2025

REPUBLIC OF CHINA

NATIONAL GREENHOUSE GAS

INVENTORY REPORT

Report Summary

May, **2025**

Executive Summary

ES.1 Background Information on National Greenhouse Gas Inventory

ES.2 Summary of National Emission and Sequestration Trends

ES.3 Emission Estimation and Trends Overview for Emission Source and Sinks Classification

ES.4 Other Information

Executive Summary

ES.1 Background Information on National Greenhouse Gas Inventory

The guidelines in Article 4[1] of the United Nations Framework Convention on Climate Change (UNFCCC), Article 13[2] of the Paris Agreement, and Article 5 of the Kyoto Protocol state that each party shall submit information of National Inventory Report (NIR) in response to climate change to the UNFCCC Convention of the Parties for review[3]. Although Taiwan is not a UNFCCC party, it has long been committed to fulfilling its responsibility as a member of the global community by endeavoring to take initiatives to help slow down global warming. The establishment of a national GHG inventory report and the estimation of GHG emission and sequestration are the fundamental obligation of a country to UNFCCC as well as one of the essential steps in reducing global warming.

Decision 18/CMA.1 of United Nations Climate Change Conference (COP 24) has stated that in order to implement the Enhanced Transparency Framework (ETF)[4].Relevant reports submitted by UNFCCC Annex I Parties must comply with the requirements of Modalities, Procedures and Guidelines (MPGs), and the National Inventory Report (NIR) electronically reports national greenhouses in the Common Reporting Tables (CRT) every year showing greenhouse gas inventory preparation procedures, emission trend description, statistics of various departments, recalculations, etc. From 2024 onward, GWP values from the IPCC AR5 must be used.

Since 1998, Taiwan has taken initiatives to prepare the national GHG inventory. According to Decision 15/CP.17[5] of the 17th Convention of the Parties (COP17) of the United Nations Framework Convention on Climate Change and the 7th Session of the Conference of the Parties (CMP7) to the Kyoto Protocol held in Durban, requesting developed countries to submit an Annual National Inventory Report starting from 2015 in accordance with the 2006 Intergovernmental Panel on Climate Change Guidelines (2006 IPCC Guidelines) for National Greenhouse Gas Inventories proposed by the Intergovernmental Panel on Climate Change (IPCC) in 2006.

However, science and other technologies have continued to advance and improve since 2006, the 2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (2019 IPCC Refinement Guidelines) was released by IPCC to support the compilation and continuous improvement of national greenhouse gas emissions by sources and removals by sinks as the latest scientific basis applicable to all Parties after 2020 to the Paris Agreement. The 2019 IPCC Refinement Guidelines are the most detailed and professional greenhouse gas inventory guidelines to date and need to be used together with the 2006 IPCC Guidelines.

The Report also carried out the statistics and compilation in accordance with the 2006 IPCC Guidelines and the 2019 IPCC Refinement Guidelines, where the Refinement methodology is more applicable, to actively demonstrate the efforts and resolution to abide by the convention. Today, Taiwan has established a greenhouse gas inventory database covering the period from 1990 to 2023. The database provides an overview on greenhouse gas inventory statistics to reflect the GHG trends in Taiwan. It also aims to quantify future greenhouse gas emissions and provide an overview of Taiwan's greenhouse gas statistics, thereby receiving comments from all fields for the continuous improvement on the quality of national greenhouse gas inventories.

1 UNFCCC, ST/AI/189/ADD.9/REV.2, 1987.
2 UNFCCC, FCCC/CP/2015/10/Add.1, 2015.
3 UNFCCC, FCCC/CP/2002/8, 2002.
4 UNFCCC, FCCC/PA/CMA/2018/3/Add.2, 2018.
5 UNFCCC, FCCC/CP/2011/9/Add.2, 2011.

ES.2 Summary of National Emission and Absorption Related Trends

Taiwan's total GHG emissions (excluding land use, land use change and forestry, the following report abbreviated as LULUCF) decreased from 291,702 kilotons of carbon dioxide equivalents in 2005 to 278,625 kilotons of carbon dioxide equivalents in 2023, with an 4.48% decrease and a negative average annual growth rate of –0.25%. To further analyze the composition of total GHG emissions in 2023, the proportion of carbon dioxide emissions is 95.86%, a decrease of 2.52% over the previous year, and that of non–carbon dioxide is 4.14%, which was also a decrease of 9.41% over last year, as shown in Figure ES2.1.

Further comparison of statistics on various greenhouse gas emissions shows that carbon dioxide accounts for the majority of greenhouse gas emissions (excluding LULUCF) in Taiwan in 2005, accounting for 91.49%, followed by methane (3.92%), fluorinated greenhouse gas (3.17%), and nitrous oxide (1.42%); however, carbon dioxide was still the largest of proportion (95.86%) in 2023, followed by methane (1.60%), then nitrous oxide (1.31%), and fluorinated greenhouse gas (1.23%), as shown in Figure ES2.2.

Between 2005 and 2023, carbon dioxide emissions grew by 0.08% with an average annual growth rate of 0.004%; carbon dioxide sequestration decreased by 2.53% with a negative average annual growth rate of –0.14%; methane emissions decreased by 61.09% with a negative average annual growth rate of –5.11%; nitrous oxide emissions decreased by 11.77% with a negative average annual growth rate of –0.69%; fluorinated greenhouse gas emissions decreased by 62.89% with a negative average annual growth rate of –5.36%, as shown in Figure ES2.3 and Table ES2.1.

1. Carbon Dioxide Emissions

The energy sector, industrial process and product use (IPPU)sector, agriculture sector, and waste sector are the main emission sources of carbon dioxide in Taiwan, as shown in Table ES2.2. In 2005, Taiwan's carbon dioxide emissions amounted to 266,888 kilotons of carbon dioxide equivalents. In 2023, that figure was 267,097 kilotons of carbon dioxide equivalents, with an 0.08% increase and an average annual growth rate of

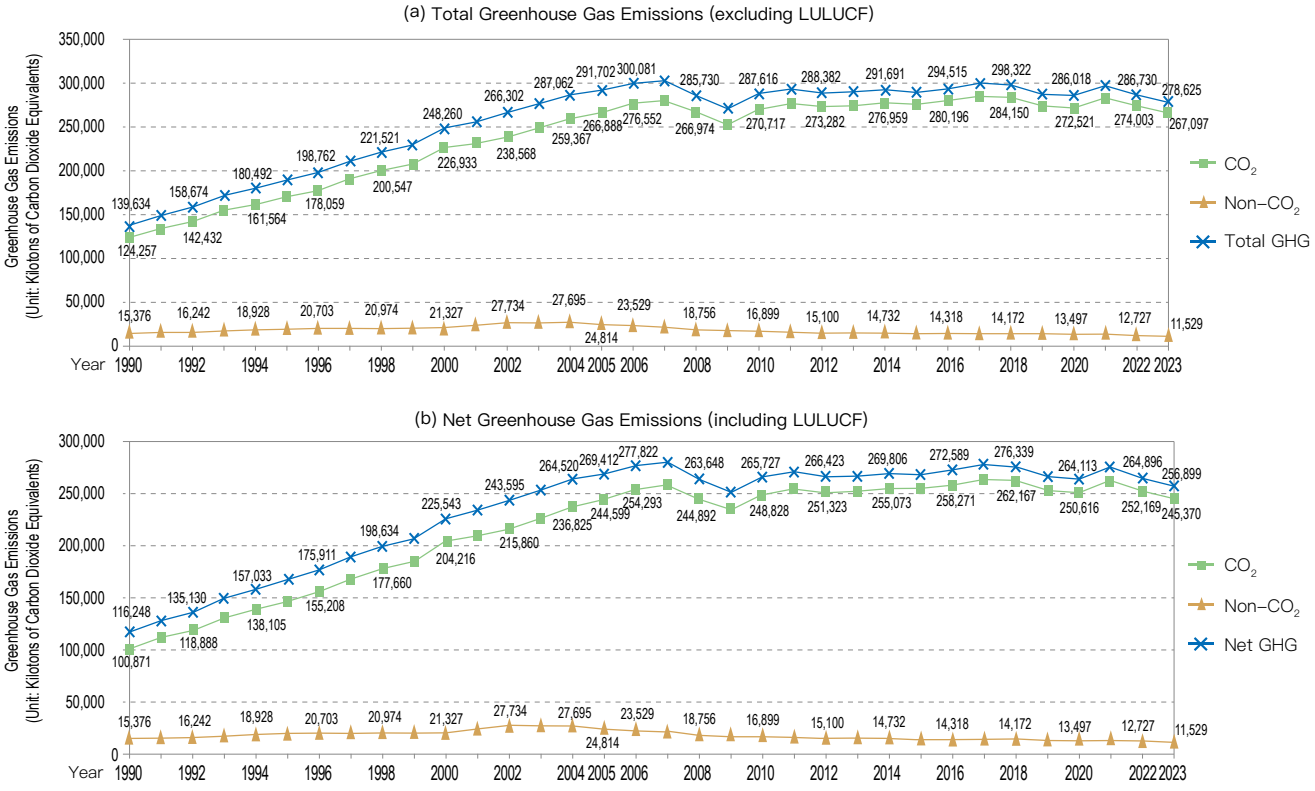

Figure ES2.1 1990–2023 Trends in Total Greenhouse Gas Emissions and Sequestration in Taiwan：(a) Emissions excluding LULUCF；(b) Emissions including LULUCF

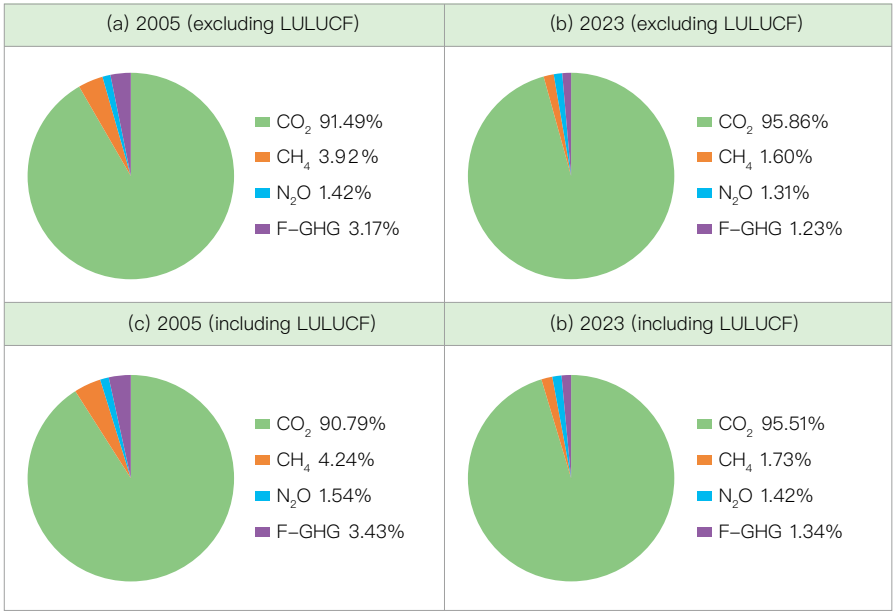

Figure ES2.2 Percentage of Various Types of Greenhouse Gas Emissions in Taiwan:(a).2005(excluding LULUCF); (b).2023(excluding LULUCF); (c).2005(including LULUCF);(d).2023(including LULUCF).

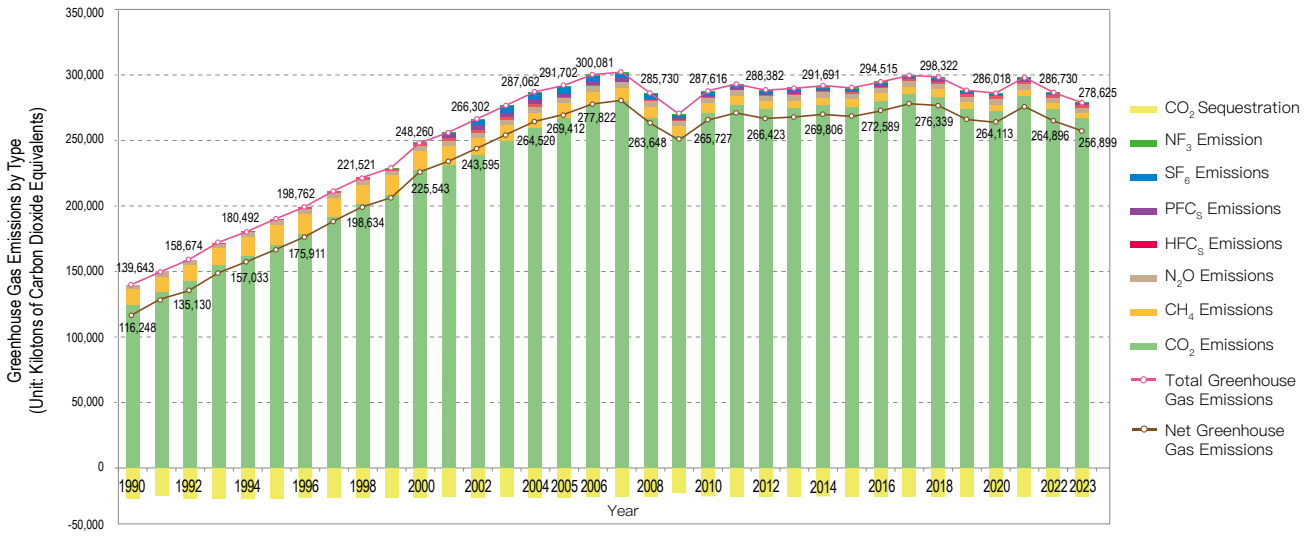

Figure ES2.3 1990–2023 Trends in Total Greenhouse Gas Emissions and Sequestration by Type in Taiwan

Table ES2.1 1990–2023 Greenhouse Gas Emissions and Sequestration in Taiwan by Type

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG	GWP	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
CO_2	1	124,257	133,631	142,432	154,046	161,564	170,065	178,059	190,782	200,547	208,024	226,933	231,431
CH_4	28	12,272	12,690	12,862	13,914	14,706	15,694	15,890	15,664	15,804	15,870	15,216	14,399
N_2O	265	3,105	3,406	3,380	3,449	3,506	3,595	3,694	3,432	3,358	3,403	3,911	3,918
HFCs	HFC–134a(1,300) etc.	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,437	2,054	2,329
PFCs	PFC–14(6,630) etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12	2,665
SF_6	23,500	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124	769
NF_3	16,100	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9	220
CO_2 Sequestration	1	–23,386	–21,490	–23,544	–23,546	–23,459	–23,340	–22,851	–23,060	–22,887	–22,764	–22,717	–21,850
Net GHG Emission (including LULUCF)		**116,248**	**128,236**	**135,130**	**148,495**	**157,033**	**166,694**	**175,911**	**188,101**	**198,634**	**206,102**	**225,543**	**233,881**
Total GHG Emission (excluding LULUCF)		**139,634**	**149,727**	**158,674**	**172,041**	**180,492**	**190,034**	**198,762**	**211,161**	**221,521**	**228,866**	**248,260**	**255,731**

Continued from the table below

Continued from the table

GHG	GWP	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
CO_2	1	238,568	249,129	259,367	266,888	276,552	280,079	266,974	253,028	270,717	276,770	273,282	274,577
CH_4	28	13,615	12,790	12,045	11,428	10,666	9,875	9,024	8,102	7,570	7,219	6,727	6,256
N_2O	265	3,981	3,930	4,111	4,136	4,593	4,649	4,250	4,407	4,758	4,642	4,565	4,367
HFCs	HFC–134a(1,300) etc.	2,016	1,857	1,685	303	331	402	356	404	393	372	482	610
PFCs	PFC–14(6,630) etc.	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665	1,054	1,253
SF_6	23,500	3,986	4,471	5,288	5,052	3,940	3,485	3,001	2,527	2,286	1,976	1,909	2,059
NF_3	16,100	373	506	617	716	644	747	191	540	241	393	363	723
CO_2 Sequestration	1	–22,707	–22,624	–22,542	–22,290	–22,259	–22,074	–22,082	–19,388	–21,889	–21,947	–21,960	–21,974
Net GHG Emission (including LULUCF)		**243,595**	**253,873**	**264,520**	**269,412**	**277,822**	**280,265**	**263,648**	**251,085**	**265,727**	**271,091**	**266,423**	**267,871**
Total GHG Emission (excluding LULUCF)		**266,302**	**276,497**	**287,062**	**291,702**	**300,081**	**302,339**	**285,730**	**270,473**	**287,616**	**293,038**	**288,382**	**289,845**
GHG	**GWP**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**		
CO_2	1	276,959	276,264	280,196	285,736	284,150	274,704	272,521	283,887	274,003	267,097		
CH_4	28	5,832	5,715	5,770	5,538	5,155	5,017	4,900	4,819	4,610	4,447		
N_2O	265	4,323	4,286	4,477	4,599	4,652	4,462	4,476	4,894	4,103	3,649		
HFCs	HFC–134a(1,300) etc.	697	726	836	971	1,125	1,252	1,390	1,515	1,649	1,725		
PFCs	PFC–14(6,630) etc.	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250	878		
SF_6	23,500	1,807	1,569	1,458	1,459	1,342	963	867	882	660	481		
NF_3	16,100	624	626	442	412	477	443	528	556	455	348		
CO_2 Sequestration	1	–21,886	–21,900	–21,926	–21,961	–21,984	–21,917	–21,905	–21,850	–21,834	–21,726		
Net GHG Emission (including LULUCF)		**269,806**	**268,535**	**272,589**	**278,059**	**276,339**	**266,240**	**264,113**	**276,056**	**264,896**	**256,899**		
Total GHG Emission (excluding LULUCF)		**291,691**	**290,436**	**294,515**	**300,021**	**298,322**	**288,157**	**286,018**	**297,906**	**286,730**	**278,625**		

Note: 1. Global Warming Potential (hereinafter referred to as GWP) is cited from the IPCC *Fifth Assessment Report*.
2. NE (not estimated) refers to the exclusion of estimation on existing emissions and sequestration.

Table ES2.2 1990–2023 Carbon Dioxide Emissions and Sequestration in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	109,465	118,443	126,058	135,206	143,103	150,810	158,579	170,835	181,518	190,446	208,724	212,554
1.A.1 Energy Industry	49,123	55,126	57,508	64,745	69,487	75,214	80,103	90,168	99,375	104,827	119,268	123,880
1.A.2 Manufacturing and Construction Industry	30,124	31,963	34,410	34,835	35,876	36,956	37,942	40,323	40,360	42,269	45,284	44,234
1.A.3 Transportation	19,646	20,888	24,033	26,103	27,540	28,822	29,801	30,536	31,844	32,772	33,207	33,267
1.A.4 Other Sectors	10,572	10,466	10,107	9,523	10,200	9,819	10,733	9,808	9,939	10,579	10,965	11,174
1.A.4.a Service Industry	3,621	3,529	2,989	2,490	3,018	2,446	3,175	2,482	2,948	3,128	3,205	3,538
1.A.4.b Residential	4,005	4,238	4,446	4,359	4,461	4,596	4,754	4,851	4,950	5,410	5,398	5,181
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	2,946	2,700	2,672	2,675	2,721	2,777	2,805	2,475	2,041	2,040	2,362	2,455
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial Process and Product Use Sector	14,557	15,007	15,926	18,408	17,826	17,528	17,677	19,483	18,410	17,179	17,388	16,186
2.A Mining Industry (Non–metal Process)	10,683	10,698	11,854	13,879	13,259	12,766	12,645	13,394	11,564	10,746	10,486	9,974
2.B Chemical Industry	575	551	575	617	770	858	999	1,026	1,007	1,079	1,148	1,232
2.C Metal Process	3,275	3,735	3,474	3,888	3,774	3,884	4,013	5,045	5,817	5,333	5,734	4,960
2.D Non–Energy Products from Fuels and Solvent Use	0.00006	0.00006	0.00006	0.00007	0.00009	0.00008	0.00008	0.00008	0.00009	0.00009	0.00008	0.00007
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.H Others	23	23	23	24	23	21	20	19	22	21	20	20
3. Agriculture Sector	142	146	139	131	135	151	151	134	127	118	131	94
4. Land Use, Land Use Change and Forestry Sector	–23,386	–21,490	–23,544	–23,546	–23,459	–23,340	–22,851	–23,060	–22,887	–22,764	–22,717	–21,850
5. Waste Sector	94	35	309	301	500	1,575	1,652	330	491	280	691	2,597
Net GHG Emission (including LULUCF)	100,871	112,141	118,888	130,500	138,105	146,725	155,208	167,722	177,660	185,260	204,216	209,582
Total GHG Emission (excluding LULUCF)	124,257	133,631	142,432	154,046	161,564	170,065	178,059	190,782	200,547	208,024	226,933	231,431

Continued from the table below

Continued from the table

GHG Emission Sources and Sinks	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1. Energy Sector	220,123	229,841	239,929	247,956	255,330	259,215	247,537	235,868	251,708	257,097	253,201	254,109
1.A.1 Energy Industry	128,157	139,316	147,288	155,014	162,298	168,580	162,125	153,989	164,270	168,491	166,837	167,023
1.A.2 Manufacturing and Construction Industry	46,373	44,211	44,551	44,008	45,309	44,845	41,410	37,874	42,612	43,691	42,515	43,307
1.A.3 Transportation	34,542	34,509	35,859	36,846	36,771	35,419	33,216	33,541	34,652	35,107	34,284	34,209
1.A.4 Other Sectors	11,052	11,806	12,230	12,089	10,952	10,371	10,785	10,463	10,174	9,808	9,566	9,571
1.A.4.a Service Industry	3,487	3,952	4,120	4,227	4,272	4,232	4,226	4,264	4,203	3,898	3,635	3,812
1.A.4.b Residential	5,107	5,042	5,133	5,235	5,033	5,047	5,017	5,030	4,857	4,786	4,672	4,484
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	2,459	2,811	2,977	2,627	1,647	1,091	1,543	1,169	1,113	1,123	1,259	1,274
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial Process and Product Use Sector	16,075	17,141	17,358	18,094	20,315	19,971	18,648	16,402	18,209	18,951	19,369	19,605
2.A Mining Industry (Non-metal Process)	10,648	10,341	10,691	11,257	11,029	10,373	9,380	8,462	8,618	9,574	9,333	9,866
2.B Chemical Industry	1,313	1,384	1,485	1,751	1,721	1,845	1,601	1,601	1,778	1,737	1,714	1,749
2.C Metal Process	4,096	5,397	5,162	5,066	7,544	7,733	7,648	6,317	7,792	7,620	8,301	7,970
2.D Non-Energy Products from Fuels and Solvent Use	0.00008	0.00009	0.00011	0.00010	0.00007	0.00007	0.00007	0.00006	0.00005	0.00004	0.00004	0.00005
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.H Others	18	18	19	20	21	20	20	21	20	20	21	19
3. Agriculture Sector	93	82	84	62	59	57	57	55	54	53	55	45
4. Land Use, Land Use Change and Forestry Sector	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947	-21,960	-21,974
5. Waste Sector	2,276	2,065	1,996	776	848	837	733	703	747	670	657	817
Net GHG Emission (including LULUCF)	**215,860**	**226,505**	**236,825**	**244,599**	**254,293**	**258,006**	**244,892**	**233,640**	**248,828**	**254,823**	**251,323**	**252,603**
Total GHG Emission (excluding LULUCF)	**238,568**	**249,129**	**259,367**	**266,888**	**276,552**	**280,079**	**266,974**	**253,028**	**270,717**	**276,770**	**273,282**	**274,577**

GHG Emission Sources and Sinks	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
1. Energy Sector	258,480	258,475	262,982	269,461	267,458	259,083	257,693	267,281	258,271	250,755		
1.A.1 Energy Industry	173,749	173,697	177,211	185,763	187,957	180,289	179,510	188,460	181,773	176,827		
1.A.2 Manufacturing and Construction Industry	40,384	39,575	39,653	38,112	35,045	34,079	33,078	35,687	32,422	29,748		
1.A.3 Transportation	34,666	35,506	36,584	36,202	35,202	35,438	35,715	33,905	34,696	34,616		
1.A.4 Other Sectors	9,681	9,698	9,533	9,384	9,254	9,277	9,389	9,229	9,380	9,564		
1.A.4.a Service Industry	3,928	3,941	3,720	3,779	3,593	3,622	3,792	3,741	3,746	3,928		
1.A.4.b Residential	4,411	4,469	4,537	4,402	4,145	4,137	4,269	4,170	4,266	4,104		
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	1,343	1,287	1,276	1,203	1,515	1,518	1,328	1,318	1,368	1,532		
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2. Industrial Process and Product Use Sector	17,703	17,253	16,592	15,631	16,024	14,889	14,001	15,670	14,778	15,430		
2.A Mining Industry (Non-metal Process)	8,728	8,347	7,117	6,269	6,408	6,500	6,563	6,835	6,473	5,982		
2.B Chemical Industry	1,884	1,842	1,760	1,709	1,684	1,666	1,550	1,730	1,270	1,192		
2.C Metal Process	7,072	7,044	7,696	7,634	7,913	6,706	5,870	7,090	7,020	8,242		
2.D Non-Energy Products from Fuels and Solvent Use	0.00006	0.00010	0.00008	0.00007	0.00006	0.00006	0.00006	0.00007	0.00006	0.00006		
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2.H Others	19	20	19	20	19	17	18	15	15	15		
3. Agriculture Sector	40	38	34	31	30	29	29	27	22	20		
4. Land Use, Land Use Change and Forestry Sector	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905	-21,850	-21,834	-21,726		
5. Waste Sector	736	498	589	613	639	703	798	909	932	893		
Net GHG Emission (including LULUCF)	**255,073**	**254,364**	**258,271**	**263,775**	**262,167**	**252,788**	**250,616**	**262,037**	**252,169**	**245,370**		
Total GHG Emission (excluding LULUCF)	**276,959**	**276,264**	**280,196**	**285,736**	**284,150**	**274,704**	**272,521**	**283,887**	**274,003**	**267,097**		

Note: 1. NE (not estimated) refers to the exclusion of estimation on existing emissions and sequestration.
2. NO (not happened) means that the emission source is not produced or used.

0.004%. Among the various sectors, emissions from the energy sector increased by 1.13%, while emissions from the industrial processes and product use (IPPU) sector decreased by 14.73%, the agriculture sector decreased by 68.43%, the land use, land-use change, and forestry (LULUCF) sector (removals) decreased by 2.53%, and the waste sector increased by 15.08%.

In 2023, carbon dioxide emissions accounted for 95.86% of total GHG emissions. The energy sector accounted for 93.88%, the industrial process and product use (IPPU)sector 5.78%, the agriculture sector 0.01%, and the waste sector 0.33%.

Compared with 2022, the emissions in 2023 decreased by 2.52% mainly because of the 2.91% decrease in the energy sector, the 4.41% increase in the IPPU sector, the 12.11% decrease in the agriculture sector, the 0.49% decrease in the LULUCF sector and the 4.22% decrease in the waste sector.

2. Methane Emissions

Methane emissions in Taiwan mainly come from the agriculture sector, waste sector, and energy sector, as shown in Table ES2.3. In 2005, the total methane emission in Taiwan was 11,428 kilotons of carbon dioxide equivalents. In 2023, the total methane emission was 4,447 kilotons of carbon dioxide equivalents, down by 61.09% compared with 2005, with a negative average annual growth rate of –5.11%. By sector, emissions from the energy sector increased by 16.67%, the IPPU sector

Table ES2.3 1990–2023 Methane Emissions in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	592	567	558	573	592	602	589	585	611	646	667	665
2. Industrial Process and Product Use Sector	6	8	7	8	9	11	13	13	11	13	15	20
3. Agriculture Sector	3,264	3,472	3,381	3,388	3,374	3,449	3,455	2,993	2,703	2,820	2,813	2,717
3.A Enteric Fermentation	750	819	826	868	883	921	921	820	755	778	775	739
3.B Manure Management	1,246	1,460	1,418	1,436	1,470	1,535	1,565	1,190	990	1,088	1,123	1,074
3.C Rice Cultivations	1,226	1,166	1,084	1,059	998	984	961	976	953	947	899	887
3.D Agricultural Soilss	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	42	28	53	24	23	8	8	8	6	8	15	17
5. Waste Sector	8,410	8,643	8,917	9,945	10,731	11,632	11,833	12,073	12,479	12,391	11,722	10,996
5.A Garbage Landfill	7,102	7,206	7,431	8,492	9,252	10,112	10,231	10,496	10,962	10,958	10,310	9,655
5.B Garbage Biological Treatment	13	0.6	0.9	0.5	0.2	0.7	0.3	1.6	0.06	2.2	0.3	0.02
5.C Incineration and Open Burning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.D Wastewater Treatment and Discharge	1,295	1,436	1,485	1,452	1,479	1,520	1,602	1,575	1,517	1,431	1,411	1,341
5.D.1 Domestic Wastewater Treatment and discharge	935	945	953	962	970	977	983	990	982	935	894	883
5.D.2 Industrial Wastewater Treatment and discharge	360	492	531	490	509	542	619	586	534	497	517	458
Total Methane Emissions	12,272	12,690	12,862	13,914	14,706	15,694	15,890	15,664	15,804	15,870	15,216	14,399
GHG Emission Sources and Sinks	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1. Energy Sector	689	746	782	749	743	741	724	713	753	779	789	804
2. Industrial Process and Product Use Sector	21	24	31	20	25	31	30	31	32	25	26	28
3. Agriculture Sector	2,565	2,451	2,363	2,495	2,461	2,371	2,303	2,247	2,244	2,278	2,252	2,237
3.A Enteric Fermentation	712	701	688	698	688	682	655	640	648	660	653	649
3.B Manure Management	1,022	1,019	1,024	1,071	1,058	994	965	924	931	944	904	874
3.C Rice Cultivations	816	721	643	717	706	690	676	678	659	668	688	710
3.D Agricultural Soilss	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	14	10	9	9	9	5	7	6	6	6	6	4
5. Waste Sector	10,339	9,569	8,868	8,164	7,437	6,732	5,968	5,111	4,542	4,137	3,660	3,187
5.A Garbage Landfill	8,976	8,192	7,482	6,786	6,066	5,349	4,644	3,942	3,347	2,862	2,432	2,054
5.B Garbage Biological Treatment	0.4	3	7	11	13	16	18	20	23	29	27	25
5.C Incineration and Open Burning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.D Wastewater Treatment and Discharge	1,363	1,375	1,379	1,367	1,359	1,367	1,306	1,149	1,171	1,246	1,201	1,108
5.D.1 Domestic Wastewater Treatment and discharge	868	860	833	808	783	752	728	700	689	661	631	609
5.D.2 Industrial Wastewater Treatment and discharge	495	515	546	559	576	615	578	449	482	584	570	499
Total Methane Emissions	13,615	12,790	12,045	11,428	10,666	9,875	9,024	8,102	7,570	7,219	6,727	6,256

Continued from the table below

Continued from the table

GHG Emission Sources and Sinks	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
1. Energy Sector	815	843	864	871	855	851	865	870	880	874		
2. Industrial Process and Product Use Sector	29	29	30	27	30	29	28	29	24	23		
3. Agriculture Sector	2,180	2,157	2,166	2,166	2,165	2,174	2,172	2,115	2,052	2,004		
3.A Enteric Fermentation	634	641	628	632	640	643	650	665	655	643		
3.B Manure Management	840	834	829	827	832	844	845	842	821	819		
3.C Rice Cultivations	702	678	705	704	689	684	677	608	576	542		
3.D Agricultural Soilss	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
3.F Field Burning of Agricultural Residues	4	5	4	4	3	2	1	1	1	1		
5. Waste Sector	2,808	2,686	2,710	2,474	2,106	1,963	1,834	1,805	1,654	1,546		
5.A Garbage Landfill	1,736	1,469	1,252	1,080	937	837	769	694	663	612		
5.B Garbage Biological Treatment	23	22	22	23	26	28	29	30	28	26		
5.C Incineration and Open Burning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
5.D Wastewater Treatment and Discharge	1,049	1,195	1,436	1,371	1,142	1,098	1,036	1,081	963	908		
5.D.1 Domestic Wastewater Treatment and discharge	593	572	537	512	491	445	423	395	373	355		
5.D.2 Industrial Wastewater Treatment and discharge	456	623	899	859	651	653	612	686	590	553		
Total Methane Emissions	5,832	5,715	5,770	5,538	5,155	5,017	4,900	4,819	4,610	4,447		

Note: NO (not happened) means that the emission source is not produced or used.

increased by 13.23%, while emissions from the agriculture sector decreased by 19.66% and the waste sector saw a significant reduction of 81.06%.

In 2023, methane emissions accounted for 1.60% of the total GHG emissions. In particular, the agriculture sector was the largest source of methane emissions, which accounted for 45.08%, followed by the waste sector (34.76%), energy sector (19.65%), and IPPU sector (0.51%).

Compared to 2022, the methane emission in 2023 was down by 3.54%, with the energy sector down by 0.64%, the IPPU sector down by 6.95%, the agriculture sector down by 2.33%, and the waste sector down by 6.52%.

3. Nitrous oxide emissions

Nitrous oxide emissions in Taiwan are mainly from the IPPU sector, the agriculture sector, and energy sector with minor emissions from the waste sector, as shown in Table ES2.4. In 2005, the total nitrous oxide emission in Taiwan was 4,136 kilotons of carbon dioxide equivalents. In 2022, the total nitrous oxide emission was 3,649 kilotons of carbon dioxide equivalents, down by 11.77% with an average growth rate of 0.69%. By sector, emissions from the energy sector decreased by 6.94%, the IPPU sector increased by 27.17%, while emissions from the agriculture sector declined by 30.92%, and the waste sector decreased by 36.81%.

Table ES2.4 1990–2023 Nitrous Oxide Emissions in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	478	516	583	628	664	698	743	785	834	888	966	1,004
1.A.1 Energy Industry	124	141	164	185	200	218	248	276	307	340	401	435
1.A.2 Manufacturing and Construction Industry	80	84	91	91	93	96	100	107	109	118	129	133
1.A.3 Transportation	259	275	314	340	357	372	381	389	406	417	423	422
1.A.4 Other Sectors	15	15	14	12	14	13	14	12	12	13	14	14
1A5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial Process and Product Use Sector	147	313	289	268	283	307	305	333	340	277	556	635
3. Agriculture Sector	2,289	2,397	2,318	2,355	2,360	2,374	2,429	2,101	1,984	2,044	2,203	2,083
3.B Livestock Waste Treatment	129	146	145	147	154	160	167	143	129	137	140	135
3.D Agricultural Soil	2,150	2,244	2,160	2,202	2,200	2,212	2,259	1,957	1,853	1,905	2,059	1,944
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	10	7	13	6	6	2	2	2	2	2	4	4
5. Waste Sector	190	181	190	198	200	216	218	213	200	194	186	196
Total Nitrous Oxide Emissionsl	3,105	3,406	3,380	3,449	3,506	3,595	3,694	3,432	3,358	3,403	3,911	3,918

Continued from the table below

Continued from the table

GHG Emission Sources and Sinks	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
1. Energy Sector	1,051	1,107	1,147	1,184	1,213	1,218	1,164	1,136	1,172	1,190	1,172	1,168
1.A.1 Energy Industry	456	513	534	560	586	610	592	570	579	584	580	574
1.A.2 Manufacturing and Construction Industry	141	138	141	141	145	144	134	126	137	144	139	141
1.A.3 Transportation	441	440	456	469	469	452	425	428	444	450	442	442
1.A.4 Other Sectors	14	15	16	15	13	12	13	12	11	11	11	11
1A5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial Process and Product Use Sector	661	741	742	891	1,311	1,399	1,185	1,334	1,670	1,605	1,527	1,407
3. Agriculture Sector	2,074	1,887	2,037	1,891	1,920	1,882	1,765	1,803	1,784	1,711	1,737	1,670
3.B Livestock Waste Treatment	131	131	130	136	136	130	129	125	125	126	123	122
3.D Agricultural Soil	1,939	1,754	1,904	1,753	1,782	1,751	1,634	1,676	1,657	1,583	1,612	1,548
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	4	2	2	2	2	1	2	1	1	1	1.5	0.9
5. Waste Sector	195	195	185	169	149	149	136	134	133	136	129	122
Total Nitrous Oxide Emissions	3,981	3,930	4,111	4,136	4,593	4,649	4,250	4,407	4,758	4,642	4,565	4,367

GHG Emission Sources and Sinks	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
1. Energy Sector	1,170	1,168	1,185	1,194	1,181	1,159	1,152	1,145	1,117	1,102		
1.A.1 Energy Industry	577	566	574	595	609	586	577	591	566	562		
1.A.2 Manufacturing and Construction Industry	136	134	133	125	108	106	104	107	95	85		
1.A.3 Transportation	446	457	468	463	453	457	461	437	446	444		
1.A.4 Other Sectors	11	11	11	10	10	10	10	10	10	11		
1A5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2. Industrial Process and Product Use Sector	1,384	1,378	1,550	1,729	1,838	1,743	1,709	2,227	1,526	1,134		
3. Agriculture Sector	1,648	1,615	1,621	1,555	1,508	1,440	1,494	1,401	1,346	1,307		
3.B Livestock Waste Treatment	121	121	122	123	125	129	130	130	130	131		
3.D Agricultural Soil	1,526	1,493	1,497	1,431	1,382	1,311	1,364	1,271	1,216	1,175		
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
3.F Field Burning of Agricultural Residues	1.0	1.2	0.9	1.0	0.7	0.6	0.2	0.2	0.2	0.3		
5. Waste Sector	121	124	121	122	125	120	121	121	114	107		
Total Nitrous Oxide Emissions	4,323	4,286	4,477	4,599	4,652	4,462	4,476	4,894	4,103	3,649		

Note: 1. NE (not estimated) refers to the exclusion of estimation on existing emissions and sequestration.
2. NO (not happened) means that the emission source is not produced or used.

In 2023, nitrous oxide emissions accounted for 1.31% of the total GHG emissions. In particular, the agriculture sector accounted for 35.80%, followed by the IPPU sector (31.06%), the energy sector (30.20%), and the waste sector (2.93%).

Compared to 2022, the nitrous oxide emission in 2023 down by 11.05%. By sector, emissions from the energy sector declined by 1.31%, the IPPU sector decreased significantly by 25.70%, the agriculture sector dropped by 2.95%, and the waste sector saw a reduction of 6.23%.

4. Fluoride-Containing Gas Emissions

In Taiwan, the majority of fluorinated greenhouse gases come from industries critical to economic development, namely the semiconductor, optoelectronics, power facilities, and magnesium alloy industries, all of which are emission-heavy industries. The fluorinated greenhouse gas emissions are shown in Table ES2.5. In particular, Taiwan's hydrofluorocarbons (HFCs) emission increased from 633 kilotons of carbon dioxide equivalents in 1993 to 1,725 kilotons of carbon dioxide equivalents in 2023. The perfluorocarbons (PFCs) emission increased from 2 kilotons of carbon dioxide equivalents in 1999 to 878 kilotons of carbon dioxide equivalents in 2023, while the sulfur hexafluoride (SF_6) emission increased from 120 kilotons of carbon dioxide equivalents in 1999 to 481 kilotons of carbon dioxide equivalents in 2023. The nitrogen trifluoride (NF_3) emission increased from 10 kilotons of carbon dioxide equivalents in 1999 to 348 kilotons of carbon dioxide equivalents in 2023.

Table ES2.5 1990–2023 Fluoride–Containing Gas Emissions in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents))

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total HFCs Emissions	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,437	2,054	2,329
2.B Chemical Industry	NE	NE	NE	633	716	671	1,094	1,238	1,745	1,348	1,943	2,151
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	43
2.F Alternatives to Ozone–depleting Substances	NE	NE	NE	NE	NE	8	26	46	66	89	111	135
Total PFCs Emissions (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12	2,665
Total SF_6 Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124	769
2.C Metal Process	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124	769
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total NF_3 Emissions (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9	220
Total Fluoride–Containing Gas Emissions	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,569	2,199	5,983
GHG Emission Sources and Sinks	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Total HFCs Emissions	2,016	1,857	1,685	303	331	402	356	404	393	372	482	610
2.B Chemical Industry	1,807	1,623	1,433	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	49	49	49	85	100	167	123	172	169	144	104	173
2.F Alternatives to Ozone–depleting Substances	160	185	204	218	232	235	234	232	225	228	378	437
Total PFCs Emissions (2.E Electronics Industry)	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665	1,054	1,253
Total SF_6 Emissions	3,986	4,471	5,288	5,052	3,940	3,485	3,001	2,527	2,286	1,976	1,909	2,059
2.C Metal Process	1,009	1,009	1,334	1,046	757	454	149	242	59	52	31	39
2.E Electronics Industry	973	1,458	1,838	2,457	2,389	2,049	1,930	1,561	1,983	1,665	1,678	1,855
2.G Manufacturing and Use of Other Products	2,003	2,003	2,116	1,549	794	982	923	724	245	260	201	165
Total NF_3 Emissions (2.E Electronics Industry)	373	506	617	716	644	747	191	540	241	393	363	723
Total Fluoride–Containing Gas Emissions	10,138	10,647	11,539	9,250	8,270	7,736	5,481	4,936	4,571	4,407	3,808	4,645
GHG Emission Sources and Sinks	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**		
Total HFCs Emissions	697	726	836	971	1,125	1,252	1,390	1,515	1,649	1,725		
2.B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
2.E Electronics Industry	184	142	160	169	169	152	161	156	151	110		
2.F Alternatives to Ozone–depleting Substances	513	584	676	802	957	1,101	1,229	1,359	1,498	1,615		
Total PFCs Emissions (2.E Electronics Industry)	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250	878		
Total SF_6 Emissions	1,807	1,569	1,458	1,459	1,342	963	867	882	660	481		
2.C Metal Process	58	44	39	61	84	45	37	62	27	22		
2.E Electronics Industry	1,600	1,393	1,334	1,317	1,105	805	693	716	507	374		
2.G Manufacturing and Use of Other Products	150	132	85	81	154	113	137	103	127	85		
Total NF_3 Emissions (2.E Electronics Industry)	624	626	442	412	477	443	528	556	455	348		
Total Fluoride–Containing Gas Emissions	4,578	4,170	4,071	4,147	4,365	3,974	4,120	4,306	4,014	3,433		

Note: 1. NO (not happened) means that the emission source is not produced or used.
2. NE (Not Estimated) means that there is no estimate for existing GHG emission source or sink.

For the total emission of fluorinated greenhouse gases, it decreased from 9,250 kilotons of carbon dioxide equivalents in 2005 (about 3.17% of the total greenhouse gas emissions in 2005) to 3,433 kilotons of carbon dioxide equivalents in 2023 (about 1.23% of the total greenhouse gas emissions in 2023), down by 62.89% with a negative average annual growth rate of –5.36%.

Compared to 2022, emissions of fluorinated greenhouse gases in 2023 decreased by 14.49%. Among them, hydrofluorocarbons (HFCs) increased by 4.62%, while perfluorocarbons (PFCs) decreased by 29.71%, sulfur hexafluoride (SF_6) declined by 27.14%, and nitrogen trifluoride (NF_3) fell by 23.56%.

ES.3 Emission Estimation and Trends Overview for Emission Source and Sinks Classification

Of all the sectors, the energy sector has long been the one accounting for the largest total greenhouse gas emission in Taiwan over the years. In 2005 and 2023, greenhouse gas emissions (excluding LULUCF) from energy sectors were responsible for approximately 85.67% and 90.71% of the total emissions, while the IPPU sector accounted for 9.69% and 7.18%, the

agricultural sector accounted for 1.52% and 1.20%, and the waste sector accounted for 3.12% and 0.91%, as shown in Figure ES3.1.

The GHG emission and trends for Taiwan from 1990 to 2023 by sector are shown in Figure ES3.2 and Table ES3.1. The total greenhouse gas emission in Taiwan in 2023 decreased by 2.83% compared with 2022. In particular, the GHG emission from the energy sector was down by 2.90%, the IPPU sector was down by 1.59%, the agriculture sector was down by 2.64%, and the waste sector was down by 5.71%. Additionally, the carbon dioxide sequestration of the LULUCF sector was down by 0.49%.

In 2023, total emissions decreased by 4.48% compared to 2005. By sector, emissions from the energy sector increased by 1.14%, while those from the IPPU sector declined by 29.15%, the agriculture sector by 25.13%, and the waste sector by 72.05%. In addition, carbon removals from the LULUCF sector decreased by 2.53%, as shown in Figure ES3.3.

1. Energy sector

The total greenhouse gas emission from the energy sector in 2005 was 249,889 kilotons of carbon dioxide equivalents and increased to 252,730 kilotons of carbon dioxide equivalents in 2023 with a growth of 1.14% and an annual average growth of 0.06%. Within the sector, emissions from category 1.A.1 "Energy Industries" increased by 14.02%; 1.A.2 "Manufacturing and Construction Industry" decreased by 32.43%; 1.A.3 "Transportation" declined by 6.06%; 1.A.4 "Other Sectors" (including service industry, residential and agriculture, forestry, fishery and husbandry) decreased

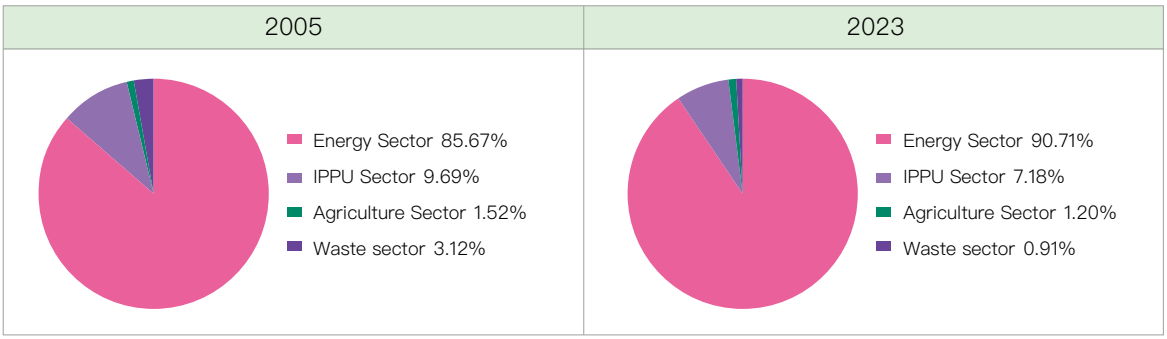

Figure ES3.1 Percentage of Greenhouse Gas Emissions (excluding LULUCF) by Sectors in Taiwan in (a) 2005 and (b) 2023.

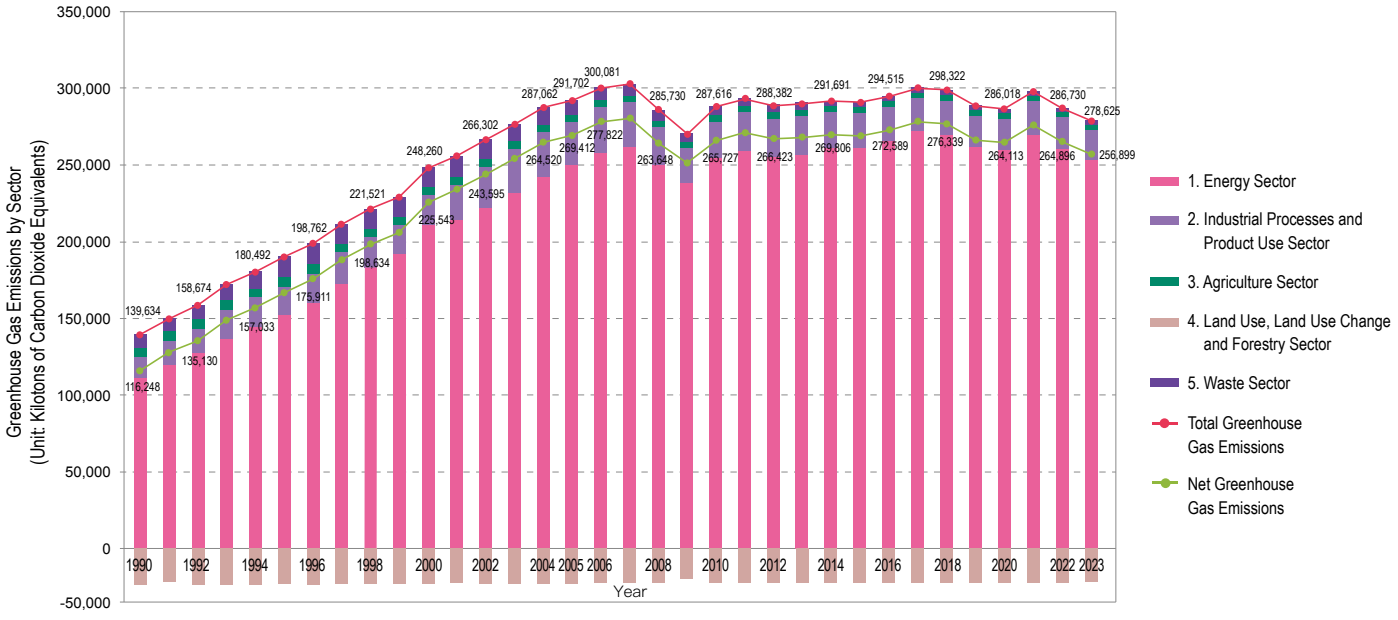

Figure ES3.2 1990–2023 Trends in Greenhouse Gas Emission by Sector in Taiwan

Table ES3.1 1990–2023 Greenhouse Gas Emission in Taiwan by Sector

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	110,536	119,525	127,198	136,407	144,359	152,110	159,910	172,204	182,963	191,980	210,357	214,224
2. IPPU Sector	14,710	15,328	16,222	19,316	18,834	18,526	19,114	21,113	20,573	19,038	20,158	22,823
3. Agriculture Sector	5,694	6,015	5,838	5,873	5,869	5,974	6,034	5,228	4,814	4,982	5,147	4,894
4. LULUCF Sector	−23,386	−21,490	−23,544	−23,546	−23,459	−23,340	−22,851	−23,060	−22,887	−22,764	−22,717	−21,850
5. Waste Sector	8,694	8,858	9,415	10,444	11,430	13,424	13,703	12,616	13,170	12,865	12,599	13,789
Net GHG Emission (including LULUCF)	**116,248**	**128,236**	**135,130**	**148,495**	**157,033**	**166,694**	**175,911**	**188,101**	**198,634**	**206,102**	**225,543**	**233,881**
Total GHG Emission (excluding LULUCF)	**139,634**	**149,727**	**158,674**	**172,041**	**180,492**	**190,034**	**198,762**	**211,161**	**221,521**	**228,866**	**248,260**	**255,731**
GHG Emission Sources and Sinks	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
1. Energy Sector	221,864	231,695	241,859	249,889	257,285	261,174	249,425	237,717	253,632	259,066	255,163	256,081
2. IPPU Sector	26,897	28,554	29,670	28,255	29,921	29,137	25,345	22,703	24,482	24,987	24,729	25,685
3. Agriculture Sector	4,732	4,420	4,484	4,449	4,441	4,310	4,124	4,105	4,081	4,042	4,043	3,952
4. LULUCF Sector	−22,707	−22,624	−22,542	−22,290	−22,259	−22,074	−22,082	−19,388	−21,889	−21,947	−21,960	−21,974
5. Waste Sector	12,810	11,829	11,050	9,109	8,434	7,719	6,836	5,948	5,421	4,943	4,447	4,127
Net GHG Emission (including LULUCF)	**243,595**	**253,873**	**264,520**	**269,412**	**277,822**	**280,265**	**263,648**	**251,085**	**265,727**	**271,091**	**266,423**	**267,871**
Total GHG Emission (excluding LULUCF)	**266,302**	**276,497**	**287,062**	**291,702**	**300,081**	**302,339**	**285,730**	**270,473**	**287,616**	**293,038**	**288,382**	**289,845**
GHG Emission Sources and Sinks	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**		
1. Energy Sector	260,465	260,486	265,031	271,526	269,493	261,092	259,710	269,295	260,267	252,730		
2. IPPU Sector	23,694	22,831	22,243	21,534	22,258	20,635	19,859	22,234	20,342	20,019		
3. Agriculture Sector	3,868	3,810	3,820	3,753	3,702	3,644	3,696	3,543	3,421	3,331		
4. LULUCF Sector	−21,886	−21,900	−21,926	−21,961	−21,984	−21,917	−21,905	−21,850	−21,834	−21,726		
5. Waste Sector	3,664	3,308	3,420	3,208	2,869	2,785	2,753	2,835	2,700	2,546		
Net GHG Emission (including LULUCF)	**269,806**	**268,535**	**272,589**	**278,059**	**276,339**	**266,240**	**264,113**	**276,056**	**264,896**	**256,899**		
Total GHG Emission (excluding LULUCF)	**291,691**	**290,436**	**294,515**	**300,021**	**298,322**	**288,157**	**286,018**	**297,906**	**286,730**	**278,625**		

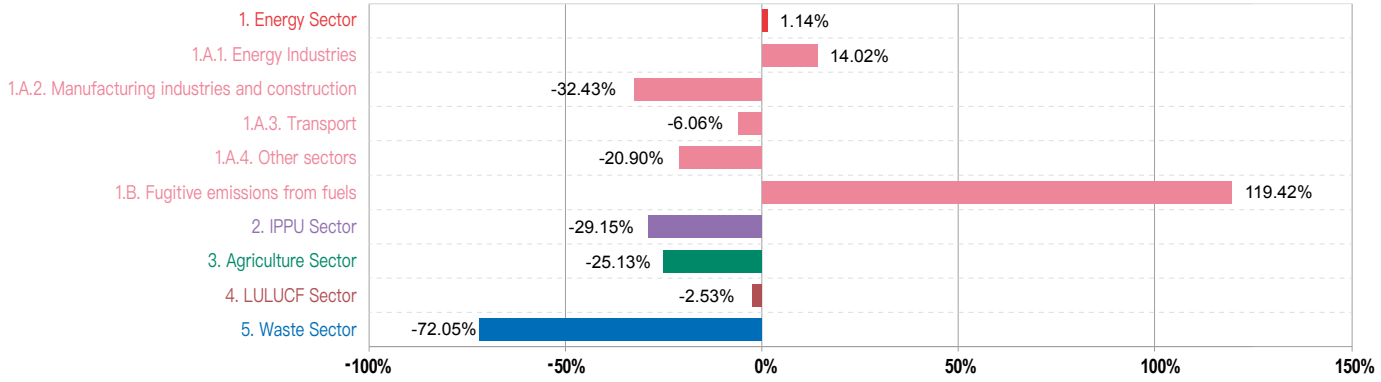

Figure ES3.3 Changes in Greenhouse Gas Emissions and Sequestrations by Sectors in Taiwan from 2005 to 2023.

by 20.90%; and 1.B.2 “Oil and Natural Gas” increased by 4.46%, as shown in Table ES3.2.

During this period, the greenhouse gas emissions from the energy sector showed a downward trend in 2008 for the first time and declined again in 2009 and 2012, followed by more reduction in 2018 to 2020 period. Compared with 2022, the greenhouse gas emissions in 2023 decreased by 2.90%.

The total greenhouse gas emission from the energy sector in 2023 accounted for 90.71% of the total greenhouse gas emission in Taiwan. In particular, 1.A.1 “Energy Industries” was responsible for 177,526 kilotons of carbon dioxide equivalents, accounting for 70.24% of the total greenhouse gas emission from the energy sector; 1.A.2 “Manufacturing and Construction Industry” was responsible for 29,896 kilotons of carbon dioxide equivalents (accounting for 11.83%); 1.A.3 “Transportation” was responsible for 35,370 kilotons of carbon dioxide equivalents (accounting for 14.00%); 1.A.4 “Others Sectors” (including service industry, residential and agriculture, forestry, fishery and husbandry) was responsible for 9,603 kilotons of carbon dioxide equivalents (accounting for 3.80%); 1.B.2 “Oil

Table ES3.2 1990–2023 Greenhouse Gas Emissions Produced by Energy Sector in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total CO_2 Emission	109,465	118,443	126,058	135,206	143,103	150,810	158,579	170,835	181,518	190,446	208,724	212,554
1.A.1 Energy Industry	49,123	55,126	57,508	64,745	69,487	75,214	80,103	90,168	99,375	104,827	119,268	123,880
1.A.2 Manufacturing and Construction Industry	30,124	31,963	34,410	34,835	35,876	36,956	37,942	40,323	40,360	42,269	45,284	44,234
1.A.3 Transportation	19,646	20,888	24,033	26,103	27,540	28,822	29,801	30,536	31,844	32,772	33,207	33,267
1.A.4 Others Sectors	10,572	10,466	10,107	9,523	10,200	9,819	10,733	9,808	9,939	10,579	10,965	11,174
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 Emission	592	567	558	573	592	602	589	585	611	646	667	665
1.A.1 Energy Industry	29	33	32	36	41	49	51	58	66	80	92	103
1.A.2 Manufacturing and Construction Industry	51	54	58	58	60	62	65	68	70	75	84	88
1.A.3 Transportation	170	183	209	226	241	256	268	275	288	298	303	305
1.A.4 Others Sectors	34	33	31	29	31	30	33	29	30	31	33	34
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	182	155	129	126	110	90	57	38	30	35	32	NO
1.B.2 Oil and Natural Gas	127	109	98	97	108	115	115	117	128	126	124	136
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total N_2O Emission	478	516	583	628	664	698	743	785	834	888	966	1,004
1.A.1 Energy Industry	124	141	164	185	200	218	248	276	307	340	401	435
1.A.2 Manufacturing and Construction Industry	80	84	91	91	93	96	100	107	109	118	129	133
1.A.3 Transportation	259	275	314	340	357	372	381	389	406	417	423	422
1.A.4 Others Sectors	15	15	14	12	14	13	14	12	12	13	14	14
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total Emission from Energy Sector	110,536	119,525	127,198	136,407	144,359	152,110	159,910	172,204	182,963	191,980	210,357	214,224

GHG Emission Sources and Sinks	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total CO_2 Emission	220,123	229,841	239,929	247,956	255,330	259,215	247,537	235,868	251,708	257,097	253,201	254,109
1.A.1 Energy Industry	128,157	139,316	147,288	155,014	162,298	168,580	162,125	153,989	164,270	168,491	166,837	167,023
1.A.2 Manufacturing and Construction Industry	46,373	44,211	44,551	44,008	45,309	44,845	41,410	37,874	42,612	43,691	42,515	43,307
1.A.3 Transportation	34,542	34,509	35,859	36,846	36,771	35,419	33,216	33,541	34,652	35,107	34,284	34,209
1.A.4 Others Sectors	11,052	11,806	12,230	12,089	10,952	10,371	10,785	10,463	10,174	9,808	9,566	9,571
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 Emission	689	746	782	749	743	741	724	713	753	779	789	804
1.A.1 Energy Industry	103	119	123	126	131	135	134	125	131	132	132	131
1.A.2 Manufacturing and Construction Industry	94	92	95	95	97	97	91	86	93	99	96	98
1.A.3 Transportation	311	321	330	339	333	324	308	314	319	322	318	318
1.A.4 Others Sectors	33	36	37	37	33	30	32	31	30	29	28	28
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	148	178	197	153	148	155	159	157	180	197	216	228
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total N_2O Emission	1,051	1,107	1,147	1,184	1,213	1,218	1,164	1,136	1,172	1,190	1,172	1,168
1.A.1 Energy Industry	456	513	534	560	586	610	592	570	579	584	580	574
1.A.2 Manufacturing and Construction Industry	141	138	141	141	145	144	134	126	137	144	139	141
1.A.3 Transportation	441	440	456	469	469	452	425	428	444	450	442	442
1.A.4 Others Sectors	14	15	16	15	13	12	13	12	11	11	11	11
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total Emission from Energy Sector	221,864	231,695	241,859	249,889	257,285	261,174	249,425	237,717	253,632	259,066	255,163	256,081

Continued from the table below

Continued from the table

GHG Emission Sources and Sinks	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total CO_2 Emission	258,480	258,475	262,982	269,461	267,458	259,083	257,693	267,281	258,271	250,755
1.A.1 Energy Industry	173,749	173,697	177,211	185,763	187,957	180,289	179,510	188,460	181,773	176,827
1.A.2 Manufacturing and Construction Industry	40,384	39,575	39,653	38,112	35,045	34,079	33,078	35,687	32,422	29,748
1.A.3 Transportation	34,666	35,506	36,584	36,202	35,202	35,438	35,715	33,905	34,696	34,616
1.A.4 Others Sectors	9,681	9,698	9,533	9,384	9,254	9,277	9,389	9,229	9,380	9,564
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 Emission	815	843	864	871	855	851	865	870	880	874
1.A.1 Energy Industry	134	139	139	140	142	139	137	140	137	137
1.A.2 Manufacturing and Construction Industry	95	94	94	89	77	76	75	77	69	63
1.A.3 Transportation	320	327	337	331	321	321	325	301	309	311
1.A.4 Others Sectors	29	28	28	27	27	27	27	27	27	28
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	238	254	267	284	288	288	302	325	337	335
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total N_2O Emission	1,170	1,168	1,185	1,194	1,181	1,159	1,152	1,145	1,117	1,102
1.A.1 Energy Industry	577	566	574	595	609	586	577	591	566	562
1.A.2 Manufacturing and Construction Industry	136	134	133	125	108	106	104	107	95	85
1.A.3 Transportation	446	457	468	463	453	457	461	437	446	444
1.A.4 Others Sectors	11	11	11	10	10	10	10	10	10	11
1.A.5 Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Natural Gas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.3 Other Emissions from Energy Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total Emission from Energy Sector	260,465	260,486	265,031	271,526	269,493	261,092	259,710	269,295	260,267	252,730

Note: 1. NO (not happened) means that the emission source is not produced or used.
2. NE (Not Estimated) means that there is no estimate for existing GHG emission source or sink.

and Natural Gas" was responsible for 335 kilotons of carbon dioxide equivalents (accounting for 0.13%), as shown in Figure ES3.4.

2. Industrial Process and Product Use (IPPU) Sector

The greenhouse gas emission from the IPPU sector in 2005 was 28,255 kilotons of carbon dioxide equivalents and decreased to 20,019 kilotons in 2023, down by 19.15% with a negative average annual growth rate of −1.90%. Within this sector, emissions from category 2.A "Mineral Industry (Non-metallic Products)" decreased by 46.86%; 2.B "Chemical Industry" decreased by 33.50%; 2.C "Metal Industry" increased by 35.22%; 2.D "Non-Energy Products from Fuels and Solvent Use" decreased by 42.00%; 2.E "Electronics Industry" declined by 64.27%; 2.F "Alternatives to Ozone-depleting Substances" rose significantly by 641.93%; 2.G "Manufacturing and Use of Other Products" decreased by 94.53%; and 2.H "Other" decreased by 26.90%, as shown in Table ES3.3.Compared to 2022, the greenhouse gas emissions in 2023 decreased by 1.59%.

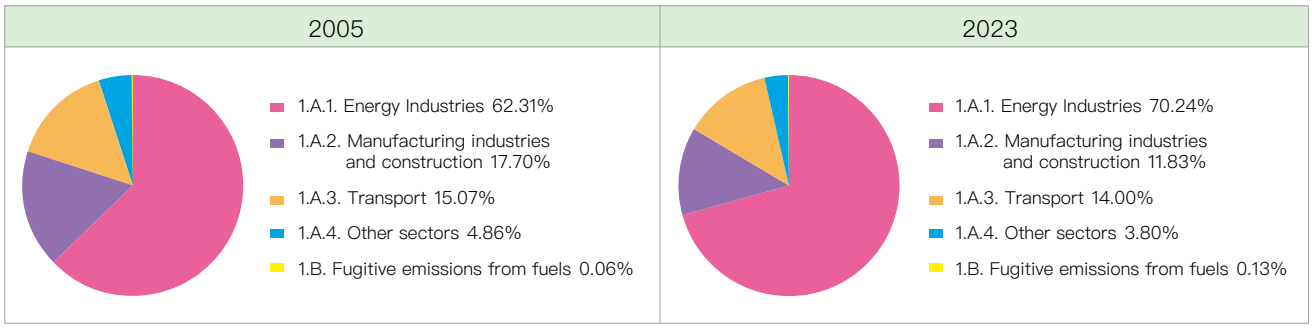

Figure ES3.4 Percentage of Greenhouse Gas Emissions by Energy Sectors in Taiwan in (a)2005 and (b)2023.

Table ES3.3 1990–2023 Greenhouse Gas Emissions Produced by Industrial Process and Product Use Sector (IPPU) in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total CO_2 Emission	14,557	15,007	15,926	18,408	17,826	17,528	17,677	19,483	18,410	17,179	17,388	16,186
2.A Mining Industry (Non-metal Products)	10,683	10,698	11,854	13,879	13,259	12,766	12,645	13,394	11,564	10,746	10,486	9,974
2.B Chemical Industry	575	551	575	617	770	858	999	1,026	1,007	1,079	1,148	1,232
2.C Metal Process	3,275	3,735	3,474	3,888	3,774	3,884	4,013	5,045	5,817	5,333	5,734	4,960
2.D Non-Energy Products from Fuels and Solvent Use	0.00006	0.00006	0.00006	0.00007	0.00009	0.00008	0.00008	0.00008	0.00009	0.00009	0.00008	0.00007
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.H Others	23	23	23	24	23	21	20	19	22	21	20	20
Total CH_4 Emission	6	8	7	8	9	11	13	13	11	13	15	20
2.B Chemical Industry	6	6	6	7	8	10	12	12	10	13	15	20
2.C Metal Process	0.2	2.0	1.5	1.2	1.0	1.4	1.3	1.3	1.3	0.4	0.2	0.1
Total N_2O Emission	147	313	289	268	283	307	305	333	340	277	556	635
2.B Chemical Industry	147	313	289	268	283	307	305	333	340	277	556	635
2.C Metal Process	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total HFCs Emission	NE	NE	NE	633	716	680	1,120	1,284	1,812	1,437	2,054	2,329
2.B Chemical Industry	NE	NE	NE	633	716	671	1,094	1,238	1,745	1,348	1,943	2,151
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	43
2.F Alternatives to Ozone-depleting Substances	NE	NE	NE	NE	NE	8	26	46	66	89	111	135
Total PFCs Emission (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	2	12	2,665
Total SF_6 Emission	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124	769
2.C Metal Process	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	120	124	769
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total NF_3 Emission (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	10	9	220
Total Emission from IPPU Sector	14,710	15,328	16,222	19,316	18,834	18,526	19,114	21,113	20,573	19,038	20,158	22,823

GHG Emission Sources and Sinks	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total CO_2 Emission	16,075	17,141	17,358	18,094	20,315	19,971	18,562	16,402	18,209	18,951	19,369	19,605
2.A Mining Industry (Non-metal Products)	10,648	10,341	10,691	11,257	11,029	10,373	9,294	8,462	8,618	9,574	9,333	9,866
2.B Chemical Industry	1,313	1,384	1,485	1,751	1,721	1,845	1,601	1,601	1,778	1,737	1,714	1,749
2.C Metal Process	4,096	5,397	5,162	5,066	7,544	7,733	7,648	6,317	7,792	7,620	8,301	7,970
2.D Non-Energy Products from Fuels and Solvent Use	0.00008	0.00009	0.00011	0.00010	0.00007	0.00007	0.00007	0.00006	0.00005	0.00004	0.00004	0.00005
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.H Others	18	18	19	20	21	20	20	21	20	20	21	19
Total CH_4 Emission	21	24	31	20	25	31	30	31	32	25	26	28
2.B Chemical Industry	21	24	31	20	20	26	24	27	26	25	26	28
2.C Metal Process	0.2	0.3	NO	NO	4.8	4.8	5.5	3.9	6.2	0.02	0.07	0.1
Total N_2O Emission	661	741	742	891	1,311	1,399	1,185	1,334	1,670	1,605	1,527	1,407
2.B Chemical Industry	661	739	742	854	861	886	697	895	1,040	1,062	904	694
2.C Metal Process	0.4	1.5	NO	NO	84	85	81	68	107	NO	NO	NO
2.E Electronics Industry	NE	NE	NE	37	365	428	407	371	523	543	623	713
Total HFCs Emission	2,016	1,857	1,685	303	331	402	356	404	393	372	482	610
2.B Chemical Industry	1,807	1,623	1,433	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	49	49	49	85	100	167	123	172	169	144	104	173
2.F Alternatives to Ozone-depleting Substances	160	185	204	218	232	235	234	232	225	228	378	437
Total PFCs Emission (2.E Electronics Industry)	3,764	3,814	3,949	3,178	3,355	3,102	1,932	1,464	1,650	1,665	1,054	1,253
Total SF_6 Emission	3,986	4,471	5,288	5,052	3,940	3,485	3,001	2,527	2,286	1,976	1,909	2,059
2.C Metal Process	1,009	1,009	1,334	1,046	757	454	149	242	59	52	31	39
2.E Electronics Industry	973	1,458	1,838	2,457	2,389	2,049	1,930	1,561	1,983	1,665	1,678	1,855
2.G Manufacturing and Use of Other Products	2,003	2,003	2,116	1,549	794	982	923	724	245	260	201	165
Total NF_3 Emission (2.E Electronics Industry)	373	506	617	716	644	747	191	540	241	393	363	723
Total Emission from IPPU Sector	26,897	28,554	29,670	28,255	29,921	29,137	25,259	22,703	24,482	24,987	24,729	25,685

Continued from the table below

Continued from the table

GHG Emission Sources and Sinks	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Total CO_2 Emission	17,703	17,253	16,592	15,631	16,024	14,889	14,001	15,670	14,778	15,430
2.A Mining Industry (Non-metal Products)	8,728	8,347	7,117	6,269	6,408	6,500	6,563	6,835	6,473	5,982
2.B Chemical Industry	1,884	1,842	1,760	1,709	1,684	1,666	1,550	1,730	1,270	1,192
2.C Metal Process	7,072	7,044	7,696	7,634	7,913	6,706	5,870	7,090	7,020	8,242
2.D Non-Energy Products from Fuels and Solvent Use	0.00006	0.00010	0.00008	0.00007	0.00006	0.00006	0.00006	0.00007	0.00006	0.00006
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.H Others	19	20	19	20	19	17	18	15	15	15
Total CH_4 Emission	29	29	30	27	30	29	28	29	24	23
2.B Chemical Industry	29	29	30	27	30	29	28	29	24	23
2.C Metal Process	0.2	0.2	0.2	NO	0.01	0.01	0.0001	NO	NO	0.0003
Total N_2O Emission	1,384	1,378	1,550	1,729	1,838	1,743	1,709	2,227	1,526	1,134
2.B Chemical Industry	647	614	854	991	987	828	541	1,053	679	531
2.C Metal Process	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	737	764	696	738	851	916	1,168	1,174	847	602
Total HFCs Emission	697	726	836	971	1,125	1,252	1,390	1,515	1,649	1,725
2.B Chemical Industry	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
2.E Electronics Industry	184	142	160	169	169	152	161	156	151	110
2.F Alternatives to Ozone-depleting Substances	513	584	676	802	957	1,101	1,229	1,359	1,498	1,615
Total PFCs Emission (2.E Electronics Industry)	1,449	1,250	1,336	1,304	1,421	1,315	1,336	1,354	1,250	878
Total SF_6 Emission	1,807	1,569	1,458	1,459	1,342	963	867	882	660	481
2.C Metal Process	58	44	39	61	84	45	37	62	27	22
2.E Electronics Industry	1,600	1,393	1,334	1,317	1,105	805	693	716	507	374
2.G Manufacturing and Use of Other Products	150	132	85	81	154	113	137	103	127	85
Total NF_3 Emission (2.E Electronics Industry)	624	626	442	412	477	443	528	556	455	348
Total Emission from IPPU Sector	23,694	22,831	22,243	21,534	22,258	20,635	19,859	22,234	20,342	20,019

Note: 1. NE (Not Estimated) means that there is no estimate for existing GHG emission source or sink.
2. NO (not happened) means that the emission source is not produced or used. For example, HCFC-22 has been put into production since 1993 and was discontinued in 2005.

The total greenhouse gas emission in 2023 accounted for 7.18% of the total greenhouse gas emission in Taiwan. In particular, 2.C "Metal Industry" was responsible for 8,264 kilotons of carbon dioxide equivalents, accounting for 41.28% (the majority) of the greenhouse gases from the IPPU sector, followed by 2.A "Mining Industry (Non-metal Products)" , which was responsible for 5,982 kilotons of carbon dioxide equivalents (accounting for 29.88%), 2.E "Electronics Industry", which was responsible for 2,313 kilotons of carbon dioxide equivalents (accounting for 11.56%), 2.B "Chemical Industry", which was responsible for 1,745 kilotons of carbon dioxide equivalents (accounting for 8.72%), 2.F "Alternatives to Ozone-depleting Substances", which was responsible for 1,615 kilotons of carbon dioxide equivalents (accounting for 8.07%), 2.G. "Manufacturing and Use of Other Products", which was responsible for 85 kilotons of carbon dioxide equivalents (accounting for 0.42%), 2.H. "Others", which was responsible for 15 kilotons of carbon dioxide equivalents (accounting for 0.07%) and 2.D. "Non-Energy Products from Fuels and Solvent Use", which was responsible for 0.00006 kilotons of carbon dioxide equivalents (accounting for 0.0000003%), as shown in Figure ES3.5.

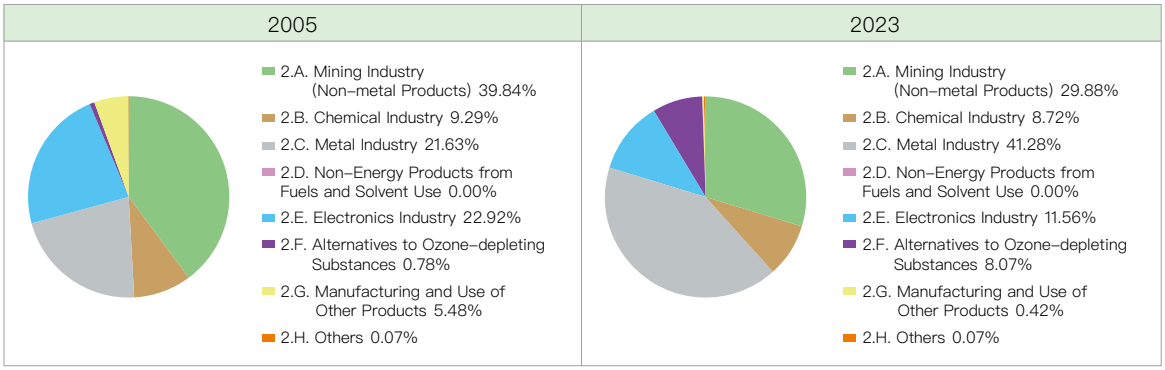

Figure ES3.5 Percentage of Greenhouse Gas Emissions by Industrial Process and Product Use Sectors in Taiwan in (a) 2005 and (b) 2023.

3. Agriculture Sector

In 2023, the greenhouse gas emissions from the agriculture sector totaled 3,331 kilotons of carbon dioxide equivalents, accounting for 1.20% of the total greenhouse gas emission in Taiwan, approximately down by 25.13% compared to 4,449 kilotons of carbon dioxide equivalents in 2005, with a negative average annual growth rate of –1.59%. Within this sector, emissions from category 3.A "Enteric Fermentation" decreased by 7.88%; 3.B "Manure Management" by 21.30%; 3.C "Rice Cultivations" by 24.48%; 3.D "Agricultural Soils" by 32.98%; 3.F "Field Burning of Agricultural Residues" by 84.98%; and 3.H "Urea Applied" by 68.43%, as shown in Table ES3.4.Compared to 2022, the greenhouse gas emissions from the agriculture sector in 2023 slightly fall by 2.64%.

Greenhouse gas emissions from the agriculture sector in 2023 were primarily attributed to category 3.D "Agricultural Soils" which represented the largest portion at 35.28%. This was followed by 3.B "Manure Management" at 28.52%, 3.A "Enteric Fermentation" at 19.29%, and 3.C "Rice Cultivations" at 16.27%. Emissions from 3.H "Urea Applied" and 3.F "Field Burning of Agricultural Residues" were relatively minimal, contributing only 0.59% and 0.05%, respectively, as depicted in Figure ES3.6.

Table ES3.4 1990–2023 Greenhouse Gas Emissions Produced by Agriculture Sector in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total CO_2 Emission	142	146	139	131	135	151	151	134	127	118	131	94
3.G Liming	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3.H Urea Applied	142	146	139	131	135	151	151	134	127	118	131	94
3.I Other Carbon-containing Fertilizers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 Emission	3,264	3,472	3,381	3,388	3,374	3,449	3,455	2,993	2,703	2,820	2,813	2,717
3.A Enteric Fermentation	750	819	826	868	883	921	921	820	755	778	775	739
3.B Manure Management	1,246	1,460	1,418	1,436	1,470	1,535	1,565	1,190	990	1,088	1,123	1,074
3.C Rice Cultivations	1,226	1,166	1,084	1,059	998	984	961	976	953	947	899	887
3.D Agricultural Soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	42	28	53	24	23	8	8	8	6	8	15	17
Total N_2O Emission	2,289	2,397	2,318	2,355	2,360	2,374	2,429	2,101	1,984	2,044	2,203	2,083
3.B Manure Management	129	146	145	147	154	160	167	143	129	137	140	135
3.D Agricultural Soils	2,150	2,244	2,160	2,202	2,200	2,212	2,259	1,957	1,853	1,905	2,059	1,944
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	10	7	13	6	6	2	2	2	2	2	4	4
Total Emission From Agriculture Sector	5,694	6,015	5,838	5,873	5,869	5,974	6,034	5,228	4,814	4,982	5,147	4,894

GHG Emission Sources and Sinks	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total CO_2 Emission	93	82	84	62	59	57	57	55	54	53	55	45
3.G Liming	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
3.H Urea Applied	93	82	84	62	59	57	57	55	54	53	55	45
3.I Other Carbon-containing Fertilizers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 Emission	2,565	2,451	2,363	2,495	2,461	2,371	2,303	2,247	2,244	2,278	2,252	2,237
3.A Enteric Fermentation	712	701	688	698	688	682	655	640	648	660	653	649
3.B Manure Management	1,022	1,019	1,024	1,071	1,058	994	965	924	931	944	904	874
3.C Rice Cultivations	816	721	643	717	706	690	676	678	659	668	688	710
3.D Agricultural Soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	14	10	9	9	9	5	7	6	6	6	6	4
Total N_2O Emission	2,074	1,887	2,037	1,891	1,920	1,882	1,765	1,803	1,784	1,711	1,737	1,670
3.B Manure Management	131	131	130	136	136	130	129	125	125	126	123	122
3.D Agricultural Soils	1,939	1,754	1,904	1,753	1,782	1,751	1,634	1,676	1,657	1,583	1,612	1,548
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
3.F Field Burning of Agricultural Residues	4	2	2	2	2	1	2	1	1	1	1	1
Total Emission From Agriculture Sector	4,732	4,420	4,484	4,449	4,441	4,310	4,124	4,105	4,081	4,042	4,043	3,952

Continued from the table below

Continued from the table

GHG Emission Sources and Sinks	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
Total CO_2 Emission	40	38	34	31	30	29	29	27	22	20		
3.G Liming	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
3.H Urea Applied	40	38	34	31	30	29	29	27	22	20		
3.I Other Carbon-containing Fertilizers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE		
Total CH_4 Emission	2,180	2,157	2,166	2,166	2,165	2,174	2,172	2,115	2,052	2,004		
3.A Enteric Fermentation	634	641	628	632	640	643	650	665	655	643		
3.B Manure Management	840	834	829	827	832	844	845	842	821	819		
3.C Rice Cultivations	702	678	705	704	689	684	677	608	576	542		
3.D Agricultural Soils	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
3.F Field Burning of Agricultural Residues	4	5	4	4	3	2	1	1	1	1		
Total N_2O Emission	1,648	1,615	1,621	1,555	1,508	1,440	1,494	1,401	1,346	1,307		
3.B Manure Management	121	121	122	123	125	129	130	130	130	131		
3.D Agricultural Soils	1,526	1,493	1,497	1,431	1,382	1,311	1,364	1,271	1,216	1,175		
3.E Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
3.F Field Burning of Agricultural Residues	1	1	1	1.0	0.7	0.6	0.2	0.2	0.2	0.3		
Total Emission From Agriculture Sector	3,868	3,810	3,820	3,753	3,702	3,644	3,696	3,543	3,421	3,331		

Note: 1. NO (not happened) means that the emission source is not produced or used.
2. NE (Not Estimated) means that there is no estimate for existing GHG emission source or sink.

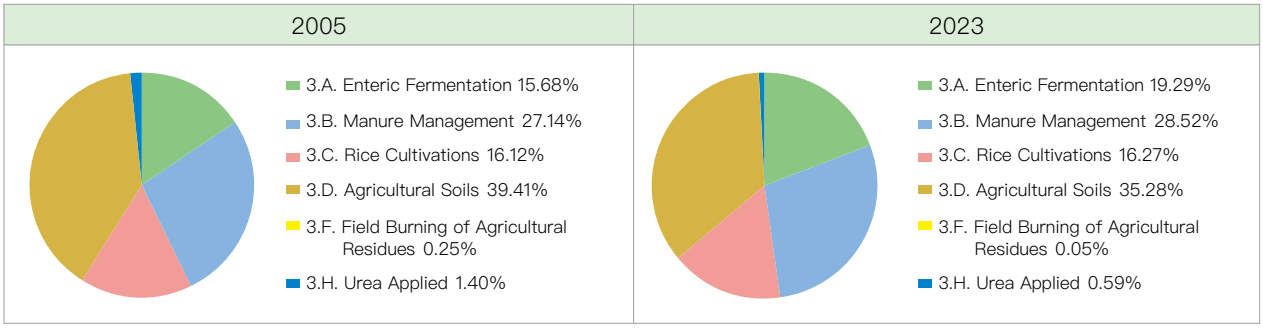

Figure ES3.6 Percentage of Greenhouse Gas Emissions by Agriculture Sectors in Taiwan in (a) 2005 and (b) 2023.

4 .Land use, land use change and forestry (LULUCF) sector

The main greenhouse gas sequestrated by the land use, land use change and forestry (LULUCF) sector is carbon dioxide, while the change in the annual sequestration does not vary much with the exception of trends in minor fluctuations for the sequestration in the past. It is mainly because of the increased sequestration from the annual growth of forest resources while the sequestration reduced from the increased sequestration of forestation and the forest interference is less. The greenhouse gas emission from land use and forestry sector in Taiwan from 1990 to 2023 (mainly consisting of carbon dioxide sequestration by forestry resources) is shown in Table ES3.5.

The carbon dioxide sequestration by forestry sector in 2005 was 22,290 kilotons of carbon dioxide equivalents. The carbon dioxide sequestration between 2005 and 2023 decreased by 2.53% with a negative average annual growth rate of –0.14%. The sequestration in 2023 was 21,726 kilotons of carbon dioxide equivalents, down by 0.49% compared with 2022.

5. Waste sector

In 2005, the greenhouse gas emissions by waste sector were 9,109 kilotons of carbon dioxide equivalents. The emissions from the waste sector in 2023 were 2,546 kilotons of carbon dioxide equivalents, approximately accounting for 0.91% of the total greenhouse gas emission in Taiwan, down by 72.05% compared with 2005, with a negative average annual growth rate of –6.84%. Specifically, emissions from category 5.A “Solid Waste Disposal” decreased by 90.98%, while 5.B “Solid Waste Biological Disposal” increased by 138.69%, and 5.C “Incineration and Open Burning of Waste” increased

Table ES3.5 1990–2023 Changes in Carbon Sequestration by LULUCF Sector in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
4.A.1 Forests Maintaining Forests	Carbon Sequestration ($\triangle CO_{2G}$)	−23,902	−23,902	−23,741	−23,580	−23,418	−23,257	−23,095	−22,934	−22,772	−22,611	−22,449	−22,288
	Carbon Emissions ($\triangle CO_{2L}$)	607	2,503[1]	333	216	190	202	559	266	326	401	389	1,112[2]
4.A.2 Other Lands Turned to Forests	Carbon Sequestration ($\triangle CO_{2G}$)	−91	−91	−136	−182	−230	−285	−315	−392	−440	−553	−656	−673
Total Carbon Sequestration from LULUCF Sector ($\triangle CO_2$)		−23,386	−21,490	−23,544	−23,546	−23,459	−23,340	−22,851	−23,060	−22,887	−22,764	−22,717	−21,850
GHG Emission Sources and Sinks		2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
4.A.1 Forests Maintaining Forests	Carbon Sequestration ($\triangle CO_{2G}$)	−22,127	−21,965	−21,804	−21,642	−21,481	−21,319	−21,158	−20,997	−20,889	−20,907	−20,932	−20,970
	Carbon Emissions ($\triangle CO_{2L}$)	167	227	243	369	251	308	199	2,753[3]	218	140	145	135
4.A.2 Other Lands Turned to Forests	Carbon Sequestration ($\triangle CO_{2G}$)	−747	−886	−981	−1,016	−1,029	−1,062	−1,123	−1,145	−1,218	−1,181	−1,173	−1,139
Total Carbon Sequestration from LULUCF Sector ($\triangle CO_2$)		−22,707	−22,624	−22,542	−22,290	−22,259	−22,074	−22,082	−19,388	−21,889	−21,947	−21,960	−21,974
GHG Emission Sources and Sinks		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023		
4.A.1 Forests Maintaining Forests	Carbon Sequestration ($\triangle CO_{2G}$)	−21,004	−21,040	−21,068	−21,105	−21,148	−21,202	−21,271	−21,318	−21,359	−21,421		
	Carbon Emissions ($\triangle CO_{2L}$)	197	189	153	107	83	116	90	121	114	187		
4.A.2 Other Lands Turned to Forests	Carbon Sequestration ($\triangle CO_{2G}$)	−1,079	−1,049	−1,011	−963	−918	−831	−724	−654	−589	−493		
Total Carbon Sequestration from LULUCF Sector ($\triangle CO_2$)		−21,886	−21,900	−21,926	−21,961	−21,984	−21,917	−21,905	−21,850	−21,834	−21,726		

Note:

a. In 1991, a forest fire broke out in Xinyi Township, Nantou County and Tataga District, Alishan Township, Chiayi County, and it was extended to more than 300 square meters, causing large losses in volume of wood.

b. In addition to the five forest fires that occurred in Takivatan, Lishan Mountain, East Peak of Mt. Shei, and Yangmingshan National Park, there were 59 breaking out of small fire in 2001, and the fire damaged area up to 395 square meters, causing heavy loss of forest resources.

c. In 2009, the typhoon Morakot caused severe disasters in central and southern Taiwan, especially in Kaohsiung and parts of Pingtung, dropped more than 2,500 millimeters of rain and produced about 1.25 million tons of driftwood, causing large losses in volume of wood.

by 15.11%. Emissions from 5.D “Wastewater Treatment and Discharge” decreased by 35.08%, as shown in Table ES3.6.Compared to 2022, the greenhouse gas emissions from the waste sector in 2023 dropped by 5.71%.

Among the waste sector emissions in 2023, greenhouse gas emissions from 5.D “Wastewater Treatment and Discharge” accounted for 38.78%, followed by greenhouse gas emissions from 5.C “Incineration and Open Burning of Waste”, accounting for 35.44%, greenhouse gas emissions from 5.A “Solid Waste Disposal”, accounting for 24.03%, greenhouse gas emissions from 5.B “Solid Waste Biological Disposal “, accounting for 1.75%, as shown in Figure ES3.7.

ES.4 Other Information

In accordance with the “Climate Change Response Act”, Taiwan established a Greenhouse Gas (GHG) emissions report and management system complying with Taiwan’s national conditions, the work division, and the hierarchical management of database. Accordingly, the relevant competent authorities will calculate GHG emissions subject to their departments and bring together experts and scholars to review the statistical data, methodology, and improvement plans. The results will be submitted to Environmental Protection Administration for compilation annually. After the cross-ministerial discussions, editing and proofreading, the National Inventory Report (NIR) will be established. Besides, Taiwan’s National GHG Registry has been established since 2013, allowing the competent authorities to submit their statistical data online. Furthermore, since 2015, the 2006 IPCC Guidelines has been applied for the compilation of annual NIR, the mission done in compliance with UNFCCC requirements.

Table ES3.6 1990–2023 Greenhouse Gas Emissions in Taiwan by Waste Sector

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Sources and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total CO_2 Emission (5.C Incineration and Open Burning of Waste)	94	35	309	301	500	1,575	1,652	330	491	280	691	2,597
Total CH_4 Emission	8,410	8,643	8,917	9,945	10,731	11,632	11,833	12,073	12,479	12,391	11,722	10,996
5.A Solid Waste Disposal	7,102	7,206	7,431	8,492	9,252	10,112	10,231	10,496	10,962	10,958	10,310	9,655
5.B Solid Waste Biological Disposal	13	0.6	0.9	0.5	0.2	0.7	0.3	2	0.06	2	0.3	0.02
5.C Incineration and Open Burning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.D Wastewater Treatment and Discharge	1,295	1,436	1,485	1,452	1,479	1,520	1,602	1,575	1,517	1,431	1,411	1,341
Total N_2O Emission	190	181	190	198	200	216	218	213	200	194	186	196
5.B Solid Waste Biological Disposal	9	0.4	0.6	0.4	0.1	0.5	0.2	1.1	0.04	1.5	0.2	0.02
5.C Incineration and Open Burning of Waste	1.0	0.4	3	3	5	16	17	3	5	3	7	27
5.D Wastewater Treatment and Discharge	180	180	186	194	194	199	201	209	195	189	179	169
Total Emission from Waste Sector	8,694	8,858	9,415	10,444	11,430	13,424	13,703	12,616	13,170	12,865	12,599	13,789
GHG Emission Sources and Sinks	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Total CO_2 Emission (5.C Incineration and Open Burning of Waste)	2,276	2,065	1,996	776	848	837	733	703	747	670	657	817
Total CH_4 Emission	10,339	9,569	8,868	8,164	7,437	6,732	5,968	5,111	4,542	4,137	3,660	3,187
5.A Solid Waste Disposal	8,976	8,192	7,482	6,786	6,066	5,349	4,644	3,942	3,347	2,862	2,432	2,054
5.B Solid Waste Biological Disposal	0.4	3	7	11	13	16	18	20	23	29	27	25
5.C Incineration and Open Burning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
5.D Wastewater Treatment and Discharge	1,363	1,375	1,379	1,367	1,359	1,367	1,306	1,149	1,171	1,246	1,201	1,108
Total N_2O Emission	195	195	185	169	149	149	136	134	133	136	129	122
5.B Solid Waste Biological Disposal	0.3	2	5	8	9	11	13	14	17	21	19	18
5.C Incineration and Open Burning of Waste	23	21	21	8	9	9	8	7	8	8	8	8
5.D Wastewater Treatment and Discharge	171	172	159	154	131	129	115	112	109	107	102	96
Total Emission from Waste Sector	12,810	11,829	11,050	9,109	8,434	7,719	6,836	5,948	5,421	4,943	4,447	4,127
GHG Emission Sources and Sinks	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**		
Total CO_2 Emission (5.C Incineration and Open Burning of Waste)	736	498	589	613	639	703	798	909	932	893		
Total CH_4 Emission	2,808	2,686	2,710	2,474	2,106	1,963	1,834	1,805	1,654	1,546		
5.A Solid Waste Disposal	1,736	1,469	1,252	1,080	937	837	769	694	663	612		
5.B Solid Waste Biological Disposal	23	22	22	23	26	28	29	30	28	26		
5.C Incineration and Open Burning of Waste	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO		
5.D Wastewater Treatment and Discharge	1,049	1,195	1,436	1,371	1,142	1,098	1,036	1,081	963	908		
Total N_2O Emission	121	124	121	122	125	120	121	121	114	107		
5.B Solid Waste Biological Disposal	16	16	16	16	18	20	21	21	20	19		
5.C Incineration and Open Burning of Waste	8	5	6	6	6	7	8	9	9	9		
5.D Wastewater Treatment and Discharge	97	103	99	100	101	93	92	91	86	79		
Total Emission from Waste Sector	3,664	3,308	3,420	3,208	2,869	2,785	2,753	2,835	2,700	2,546		

Note: NO (not happened) means that the emission source is not produced or used.

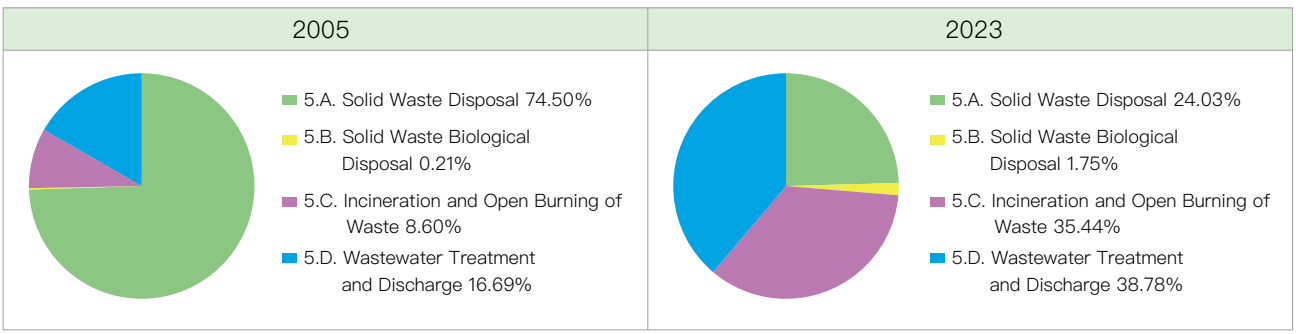

Figure ES3.7 Percentage of Greenhouse Gas Emissions by Waste Sectors in Taiwan in (a)2005 and (b)2023.

2025
REPUBLIC OF CHINA
NATIONAL GREENHOUSE GAS
INVENTORY REPORT Report Summary

環境部
Ministry of Environment