2014 Taiwan Greenhouse Gas Inventory Report Summary

November, 2014

Executive Summary

ES.1 Background Information on National Greenhouse Gas Inventory Background Information

The guidelines in Article 4 and Article 12 of the United Nation Framework Convention on Climate Change (UNFCCC) and Article 7 of 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 an Annex prepared in Common Reporting Format (CRF), in which the UNFCCC[1] requires each country to report on its national greenhouse gas inventory describing the procedures for greenhouse gas emission inventory preparation, information on emission trends, statistics by sectors, and a national report of re-calculation. For countries included on Annex I, UNFCCC encourages them to submit such report; nonetheless no country excluded from the country list on Annex (Developing Countries) has voluntarily submitted a complete NIR report. Although Taiwan is not a UNFCCC party, it has long been committed to fulfill its responsibility as a member of the global village by taking initiatives to slow down global warming with arduous efforts. The establishment of a national greenhouse gas inventory report and the estimation of greenhouse gas emission and absorption is the fundamental obligation of a country to UNFCCC as well as one of the essential steps in reducing global warming. For this reason, Taiwan is preparing the NIR report for the first time in 2014 to exhibit Taiwan' s effectiveness in controlling greenhouse gas emission and absorption.

Since 1998, Taiwan has taken initiatives to prepare the GHG inventory in compliance with the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the 1996 IPCC Guidelines)[2] published by the Intergovernmental Panel on Climate Change (IPCC) in 1997. Taiwan also referred to the "Good Practice Guidance" and "Uncertainty Management" published by IPCC in 2000 and 2003 respectively[3,4], to prepare its national greenhouse gas inventories. Today, the country has established a greenhouse gas

1 UNFCCC, FCCC/CP/2002/8, 2002.
2 IPCC, Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, 1996.
3 IPCC, Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories, 2000..
4 IPCC, Good Practice Guidance for Land Use, Land-Use Change and Forestry in the Preparation of National Greenhouse Gas Inventories under the Convention, 2003.

inventory database from 1990 to 2012. The database aims to summarize the overview on greenhouse gas inventory statistics to explain the GHG trends in Taiwan. It is also part of the continual effort to quantify future greenhouse gas emissions, to introduce Taiwan' s greenhouse gas statistics overview, and thereby to receive comments from all fields for the continuous improvement on the quality of national greenhouse gas inventories.

ES.2 Summary of National Emission and Removal Related Trends

Taiwan' s total greenhouse gas (GHG) emissions increased from 136,681 Kilotons of carbon dioxide (excluding carbon dioxide removal) in 1990 up to 270,682 Kilotons of carbon dioxide equivalents (excluding carbon dioxide removal) in 2012, with emission increased by 98.04% at an average annual growth rate of 3.15%. The total emission in 2012 is lowered than the previous year by 2.03%. Net greenhouse gas emission increased from 117,849 Kilotons of carbon dioxide equivalents (excluding carbon dioxide removal) in 1990 up to 251,553 Kilotons of carbon dioxide equivalents (excluding carbon dioxide removal) in 2012, with emissions increased by 113.45%, at an average annual growth rate of 3.51%. The total emissions in 2012 are less than the previous year by 2.19%, 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 in Taiwan in 2012, followed by nitrous oxide and then fluorinated greenhouse gas. Between 1990 and 2012, carbon dioxide emissions grew by 116.65%, increasing at an average annual growth rate of 3.58%; methane emission decreased by 76.52% with an average annual growth rate of -6.37%, as negative growth; nitrous oxide emission decreased by 2.37% with an annual growth rate of 0.11%, as shown in Table ES2.1.

Energy sector, industrial manufacturing sector and waste treatment sector are the main emission sources of carbon dioxide in Taiwan, as shown in Table ES2.2. In 1990, Taiwan had carbon dioxide emission of 120,206 Kilotons of carbon dioxide equivalents. In 2012, the figure was 260,431 Kilotons of carbon dioxide equivalent, with an increase by 116.65% and an average annual growth rate of 3.58%. In 2012 alone, energy sector accounted for 93.49%, industrial manufacturing sector 6.49% and waste sector 0.01%. The emission in 2012 compared with 2011 was decreased by 1.84%, mainly because of the reduction of emission by 1.88% in energy sector, 1.06% in industrial process sector, and 49.53% in waste sector.

The main methane emission in Taiwan is from the agriculture sector, waste sector, energy sector and industrial process sector, as shown in Table ES2.3. In 1990, total methane emission in Taiwan was 12,455 Kilotons of carbon dioxide equivalents. In 2012, total methane emission was 2,924 Kilotons of carbon dioxide equivalents, down by 76.52% with an average growth rate of -6.37%. Compared to 2011, the 2012 methane emission was reduced by 1.04%. In particular, waste sector is the largest source for methane emission, responsible for 51.69%, followed by agricultural sector 37.77%, energy sector 9.26%, and industrial process sector 1.29%.

The main nitrous oxide emission in Taiwan is from the agriculture sector with minor emissions from the waste sector, industrial process sector and energy sector, as shown in Table ES2.4. In 1990, total nitrous oxide emission in Taiwan was 4,021 Kilotons of carbon dioxide equivalents. In 2012, total nitrous oxide emission was 4,116 Kilotons of carbon dioxide equivalents, up by 2.37% with an average growth rate of -0.11%. In particular, the agriculture sector is the largest source for nitrous oxide in Taiwan in 2012, responsible for 64.61%, followed by energy sector 20.23%, waste sector 9.96%, and industrial process sector 5.20%. Compared to 2011, the 2012 nitrous oxide emission was down by 0.50%, with industrial process and product use sector down by 14.20% (most substantial decrease), waste sector dropped by 2.43%, energy sector down by 1.68%, and agriculture sector up by 1.50% on the contrary.

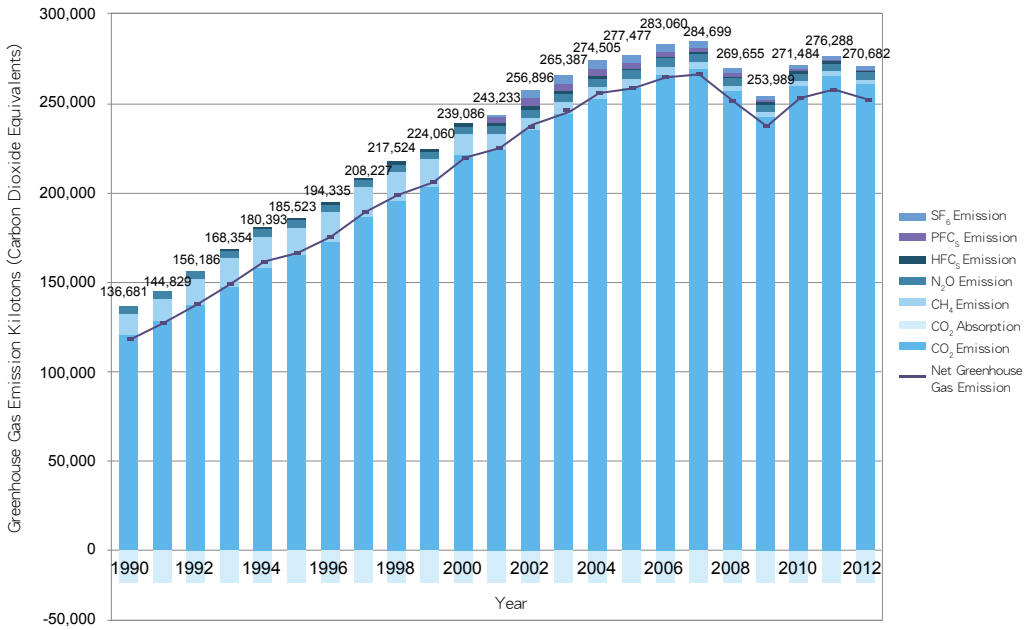

Figure ES2.1 Taiwan Greenhouse Gas Emissions Trends from Year 1990 to 2012

Table ES2.1 Taiwan Greenhouse Gas Emission Inventories from Year 1990 to 2012 By Gas Type

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	CO_2	CO_2 Absorption	CH_4	N_2O	HFCs	PFCs	SF_6	Net GHG	Total GHG
1990	120,206	-18,832	12,455	4,021	NE	NE	NE	117,849	136,681
1991	128,985	-17,372	11,750	4,095	NE	NE	NE	127,457	144,829
1992	137,107	-19,008	15,050	4,029	NE	NE	NE	137,178	156,186
1993	147,836	-19,107	15,697	4,223	597	NE	NE	149,247	168,354
1994	158,019	-19,162	17,566	4,132	676	NE	NE	161,231	180,393
1995	165,010	-19,187	15,666	4,213	634	NE	NE	166,336	185,523
1996	172,661	-19,041	16,322	4,320	1,032	NE	NE	175,294	194,335
1997	186,658	-19,217	16,344	4,057	1,168	NE	NE	189,010	208,227
1998	195,845	-19,217	16,077	3,955	1,647	NE	NE	198,307	217,524
1999	203,545	-19,220	15,328	3,915	1,272	NE	NE	204,840	224,060
2000	221,649	-19,275	11,315	4,289	1,833	NE	NE	219,811	239,086
2001	224,123	-18,692	8,893	4,451	2,081	2,939	746	224,541	243,233
2002	235,258	-19,455	6,880	4,518	2,174	4,143	3,914	237,431	256,886
2003	244,384	-19,499	6,047	4,382	1,991	4,198	4,385	245,888	265,387
2004	252,430	-18,905	5,819	4,601	2,093	4,341	5,193	255,572	274,477
2005	258,802	-18,843	4,940	4,469	1,070	3,070	4,683	258,191	277,034
2006	266,179	-18,938	4,511	4,529	987	3,264	3,590	264,122	283,060
2007	269,095	-18,920	3,921	4,543	1,093	2,933	3,114	265,779	284,699
2008	256,733	-19,015	3,248	4,301	1,046	1,682	2,644	250,640	269,655
2009	242,385	-17,218	3,065	4,272	982	1,143	2,142	236,771	253,989
2010	259,935	-18,923	3,019	4,320	934	1,354	1,922	252,561	271,484
2011	265,303	-19,103	2,955	4,137	1,129	1,240	1,525	257,185	276,288
2012	260,431	-19,129	2,924	4,116	997	725	1,490	251,553	270,682

Source: NE (not estimated), refers to the exclusion of estimation on existing emissions and removals.

Table ES2.2 Taiwan Greenhouse Gas Emission Inventories from Year 1990 to 2012 by Sector

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	107,550	116,275	123,727	132,754	140,487	147,835	155,330	167,221	177,688	186,749	205,339	208,951
1.A.1. Energy Industry	48,544	54,748	58,080	65,384	70,078	75,982	80,669	91,330	99,730	105,983	121,041	125,268
1.A.2. Manufacturing Industry and Construction	29,081	30,477	31,839	32,087	33,034	33,586	34,518	35,934	36,576	37,805	40,578	39,665
1.A.3. Transportation	19,447	20,676	23,788	25,837	27,261	28,529	29,498	30,226	31,521	32,439	32,870	32,909
1.A.4. Others	10,478	10,375	10,019	9,446	10,114	9,738	10,645	9,731	9,861	10,521	10,849	11,108
1.A.4.a Commerce (Service Industry)	3,580	3,488	2,953	2,464	2,984	2,418	3,142	2,457	2,916	3,121	3,187	3,526
1.A.4.b Residential	3,983	4,215	4,422	4,335	4,437	4,573	4,728	4,825	4,925	5,381	5,326	5,153
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	2,916	2,672	2,645	2,647	2,693	2,748	2,775	2,449	2,020	2,019	2,337	2,429
2. Industrial Process	12,645	12,706	13,343	15,050	17,464	16,975	17,106	19,391	18,087	16,761	16,205	14,790
4. Waste Sector	11	4	36	32	69	200	225	47	70	36	105	382
5. Land use change and Forestry secto	-18,832	-17,372	-19,008	-19,107	-19,162	-19,187	-19,041	-19,217	-19,217	-19,220	-19,275	-18,692
Net CO_2 Emission	101,374	111,613	118,098	128,729	138,857	145,823	153,620	167,441	176,628	184,325	202,374	205,431
Total CO_2 Emission	120,206	128,985	137,107	147,836	158,019	165,010	172,661	186,658	195,845	203,545	221,649	224,123

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1. Energy Sector	216,725	226,110	233,928	240,590	247,214	250,903	239,841	227,737	243,246	248,142	243,484	
1.A.1. Energy Industry	129,268	139,679	145,510	152,637	159,272	163,091	157,098	147,793	158,509	161,931	159,528	
1.A.2. Manufacturing Industry and Construction	42,296	40,727	40,978	39,693	40,877	42,670	39,380	36,649	40,456	41,634	40,104	
1.A.3. Transportation	34,191	34,159	35,496	36,471	36,396	35,056	33,055	33,370	34,472	34,936	34,153	
1.A.4. Others	10,969	11,545	11,943	11,789	10,669	10,086	10,308	9,925	9,809	9,641	9,698	
1.A.4.a Commerce (Service Industry)	3,457	3,920	4,077	4,193	4,208	4,153	4,163	4,188	4,166	3,926	3,923	
1.A.4.b Residential	5,079	4,843	4,920	4,996	4,831	4,853	4,794	4,750	4,712	4,788	4,745	
1.A.4.c Agriculture, Forestry, Fishery, and Husbandry	2,433	2,782	2,946	2,599	1,629	1,079	1,351	988	931	927	1,030	
2. Industrial Process	18,124	17,979	18,223	18,020	18,716	17,892	16,656	14,559	16,575	17,094	16,914	
4. Waste Sector	409	294	280	192	249	300	236	89	114	67	34	
5. Land use change and Forestry secto	-19,455	-19,499	-18,905	-18,843	-18,938	-18,920	-19,015	-17,218	-18,923	-19,103	-19,129	
Net CO_2 Emission	215,803	224,885	233,525	239,959	247,241	250,175	237,718	225,167	241,012	246,200	241,302	
Total CO_2 Emission	235,258	244,384	252,430	258,802	266,179	269,095	256,733	242,385	259,935	265,303	260,431	

Table ES2.3 Methane Emission Inventories for Taiwan from Year 1990 to 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	143	153	164	174	186	196	203	211	223	237	248	250
2. Industrial Process Sector	18	17	17	18	23	27	29	30	29	30	31	40
4. Agriculture sector	1,567	1,601	1,550	1,573	1,547	1,578	1,564	1,467	1,383	1,400	1,379	1,331
4.A. Livestock Gastrointestinal Fermentation	576	628	633	666	677	706	705	630	581	598	596	568
4.B. Livestock waste treatment	173	199	196	202	207	217	223	184	161	172	176	169
4.C. Rice Culturing	806	763	710	693	651	644	625	642	631	620	590	579
4.F. Agricultural waste burning (Crop burning)	12	12	11	12	11	11	10	11	10	10	17	15
6. Waste sector	10,726	9,979	13,319	13,932	15,810	13,865	14,526	14,637	14,443	13,660	9,656	7,273
6.A. Garbage landfill	9,456	8,573	11,875	12,520	14,376	12,399	12,998	13,130	12,984	12,263	8,322	5,946
6.B. Waste water treatment	1,261	1,405	1,444	1,412	1,434	1,466	1,527	1,506	1,460	1,396	1,334	1,327
6.D. Others	10	0	1	0	0	1	0	1	0	2	0	0
Total	12,455	11,750	15,050	15,697	17,566	15,666	16,322	16,344	16,077	15,328	11,315	8,893

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1. Energy Sector	254	266	277	281	282	281	271	263	271	273	271	
2. Industrial Process Sector	40	41	41	43	38	46	41	39	45	41	38	
4. Agriculture sector	1,258	1,185	1,122	1,177	1,161	1,138	1,103	1,088	1,083	1,106	1,104	
4.A. Livestock Gastrointestinal Fermentation	548	539	528	535	527	523	502	491	498	507	501	
4.B. Livestock waste treatment	163	161	162	164	163	155	151	147	148	151	144	
4.C. Rice Culturing	535	477	424	471	463	456	444	446	432	442	453	
4.F. Agricultural waste burning (Crop burning)	12	9	7	8	8	4	6	5	5	5	5	
6. Waste sector	5,327	4,555	4,380	3,440	3,031	2,456	1,832	1,674	1,621	1,535	1,511	
6.A. Garbage landfill	4,004	3,149	3,043	2,061	1,669	999	433	290	304	215	143	
6.B. Waste water treatment	1,323	1,404	1,332	1,370	1,352	1,445	1,385	1,369	1,300	1,298	1,347	
6.D. Others	0	2	6	8	9	12	14	15	18	22	20	
Total	6,880	6,047	5,819	4,940	4,511	3,921	3,248	3,065	3,019	2,955	2,924	

In Taiwan, the majority of fluorinated greenhouse gases come from economically critical industries, including the semiconductor, optoelectronics, power facilities, and magnesium alloy, which are emission-heavy industries. The fluorinated greenhouse gas emissions are shown in Table ES2.5. In particular, the emission from Taiwan' s HFCs decreased from 597 kilotons of carbon dioxide equivalents in 1993 to 3,211 kilotons of carbon dioxide equivalents in 2012. The emission from PFCs decreased from 2,939 kilotons of carbon dioxide equivalents in 2001 to 725 kilotons of carbon dioxide equivalents in 2012; while the emission from SF_6 increased from 746 kilotons of carbon dioxide equivalents in 2001 to 1,490 kilotons of carbon dioxide equivalents in 2012. For total emission of fluorinated greenhouse gases, it decreased from 5,766 kilotons of carbon dioxide equivalents in 2001(about 2.37% of total greenhouse gas emission for 2001) to

Table ES2.4 Nitrous Oxide Emission Inventories for Taiwan from Year 1990 to 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Yes	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	315	340	378	505	430	451	488	525	561	600	679	702
2. Industrial Process Sector	183	195	175	183	168	194	205	229	220	163	115	269
4. Agriculture Sector	3,167	3,216	3,112	3,156	3,148	3,139	3,193	2,892	2,780	2,751	3,085	3,027
4.B. Livestock Waste Treatment	50	52	54	56	62	64	70	73	74	75	76	73
4.D. Agricultural soil emission	3,113	3,160	3,054	3,096	3,083	3,072	3,120	2,816	2,702	2,672	3,003	2,948
4.F. Agricultural waste burning(crop burning)	4	4	4	4	4	4	3	4	3	3	6	5
6. Waste Sector	356	343	364	380	386	429	434	411	395	401	410	453
Total	4,021	4,095	4,029	4,223	4,132	4,213	4,320	4,057	3,955	3,915	4,289	4,451
Yes	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1. Energy Sector	735	786	815	840	869	893	856	816	839	847	833	
2. Industrial Process Sector	297	299	303	318	299	345	319	295	347	249	214	
4. Agriculture Sector	3,029	2,839	3,037	2,851	2,897	2,830	2,704	2,758	2,716	2,620	2,660	
4.B. Livestock Waste Treatment	73	74	72	74	75	74	75	74	73	74	74	
4.D. Agricultural soil emission	2,951	2,762	2,963	2,774	2,819	2,755	2,627	2,683	2,641	2,545	2,584	
4.F. Agricultural waste burning(crop burning)	4	3	3	3	3	2	2	2	2	2	2	
6. Waste Sector	457	459	445	459	464	475	423	403	418	420	410	
Total	4,518	4,382	4,601	4,469	4,529	4,543	4,301	4,272	4,320	4,137	4,116	

3,211 kilotons of carbon dioxide equivalents in 2012(about 1.19% of total greenhouse gas emission for 2012), with emissions reduced by 44.31%.

ES.3 Emission Statistics and Trends Analysis on Emission Source and Absorption Categories

The energy sector, among all segments, has long been the one accounting for the largest total greenhouse gas emissions in Taiwan over the years. The GHG emission for the energy sector was responsible for approximately 90.36% of the total emissions in 2012 (excluding land use and forestry absorption), the industrial process sector 7.53%, agriculture sector 1.39%, and the waste sector 0.72%. The GHG emission and trends for Taiwan from year 1990 to 2012 by sector are shown in Figure ES3.1 and Table ES3.1. Between 1990 and 2012, the GHS emissions from energy sector increased by 126.45% with an average annual growth rate of 3.79%, the industrial process sector increased by 58.61% with an average growth rate of 2.12%, the agriculture sector decreased by 20.49% with an average annual growth rate of -1.04%, a negative growth. The GHG emissions from waste sector decreased by 82.37% with an average annual growth rate of -7.59%, a negative growth while the GHG emission absorption for land use and forestry sector increased by 1.58% with an average annual growth rate of 0.07%. The total greenhouse gas emission for Taiwan in 2012 was dropped by 2.03%, compared to that in 2011. In particular, the GHG emission from energy sector was down by 1.88%, industrial process sector down

Table ES2.5 Fluorinated Greenhouse Gas Emissions for Taiwan from Year 1993 to 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Total emissions from HFCs	597	676	634	1,032	1,168	1,647	1,272	1,833	2,081	2,174	1,991	2,093
Total emissions PFCs	NE	NE	NE	NE	NE	NE	NE	NE	2,939	4,143	4,198	4,341
Total emissions SF_6	NE	NE	NE	NE	NE	NE	NE	NE	746	3,914	4,385	5,193
Total Emissions	597	676	634	1,032	1,168	1,647	1,272	1,833	5,766	10,231	10,574	11,626
Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**				
Total emissions from HFCs	1,070	987	1,093	1,046	982	934	1,129	997				
Total emissions PFCs	3,070	3,264	2,933	1,682	1,143	1,354	1,240	725				
Total emissions SF_6	4,683	3,590	3,114	2,644	2,142	1,922	1,525	1,490				
Total Emissions	8,823	7,841	7,140	5,373	4,268	4,210	3,894	3,211				

Source: NE (not estimated), refers to the exclusion of estimation on existing emissions and removals.

by 4.24%, agriculture sector up by 1.01%, and the waste sector down by 3.31%. Additionally, the carbon dioxide absorption of land use change and forestry sector was up by 0.14%.

The total greenhouse gas emission from the energy sector in 1990 was 108,008 kilotons of carbon dioxide equivalents and increased to 244,587 kilotons of carbon dioxide equivalents in 2012 with an average growth by 126.45% and annual average growth of 3.79%, as shown in ES3.2. During this period, the greenhouse gas emission 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. The total greenhouse gas emission from the energy sector in 2012 accounted for 90.36% of total greenhouse gas emissions in Taiwan. In particular, 1.A. "energy industry" was responsible for 160,185 kilotons of carbon dioxide equivalents, accounting for 64.49% of the total greenhouse gas emission from the energy sector. 2.A. "manufacturing industry and construction" was responsible for 40,261 kilotons of carbon dioxide equivalents (accounting for 16.46%). 3.A. "transportation" was responsible for 34,397 kilotons of carbon dioxide equivalents (accounting for 14.06%), and finally 4.A. "Others" was responsible for 9,743 kilotons of carbon dioxide equivalents (accounting for 3.98%).

The greenhouse gas emission from the industrial process sector in 2012 was 20,376 kilotons of carbon dioxide equivalents, which accounted approximately for 7.53% of the total

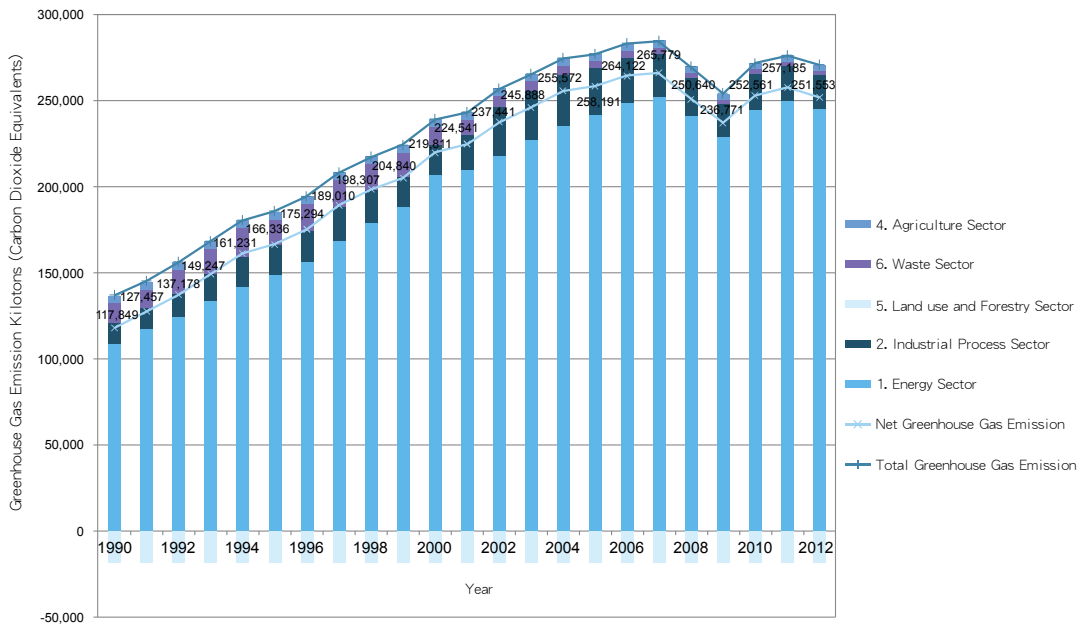

Figure ES3.1 Various Greenhouse Gas Emission Trends for Taiwan from Year 1990 to 2012 by Sector

greenhouse gas emissions in Taiwan, as shown in Table ES3.3. In particular, "Mining industry (non-metal process)" was responsible for 9,110 kilotons of carbon dioxide equivalents, accounting for 44.71% of the greenhouse gas from industrial process sector, followed by 2.C. "metal process" responsible for 7,890 kilotons of carbon dioxide equivalents (accounting for 38.27%), 2.F. "Halo and SF6 use" responsible for 3,211 kilotons of carbon dioxide equivalents (accounting for 15.76%), and 2.B. "Chemical industry" responsible for 256 kilotons of carbon dioxide equivalents (accounting for 1.26%).

Table ES3.1 Greenhouse Gas Emissions for Taiwan from Year 1990 to 2012 by Sector

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1. Energy Sector	108,008	116,768	124,269	133,434	141,103	148,483	156,022	167,956	178,472	187,586	206,266	209,903
2. Industrial Process Sector	12,847	12,918	13,535	15,847	18,331	17,829	18,373	20,818	19,982	18,226	18,185	20,865
4. Agriculture Sector	4,734	4,817	4,662	4,728	4,695	4,718	4,757	4,359	4,162	4,151	4,464	4,358
5. Land use and forestry sector	-18,832	-17,372	-19,008	-19,107	-19,162	-19,187	-19,041	-19,217	-19,217	-19,220	-19,275	-18,692
6. Waste sector	11,093	10,326	13,719	14,344	16,264	14,494	15,184	15,094	14,908	14,097	10,171	8,108
Net Greenhouse Gas Emission (including land use change and forestry absorption)	117,849	27,457	137,178	49,247	161,231	166,336	175,294	189,010	198,307	204,840	219,811	224,541
Total Greenhouse Gas Emission (excluding land use change and forestry absorption)	136,681	144,829	156,186	168,354	180,393	185,523	194,335	208,227	217,524	224,060	239,086	243,233

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
1. Energy Sector	217,714	227,163	35,019	241,711	248,365	252,077	240,968	228,816	244,356	249,262	244,587	
2. Industrial Process Sector	28,692	28,892	30,193	27,204	26,893	25,424	22,389	19,161	21,176	21,279	20,376	
4. Agriculture Sector	4,287	4,024	4,159	4,028	4,058	3,968	3,807	3,847	3,799	3,726	3,764	
5. Land use and forestry sector	-19,455	-19,499	-18,905	-18,843	-18,938	-18,920	-19,015	-17,218	-18,923	-19,103	-19,129	
6. Waste sector	6,193	5,308	5,105	4,091	3,744	3,230	2,490	2,166	2,153	2,022	1,955	
Net Greenhouse Gas Emission (including land use change and forestry absorption)	237,431	245,888	255,572	258,191	264,122	265,779	250,640	236,771	252,561	257,185	251,553	
Total Greenhouse Gas Emission (excluding land use change and forestry absorption)	256,886	265,387	274,477	277,034	283,060	284,699	269,655	253,989	271,484	276,288	270,682	

Table ES3.2 Greenhouse Gas Emission from Energy Sector for Taiwan from Year 1990 to 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total carbon dioxide emission	107,550	116,275	123,727	132,754	140,487	147,835	155,330	167,221	177,688	186,749	205,339	208,951
1.A.1. Energy Industry	48,544	54,748	58,080	65,384	70,078	75,982	80,669	91,330	99,730	105,983	121,041	125,268
1.A.2. Manufacturing Industry and Construction	29,081	30,477	31,839	32,087	33,034	33,586	34,518	35,934	36,576	37,805	40,578	39,665
1.A.3. Transportation	19,447	20,676	23,788	25,837	27,261	28,529	29,498	30,226	31,521	32,439	32,870	32,909
1.A.4. Others	10,478	10,375	10,019	9,446	10,114	9,738	10,645	9,731	9,861	10,521	10,849	11,108
Total methane emission	143	153	164	174	186	196	203	211	223	237	248	250
1.A.1. Energy Industry	26	26	25	23	25	24	26	24	25	27	28	28
1.A.2. Manufacturing Industry and Construction	10	10	8	7	8	7	9	7	8	9	9	10
1.A.3. Transportation	12	13	13	13	13	13	14	14	14	16	16	15
1.A.4. Others	4	4	4	4	4	4	4	3	3	3	3	3
Total Nitrous Oxide emission	315	340	378	505	430	451	488	525	561	600	679	702
1.A.1. Energy Industry	25	25	24	22	24	23	25	23	23	25	25	26
1.A.2. Manufacturing Industry and Construction	9	8	7	6	7	5	7	6	7	7	7	8
1.A.3. Transportation	9	10	10	10	10	10	11	11	11	13	12	12
1.A.4. Others	7	7	7	7	7	7	7	6	5	5	6	6
Total Emission from Energy Sector	108,008	116,768	124,269	133,434	141,103	148,483	156,022	167,956	178,472	187,586	206,266	209,903

年	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Total carbon dioxide emission	216,725	226,110	233,928	240,590	247,214	250,903	239,841	227,737	243,246	248,142	243,484	
1.A.1. Energy Industry	129,268	139,679	145,510	152,637	159,272	163,091	157,098	147,793	158,509	161,931	159,528	
1.A.2. Manufacturing Industry and Construction	42,296	40,727	40,978	39,693	40,877	42,670	39,380	36,649	40,456	41,634	40,104	
1.A.3. Transportation	34,191	34,159	35,496	36,471	36,396	35,056	33,055	33,370	34,472	34,936	34,153	
1.A.4. Others	10,969	11,545	11,943	11,789	10,669	10,086	10,308	9,925	9,809	9,641	9,698	
Total methane emission	254	266	277	281	282	281	271	263	271	273	271	
1.A.1. Energy Industry	28	29	30	30	28	27	27	26	26	25	25	
1.A.2. Manufacturing Industry and Construction	10	11	11	11	11	11	11	11	11	10	10	
1.A.3. Transportation	15	14	14	14	14	14	14	14	13	14	13	
1.A.4. Others	3	4	4	4	2	2	2	1	1	1	1	
Total Nitrous Oxide emission	735	786	815	840	869	893	856	816	839	847	833	
1.A.1. Energy Industry	26	27	28	27	24	23	23	22	21	20	20	
1.A.2. Manufacturing Industry and Construction	8	9	9	9	9	9	9	9	9	8	8	
1.A.3. Transportation	11	11	11	11	11	11	10	10	10	10	10	
1.A.4. Others	6	7	7	7	4	3	3	2	2	2	3	
Total Emission from Energy Sector	217,714	227,163	235,019	241,711	248,365	252,077	240,968	28,816	244,356	249,262	244,587	

Table ES3-3 Greenhouse Gas Emission from Industrial Process Sector for Taiwan from Year 1990 to 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total carbon dioxide emission	12,645	12,706	13,343	15,050	17,464	16,975	17,106	19,391	18,087	16,761	16,205	14,790
2.A. Mining industry (non-metal process)	8,644	8,545	9,491	10,717	13,240	12,638	12,642	13,383	11,548	10,727	9,540	7,805
2.B. Chemical Industry	66	61	61	65	70	62	58	62	54	49	34	26
2.C. Metal process	3,933	4,098	3,789	4,265	4,151	4,273	4,404	5,945	6,483	5,983	6,630	6,957
2.D. Other industrial production	2	2	2	2	2	2	2	2	2	2	2	2
Total methane emission	18	17	17	18	23	27	29	30	29	30	31	40
2.B. Chemical Industry	18	17	17	18	23	27	29	30	29	30	31	35
2.C. Metal process	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	4
Total nitrous dioxide emission	183	195	175	183	168	194	205	229	220	163	115	269
2.B. Chemical Industry	183	195	175	183	168	194	205	229	220	163	115	183
2.C. Metal process	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	IE	86
Total Fluorinated gas emission	NE	NE	NE	597	676	634	1,032	1,168	1,647	1,272	1,833	5,766
2.E Halo and SF_6 manufacturing	NO	NO	NO	597	676	634	1,032	1,168	1,647	1,272	1,833	2,030
2.F halo and SF_6 use	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	3,736
Total Industrial Process Sector and Product Use Emission	12,847	12,918	13,535	15,847	18,331	17,829	18,373	20,818	19,982	18,226	18,185	20,865

Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Total carbon dioxide emission	18,124	17,979	18,223	18,020	18,716	17,892	16,656	14,559	16,575	17,094	16,914	
2.A. Mining industry (non-metal process)	10,709	10,519	10,963	11,577	11,270	10,208	9,209	8,316	8,340	9,528	9,110	
2.B. Chemical Industry	26	14	NO	3	4	5	4	4	4	4	4	
2.C. Metal process	7,387	7,445	7,258	6,438	7,440	7,677	7,442	6,237	8,230	7,561	7,798	
2.D. Other industrial production	2	2	2	2	2	2	2	2	2	2	2	
Total methane emission	40	41	41	43	38	46	41	39	45	41	38	
2.B. Chemical Industry	35	36	36	38	37	42	37	36	39	40	38	
2.C. Metal process	5	5	5	4	1	5	5	4	5	1	IE	
Total nitrous dioxide emission	297	299	303	318	299	345	319	295	347	249	214	
2.B. Chemical Industry	207	207	212	232	208	239	217	210	227	224	214	
2.C. Metal process	90	92	92	86	91	107	101	85	119	25	IE	
Total Fluorinated gas emission	10,231	10,574	11,626	8,823	7,841	7,140	5,373	4,268	4,210	3,894	3,211	
2.E Halo and SF_6 manufacturing	1,705	1,531	1,352	NO	NO	NO	NO	NO	NO	NO	NO	
2.F halo and SF_6 use	8,526	9,043	10,275	8,823	7,841	7,140	5,373	4,268	4,210	3,894	3,211	
Total Industrial Process Sector and Product Use Emission	28,692	28,892	30,193	27,204	26,893	25,424	22,389	19,161	21,176	21,279	20,376	

Note: IE (Listed under others), including estimation on greenhouse gas emission and removal, listed under 2.C. metal-process carbon dioxide emission

NE (not yet estimated) , excluding estimation on existing emission sources and removal.

NO (not yet occurred) , referring to phase-out production or use in Taiwan such as suspension of production.

In 2012, greenhouse gas emissions from the agricultural sector totaled 3,764 kilotons of carbon dioxide equivalents, accounting for 1.29% of total greenhouse gas emission in Taiwan, approximately down by 20.49% when compared to that in 1990, with an average annual growth rate of -1.04%, as shown in ES3.4. The greenhouse gas emission from the agriculture sector in 2012 was up by 1.01%, compared to that in 2011. In particular, 4.D. Nitrous dioxide emission from "agricultural soil" accounted for 68.66% (majority), methane emission from 4.A. "Livestock gastrointestinal fermentation" accounted for 13.32%, methane emission from 4.C. "Rice culturing" accounted for 12.04%, methane emission from 4.B. "Livestock waste treatment" accounted for 3.84%, nitrous dioxide emission from 4.B. "Livestock waste treatment" accounted for 1.95%, methane emission from 4.F. "Agricultural waste burning" accounted for 0.14%, and nitrous dioxide emission from "agricultural waste burning" accounted for 0.05%.

Table ES3.4 Greenhouse Gas Emission from Agriculture Sector for Taiwan from Year 1990 to 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total Methane Emission	1,567	1,601	1,550	1,573	1,547	1,578	1,564	1,467	1,383	1,400	1,379	1,331
4A. Livestock Gastrointestinal Fermentation	576	628	633	666	677	706	705	630	581	598	596	568
4B. Livestock waste treatment	173	199	196	202	207	217	223	184	161	172	176	169
4C. Rice culturing	806	763	710	693	651	644	625	642	631	620	590	579
4F. Agricultural waste burning	12	12	11	12	11	11	10	11	10	10	17	15
Total Nitrous Dioxide Emission	3,167	3,216	3,112	3,156	3,148	3,139	3,193	2,892	2,780	2,751	3,085	3,027
4.B. Livestock waste treatment	50	52	54	56	62	64	70	73	74	75	76	73
4.D. Agricultral soil emission	3,113	3,160	3,054	3,096	3,083	3,072	3,120	2,816	2,702	2,672	3,003	2,948
4.F. Agricultural waste burning	4	4	4	4	4	4	3	4	3	3	6	5
Total Emission from Agriculture Sector	4,734	4,817	4,662	4,728	4,695	4,718	4,757	4,359	4,162	4,151	4,464	4,358
Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Total Methane Emission	1,258	1,185	1,122	1,177	1,161	1,138	1,103	1,088	1,083	1,106	1,104	
4A. Livestock Gastrointestinal Fermentation	548	539	528	535	527	523	502	491	498	507	501	
4B. Livestock waste treatment	163	161	162	164	163	155	151	147	148	151	144	
4C. Rice culturing	535	477	424	471	463	456	444	446	432	442	453	
4F. Agricultural waste burning	12	9	7	8	8	4	6	5	5	5	5	
Total Nitrous Dioxide Emission	3,029	2,839	3,037	2,851	2,897	2,830	2,704	2,758	2,716	2,620	2,660	
4.B. Livestock waste treatment	73	74	72	74	75	74	75	74	73	74	74	
4.D. Agricultral soil emission	2,951	2,762	2,963	2,774	2,819	2,755	2,627	2,683	2,641	2,545	2,584	
4.F. Agricultural waste burning	4	3	3	3	3	2	2	2	2	2	2	
Total Emission from Agriculture Sector	4,287	4,024	4,159	4,028	4,058	3,968	3,807	3,847	3,799	3,726	3,764	

The main source of greenhouse gas absorbed by land use and forestry sector is carbon dioxide and the annual carbon stock increase from forestry resources. The greenhouse gas emission from land use and forestry sector for Taiwan from year 1990 to 2012 (mainly consists of carbon dioxide absorption by forestry resources) is shown in ES3.5. The 2012 absorption was 19,129 kilotons of carbon dioxide equivalents, up by 26 kilotons of carbon dioxide equivalents compared to that in 2011 (0.13%). The carbon dioxide absorption between 1990 and 2012 was up 1.58%, with an average annual growth rate of 0.07%.

Table ES3.5 Carbon Dioxide Absorption of Forest Resruces for Taiwan from Year 1990 to 2012

Year	$\triangle C_{G\text{-}TOTAL}$ (Kilotons of Carbon Dioxide)	$\triangle C_{G\text{-}AFF}$ (Kilotons of Carbon Dioxide)	$L_{WOOD\text{-}REMOVALS}$ (Kilotons of Carbon Dioxide)	$L_{fuelwood}$ (Kilotons of Carbon Dioxide)	$L_{disturbance}$ (Kilotons of Carbon Dioxide)	$\triangle C$ (Kilotons of Carbon Dioxide)	Annual Carbon Absorption Change (Unit: Kilotons of Carbon Dioxide Equivalents)
1990	5,210	18.89	78.88	12.52	1.07	5,136	18,832
1991	5,210	16.41	51.84	7.35	428.74	4,738	17,372
1992	5,210	25.68	43.45	6.95	0.81	5,184	19,008
1993	5,210	35.47	27.77	2.72	3.26	5,211	19,107
1994	5,209	45.10	23.28	1.93	3.01	5,226	19,162
1995	5,208	54.63	23.20	5.35	1.13	5,233	19,187
1996	5,207	59.18	23.98	3.06	45.95	5,193	19,041
1997	5,206	71.61	16.92	3.58	16.55	5,241	19,217
1998	5,205	79.35	17.31	4.11	22.44	5,241	19,217
1999	5,205	96.82	18.35	3.15	37.77	5,242	19,220
2000	5,204	114.35	17.01	1.62	42.68	5,257	19,275
2001	5,203	117.34	14.65	2.37	204.73	5,098	18,692
2002	5,202	129.48	21.93	2.33	1.34	5,306	19,455
2003	5,200	152.15	28.64	5.76	0.34	5,318	19,499
2004	5,023	167.62	24.07	3.81	10.46	5,152	18,905
2005	5,006	174.04	22.96	2.36	30.85	5,124	18,843
2006	4,995	176.12	29.91	3.45	1.14	5,136	18,938
2007	4,989	181.46	29.56	3.67	13.22	5,124	18,920
2008	4,979	191.30	24.25	2.31	1.46	5,142	19,015
2009	4,978	194.67	27.48	1.16	505.47	4,639	17,218
2010	4,924	206.30	26.13	0.10	1.65	5,102	18,923
2011	4,922	203.47	19.19	0.24	0.43	5,106	19,103
2012	4,913	224.21	20.33	0.89	0.30	5,115	19,129

Note:

$\triangle C = ((\triangle C_{GTOTAL} + \triangle C_{GAFF}) - (L_{WOOD\text{-}REMOVALS} + L_{fuelwood} + L_{disturbance})$

$\triangle C_{G\text{-}TOTAL}$: average annual carbon stock change for forestry resources

$\triangle C_{G\text{-}AFF}$: annual carbon stock change due to forestation

$L_{WOOD\text{-}REMOVALS}$: annual carbon stock decrease due to commercial logging

$L_{fuelwood}$: annual carbon stock decrease due to firewood usage

$L_{disturbance}$: annual carbon stock decrease due to other factors

The greenhouse gas emission from waste sector in 2012 was 1,955 kilotons of carbon dioxide equivalents, approximately accounting for 0.72% of total greenhouse gas emission in Taiwan (as shown in Table ES3.6), down by 82.37% compared to that in 1990, with an average annual growth down by 7.59%. Among the waste sector emission in 2012, methane emission from 6.B. "waste water treatment" accounted for 68.91%, followed by nitrous oxide from 6.B. "waste water treatment" accounting for 19.34%.

Table ES3.6 Greenhouse Gas Emission from Waste Sector for Taiwan from Year 1990 o 2012

(Unit: Kilotons of Carbon Dioxide Equivalents)

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
Total carbon dioxide emission	11	4.0	36	32	69	200	225	47	70	36	105	382
6.C. Waste burning	11	4.0	36	32	69	200	225	47	70	36	105	382
Total methane emission	10,726	9,979	13,319	13,932	15,810	13,865	14,526	14,637	14,443	13,660	9,656	7,273
6.A. Garbage landfill	9,456	8,573	11,875	12,520	14,376	12,399	12,998	13,130	12,984	12,263	8,322	5,946
6.B. Waste water treatment	1,261	1,405	1,444	1,412	1,434	1,466	1,527	1,506	1,460	1,396	1,334	1,327
6.D. Others	10	1	1	0	0	1	0	1	0	2	0	0
Total nitrous oxide emission	356	343	364	380	386	429	434	411	395	401	410	453
6.B. Waste water treatment	342	342	354	370	370	380	383	399	379	390	388	373
6.C. Waste burning	3	1	10	9	15	48	51	10	15	9	21	80
6.D. Others	11	1	1	0	0	1	0	1	0	2	0	0
Total emission from waste sector	11,093	10,326	13,719	14,344	16,264	14,494	15,184	15,094	14,908	14,097	10,171	8,108
Year	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	
Total carbon dioxide emission	409	294	280	192	249	300	236	89	114	67	34	
6.C. Waste burning	409	294	280	192	249	300	236	89	114	67	34	
Total methane emission	5,3279	4,555	4,380	3,440	3,031	2,456	1,832	1,674	1,621	1,535	1,511	
6.A. Garbage landfill	4,0049	3,149	3,043	2,061	1,669	999	433	290	304	215	143	
6.B. Waste water treatment	1,323	1,404	1,332	1,370	1,352	1,445	1,385	1,369	1,300	1,298	1,347	
6.D. Others	0	2	6	8	10	12	14	15	18	22	21	
Total nitrous oxide emission	457	459	445	459	465	475	423	403	418	420	410	
6.B. Waste water treatment	387	393	378	377	373	383	353	364	370	377	378	
6.C. Waste burning	70	63	61	73	81	79	55	23	29	19	9	
6.D. Others	0	2	6	9	11	14	15	17	19	24	23	
Total emission from waste sector	6,193	5,308	5,105	4,091	3,744	3,230	2,490	2,166	2,153	2,022	1,955	

Note: 6.D. Others refer to the greenhouse gas emitted from the waste sector handling other activities, including biological waste treatment.

ES.4 Other Information

According to the Durban Platform signed at "the 17th Conference of the Parties (COP 17) to the United Nations Framework Convention on Climate and 7th session of Meeting of Parties to the Kyoto Protocol (UNFCCC COP17/ CMP 7), all countries listed on Annex I shall submit the National Inventory Report, Biennial Report, and National Communications while countries not listed in Annex I shall submit Biennial Update Report and National Communications. These national reports all relate to the content of National Greenhouse Gas Inventory. Taiwan is currently taking the initiative in establishing a national system that is feasible to conform to Taiwan customs, division of labor in sectors and the hierarchical management of database. In addition to formulating regulations governing national greenhouse gas inventory review, Taiwan also established a review committee, a review on greenhouse gas inventory, and a sound management system to comply with procedures of Measurement Reporting, Verification (MRV). Moreove, in order to cooperate with UNFCCC, Taiwan shall apply 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as 2006 IPPC Guidelines) starting in 2015. We have started preparing a national greenhouse gas inventory with 2006 IPCC Guidelines based statistical foundation and framework in addition to designing and establishing a registration platform for electronic national greenhouse gas inventory starting in 2013. At the same time, the relevant departments will test run this registration platform and submit the national greenhouse gas inventory statistics online. Taiwan is scheduled to comprehensively apply (or adopt) the 2006 IPCC Guidelines in step with UNFCCC starting in 2015.

2014 Taiwan Greenhouse Gas Inventory Report Summary

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