

REPUBLIC OF CHINA
**NATIONAL
GREENHOUSE GAS**
INVENTORY REPORT
Report Summary



2022

TAIWAN

Executive Summary

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Executive Summary

ES.1 Background Information on National Greenhouse Gas Inventory

The guidelines in Article 4 and Article 12 of the United Nations Framework Convention on Climate Change (UNFCCC) and Article 5 of the Kyoto Protocol state that each party shall submit information on its progress in response to climate change to the UNFCCC Convention of the Parties for review. In particular, the National Inventory Report (NIR) is a national report in which the UNFCCC¹ requires each Annex 1 country to report on its national greenhouse gas (GHG) inventory describing the procedures for GHG emission inventory preparation, information on emission trends, statistics by sectors, and a national report of re-calculation while submitting its inventory based on Common Reporting Format (CRF). 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.

Since 1998, Taiwan has taken initiatives to prepare the national GHG inventory. According to Decision 24/CP.17 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. The Report also carried out the statistics and compilation in accordance with the *2006 IPCC Guidelines*

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 2020. 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.

ES.2 Summary of National Emission and Absorption Related Trends

Taiwan's total GHG emissions increased from 290,552 kilotons of carbon dioxide equivalents (excluding land use, land use change and forestry, the following report abbreviated as LULUCF) in 2005 to 285,131 kilotons of carbon dioxide equivalents (excluding LULUCF) in 2020, with emissions decreased by 1.87% at a negative average annual growth rate of -0.13%. Among the greenhouse gas emissions in 2020, the proportion of carbon dioxide emissions is 95.29% and that of non-carbon dioxide is 4.71%. The total emissions in 2020 saw a decrease of 0.82% from the previous 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 91.71%, followed by methane (3.27%), nitrous oxide (1.48%), and fluorinated greenhouse gas (3.54%); however, carbon dioxide was still the largest of proportion (95.29%) in 2020, followed by nitrous oxide (1.72%), methane (1.62%), and then fluorinated greenhouse gas (1.37%), as shown in Figure ES2.2.

Between 2005 and 2020, carbon dioxide emissions grew by 1.97% with an average annual growth rate of 0.13%; carbon dioxide sequestration decreased by 1.73% with a negative average annual growth rate of -0.12%; methane emissions decreased by 51.43% with a negative average annual growth rate of -4.70%; nitrous oxide

1 UNFCCC, FCCC/CP/2002/8, 2002.

emissions increased by 14.08% with an annual growth rate of 0.88%; fluorinated greenhouse gas emissions decreased by 62.02% with a negative average annual growth rate of -6.25%, as shown in Figure ES2.3 and Table ES2.1.

1. Carbon Dioxide

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 266,460 kilotons of carbon dioxide equivalents. In 2020, that figure was 271,702 kilotons of

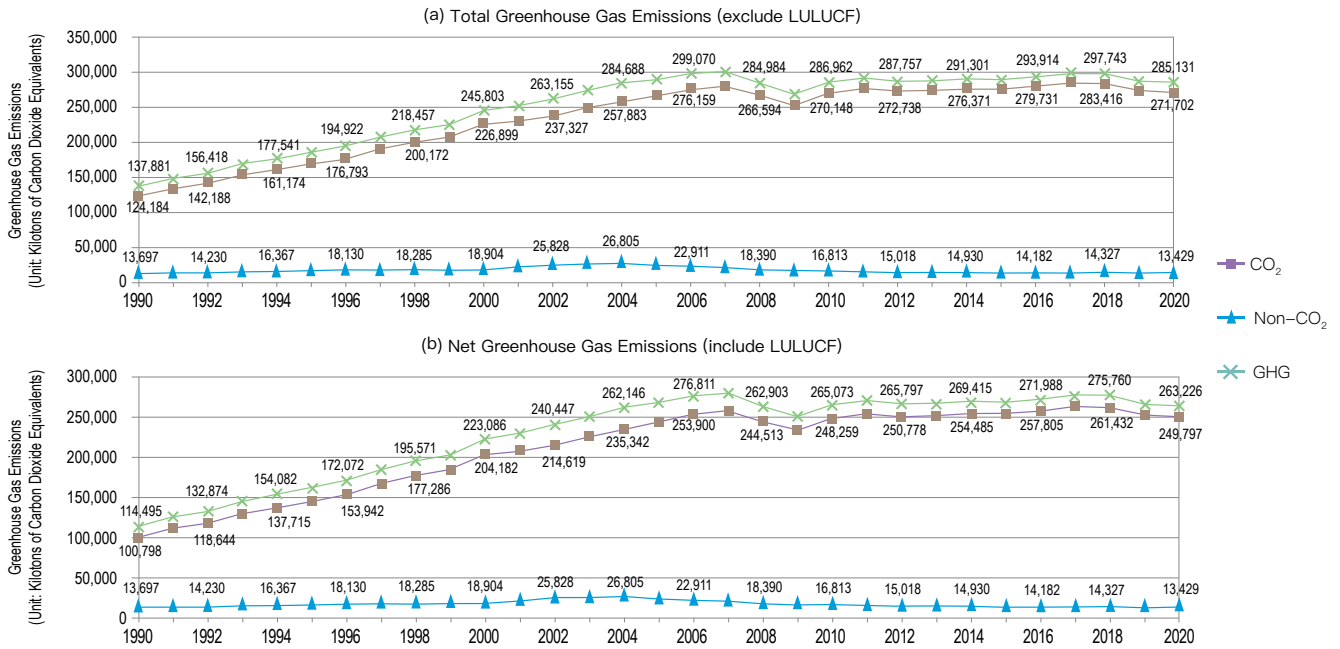


Figure ES2.1 1990–2020 Trends in Total Greenhouse Gas Emissions and Sequestration in Taiwan : (a) Emissions exclude LULUCF ; (b) Emissions include LULUCF

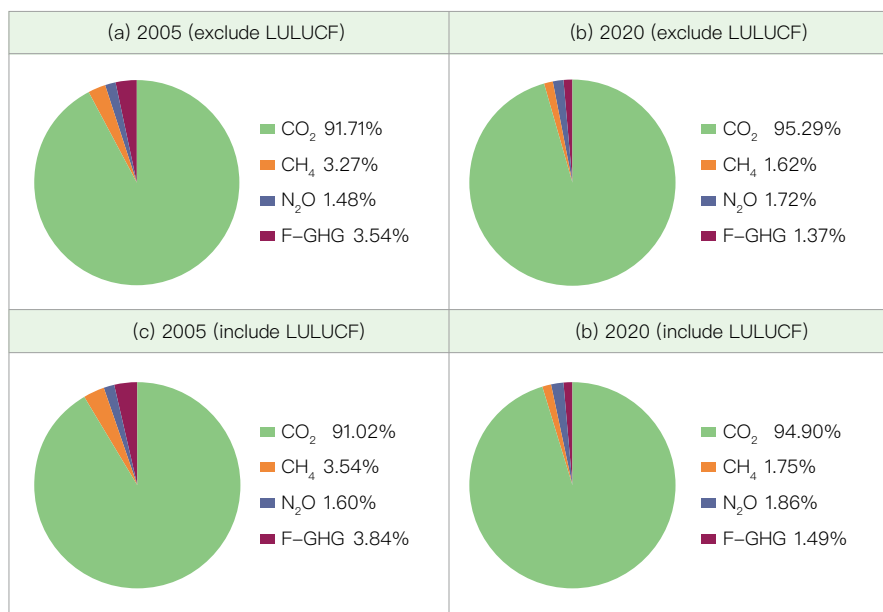


Figure ES2.2 Percentage of Various Types of Greenhouse Gas Emissions in Taiwan: (a).2005(exclude LULUCF);(b).2020(exclude LULUCF); (c).2005(include LULUCF);(d).2020(include LULUCF).

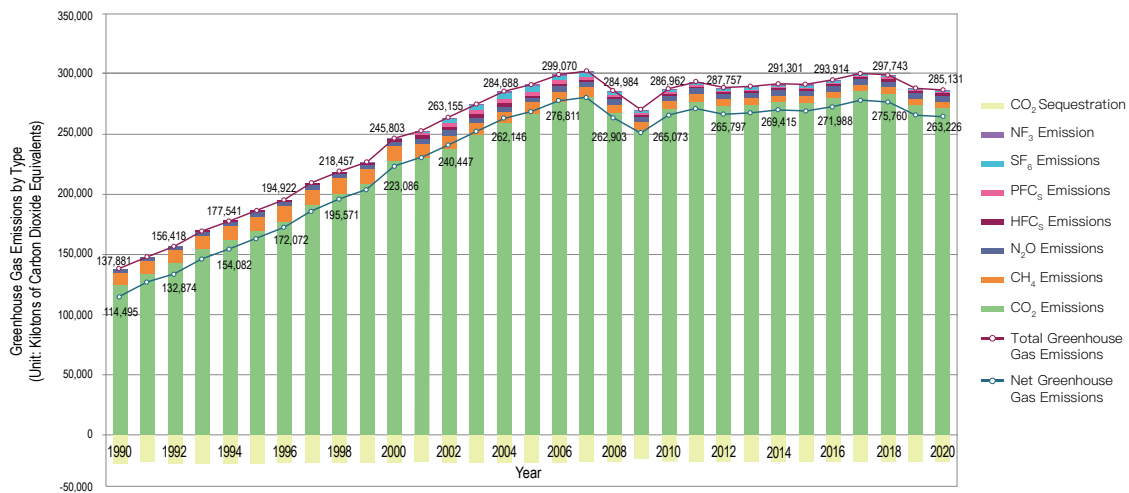


Figure ES2.3 1990–2020 Trends in Total Greenhouse Gas Emissions and Sequestration by Type in Taiwan

Table ES2.1 1990–2020 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
CO ₂	1	124,184	133,604	142,188	153,808	161,174	168,887	176,793	190,557	200,172	207,809	226,899
CH ₄	25	10,705	11,030	10,977	11,383	12,141	12,899	13,291	13,001	12,899	13,188	12,556
N ₂ O	298	2,992	3,262	3,253	3,324	3,371	3,448	3,533	3,377	3,303	3,274	3,886
HFCs	HFC–134a(1,430) etc.	NE	NE	NE	755	855	801	1,305	1,477	2,083	1,609	2,319
PFCs	PFC–14(7,390) etc.	NE	NE	NE	NE	NE	NE	NE	NE	NE	3	13
SF ₆	22,800	NE	NE	NE	NE	NE	NE	NE	NE	NE	116	120
NF ₃	17,200	NE	NE	NE	NE	NE	NE	NE	NE	NE	11	10
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
Net GHG Emission (including LULUCF)		114,495	126,406	132,874	145,723	154,082	162,696	172,072	185,352	195,571	203,245	223,086
Total GHG Emission (excluding LULUCF)		137,881	147,896	156,418	169,270	177,541	186,036	194,922	208,412	218,457	226,009	245,803
GHG	GWP	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
CO ₂	1	229,777	237,327	248,248	257,883	266,460	276,159	279,800	266,594	252,506	270,148	276,282
CH ₄	25	11,734	11,128	10,606	9,969	9,508	8,886	8,318	7,659	7,044	6,570	6,226
N ₂ O	298	3,937	4,030	4,046	4,192	4,300	4,800	4,873	4,458	4,622	5,026	4,927
HFCs	HFC–134a(1,430) etc.	2,619	2,216	2,397	2,451	1,098	1,015	1,122	1,074	1,018	971	1,053
PFCs	PFC–14(7,390) etc.	2,939	4,143	4,198	4,341	3,470	3,664	3,372	2,082	1,560	1,770	1,781
SF ₆	22,800	746	3,914	4,385	5,193	4,951	3,858	3,381	2,912	2,452	2,218	1,918
NF ₃	17,200	235	398	540	659	765	688	798	204	577	258	420
CO ₂ Sequestration	1	-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
Net GHG Emission (including LULUCF)		230,137	240,447	251,796	262,146	268,262	276,811	279,591	262,903	250,391	265,073	270,660
Total GHG Emission (excluding LULUCF)		251,987	263,155	274,420	284,688	290,552	299,070	301,665	284,984	269,779	286,962	292,607
GHG	GWP	2012	2013	2014	2015	2016	2017	2018	2019	2020		
CO ₂	1	272,738	273,873	276,371	275,867	279,731	285,247	283,416	273,954	271,702		
CH ₄	25	5,890	5,547	5,305	5,105	5,032	4,922	4,891	4,775	4,618		
N ₂ O	298	4,841	4,643	4,624	4,593	4,794	5,003	5,076	4,905	4,906		
HFCs	HFC–134a(1,430) etc.	907	1,019	1,048	1,020	1,026	1,023	1,013	1,027	1,053		
PFCs	PFC–14(7,390) etc.	1,141	1,345	1,556	1,347	1,441	1,409	1,536	1,420	1,447		
SF ₆	22,800	1,852	1,997	1,730	1,523	1,418	1,416	1,302	935	842		
NF ₃	17,200	388	773	667	662	472	440	509	473	564		
CO ₂ Sequestration	1	-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905		
Net GHG Emission (including LULUCF)		265,797	267,223	269,415	268,216	271,988	277,499	275,760	265,573	263,226		
Total GHG Emission (excluding LULUCF)		287,757	289,197	291,301	290,117	293,914	299,460	297,743	287,489	285,131		

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

carbon dioxide equivalents, with an 1.97% increase and an average annual growth rate of 0.13%. In 2020, carbon dioxide emissions accounted for 95.29% of total GHG emissions. The energy sector accounted for 94.75%, the industrial process and product use (IPPU) sector 5.13%, the waste sector 0.11%, and the agriculture sector 0.01%. Compared with 2019, the emissions in 2020 decreased by 0.82% mainly because of the 0.54% decrease in the energy sector, the 6.37% decrease in the IPPU sector,

the 0.71% increase in the agriculture sector, the 0.05% decrease in the LULUCF sector and the 38.95% increase 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 9,508 kilotons of carbon dioxide equivalents.

Table ES2.2 1990–2020 Carbon Dioxide Emissions and Sequestration in Taiwan

(Unit: Kilotons of Carbon Dioxide Equivalents)

GHG Emission Source and Sinks	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
1. Energy Sector	109,465	118,443	126,058	135,206	143,103	150,810	158,579	170,835	181,518	190,446	209,122
1.A.1 Energy Industry	49,123	55,126	58,529	65,962	70,771	76,400	81,254	91,407	100,414	105,782	121,143
1.A.2 Manufacturing and Construction Industry	30,124	31,963	33,389	33,618	34,592	35,769	36,791	39,084	39,321	41,314	43,850
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
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	10,922
1.A.4.a Service Industry	3,621	3,529	2,989	2,490	3,018	2,445	3,175	2,482	2,946	3,128	3,205
1.A.4.b Residential	4,005	4,238	4,446	4,359	4,461	4,597	4,754	4,851	4,952	5,410	5,354
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. 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
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
2.B Chemical Industry	575	551	575	617	770	858	999	1,026	1,007	1,079	1,148
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
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
2.H Others	23	23	23	24	23	21	20	19	22	21	20
3. Agriculture Sector	142	146	139	131	135	151	151	134	127	118	131
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
5. Waste Sector	20	8	65	63	110	398	387	105	117	65	259
Net GHG Emission (including LULUCF)	100,798	112,114	118,644	130,261	137,715	145,548	153,942	167,497	177,286	185,045	204,182
Total GHG Emission (excluding LULUCF)	124,184	133,604	142,188	153,808	161,174	168,887	176,793	190,557	200,172	207,809	226,899
GHG Emission Source and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	212,957	220,546	230,607	239,929	247,956	255,331	259,214	247,536	235,868	251,708	257,096
1.A.1 Energy Industry	126,142	130,463	141,730	148,677	156,351	163,615	170,131	164,432	155,166	165,522	169,884
1.A.2 Manufacturing and Construction Industry	42,395	44,489	42,563	43,163	42,671	43,994	43,293	39,104	36,698	41,360	42,298
1.A.3 Transportation	33,246	34,542	34,509	35,859	36,846	36,771	35,419	33,216	33,541	34,652	35,107
1.A.4 Other Sectors	11,174	11,052	11,806	12,230	12,089	10,952	10,370	10,785	10,463	10,174	9,807
1.A.4.a Service Industry	3,538	3,487	3,952	4,120	4,227	4,272	4,232	4,226	4,264	4,204	3,898
1.A.4.b Residential	5,181	5,107	5,042	5,133	5,235	5,033	5,047	5,017	5,030	4,857	4,786
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	2,455	2,459	2,811	2,977	2,627	1,647	1,091	1,543	1,169	1,113	1,123
2. Industrial Process and Product Use Sector	16,186	16,075	17,141	17,358	18,094	20,299	19,967	18,558	16,428	18,178	18,985
2.A Mining Industry (Non-metal Process)	9,974	10,648	10,341	10,691	11,257	11,014	10,369	9,289	8,467	8,616	9,577
2.B Chemical Industry	1,232	1,313	1,384	1,485	1,751	1,721	1,845	1,601	1,623	1,750	1,768
2.C Metal Process	4,960	4,096	5,397	5,162	5,066	7,544	7,733	7,648	6,317	7,792	7,620
2.D Non-Energy Products from Fuels and Solvent Use	0.00007	0.00008	0.00009	0.00011	0.00010	0.00007	0.00007	0.00007	0.00006	0.00005	0.00004
2.H Others	20	18	18	19	20	21	20	20	21	20	20
3. Agriculture Sector	94	93	82	84	62	59	57	57	55	54	53
4. Land Use, Land Use Change and Forestry Sector	-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
5. Waste Sector	540	612	418	512	348	470	562	443	154	208	149
Net GHG Emission (including LULUCF)	207,927	214,619	225,624	235,342	244,170	253,900	257,726	244,513	233,118	248,259	254,335
Total GHG Emission (excluding LULUCF)	229,777	237,327	248,248	257,883	266,460	276,159	279,800	266,594	252,506	270,148	276,282

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GHG Emission Source and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020
1. Energy Sector	253,166	254,070	258,481	258,476	262,982	269,462	267,208	258,821	257,434
1.A.1 Energy Industry	168,333	168,271	175,180	175,198	178,569	187,135	189,212	181,334	180,662
1.A.2 Manufacturing and Construction Industry	40,983	42,019	38,953	38,074	38,296	36,741	33,480	32,726	31,615
1.A.3 Transportation	34,284	34,209	34,666	35,506	36,584	36,202	35,207	35,443	35,727
1.A.4 Other Sectors	9,566	9,571	9,681	9,698	9,533	9,384	9,310	9,318	9,430
1.A.4.a Service Industry	3,635	3,812	3,928	3,941	3,720	3,779	3,317	3,337	3,499
1.A.4.b Residential	4,672	4,484	4,411	4,469	4,537	4,402	4,480	4,467	4,605
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	1,259	1,274	1,343	1,287	1,276	1,203	1,512	1,514	1,326
2. Industrial Process and Product Use Sector	19,369	19,605	17,704	17,251	16,583	15,625	16,019	14,890	13,942
2.A Mining Industry (Non-metal Process)	9,333	9,866	8,728	8,345	7,108	6,262	6,403	6,501	6,504
2.B Chemical Industry	1,714	1,749	1,884	1,842	1,760	1,709	1,684	1,666	1,550
2.C Metal Process	8,301	7,970	7,072	7,044	7,696	7,634	7,913	6,706	5,870
2.D Non-Energy Products from Fuels and Solvent Use	0.00004	0.00005	0.00006	0.00010	0.00008	0.00007	0.00006	0.00006	0.00006
2.H Others	21	19	19	20	19	20	19	17	18
3. Agriculture Sector	55	45	40	38	34	31	30	29	29
4. Land Use, Land Use Change and Forestry Sector	-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905
5. Waste Sector	149	153	146	103	132	129	159	214	297
Net GHG Emission (including LULUCF)	250,778	251,899	254,485	253,967	257,805	263,286	261,432	252,037	249,797
Total GHG Emission (excluding LULUCF)	272,738	273,873	276,371	275,867	279,731	285,247	283,416	273,954	271,702

Table ES2.3 1990–2020 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
1. Energy Sector	530	506	497	511	526	533	520	514	535	561	574
2. Industrial Process and Product Use Sector	5	7	6	7	8	10	11	12	10	12	14
3. Agriculture Sector	2,914	3,100	3,018	3,025	3,012	3,079	3,085	2,672	2,421	2,517	2,511
3.A Livestock Gastrointestinal Fermentation	670	731	738	775	789	822	822	732	674	694	692
3.B Livestock Waste Treatment	1,112	1,304	1,266	1,282	1,312	1,371	1,398	1,062	884	971	1,003
3.C Rice Culturing	1,094	1,040	968	946	891	879	858	871	858	845	802
3.F Field Burning of Agricultural Residues	38	25	48	22	21	7	7	7	6	7	14
5. Waste Sector	7,257	7,416	7,455	7,839	8,595	9,277	9,675	9,803	9,933	10,098	9,457
5.A Garbage Landfill	5,833	5,919	5,930	6,325	7,063	7,721	8,082	8,215	8,376	8,608	8,030
5.B Garbage Biological Treatment	11	0.5	0.8	0.5	0.1	0.6	0.3	1.4	0.05	1.9	0.3
5.D Wastewater Treatment and Discharge	1,412	1,497	1,525	1,514	1,532	1,555	1,593	1,587	1,557	1,488	1,427
5.D.1 Domestic Wastewater Treatment and discharge	1,001	1,011	1,020	1,029	1,038	1,046	1,053	1,059	1,051	1,000	957
5.D.2 Industrial Wastewater Treatment and discharge	411	486	504	485	494	509	541	527	505	488	470
Total Methane Emissions	10,705	11,030	10,977	11,383	12,141	12,899	13,291	13,001	12,899	13,188	12,556
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	565	584	629	661	631	625	622	604	597	631	654
2. Industrial Process and Product Use Sector	18	19	22	28	18	22	28	27	21	23	15
3. Agriculture Sector	2,425	2,290	2,188	2,110	2,228	2,197	2,116	2,056	2,006	2,003	2,034
3.A Livestock Gastrointestinal Fermentation	660	636	626	614	623	614	609	584	571	578	590
3.B Livestock Waste Treatment	959	913	909	915	957	945	888	861	825	831	843
3.C Rice Culturing	792	729	644	574	640	630	616	604	605	589	596
3.F Field Burning of Agricultural Residues	15	13	9	8	8	8	5	6	5	5	5
5. Waste Sector	8,726	8,235	7,767	7,171	6,631	6,042	5,553	4,972	4,420	3,913	3,523
5.A Garbage Landfill	7,311	6,830	6,322	5,777	5,231	4,666	4,144	3,608	3,072	2,601	2,226
5.B Garbage Biological Treatment	0.02	0.4	2	7	10	11	14	16	18	21	26
5.D Wastewater Treatment and Discharge	1,416	1,404	1,443	1,387	1,391	1,365	1,395	1,348	1,330	1,290	1,271
5.D.1 Domestic Wastewater Treatment and discharge	945	929	920	892	865	838	805	779	755	740	706
5.D.2 Industrial Wastewater Treatment and discharge	471	475	523	495	526	527	589	569	575	551	565
Total Methane Emissions	11,734	11,128	10,606	9,969	9,508	8,886	8,318	7,659	7,044	6,570	6,226

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GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
1. Energy Sector	663	676	686	710	730	738	721	717	730		
2. Industrial Process and Product Use Sector	23	25	26	26	27	24	27	26	25		
3. Agriculture Sector	2,010	1,997	1,947	1,927	1,933	1,932	1,932	1,942	1,938		
3.A Livestock Gastrointestinal Fermentation	583	579	566	573	561	564	572	575	580		
3.B Livestock Waste Treatment	807	781	750	744	740	738	743	754	755		
3.C Rice Culturing	614	634	626	605	629	626	615	611	602		
3.F Field Burning of Agricultural Residues	5	3	4	5	3	3	2	2	1		
5. Waste Sector	3,194	2,849	2,647	2,442	2,342	2,228	2,211	2,091	1,925		
5.A Garbage Landfill	1,890	1,598	1,351	1,141	970	835	723	645	596		
5.B Garbage Biological Treatment	24	23	20	20	20	20	23	25	26		
5.D Wastewater Treatment and Discharge	1,279	1,228	1,275	1,281	1,352	1,373	1,465	1,421	1,303		
5.D.1 Domestic Wastewater Treatment and discharge	673	651	631	606	583	551	526	481	452		
5.D.2 Industrial Wastewater Treatment and discharge	607	578	644	674	768	821	940	941	851		
Total Methane Emissions	5,890	5,547	5,305	5,105	5,032	4,922	4,891	4,775	4,618		

In 2020, the total methane emission was 4,618 kilotons of carbon dioxide equivalents, down by 51.43% compared with 2005, with a negative average annual growth rate of -4.70%. In 2020, methane emissions accounted for 1.62% of the total GHG emissions. In particular, the agriculture sector was the largest source of methane emissions, which accounted for 41.97%, followed by the waste sector (41.68%), energy sector (15.82%), and IPPU sector (0.54%).

Compared to 2019, the methane emission in 2020 was down by 3.30%, with the waste sector down by 7.96%, the IPPU sector down by 3.03%, the agriculture sector down by 0.20%, and the energy sector up by 1.89%.

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 4,300 kilotons of carbon dioxide equivalents. In 2020, the total nitrous oxide emission was 4,906 kilotons of carbon dioxide equivalents, up by 14.08% with an average growth rate of 0.88%. In 2020, nitrous oxide emissions accounted for 1.72% of the total GHG emissions. In particular, the IPPU sector accounted for 39.18%, followed by the agriculture sector (28.08%), the energy sector (24.88%), and the waste sector (7.86%).

Compared to 2019, the nitrous oxide emission in 2020 slightly grew by 0.02%, with the IPPU sector down by 1.96%, the waste sector down by 0.64%, the energy sector down by 0.47%, and the agriculture sector up by 3.58%.

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 755 kilotons of carbon dioxide equivalents in 1993 to 1,053 kilotons of carbon dioxide equivalents in 2020. The perfluorocarbons (PFCs) emission increased from 3 kilotons of carbon dioxide equivalents in 1999 to 1,447 kilotons of carbon dioxide equivalents in 2020, while the sulfur hexafluoride (SF₆) emission increased from 116 kilotons of carbon dioxide equivalents in 1999 to 842 kilotons of carbon dioxide equivalents in 2020. The nitrogen trifluoride (NF₃) emission increased from 11 kilotons of carbon dioxide equivalents in 1999 to 564 kilotons of carbon dioxide equivalents in 2020.

For the total emission of fluorinated greenhouse gases, it decreased from 10,284 kilotons of carbon dioxide equivalents in 2005 (about 3.54% of the total greenhouse gas emissions in 2005) to 3,906 kilotons of carbon dioxide equivalents in 2020 (about 1.37% of the total greenhouse gas emissions in 2020), down by 62.02% with a negative average annual growth rate of -6.25%. Compared to 2019, the emission in 2020 increased by 1.30%.



Table ES2.4 1990–2020 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
1. Energy Sector	537	578	653	703	742	778	825	866	917	968	1,052
1.A.1 Energy Industry	138	157	183	207	223	240	271	300	331	361	428
1.A.2 Manufacturing and Construction Industry	90	95	101	100	103	105	109	114	115	123	133
1.A.3 Transportation	291	309	353	382	402	418	428	438	456	469	475
1.A.4 Other Sectors	17	17	15	14	15	14	16	14	14	14	15
2. Industrial Process and Product Use Sector	166	352	325	301	318	345	343	374	383	312	625
3. Agriculture Sector	1,994	2,048	1,977	2,008	1,997	1,991	2,028	1,800	1,683	1,665	1,879
3.B Livestock Waste Treatment	145	164	163	165	173	180	188	160	145	154	158
3.D Agricultural Soil	1,837	1,876	1,800	1,837	1,818	1,808	1,838	1,638	1,536	1,509	1,717
3.F Field Burning of Agricultural Residues	12	8	15	7	6	2	2	2	2	2	4
5. Waste Sector	296	285	298	311	313	334	337	337	321	329	331
Total Nitrous Oxide Emissions	2,992	3,262	3,253	3,324	3,371	3,448	3,533	3,377	3,303	3,274	3,886
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	1,083	1,132	1,187	1,228	1,269	1,299	1,303	1,239	1,211	1,248	1,268
1.A.1 Energy Industry	458	480	537	556	584	612	638	616	593	603	607
1.A.2 Manufacturing and Construction Industry	134	141	137	141	140	145	143	131	124	135	144
1.A.3 Transportation	475	496	495	513	527	527	508	478	480	497	505
1.A.4 Other Sectors	16	16	17	18	17	15	13	14	13	13	12
2. Industrial Process and Product Use Sector	714	744	833	834	1,002	1,474	1,573	1,332	1,500	1,877	1,805
3. Agriculture Sector	1,801	1,806	1,674	1,787	1,679	1,709	1,670	1,587	1,616	1,598	1,539
3.B Livestock Waste Treatment	152	147	148	147	153	153	146	145	141	141	142
3.D Agricultural Soil	1,644	1,654	1,523	1,638	1,524	1,554	1,522	1,440	1,474	1,456	1,396
3.F Field Burning of Agricultural Residues	5	4	3	2	2	3	1.4	1.9	1.6	1.6	1.7
5. Waste Sector	340	348	353	343	350	318	328	300	295	302	314
Total Nitrous Oxide Emissions	3,937	4,030	4,046	4,192	4,300	4,800	4,873	4,458	4,622	5,026	4,927
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
1. Energy Sector	1,247	1,241	1,246	1,242	1,264	1,276	1,257	1,226	1,221		
1.A.1 Energy Industry	603	595	599	585	595	621	633	605	598		
1.A.2 Manufacturing and Construction Industry	137	140	133	131	131	123	103	101	99		
1.A.3 Transportation	495	494	500	513	526	521	510	508	513		
1.A.4 Other Sectors	12	12	13	13	12	12	11	11	12		
2. Industrial Process and Product Use Sector	1,717	1,582	1,557	1,550	1,744	1,944	2,067	1,961	1,922		
3. Agriculture Sector	1,564	1,497	1,490	1,459	1,456	1,406	1,385	1,330	1,377		
3.B Livestock Waste Treatment	139	137	136	136	138	139	141	145	146		
3.D Agricultural Soil	1,424	1,359	1,353	1,321	1,318	1,266	1,243	1,184	1,231		
3.F Field Burning of Agricultural Residues	1.7	1.0	1.1	1.4	1.0	1.1	0.8	0.8	0.4		
5. Waste Sector	313	323	332	342	330	377	368	388	386		
Total Nitrous Oxide Emissions	4,841	4,643	4,624	4,593	4,794	5,003	5,076	4,905	4,906		

Table ES2.5 1990–2020 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
Total HFCs Emissions	NE	NE	NE	755	855	801	1,305	1,477	2,083	1,609	2,319
Total PFCs Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	3	13
Total SF ₆ Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	116	120
Total NF ₃ Emissions	NE	NE	NE	NE	NE	NE	NE	NE	NE	11	10
Total Fluoride-Containing Gas Emissions	NE	NE	NE	755	855	801	1,305	1,477	2,083	1,738	2,462
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total HFCs Emissions	2,619	2,216	2,397	2,451	1,098	1,015	1,122	1,074	1,018	971	1,053
Total PFCs Emissions	2,939	4,143	4,198	4,341	3,470	3,664	3,372	2,082	1,560	1,770	1,781
Total SF ₆ Emissions	746	3,914	4,385	5,193	4,951	3,858	3,381	2,912	2,452	2,218	1,918
Total NF ₃ Emissions	235	398	540	659	765	688	798	204	577	258	420
Total Fluoride-Containing Gas Emissions	6,538	10,671	11,520	12,643	10,284	9,225	8,673	6,273	5,607	5,217	5,172
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Total HFCs Emissions	907	1,019	1,048	1,020	1,026	1,023	1,013	1,027	1,053		
Total PFCs Emissions	1,141	1,345	1,556	1,347	1,441	1,409	1,536	1,420	1,447		
Total SF ₆ Emissions	1,852	1,997	1,730	1,523	1,418	1,416	1,302	935	842		
Total NF ₃ Emissions	388	773	667	662	472	440	509	473	564		
Total Fluoride-Containing Gas Emissions	4,288	5,134	5,001	4,552	4,356	4,288	4,360	3,855	3,906		

Note: NE (not estimated) refers to the exclusion of estimation on existing emissions and sequestration.

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 2020, greenhouse gas emissions (exclude LULUCF) from energy sectors were responsible for approximately 85.99% and 90.97% of the total emissions, while the IPPU sector accounted for 10.12% and 6.94%, the agricultural sector accounted for 1.37% and 1.17%, and the waste sector accounted for 2.52% and 0.92%, as shown in Figure ES3.1.

The GHG emission and trends for Taiwan from 1990 to 2020 by sector are shown in Figure ES3.2 and Table ES3.1. The total greenhouse gas emission in Taiwan in 2020 decreased by 0.82% compared with 2019. In particular, the GHG emission from the energy sector was down by 0.53%, the IPPU sector was down by 4.52%, the

agriculture sector was up by 1.33%, and the waste sector was down by 3.18%. Additionally, the carbon dioxide sequestration of the LULUCF sector was down by 0.05%.

Compared to 2005(Base year), the emission in 2020 decreased by 1.87%. In particular, the GHG emission from the energy sector was up by 3.81%, the IPPU sector was down by 32.67%, the agriculture sector was down by 15.73%, and the waste sector was down by 64.43%. Additionally, the carbon dioxide sequestration of the LULUCF sector was down by 1.73%, as shown in Figure ES3.3.

1. Energy sector

The total greenhouse gas emission from the energy sector in 2005 was 249,855 kilotons of carbon dioxide equivalents and increased to 259,385 kilotons of carbon dioxide equivalents in 2020 with a growth of 3.81% and an annual average growth of 0.25%, as shown in Table

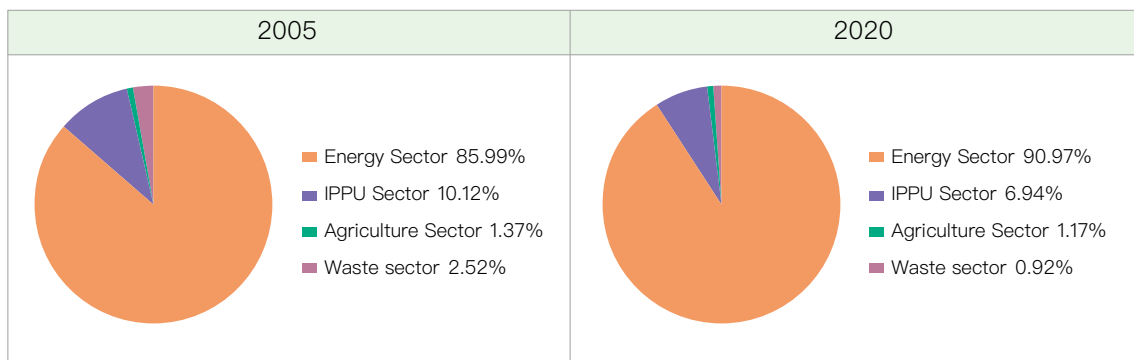


Figure ES3.1 Percentage of Greenhouse Gas Emissions (exclude LULUCF) by Sectors in Taiwan in (a) 2005 and (b) 2020.

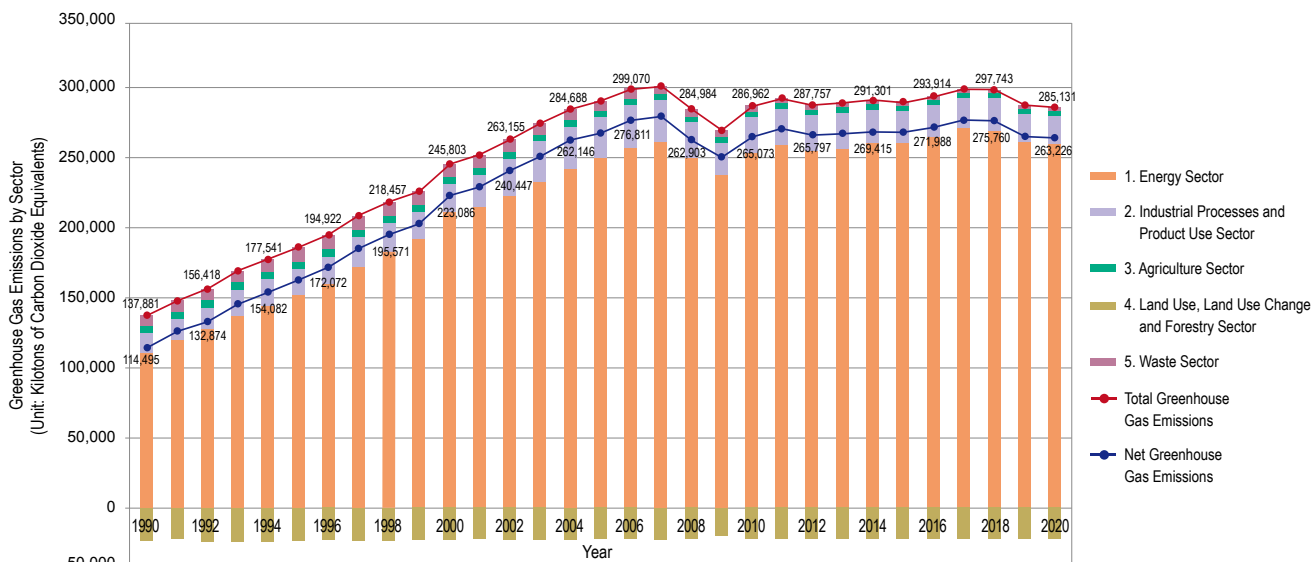


Figure ES3.2 1990–2020 Trends in Greenhouse Gas Emission by Sector in Taiwan



Table ES3.1 1990–2020 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
1. Energy Sector	110,532	119,527	127,208	136,421	144,371	152,121	159,923	172,215	182,970	191,975	210,747
2. IPPU Sector	14,728	15,366	16,257	19,471	19,007	18,685	19,336	21,346	20,886	19,241	20,488
3. Agriculture Sector	5,049	5,294	5,134	5,164	5,144	5,221	5,263	4,606	4,231	4,301	4,521
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
5. Waste Sector	7,573	7,709	7,818	8,214	9,018	10,009	10,399	10,245	10,370	10,493	10,047
Net GHG Emission (including LULUCF)	114,495	126,406	132,874	145,723	154,082	162,696	172,072	185,352	195,571	203,245	223,086
Total GHG Emission (excluding LULUCF)	137,881	147,896	156,418	169,270	177,541	186,036	194,922	208,412	218,457	226,009	245,803
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
1. Energy Sector	214,604	222,262	232,423	241,818	249,855	257,255	261,138	249,380	237,676	253,588	259,018
2. IPPU Sector	23,456	27,509	29,516	30,864	29,398	31,019	30,241	26,190	23,557	25,296	25,977
3. Agriculture Sector	4,320	4,189	3,944	3,981	3,969	3,966	3,844	3,699	3,678	3,655	3,626
4. LULUCF Sector	-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
5. Waste Sector	9,606	9,195	8,538	8,026	7,329	6,830	6,443	5,715	4,868	4,423	3,986
Net GHG Emission (including LULUCF)	230,137	240,447	251,796	262,146	268,262	276,811	279,591	262,903	250,391	265,073	270,660
Total GHG Emission (excluding LULUCF)	251,987	263,155	274,420	284,688	290,552	299,070	301,665	284,984	269,779	286,962	292,607
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
1. Energy Sector	255,075	255,987	260,413	260,428	264,977	271,475	269,185	260,764	259,385		
2. IPPU Sector	25,397	26,346	24,287	23,379	22,710	21,882	22,473	20,732	19,794		
3. Agriculture Sector	3,629	3,540	3,476	3,423	3,423	3,369	3,347	3,301	3,345		
4. LULUCF Sector	-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905		
5. Waste Sector	3,655	3,325	3,125	2,886	2,804	2,734	2,738	2,693	2,607		
Net GHG Emission (including LULUCF)	265,797	267,223	269,415	268,216	271,988	277,499	275,760	265,573	263,226		
Total GHG Emission (excluding LULUCF)	287,757	289,197	291,301	290,117	293,914	299,460	297,743	287,489	285,131		

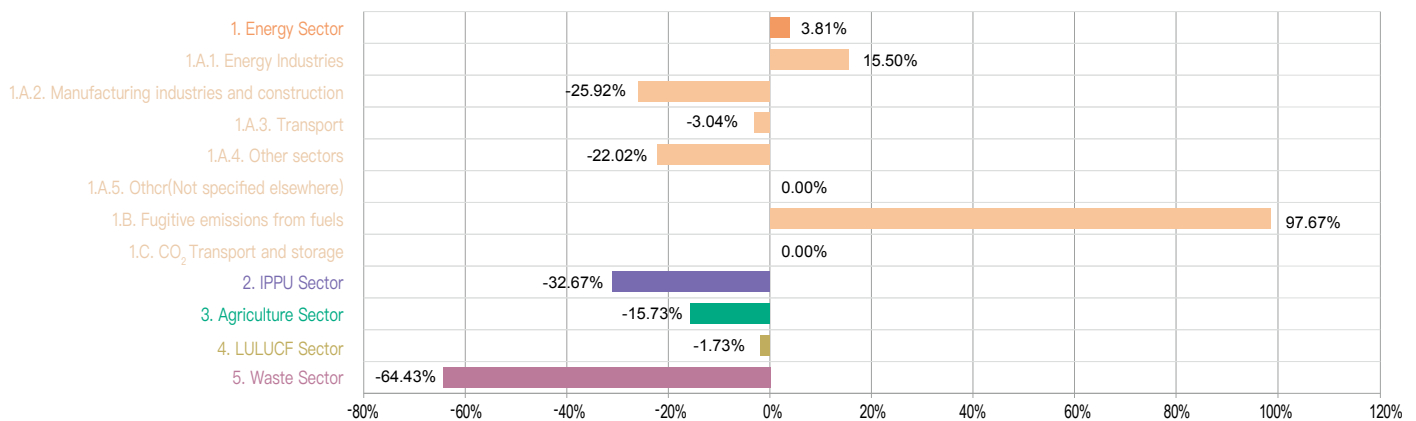


Figure ES3.3 Changes in Greenhouse Gas Emissions and Sequestrations by Sectors in Taiwan from 2005 to 2020.

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, followed by more reduction in 2012. Compared with 2019, the greenhouse gas emissions in 2020 slightly decreased by 0.53%. The total greenhouse gas emission from the energy sector in 2020 accounted for 90.97% of the total greenhouse gas emission in Taiwan. In particular, 1.A.1 “energy industry” was responsible for 181,349 kilotons of carbon dioxide equivalents, accounting for 69.92% of the total greenhouse gas emission from the energy sector; 1.A.2 “manufacturing and construction industry”

was responsible for 31,770 kilotons of carbon dioxide equivalents (accounting for 12.25%); 1.A.3 “transportation” was responsible for 36,530 kilotons of carbon dioxide equivalents (accounting for 14.08%); 1.A.4 “other sectors (including service industry, residential and agriculture, forestry, fishery and husbandry)” was responsible for 9,466 kilotons of carbon dioxide equivalents (accounting for 3.65%); 1.B.2 “oil and gas” was responsible for 270 kilotons of carbon dioxide equivalents (accounting for 0.10%), as shown in Figure ES3.4.

Table ES3.2 1990–2020 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
Total CO₂ Emission	109,465	118,443	126,058	135,206	143,103	150,810	158,579	170,835	181,518	190,446	209,122
1.A.1 Energy Industry	49,123	55,126	58,529	65,962	70,771	76,400	81,254	91,407	100,414	105,782	121,143
1.A.2 Manufacturing and Construction Industry	30,124	31,963	33,389	33,618	34,592	35,769	36,791	39,084	39,321	41,314	43,850
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
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	10,922
Total CH₄ Emission	530	506	497	511	526	533	520	514	535	561	574
1.A.1 Energy Industry	26	29	28	32	35	40	41	46	50	58	66
1.A.2 Manufacturing and Construction Industry	46	48	52	51	52	54	56	58	59	63	69
1.A.3 Transportation	152	163	187	202	216	228	239	245	257	266	270
1.A.4 Others Sectors	30	29	28	26	28	27	29	26	27	28	29
1.B.1 Solid Fuel	162	138	115	113	98	81	51	34	27	31	28
1.B.2 Oil and Gas	115	98	88	87	97	103	103	104	115	113	111
Total N₂O Emission	537	578	653	703	742	778	825	866	917	968	1,052
1.A.1 Energy Industry	138	157	183	207	223	240	271	300	331	361	428
1.A.2 Manufacturing and Construction Industry	90	95	101	100	103	105	109	114	115	123	133
1.A.3 Transportation	291	309	353	382	402	418	428	438	456	469	475
1.A.4 Others Sectors	17	17	15	14	15	14	16	14	14	14	15
Total Emission from Energy Sector	110,525	119,521	127,202	136,414	144,365	152,115	159,917	172,206	182,970	191,975	210,747
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO₂ Emission	212,957	220,546	230,607	239,929	247,956	255,331	259,214	247,536	235,868	251,708	257,096
1.A.1 Energy Industry	126,142	130,463	141,730	148,677	156,351	163,615	170,131	164,432	155,166	165,522	169,884
1.A.2 Manufacturing and Construction Industry	42,395	44,489	42,563	43,163	42,671	43,994	43,293	39,104	36,698	41,360	42,298
1.A.3 Transportation	33,246	34,542	34,509	35,859	36,846	36,771	35,419	33,216	33,541	34,652	35,107
1.A.4 Others Sectors	11,174	11,052	11,806	12,230	12,089	10,952	10,370	10,785	10,463	10,174	9,807
Total CH₄ Emission	565	584	629	661	631	625	622	604	597	631	654
1.A.1 Energy Industry	70	69	78	81	84	88	90	88	81	86	86
1.A.2 Manufacturing and Construction Industry	71	74	73	75	75	78	77	71	67	74	79
1.A.3 Transportation	272	278	287	295	303	298	289	275	281	284	287
1.A.4 Others Sectors	30	30	32	33	33	29	27	28	27	26	25
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
1.B.2 Oil and Gas	122	132	159	176	137	133	138	142	141	161	176
Total N₂O Emission	1,083	1,132	1,187	1,228	1,269	1,299	1,303	1,239	1,211	1,248	1,268
1.A.1 Energy Industry	458	480	537	556	584	612	638	616	593	603	607
1.A.2 Manufacturing and Construction Industry	134	141	137	141	140	145	143	131	124	135	144
1.A.3 Transportation	475	496	495	513	527	527	508	478	480	497	505
1.A.4 Others Sectors	16	16	17	18	17	15	13	14	13	13	12
Total Emission from Energy Sector	214,604	222,262	232,423	241,818	249,855	257,255	261,138	249,380	237,676	253,588	259,018
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Total CO₂ Emission	253,166	254,070	258,481	258,476	262,982	269,462	267,208	258,821	257,434		
1.A.1 Energy Industry	168,333	168,271	175,180	175,198	178,569	187,135	189,212	181,334	180,662		
1.A.2 Manufacturing and Construction Industry	40,983	42,019	38,953	38,074	38,296	36,741	33,480	32,726	31,615		
1.A.3 Transportation	34,284	34,209	34,666	35,506	36,584	36,202	35,207	35,443	35,727		
1.A.4 Others Sectors	9,566	9,571	9,681	9,698	9,533	9,384	9,310	9,318	9,430		
Total CH₄ Emission	663	676	686	710	730	738	721	717	730		
1.A.1 Energy Industry	86	85	88	91	92	94	94	90	89		
1.A.2 Manufacturing and Construction Industry	76	78	74	74	74	69	59	58	57		
1.A.3 Transportation	283	284	285	292	301	295	286	287	290		
1.A.4 Others Sectors	25	25	25	25	25	24	24	24	24		
1.B.1 Solid Fuel	NO	NO	NO	NO	NO	NO	NO	NO	NO		
1.B.2 Oil and Gas	193	205	214	228	239	255	258	258	270		
Total N₂O Emission	1,247	1,241	1,246	1,242	1,264	1,276	1,257	1,226	1,221		
1.A.1 Energy Industry	603	595	599	585	595	621	633	605	598		
1.A.2 Manufacturing and Construction Industry	137	140	133	131	131	123	103	101	99		
1.A.3 Transportation	495	494	500	513	526	521	510	508	513		
1.A.4 Others Sectors	12	12	13	13	12	12	11	11	12		
Total Emission from Energy Sector	255,075	255,987	260,413	260,428	264,977	271,475	269,185	260,764	259,385		

Note: 1. NO (not happened). Taiwanese coal has been discontinued since 2001.

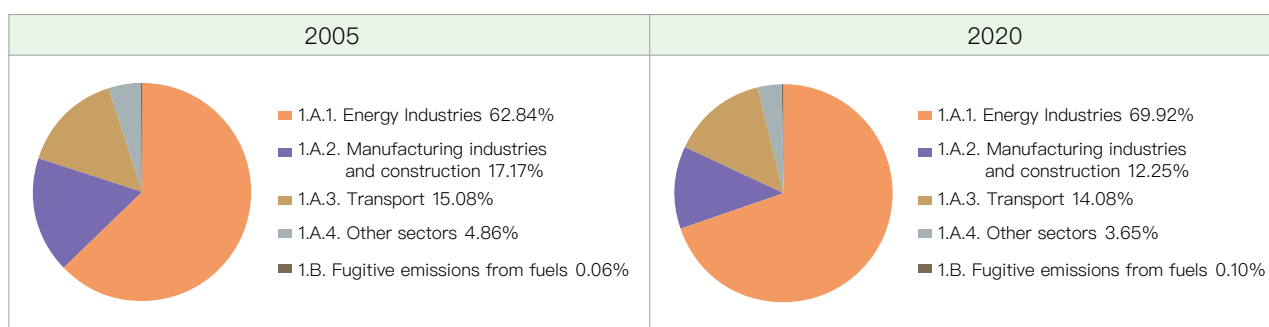


Figure ES3.4 Percentage of Greenhouse Gas Emissions by Energy Sectors in Taiwan in (a)2005 and (b)2020.

2. Industrial Process and Product Use (IPPU) Sector

The greenhouse gas emission from the IPPU sector in 2005 was 29,398 kilotons of carbon dioxide equivalents and decreased to 19,794 kilotons in 2020, down by 32.67% with a negative average annual growth rate of -2.66%, as shown in Table ES3.3. Compared with 2019, the greenhouse gas emissions in 2020 decreased by 4.52%. The total greenhouse gas emission in 2020 accounted for 6.94% of the total greenhouse gas emission in Taiwan. In particular, 2.A “mining industry (non-metal process)” was responsible for 6,504 kilotons of carbon dioxide equivalents, accounting for 32.86% (the majority) of the greenhouse gases from the IPPU sector, followed by 2.C “metal process”, which was responsible for 5,906 kilotons of carbon dioxide equivalents (accounting for 29.84%),

2.E “electronics industry”, which was responsible for 4,189 kilotons of carbon dioxide equivalents (accounting for 21.17%), 2.B “chemical industry”, which was responsible for 2,183 kilotons of carbon dioxide equivalents (accounting for 11.03%), 2.F “alternatives to ozone-depleting substances”, which was responsible for 861 kilotons of carbon dioxide equivalents (accounting for 4.35%), 2.G. “manufacturing and use of other products”, which was responsible for 133 kilotons of carbon dioxide equivalents (accounting for 0.67%), 2.H. “others”, which was responsible for 18 kilotons of carbon dioxide equivalents (accounting for 0.09%) and 2.D. “Non-Energy Products from Fuels and Solvent Use”, which was responsible for 0.0006 kilotons of carbon dioxide equivalents (accounting for 0.0000003%), as shown in Figure ES3.5.

Table ES3-3 1990-2020 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
Total CO₂ Emission	14,557	15,007	15,926	18,408	17,826	17,528	17,677	19,483	18,410	17,179	17,388
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
2.B Chemical Industry	575	551	575	617	770	858	999	1,026	1,007	1,079	1,148
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
2.D Non-Energy Products from Fuels and Solvent Use	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
2.H Others	23	23	23	24	23	21	20	19	22	21	20
Total CH₄ Emission	5	7	6	7	8	10	11	12	10	12	14
2.B Chemical Industry	5	5	5	6	7	9	10	11	9	11	13
2.C Metal Process	0.2	1.8	1.4	1.1	0.9	1.2	1.1	1.2	1.1	0.4	0.2
Total N₂O Emission	166	352	325	301	318	345	343	374	383	312	625
2.B Chemical Industry	166	352	325	301	318	345	343	374	383	312	625
2.C Metal Process	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total HFCs Emission	NE	NE	NE	755	855	801	1,305	1,477	2,083	1,609	2,319
2.B Chemical Industry	NE	NE	NE	755	855	801	1,305	1,477	2,083	1,609	2,319
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.F Alternatives to Ozone-depleting Substances	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total PFCs Emission (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	3	13
Total SF₆ Emission	NE	NE	NE	NE	NE	NE	NE	NE	NE	116	120
2.C Metal Process	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	116	120
2.G Manufacturing and Use of Other Products	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total NF₃ Emission (2.E Electronics Industry)	NE	NE	NE	NE	NE	NE	NE	NE	NE	11	10
Total Emission from IPPU Sector	14,728	15,366	16,257	19,471	19,007	18,685	19,336	21,346	20,886	19,241	20,488

Continued from the table below

Continued from the above table

GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO₂ Emission	16,186	16,075	17,141	17,358	18,094	20,299	19,967	18,558	16,428	18,178	18,985
2.A Mining Industry (Non-metal Products)	9,974	10,648	10,341	10,691	11,257	11,014	10,369	9,289	8,467	8,616	9,577
2.B Chemical Industry	1,232	1,313	1,384	1,485	1,751	1,721	1,845	1,601	1,623	1,750	1,768
2.C Metal Process	4,960	4,096	5,397	5,162	5,066	7,544	7,733	7,648	6,317	7,792	7,620
2.D Non-Energy Products from Fuels and Solvent Use	0.00007	0.00008	0.00009	0.00011	0.00010	0.00007	0.00007	0.00007	0.00006	0.00005	0.00004
2.H Others	20	18	18	19	20	21	20	20	21	20	20
Total CH₄ Emission	18	19	22	28	18	22	28	27	21	23	15
2.B Chemical Industry	18	19	22	28	18	18	23	22	18	18	15
2.C Metal Process	0.1	0.2	0.2	NE	NE	4	4	5	3	6	0.01
Total N₂O Emission	714	744	833	834	1,002	1,474	1,573	1,332	1,500	1,877	1,805
2.B Chemical Industry	714	743	831	834	960	969	996	784	1,006	1,170	1,195
2.C Metal Process	NE	0.4	2	NE	NE	94	95	90	76	119	NE
2.E Electronics Industry	NE	NE	NE	NE	42	411	481	458	417	588	611
Total HFCs Emission	2,619	2,216	2,397	2,451	1,098	1,015	1,122	1,074	1,018	971	1,053
2.B Chemical Industry	2,567	2,157	1,937	1,710	NE	NE	NE	NE	NE	NE	NE
2.E Electronics Industry	51	59	59	59	102	119	199	146	206	201	172
2.F Alternatives to Ozone-depleting Substances	NE	NE	401	682	996	896	922	928	812	770	881
Total PFCs Emission (2.E Electronics Industry)	2,939	4,143	4,198	4,341	3,470	3,664	3,372	2,082	1,560	1,770	1,781
Total SF₆ Emission	746	3,914	4,385	5,193	4,951	3,858	3,381	2,912	2,452	2,218	1,918
2.C Metal Process	NE	1,027	1,027	1,357	1,063	770	440	144	235	57	50
2.E Electronics Industry	746	944	1,415	1,783	2,384	2,318	1,988	1,872	1,514	1,923	1,615
2.G Manufacturing and Use of Other Products	NE	1,943	1,943	2,053	1,503	770	953	895	703	238	252
Total NF₃ Emission (2.E Electronics Industry)	235	398	540	659	765	688	798	204	577	258	420
Total Emission from IPPU Sector	23,456	27,509	29,516	30,864	29,398	31,019	30,241	26,190	23,557	25,296	25,977
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Total CO₂ Emission	19,369	19,605	17,704	17,251	16,583	15,625	16,019	14,890	13,942		
2.A Mining Industry (Non-metal Products)	9,333	9,866	8,728	8,345	7,108	6,262	6,403	6,501	6,504		
2.B Chemical Industry	1,714	1,749	1,884	1,842	1,760	1,709	1,684	1,666	1,550		
2.C Metal Process	8,301	7,970	7,072	7,044	7,696	7,634	7,913	6,706	5,870		
2.D Non-Energy Products from Fuels and Solvent Use	0.00004	0.00005	0.00006	0.00010	0.00008	0.00007	0.00006	0.00006	0.00006		
2.H Others	21	19	19	20	19	20	19	17	18		
Total CH₄ Emission	23	25	26	26	27	24	27	26	25		
2.B Chemical Industry	23	25	26	26	26	24	27	26	25		
2.C Metal Process	0.06	0.1	0.2	0.2	0.2	NE	0.01	0.01	0.0001		
Total N₂O Emission	1,717	1,582	1,557	1,550	1,744	1,944	2,067	1,961	1,922		
2.B Chemical Industry	1,016	780	728	691	961	1,114	1,110	931	608		
2.C Metal Process	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2.E Electronics Industry	701	802	829	860	783	830	957	1,030	1,314		
Total HFCs Emission	907	1,019	1,048	1,020	1,026	1,023	1,013	1,027	1,053		
2.B Chemical Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE		
2.E Electronics Industry	124	207	220	170	191	202	201	181	192		
2.F Alternatives to Ozone-depleting Substances	783	812	828	851	835	821	811	846	861		
Total PFCs Emission (2.E Electronics Industry)	1,141	1,345	1,556	1,347	1,441	1,409	1,536	1,420	1,447		
Total SF₆ Emission	1,852	1,997	1,730	1,523	1,418	1,416	1,302	935	842		
2.C Metal Process	30	38	33	43	41	59	81	43	36		
2.E Electronics Industry	1,628	1,800	1,552	1,351	1,295	1,278	1,072	781	672		
2.G Manufacturing and Use of Other Products	195	160	146	128	82	79	149	110	133		
Total NF₃ Emission (2.E Electronics Industry)	388	773	667	662	472	440	509	473	564		
Total Emission from IPPU Sector	25,397	26,346	24,287	23,379	22,710	21,882	22,473	20,732	19,794		

Note: NE (not estimated) refers to the exclusion of estimation on existing emissions and sequestration.

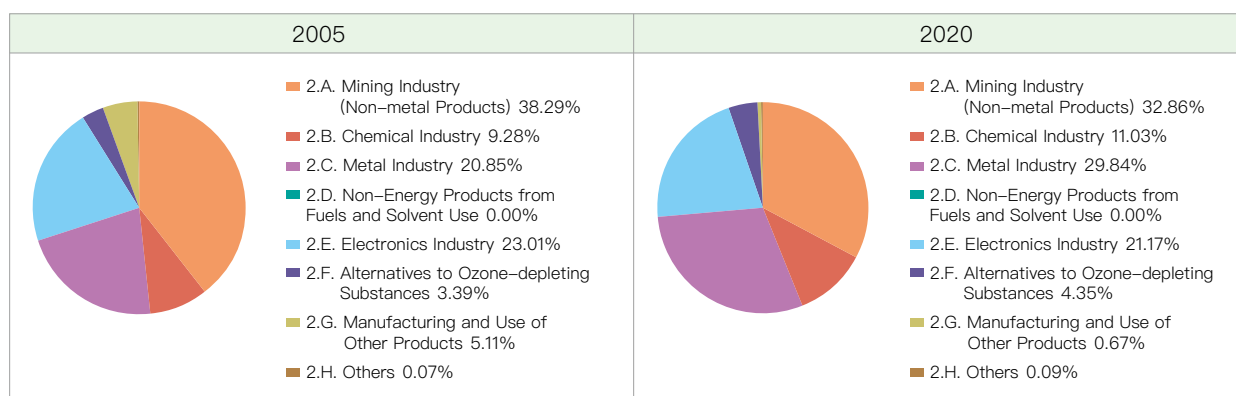


Figure ES3.5 Percentage of Greenhouse Gas Emissions by Industrial Process and Product Use Sectors in Taiwan in (a) 2005 and (b) 2020.



3. Agriculture Sector

In 2020, the greenhouse gas emissions from the agriculture sector totaled 3,345 kilotons of carbon dioxide equivalents, accounting for 1.17% of the total greenhouse gas emission in Taiwan, approximately down by 15.73% compared to 3,969 kilotons of carbon dioxide equivalents in 2005, with a negative average annual growth rate of -1.13%, as shown in Table ES3.4. Compared to 2019, the greenhouse gas emissions from the agriculture sector in 2020 slightly grew by 1.33%. In particular, greenhouse gas emissions from 3.D “agricultural soil” accounted for 36.81%, greenhouse gas emissions from 3.B “livestock waste treatment” accounted for 26.92%, greenhouse

gas emissions from 3.C “rice culturing” accounted for 17.99%, greenhouse gas emissions from 3.A “livestock gastrointestinal fermentation” accounted for 17.35%, greenhouse gas emissions from 3.H “urea use” accounted for 0.88%, and greenhouse gas emissions from 3.F “field burning of agricultural residues” accounted for 0.05%, as shown in Figure ES3.6.

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

The main greenhouse gas sequestered 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

Table ES3.4 1990–2020 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
Total CO₂ Emission (3.H Urea applied)	142	146	139	131	135	151	151	134	127	118	131
Total CH₄ Emission	2,914	3,100	3,018	3,025	3,012	3,079	3,085	2,672	2,421	2,517	2,511
3.A Livestock Gastrointestinal Fermentation	670	731	738	775	789	822	822	732	674	694	692
3.B Livestock Waste Treatment	1,112	1,304	1,266	1,282	1,312	1,371	1,398	1,062	884	971	1,003
3.C Rice Culturing	1,094	1,040	968	946	891	879	858	871	858	845	802
3.F Field Burning of Agricultural Residues	38	25	48	22	21	7	7	7	6	7	14
Total N₂O Emission	1,994	2,048	1,977	2,008	1,997	1,991	2,028	1,800	1,683	1,665	1,879
3.B Livestock Waste Treatment	145	164	163	165	173	180	188	160	145	154	158
3.D Agricultural Soil	1,837	1,876	1,800	1,837	1,818	1,808	1,838	1,638	1,536	1,509	1,717
3.F Field Burning of Agricultural Residues	12	8	15	7	6	2	2	2	2	2	4
Total Emission From Agriculture Sector	5,049	5,294	5,134	5,164	5,144	5,221	5,263	4,606	4,231	4,301	4,521
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO₂ Emission (3.H Urea applied)	94	93	82	84	62	59	57	57	55	54	53
Total CH₄ Emission	2,425	2,290	2,188	2,110	2,228	2,197	2,116	2,056	2,006	2,003	2,034
3.A Livestock Gastrointestinal Fermentation	660	636	626	614	623	614	609	584	571	578	590
3.B Livestock Waste Treatment	959	913	909	915	957	945	888	861	825	831	843
3.C Rice Culturing	792	729	644	574	640	630	616	604	605	589	596
3.F Field Burning of Agricultural Residues	15	13	9	8	8	8	5	6	5	5	5
Total N₂O Emission	1,801	1,806	1,674	1,787	1,679	1,709	1,670	1,587	1,616	1,598	1,539
3.B Livestock Waste Treatment	152	147	148	147	153	153	146	145	141	141	142
3.D Agricultural Soil	1,644	1,654	1,523	1,638	1,524	1,554	1,522	1,440	1,474	1,456	1,396
3.F Field Burning of Agricultural Residues	5	4	3	2	2	3	1.4	1.9	1.6	1.6	1.7
Total Emission From Agriculture Sector	4,320	4,189	3,944	3,981	3,969	3,966	3,844	3,699	3,678	3,655	3,626
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Total CO₂ Emission (3.H Urea applied)	55	45	40	38	34	31	30	29	29		
Total CH₄ Emission	2,010	1,997	1,947	1,927	1,933	1,932	1,932	1,942	1,938		
3.A Livestock Gastrointestinal Fermentation	583	579	566	573	561	564	572	575	580		
3.B Livestock Waste Treatment	807	781	750	744	740	738	743	754	755		
3.C Rice Culturing	614	634	626	605	629	626	615	611	602		
3.F Field Burning of Agricultural Residues	5	3	4	5	3	3	2	2	1		
Total N₂O Emission	1,564	1,497	1,490	1,459	1,456	1,406	1,385	1,330	1,377		
3.B Livestock Waste Treatment	139	137	136	136	138	139	141	145	146		
3.D Agricultural Soil	1,424	1,359	1,353	1,321	1,318	1,266	1,243	1,184	1,231		
3.F Field Burning of Agricultural Residues	1.7	1.0	1.1	1.4	1.0	1.1	0.8	0.8	0.4		
Total Emission From Agriculture Sector	3,629	3,540	3,476	3,423	3,423	3,369	3,347	3,301	3,345		

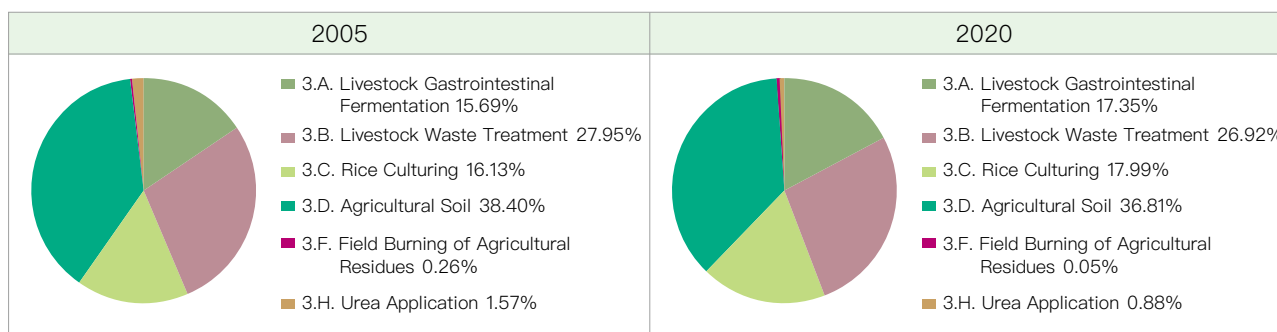


Figure ES3.6 Percentage of Greenhouse Gas Emissions by Agriculture Sectors in Taiwan in (a) 2005 and (b) 2020.

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 2020 (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 2020 decreased by 1.73% with a negative average annual growth rate of -0.12%. The sequestration in 2020 was 21,905 kilotons of carbon dioxide equivalents, down by 0.05% compared with 2019.

Table ES3.5 1990–2020 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
4.A.1 Forests Maintaining Forests	Biomass Carbon Sequestration (ΔCO_{2g})	-23,902	-23,902	-23,741	-23,580	-23,418	-23,257	-23,095	-22,934	-22,772	-22,611	-22,449
	Biomass Carbon Emissions (ΔCO_{2e})	607.25	2,503 ¹	333	216	190	202	559	266	326	401	389
4.A.2 Other Lands Turned to Forests	Biomass Carbon Sequestration (ΔCO_{2g})	-91	-91	-136	-182	-230	-285	-315	-392	-440	-553	-656
Total Carbon Sequestration (ΔCO_2)		-23,386	-21,490	-23,544	-23,546	-23,459	-23,340	-22,851	-23,060	-22,887	-22,764	-22,717
GHG Emission Sources and Sinks		2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
4.A.1 Forests Maintaining Forests	Biomass Carbon Sequestration (ΔCO_{2g})	-22,288	-22,127	-21,965	-21,804	-21,642	-21,481	-21,319	-21,158	-20,997	-20,889	-20,907
	Biomass Carbon Emissions (ΔCO_{2e})	1,112 ²	167	227	243	369	251	308	199	2,753 ³	218	140
4.A.2 Other Lands Turned to Forests	Biomass Carbon Sequestration (ΔCO_{2g})	-673	-747	-886	-981	-1,016	-1,029	-1,062	-1,123	-1,145	-1,218	-1,181
Total Carbon Sequestration (ΔCO_2)		-21,850	-22,707	-22,624	-22,542	-22,290	-22,259	-22,074	-22,082	-19,388	-21,889	-21,947
GHG Emission Sources and Sinks		2012	2013	2014	2015	2016	2017	2018	2019	2020		
4.A.1 Forests Maintaining Forests	Biomass Carbon Sequestration (ΔCO_{2g})	-20,932	-20,970	-21,004	-21,040	-21,068	-21,105	-21,148	-21,202	-21,271		
	Biomass Carbon Emissions (ΔCO_{2e})	145	135	197	189	153	107	83	116	90		
4.A.2 Other Lands Turned to Forests	Biomass Carbon Sequestration (ΔCO_{2g})	-1,173	-1,139	-1,079	-1,049	-1,011	-963	-918	-831	-724		
Total Carbon Sequestration (ΔCO_2)		-21,960	-21,974	-21,886	-21,900	-21,926	-21,961	-21,984	-21,917	-21,905		

Note:

- 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.
- 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.
- 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.



5. Waste sector

In 2005, the greenhouse gas emissions by waste sector were 7,329 kilotons of carbon dioxide equivalents. The emissions from the waste sector in 2020 were 2,607 kilotons of carbon dioxide equivalents, approximately accounting for 0.92% of the total greenhouse gas emission in Taiwan, down by 64.43% compared with 2005, with a negative average annual growth rate of -6.66% (as shown in Table ES3.6). Compared to 2019, the greenhouse gas emissions from the waste sector in 2020 were down

by 3.18%. Among the waste sector’s emissions in 2020, greenhouse gas emissions from 5.D “wastewater treatment and discharge” accounted for 63.50%, followed by greenhouse gas emissions from 5.A “solid waste disposal”, accounting for 22.85%, greenhouse gas emissions from 5.C “waste incineration and opening burning”, accounting for 11.75%, greenhouse gas emissions from 5.B “waste biological disposal”, accounting for 1.90%, as shown in Figure ES3.7.

Table ES3.6 1990–2020 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
Total CO₂ Emission (5.C Incineration and Open Burning of Waste)	20	8	65	63	110	398	387	105	117	65	259
Total CH₄ Emission	7,257	7,416	7,455	7,839	8,595	9,277	9,675	9,803	9,933	10,098	9,457
5.A Solid Waste Disposal	5,833	5,919	5,930	6,325	7,063	7,721	8,082	8,215	8,376	8,608	8,030
5.B Solid Waste Biological Disposal	11	0.5	0.8	0.5	0.1	0.6	0.3	1.4	0.05	1.9	0.3
5.D Wastewater Treatment and Discharge	1,412	1,497	1,525	1,514	1,532	1,555	1,593	1,587	1,557	1,488	1,427
Total N₂O Emission	296	285	298	311	313	334	337	337	321	329	331
5.B Solid Waste Biological Disposal	10	0.5	0.7	0.4	0.1	0.6	0.2	1.3	0.05	1.7	0.2
5.C Waste Burn	1.1	0.4	4	3	6	18	19	4	6	3	8
5.D Wastewater Treatment and Discharge	285	284	294	307	307	316	318	332	315	324	322
Total Emission from Waste Sector	7,573	7,709	7,818	8,214	9,018	10,009	10,399	10,245	10,370	10,493	10,047
GHG Emission Sources and Sinks	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Total CO₂ Emission (5.C Incineration and Open Burning of Waste)	540	612	418	512	348	470	562	443	154	208	149
Total CH₄ Emission	8,726	8,235	7,767	7,171	6,631	6,042	5,553	4,972	4,420	3,913	3,523
5.A Solid Waste Disposal	7,311	6,830	6,322	5,777	5,231	4,666	4,144	3,608	3,072	2,601	2,226
5.B Solid Waste Biological Disposal	0.02	0.4	2	7	10	11	14	16	18	21	26
5.D Wastewater Treatment and Discharge	1,416	1,404	1,443	1,387	1,391	1,365	1,395	1,348	1,330	1,290	1,271
Total N₂O Emission	340	348	353	343	350	318	328	300	295	302	314
5.B Solid Waste Biological Disposal	0.02	0.3	2	6	9	10	13	15	16	19	23
5.C Waste Burn	30	26	24	23	27	30	30	21	9	11	9
5.D Wastewater Treatment and Discharge	310	321	327	314	314	278	285	265	270	273	282
Total Emission from Waste Sector	9,606	9,195	8,538	8,026	7,329	6,830	6,443	5,715	4,868	4,423	3,986
GHG Emission Sources and Sinks	2012	2013	2014	2015	2016	2017	2018	2019	2020		
Total CO₂ Emission (5.C Incineration and Open Burning of Waste)	149	153	146	103	132	129	159	214	297		
Total CH₄ Emission	3,194	2,849	2,647	2,442	2,342	2,228	2,211	2,091	1,925		
5.A Solid Waste Disposal	1,890	1,598	1,351	1,141	970	835	723	645	596		
5.B Solid Waste Biological Disposal	24	23	20	20	20	20	23	25	26		
5.D Wastewater Treatment and Discharge	1,279	1,228	1,275	1,281	1,352	1,373	1,465	1,421	1,303		
Total N₂O Emission	313	323	332	342	330	377	368	388	386		
5.B Solid Waste Biological Disposal	22	20	18	18	18	18	21	22	23		
5.C Waste Burn	9	9	9	6	7	7	7	8	9		
5.D Wastewater Treatment and Discharge	282	294	305	318	306	352	340	358	353		
Total Emission from Waste Sector	3,655	3,325	3,125	2,886	2,804	2,734	2,738	2,693	2,607		

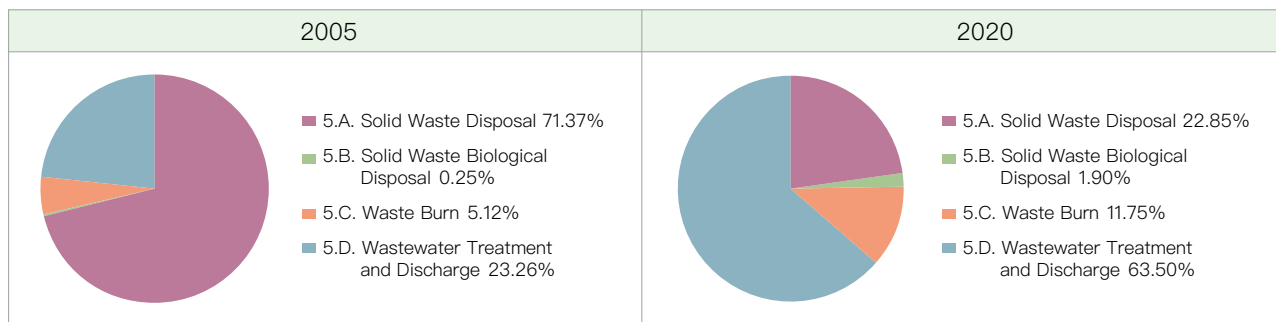


Figure ES3.7 Percentage of Greenhouse Gas Emissions by Waste Sectors in Taiwan in (a)2005 and (b)2020.

ES.4 Other Information

In accordance with the “Greenhouse Gas Reduction and Management 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.



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Environmental Protection Administration
Executive Yuan, R.O.C. (TAIWAN)