	2,054	2,083
Category 8 (Upstream Leased Assets)	t-CO_2e	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE
Category 9 (Downstream Transportation and Distribution)	t-CO_2e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Category 10 (Processing of Sold Products)	t-CO_2e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Category 11 (Use of Sold Products)	t-CO_2e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Category 12 (End-of-Life Treatment of Sold Products)	t-CO_2e	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Category 13 (Downstream Leased Assets)	t-CO_2e	209	190	116	171	202	190	183	164	166	225
Category 14 (Franchises)	t-CO_2e	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Category 15 (Investments)	t-CO_2e	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
GHG emission (Scope 1+Scope 2 [market-based])	**t-CO_2e**	**119,521**	**117,465**	**119,780**	**120,131**	**112,620**	**93,619**	**109,320**	**103,985**	**91,423**	**98,594**
GHG emission (Scope 1+Scope 2 [market-based] +Scope 3)	**t-CO_2e**	**333,526**	**348,151**	**283,046**	**257,225**	**259,648**	**248,039**	**280,476**	**268,486**	**254,390**	**275,820**
Compared to FY2013 (Scope 1 + Scope 2 [market-based])	%	100.0%	98.3%	100.2%	100.5%	94.2%	78.3%	91.5%	87.0%	76.5%	82.5%
Compared to FY2013 (Scope 1 + Scope 2 [market-based] + Scope 3)	%	100.0%	104.4%	84.9%	77.1%	77.8%	74.4%	84.1%	80.5%	76.3%	82.7%

Table 4 presents the GHG emissions by emission source for FY2022, listed in descending order of emission volume.

Table 4. GHG Emissions by Emission Source at Hokkaido University (in Descending Order of Amount of Emissions, FY2022)

No.	Scope	GHG	Category	Unit	2022	%
301	Scope3	CO_2e	Category 1 (Purchased Goods and Services)	t-CO_2e	94,071	34.1%
201	Scope2	CO_2	Comsumption of Purchased electricity [market-based]	t-CO_2e	64,976	23.6%
302	Scope3	CO_2e	Category 2 (Capital Goods)	t-CO_2e	49,396	17.9%
101	Scope1	CO_2	Stationary and mobile combustion of fuels	t-CO_2e	30,434	11.0%
303	Scope3	CO_2e	Category 3 (Fuel- and Energy-Related Activities Not Included in Scope 1 or Scope 2)	t-CO_2e	16,367	5.9%
306	Scope3	CO_2e	Category 6 (Business Travel)	t-CO_2e	13,287	4.8%
147	Scope1	HFCs	Fugitive emissions of HFCs from commercial refrigeration and air-conditioning equipment	t-CO_2e	2,088	0.8%
307	Scope3	CO_2e	Category 7 (Employee Commuting)	t-CO_2e	2,083	0.8%
305	Scope3	CO_2e	Category 5 (Waste Generated in Operations)	t-CO_2e	1,798	0.7%
124	Scope1	CH_4	Enteric fermentation in livestock	t-CO_2e	334	0.1%
313	Scope3	CO_2e	Category 13 (Downstream Leased Assets)	t-CO_2e	225	0.1%
135	Scope1	N_2O	Fugitive emissions of anesthetic gases	t-CO_2e	214	0.1%
117	Scope1	CH_4	Stationary combustion of fuels in facilities and equipment	t-CO_2e	153	0.1%
202	Scope2	CO_2	Comsumption of Purchased heat [market-based]	t-CO_2e	140	0.1%
136	Scope1	N_2O	Manure management in livestock	t-CO_2e	57.2	0.0%
125	Scope1	CH_4	Manure management in livestock	t-CO_2e	52.3	0.0%
151	Scope1	HFCs	Use of spray	t-CO_2e	35.9	0.0%
132	Scope1	N_2O	Stationary combustion of fuels in facilities and equipment	t-CO_2e	25.5	0.0%
114	Scope1	CO_2	Use of Dry Ice	t-CO_2e	24.8	0.0%
115	Scope1	CO_2	Use of spray	t-CO_2e	19.4	0.0%
137	Scope1	N_2O	Addition of synthetic fertilizers	t-CO_2e	17.9	0.0%
OTH-SF6	Scope1	SF_6	Other use of SF_6	t-CO_2e	11.9	0.0%
126	Scope1	CH_4	Rice cultivation	t-CO_2e	5.5	0.0%
138	Scope1	N_2O	Crop residues to soils	t-CO_2e	1.8	0.0%
130	Scope1	CH_4	Wastewater treatment	t-CO_2e	0.51	0.0%
141	Scope1	N_2O	Wastewater treatment	t-CO_2e	0.29	0.0%
146	Scope1	HFCs	Industrial process refrigeration of commercial refrigeration and air-conditioning equipment	t-CO_2e	0.23	0.0%
112	Scope1	CO_2	Use of Acetylene Derived from Calcium Carbide	t-CO_2e	0.042	0.0%
107	Scope1	CO_2	Use of Soda Ash (Sodium Carbonate) in Industrial Processes	t-CO_2e	0.035	0.0%
			GHG emissions (Scope1+Scope2 [market-based] +Scope3)	t-CO_2e	275,820	100.0%

3.2. GHG Emissions by Gas Type

Figure 4 and Tables 5 and 6 present the calculated GHG emissions by gas type over the reporting period. Emissions by gas type are aggregated for Scope 1 and Scope 2, with Scope 2 emissions calculated using the market-based approach.

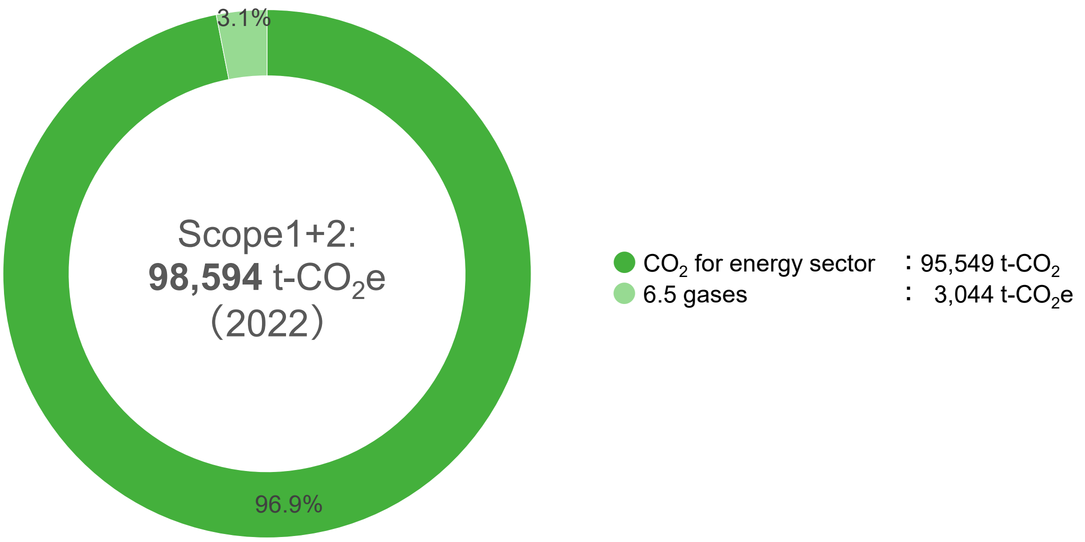


Figure 4. GHG Emissions of Hokkaido University by Gas Type (FY2022)

* 6.5 gases : GHG emissions excluding CO_2 for energy sector (CO_2, CH_4, N_2O, HFCs, PFCs, SF_6, NF_3)

Table 5. GHG Emissions of Hokkaido University by Gas Type (FY2022)

List of gas	Unit	2022	%
CO_2 for energy sector (Scope1＋2 [market-based])	**t-CO_2**	**95,549**	**96.9%**
6.5 gases (GHG emissions (excluding CO_2 for energy sector))	**t-CO_2e**	**3,044**	**3.1%**
CO_2 for non-energy sector	t-CO_2e	44	0.0%
CH_4	t-CO_2e	546	0.6%
N_2O	t-CO_2e	317	0.3%
HFCs	t-CO_2e	2,125	2.2%
PFCs	t-CO_2e	0	0.0%
SF_6	t-CO_2e	12	0.0%
NF_3	t-CO_2e	0	0.0%
GHG emissions (Scope1+2 [market-based]))	t-CO_2e	98,594	100.0%

Table 6. Trends in GHG Emissions at Hokkaido University by Gas Type (FY 2013–2022)

List of gas	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
CO_2 for energy sector (Scope1＋2 [market-based])	t-CO_2	118,415	116,163	118,521	118,850	110,880	92,081	107,752	101,694	88,595	95,549
CO_2 for non-energy sector	t-CO_2	44	53	51	43	46	48	42	36	38	44
CH_4	t-CH_4	20.91	26.97	26.31	26.21	27.42	26.37	25.19	26.45	24.24	21.84
	t-CO_2e	523	674	658	655	685	659	630	661	606	546
N_2O	t-NO_2	0.6136	0.6092	0.6180	0.6946	0.6788	0.5916	0.7572	0.8359	0.7651	1.0639
	t-CO_2e	183	182	184	207	202	176	226	249	228	317
HFCs	t-HFC-32	0.052	0.052	0.052	0.079	0.159	0.130	0.130	0.266	0.379	0.479
	t-HFC-125	0.057	0.057	0.057	0.080	0.162	0.133	0.133	0.273	0.396	0.481
	t-HFC-134a	0.076	0.076	0.077	0.008	0.068	0.062	0.061	0.105	0.122	0.061
	t-HFC-143a	0.003	0.003	0.003	0.000	0.000	0.000	0.000	0.003	0.017	0.000
	t-HFC-152a	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0.000	0.000	0.006
	t-HFC-227ea	0.000	0.000	0.003	0.004	0.008	0.004	0.003	0.008	0.012	0.009
	t-CO_2e	354	357	365	357	797	655	651	1,325	1,934	2,125
PFCs	t-PFCs	0	0	0	0	0	0	0	0	0	0
	t-CO_2e	0	0	0	0	0	0	0	0	0	0
SF_6	t-SF_6	0.00010	0.00161	0.00000	0.00084	0.00042	0.00000	0.00085	0.00086	0.00097	0.00052
	t-CO_2e	2	37	0	19	10	0	19	20	22	12
NF_3	t-NF_3	0	0	0	0	0	0	0	0	0	0
	t-CO_2e	0	0	0	0	0	0	0	0	0	0
GHG emissions （Scope1+2 [market-based])	**t-CO_2e**	**119,521**	**117,465**	**119,780**	**120,131**	**112,620**	**93,619**	**109,320**	**103,985**	**91,423**	**98,594**

3.3. Trends in GHG Emission Intensity (Indicator)

Figure 5 and Table 7 present the estimated GHG emissions intensity (indicator) over the assessment period. This indicator is defined as the total GHG emissions (combined Scope 1 and Scope 2, with Scope 2 calculated using the market-based method) divided by the total floor area of owned buildings. In the most recent year, FY2022, the GHG emissions intensity was 109.1 kg-CO_2e/m², representing an 18.8% reduction from 134.3 kg-CO_2e/m² in FY2013. The main factors contributing to this reduction are as follows:

- A decrease in Scope 2 emissions, primarily due to a reduction in the emission factors of electricity providers
- Improvements in energy efficiency through the implementation of energy-saving measures

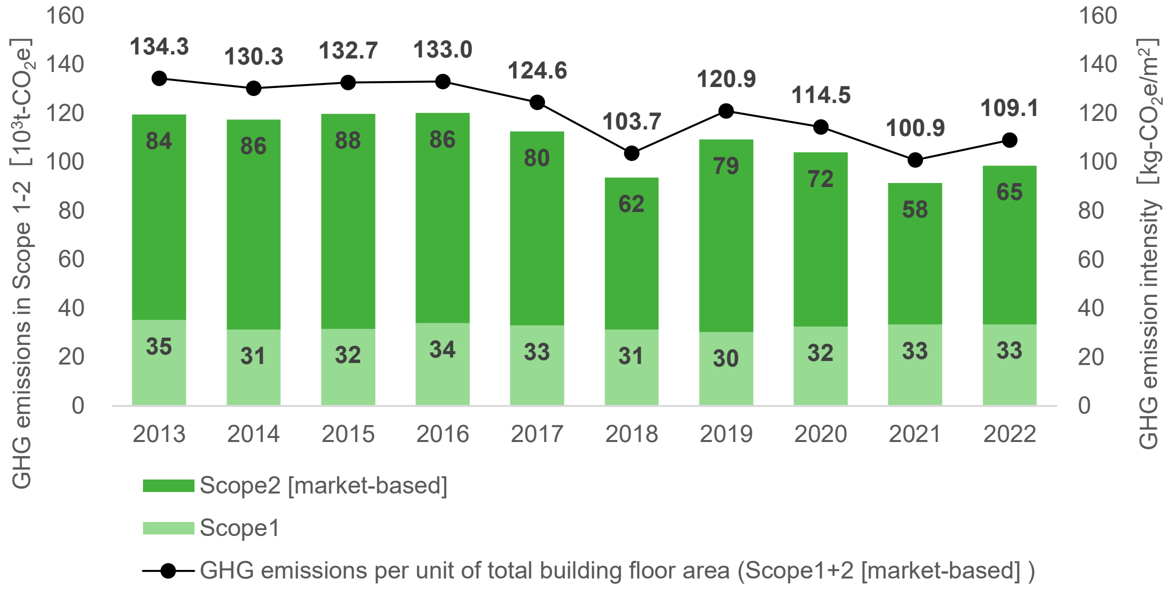


Figure 5 Trends in GHG Emissions (Scope 1 and 2) and GHG Emission Intensity (Indicator) at Hokkaido University (FY2013–2022)

Table 7. Trends in GHG Emissions (Scope 1 and 2), Total Building Floor Area, and GHG Emission Intensity (Indicator) at Hokkaido University

Category		Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Scope 1		t-CO_2e	35,256	31,295	31,633	33,917	33,027	31,286	30,316	32,458	33,374	33,478
Scope 2 [market-based]		t-CO_2e	84,265	86,170	88,147	86,214	79,593	62,333	79,004	71,528	58,049	65,116
GHG emissions (Scope 1+2 [market-based])	(A)	t-CO_2e	119,521	117,465	119,780	120,131	112,620	93,619	109,320	103,985	91,423	98,594
Total Building Floor Area (Aggregate Floor Area of Owned Facilities)	(B)	m^2	889,705	901,829	902,853	902,930	903,986	903,073	903,846	908,497	906,461	903,983
GHG Emissions per Unit of Building Floor Area (Scope 1 + 2, [market-based])	(A/B)	kg-CO_2e/m^2	134.3	130.3	132.7	133.0	124.6	103.7	120.9	114.5	100.9	109.1

3.4. Trends in Energy Consumption

This section outlines the trends in primary energy consumption, which serves as the activity data corresponding to CO_2 emissions from energy use—the predominant source of emissions in Scope 1 and Scope 2 at Hokkaido University. Figure 6 and Table 8 present the estimated primary energy consumption over the reporting period. In FY2022, primary energy consumption amounted to 1,774,451 GJ, marking a 4.4% decrease from 1,856,852 GJ in FY2013. In FY2022, the primary energy consumption intensity—defined as consumption per unit of total floor area of buildings—was 1.963 GJ/m^2, reflecting a 5.9% reduction from 2.087 GJ/m^2 in FY2013. This decline is attributed to improvements in energy efficiency achieved through energy-saving measures. However, the current rate of decrease is limited, highlighting the need for more radical and structural measures to achieve carbon neutrality by 2050.

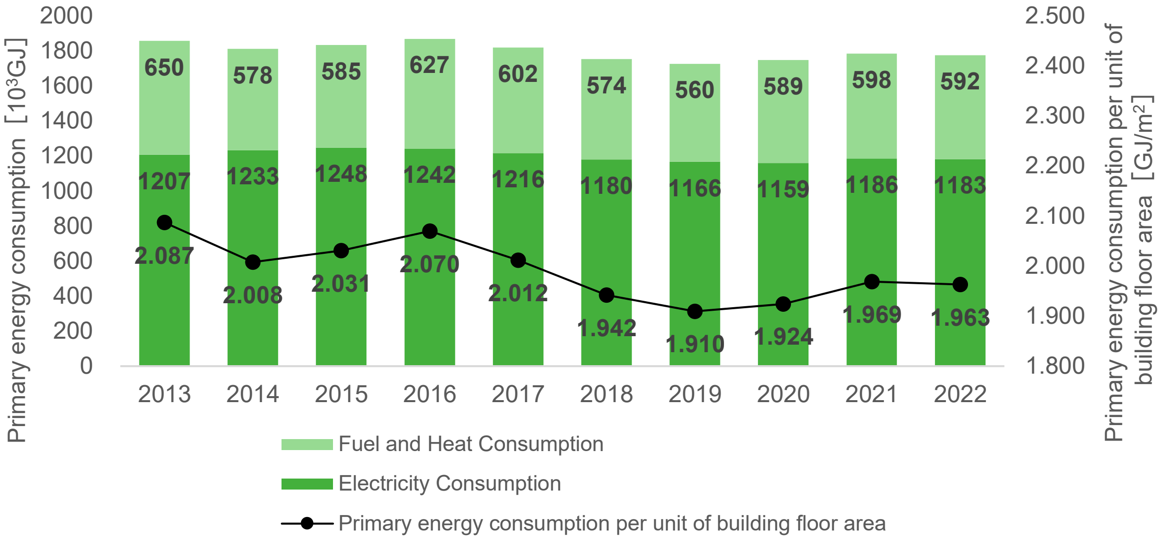


Figure 6. Trends in Primary Energy Consumption and Primary Energy Consumption Per Total Floor Area of Buildings at Hokkaido University (FY2013–FY2022)

(Unit: 10^3 GJ (Left), GJ /m^2 (Right))

Table 8. Estimated Fuel Consumption, Primary Energy Consumption, and Primary Energy Consumption Intensity (Indicator) at Hokkaido University

Category	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Primary Energy Consumption	(Primary energy conversion factors based on the Act on Rationalization of Energy Use and Shift to Non-fossil Energy)										
Scope1 Fuel Use (No.101) – Primary Energy Consumption											
Gasoline	GJ	2,291	2,163	2,156	2,056	2,280	2,217	2,022	1,836	2,159	1,905
Kerosene	GJ	6,973	4,771	5,216	4,110	4,221	4,037	4,072	3,861	5,893	6,019
Diesel Oil	GJ	10,243	9,711	9,021	9,638	8,875	9,438	8,968	8,574	8,214	6,755
Heavy Oil A	GJ	80,198	52,398	53,911	65,954	58,525	51,529	38,572	35,649	30,359	41,763
Liquefied Petroleum Gas (LPG)	GJ	437	462	472	528	477	470	424	128	51	51
Natural Gas (excluding LPG)	GJ	461	563	676	1,172	74	119	309	44	0	0
City Gas	GJ	545,432	504,479	510,258	539,105	524,198	502,568	501,268	535,478	547,857	531,935
Subtotal – Fuel Consumption	GJ	646,033	574,547	581,710	622,564	598,649	570,379	555,635	585,569	594,533	588,427
Scope2 Electricity Consumption from External Supply (No.201) - Primary Energy Consumption											
Electricity	GJ	1,206,959	1,232,920	1,248,269	1,242,120	1,216,209	1,179,771	1,166,336	1,159,013	1,186,071	1,182,684
Scope2 Heat Consumption of Externally Supplier (No.202) – Primary Energy Consumption											
Heated Water	GJ	3,859	3,163	3,416	4,108	3,692	3,752	3,949	3,728	3,908	3,341
Total	**GJ**	**1,856,852**	**1,810,630**	**1,833,394**	**1,868,791**	**1,818,551**	**1,753,902**	**1,725,920**	**1,748,311**	**1,784,512**	**1,774,451**
Compared to FY2013	%	100.0%	97.5%	98.7%	100.6%	97.9%	94.5%	92.9%	94.2%	96.1%	95.6%
Primary Energy Consumption Intensity (Indicator)											
Total Building Floor Area (Aggregate Floor Area of Owned Facilities)	m^2	889,705	901,829	902,853	902,930	903,986	903,073	903,846	908,497	906,461	903,983
Primary Energy Consumption per Unit of Building Floor Area	**GJ/m^2**	**2.087**	**2.008**	**2.031**	**2.070**	**2.012**	**1.942**	**1.910**	**1.924**	**1.969**	**1.963**
Compared to FY2013	%	100.0%	96.2%	97.3%	99.2%	96.4%	93.1%	91.5%	92.2%	94.3%	94.1%

3.5. Trends in GHG Emissions from Biomass Fuel Combustion

According to the GHG Protocol, GHG emissions from the combustion of biomass fuels were reported separately from Scope 1, Scope 2, and Scope 3 emissions. At Hokkaido University, as part of its research activities, biogas is produced on the University's farm through anaerobic digestion of livestock manure and is used as fuel for heating fermentation tanks. The combustion of this biogas results in the release of GHGs such as CH_4 and N_2O. The trends in GHG emissions from the combustion of biomass fuels are presented below.

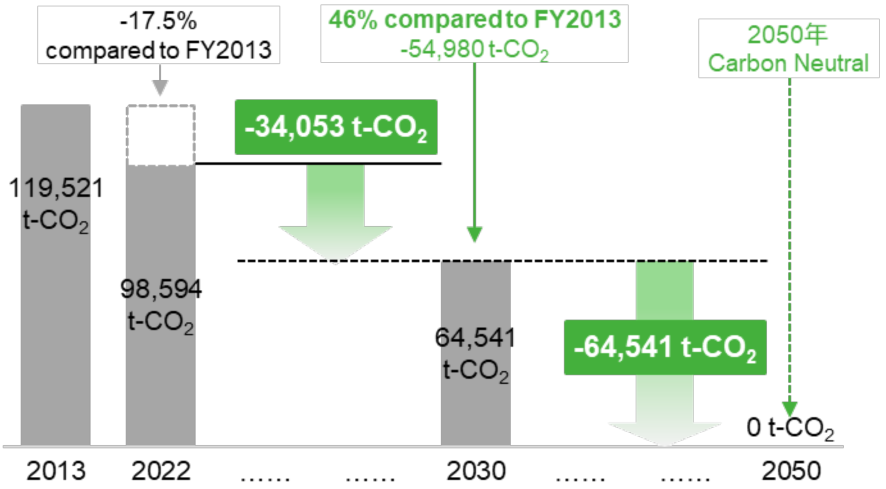
Table 9. Trends in GHG Emissions from Biomass Fuel Combustion at Hokkaido University

Category	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Emissions from Biogas Combustion (CH_4)	t-CH_4	0.000090	0.000097	0.000093	0.000093	0.000093	0.000093	0.000316	0.000539	0.000439	0.000260
(in t-CO_2e)	t-CO_2e	0.0023	0.0024	0.0023	0.0023	0.0023	0.0023	0.0079	0.0135	0.0110	0.0065
Emissions from Biogas Combustion (N_2O)	t-N_2O	0.0000090	0.0000097	0.0000093	0.0000093	0.0000093	0.0000093	0.0000316	0.0000539	0.0000439	0.0000260
(in t-CO_2e)	t-CO_2e	0.0027	0.0029	0.0028	0.0028	0.0028	0.0028	0.0094	0.0161	0.0131	0.0078
Total (in t-CO2e)	**t-CO_2e**	**0.0049**	**0.0053**	**0.0051**	**0.0051**	**0.0051**	**0.0051**	**0.0173**	**0.0295**	**0.0240**	**0.0143**

ES.4. Remarks

4.1. GHG Emissions Reduction Measures

Since the establishment of the Hokkaido University Environmental Policy in 2005, the University has consistently worked to reduce the environmental impact associated with its campus operations. In terms of GHG reduction, the highest priority has been placed on reducing Scope 1 and Scope 2 emissions through energy-saving measures. As part of this effort, both hard technological and soft behavioral approaches have been promoted—such as the development of Net Zero Energy Buildings (ZEB), installation of high-efficiency equipment, and behavioral initiatives aimed at fostering sustainable practices among university members. As a result of these ongoing efforts, GHG emissions have shown a consistent downward trend since FY2013. However, the effectiveness of the existing measures appears to be reaching its limit. To achieve CN by 2050, the University must adopt more comprehensive and transformative strategies.



- Corresponding to the national target of a 46% reduction in GHG emissions from FY2013 levels –

Figure 7. Reference Framework for Setting GHG Emission Reduction Targets (Scope 1 and 2, [market-based]) at Hokkaido University

Taking this situation into account, Hokkaido University has outlined an implementation plan as part of its latest strategic framework—the Fourth Mid-Term Goals and Mid-Term Plan. The University will advance the development and execution of GHG reduction strategies, including the establishment of quantitative targets, with the aim of achieving carbon neutrality by 2050.

4.2. Renewable Energy

Hokkaido University has installed solar power (PV) systems on its campus. The following presents the actual power generation performance and the estimated reductions in GHG emissions. All electricity generated is consumed internally within the University and is neither sold to the grid nor converted into carbon credits.

Table 10. Performance of Solar Power (PV) Systems and Estimated Reduction in GHG Emissions

Category	Unit	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Hokkaido University Conference Hall	kWh	14,528	15,635	15,005	14,494	13,261	13,021	13,894	14,732	16,251	15,666
Graduate School of Environmental Science / Faculty of Environmental Earth Science	kWh	20,140	21,642	20,714	20,001	19,845	18,610	19,986	20,435	22,538	21,663
Total Amount of Solar Power Generated	**kWh**	**34,668**	**37,277**	**35,719**	**34,495**	**33,106**	**31,631**	**33,880**	**35,167**	**38,789**	**37,329**
GHG emission factors [location-based])	tCO_2/kWh	0.000571	0.000570	0.000552	0.000534	0.000518	0.000496	0.000462	0.000445	0.000445	0.000434
Estimated GHG Emission Reduction	**tCO_2**	**19.8**	**21.2**	**19.7**	**18.4**	**17.1**	**15.7**	**15.7**	**15.6**	**17.3**	**16.2**

***Note (Table 10)**

- The estimated amount of GHG emission reduction was calculated using the following formula:
  Solar Power Generation × Emission Factor (Location-Based).
  (The emission factor applied follows the location-based method)
- Limitations on Solar Power Generation Data for the Graduate School of Environmental Science / Faculty of Environmental Earth Science:
  Due to malfunctions in the measurement equipment, some power generation data were unavailable for the periods from April 2013 to December 2016, and from April 2020 onward.
  For these periods, power generation was estimated based on observed trends during data-available periods, as well as reference values from the solar power generation at the Hokkaido University Conference Hall.

4.3. Accounting for GHG Absorption

At Hokkaido University, the amount of CO_2 absorption by the University-owned research forests has been estimated in accordance with the "*Promotion Plan for Northern Forests Project, Hokkaido University* (May 2012)" which aims to enhance CO_2 absorption through forest management and conservation. Based on changes in forest stock volume calculated from forest survey records and the forest stock volumes by forest type [m^3/ha] specified in "*Long-term Plan, Forest Research Station, Field Science Center for Northern Biosphere, Hokkaido University"* developed in 1995 and 2005, it was estimated that the approximately 65,000 hectares (ha) of University-owned research forests absorb an average of approximately 116,000 tons of CO_2 per year (reference value).

With a view toward achieving carbon neutrality, Hokkaido University is currently conducting feasibility studies on various GHG removal measures. In FY2024, the University plans to re-estimate the amount of GHG removal by calculating the current standing timber volume [m^3/ha] in its research forests. This estimation will be based on forest surveys conducted under the Long-term plan by Field Science Center for Northern Biosphere (FSC).

4.4. Carbon Offset

To date, Hokkaido University has not purchased carbon credits from external sources nor sold offsets to outside parties. The University is currently in the process of formulating its policies, objectives, and strategies related to carbon neutrality, which will also define its position on carbon offsets. It is noted that offsets are recognized as a measure only after all viable options for reducing GHG emissions and any future decisions regarding the purchase or sale of offsets will be approached cautiously and with due consideration.

4.5. Verification

The GHG emissions reported in this inventory were estimated based on discussions with knowledgeable stakeholders both external to and within the University; however, they have not yet undergone independent third-party verification. To enhance the credibility of this inventory, Hokkaido University plans to pursue appropriate verification procedures going forward, with the aim of improving both the accuracy and transparency of the reported data.

＊1 Hokkaido University, *the Fourth Period of Mid-Term Goals and Mid-Term Plan*. (Goals and Plans for carbon neutrality (No. 26)) (https://www.hokudai.ac.jp/introduction/plan/chuki/folder3/)

＊2 According to the GHG Protocol, GHG emissions are classified into the following three scopes:

・**Scope 1 (Direct GHG Emissions):**

Emissions originating from sources that are owned or controlled by the company—for example, emissions resulting from fuel combustion or chemical production processes.

・**Scope 2 (Indirect GHG Emissions):**

Emissions resulting from the generation of purchased electricity, heat, and steam that are consumed in equipment or operations owned or controlled by the company.

・**Scope 3 (Other indirect GHG Emissions):**

Indirect emissions other than Scope 1 and Scope 2, resulting from activities of other organizations but related to the company's own business operations.

＊3 The organizational boundary defines the scope of operations that are either owned or controlled by the reporting organization. It serves as the basis for determining which GHG emissions are included in the inventory.

＊4 Organizational boundaries can be determined using two approaches specified in the GHG Protocol: the equity share approach or the control approach. Under the equity share approach, GHG emissions are consolidated in proportion to the equity share (ownership interest) held in the operation. Under the control approach, 100% of the emissions from operations under the control are accounted for, regardless of the equity share. In cases where an entity holds a high equity share but does not have control, emissions are not included under this method. Here, "control" can be defined from either of the following perspectives: (1) Financial control: the ability to direct the financial and operating policies of the operation with a view to gaining economic benefits from its activities; or (2) Operational control: the full authority to introduce and implement operating policies at the operation.

＊5 Once the organizational boundary is established, the next step is to define the operational boundary. This involves determining—based on the organization's business goals—whether to account for only Scope 1 and Scope 2 emissions, or to also include relevant Scope 3 categories associated with its operations.

＊6 An emission factor database is a compilation of emission factors published by national governments and other relevant organizations. （https://www.env.go.jp/earth/ondanka/supply_chain/gvc/estimate_05.html）

＊7 According to the GHG Protocol Scope 2 Guidance, organizations are required to report Scope 2 emissions using both of the following approaches (Dual reporting): market-based and location-based approaches. These approaches require the use of different emission factors to calculate emissions associated with electricity consumption. The emission factors used for each approach are as follows.

Market-based Method：A market-based method reflects emissions from electricity that companies have purposefully chosen.

・It uses emission factor based on direct contract.

・It can include energy attribute certificates (REC, NFC, J-credit, etc.)

Location-based Method：A location-based method reflects the average emissions intensity of grids on which energy consumption occurs (using mostly grid-average emission factor data).

・It uses grid average emission factors—for example, national or regional emission factors

・It does not include energy attribute certificates (REC, NFC, J-credit, etc.)