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The People's Republic of China Fourth Biennial Update Report on Climate Change

December 2024

Foreword

Climate change is a common challenge facing all humanity. The government of the People's Republic of China (hereinafter referred to as "China") attaches great importance to addressing climate change, adheres to the principles of equity, common but differentiated responsibilities and respective capabilities (CBDR–RC), firmly upholds multilateralism, and facilitates the joint implementation of the *United Nations Framework Convention on Climate Change* (hereinafter referred to as the "UNFCCC") and its *Paris Agreement*.

According to decision 1/CP.16 and decision 2/CP.17, non-Annex I Parties, consistent with their capabilities and the level of support received for reporting, are expected to submit biennial update reports starting from 2014. The Chinese Government has submitted four National Communications (NCs) and three Biennial Update Reports (BURs), comprehensively reporting on China's actions, progress, and achievements in implementing the objectives of the UNFCCC.

The People’s Republic of China Fourth Biennial Update Report on Climate Change, as the latest BUR submitted by China, has received support from GEF's "Enabling China to Prepare Its Fourth National Communication, and Biennial Update Reports on Climate Change" Capacity Building Project. It was prepared in accordance with the guidelines for the preparation of BURs for non-Annex I Parties under the UNFCCC, and with reference to the modalities, procedures and guidelines (MPGs) for the Enhanced Transparency Framework (ETF) under the Paris Agreement. This report includes chapters on National Greenhouse Gas (GHG) Inventory, Mitigation Actions and Effects, Information of Hong Kong Special Administrative Region (hereinafter referred to as "HKSAR") on Climate Change, and Information of Macao Special Administrative Region (hereinafter referred to as "MSAR") on Climate Change. With regard to finance, technology and capacity-building support received and needed, please refer to The People’s Republic of China First Biennial Transparency Report on Climate Change (hereinafter referred to as "1BTR"), and the relevant content will not be repeated in this report.

The preparation of this report was led by the Ministry of Ecology and Environment (MEE) and jointly complied by relevant departments. The information of HKSAR and MSAR on climate change in this report was provided by Environmental Protection Department (EPD) of the HKSAR Government and Macao Meteorological and Geophysical Bureau (DSMG) of the MSAR Government, respectively. After being approved by the State Council, the report, along with 1BTR, was officially submitted to the UNFCCC Secretariat. China will, as always, join hands with all parties to address climate change and make concerted efforts to protect the common home of mankind.

Contents

Part I National GHG Inventory

The National GHG Inventory 2020 (NGI2020) includes emissions and removals of carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6) from five categories: Energy, Industrial Processes and Product Use (IPPU), Agriculture, Land Use, Land-Use Change and Forestry (LULUCF), and Waste. According to the implementation rules of the Paris Agreement, starting from 2024, the National GHG Inventories submitted by Parties should be prepared with reference to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories (hereinafter referred to as the "2006 IPCC Guidelines") and the 2013 Supplement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories: Wetlands (hereinafter referred to as the "2013 IPCC Wetlands Supplement"), and reported using the 100-year time-horizon GWP values from the IPCC Fifth Assessment Report (AR5). [1] Therefore, the NGI2020 was prepared in accordance with the above requirements. The activity data were mainly sourced from official statistics, and the emission factors were primarily based on country-specific parameters.

Chapter 1 Scope and Methods

1.1 Key Category Analysis

In accordance with the 2006 IPCC Guidelines, Approach 1 was used to identify NGI2020 key categories. The results showed that NGI2020 included 76 key categories, including: Energy-related sources, such as public electricity and heat production, iron and steel, non-metallic minerals and road transportation; IPPU-related sources, including CO_2 emissions from cement production, and N_2O emissions from adipic acid production; Agriculture-related sources, including CH_4 emissions from enteric fermentation, manure management and rice cultivation, and N_2O emissions from agricultural soils; Waste-related sources, including CH_4 emissions from solid waste disposal,wastewater treatment and dischage; LULUCF-related sources and sinks, such as forest land remainingforest land, land converted to forest land, and cropland remaining cropland. Emissions from these key categories were calculated with higher-tier methods and country-specific emission factors for NGI2020. The methodologies for NGI2020 are shown in Table 1-1.

[1] IPCC: Intergovernmental Panel on Climate Change

Table 1-1 Methodologies Used for NGI2020

Source/Sink Categories	CO_2		CH_4		N_2O	
	Methodology	Emission Factors	Methodology	Emission Factors	Methodology	Emission Factors
1.A.1 Energy industries	T1, T2	D, CS	T1, T2	D, CS	T1, T2	D, CS
1.A.2 Manufacturing industries and construction	T1, T2	D, CS	T1	D	T1	D
1.A.3 Transport	T1, T2, T3	D, CS	T1, T3	D, CS	T1, T3	D, CS
1.A.4 Other sectors	T1, T2	D, CS	T1	D	T1	D
1.B.1 Solid fuels			T1, T2, T3	D, CS		
1.B.2 Oil and natural gas system			T1, T3	D, CS		
2.A Mineral industry	T1, T2	D, CS				
2.B Chemical industry	T1, T2	D, CS			T1, T2	D, CS
2.C Metal industry	T1, T2	D, CS	T1	D	NO	NO
2.D Non-energy products from fuels and solvent use	T1	D				
3.A Enteric fermentation			T1, T2	D, CS		
3.B Manure management			T1, T2	D, CS	T1, T2	D, CS
3.C Rice cultivation			T2, T3	CS		
3.D Agricultural soils					T1, T2	D, CS
3.F Field burning of agricultural residues			T1	D	T1	D
4.A Forest land	T2	CS	T1	D	T1	D
4.B Cropland	T3	CS				
4.C Grassland	T2	CS	T1	D	T1	D
4.D Wetlands	T2	CS	T2	CS	NE	NE
4.E Settlements	T2	CS				
4.F Other land	T2	CS				
4.G Harvested wood products	T2	CS				
4.H Other biomass	T2	CS				
5.A Soil waste disposal			T2	D, CS		
5.B Biological treatment of solid waste			T1	D	T1	D
5.C Incineration of waste	T2	CS	T1, T2	D, CS	T1, T2	D, CS
5.D Wastewater treatment and discharge			T2	CS	T1	D
1.D.1.a International aviation	T3	CS	T3	CS	T3	CS
1.D.1.b International navigation	T1	D	T1	D	T1	D
1.D.3 CO_2 emissions from biomass	T1	D				

Table 1-1 continued

Source/Sink Categories	HFCs		PFCs		SF_6	
	Methodology	Emission Factors	Methodology	Emission Factors	Methodology	Emission Factors
2.A Mineral industry						
2.B Chemical industry	T1,T2	D,CS	T1	D	T1	D
2.C Metal industry			T2	CS	NO	NO
2.D Non-energy products from fuels and solvent use						
2.E Electronics industry			T2	CS		
2.F Product uses as substitutes for ozone depleting substances	T1,T2	D,CS				
2.G Other product manufacture and use					T2	CS

Notes: 1). The methodological codes T1, T2 and T3 represent Tier 1, Tier 2 and Tier 3 methods respectively.

2). The emission factor code CS represents the country-specific emission factor in China, D represents the default IPCC emission factor.

3). Shaded cells do not require entries.

4). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

5). "NO" (not occurring) indicates that a particular source or sink category do not occur.

6). When listed together, it means that subcategories within this category use different Tier methods or emission factor data sources.

1.2 Energy

The NGI2020 on Energy covers fuel combustion and fugitive emissions. Fuel combustion sources include CO_2, CH_4, and N_2O emissions from energy industries, manufacturing industries and construction, transport, and other sectors. Other sectors can be further segmented into commercial/institutional, residential, and Agriculture/forestry/fishing. Fugitive emissions cover CH_4 emissions from solid fuels, oil and natural gas system. CO_2 emissions from fuel combustion were calculated by the Sectoral Approach and verified with the Reference Approach. Tier 2 method was used for CH_4 and N_2O emissions from power generation and heating, and Tier 1 method was used for CH_4 and N_2O emissions from other stationary sources. With regard to mobile sources, Tier 2 method was used for CO_2 emissions from road transportation, and COPERT model was used for CH_4 and N_2O emissions; Tier 3 method was used for GHG emissions from domestic aviation, and Tier 1 method was used for railways, domestic navigation and pipeline transportation. With regard to other fuels, Tier 2 method was used for CH_4 emissions from residential biomass combustion, and fossil-derived GHG emissions from MSW incineration, while Tier 1 method was used for other components. Tier 2 method was used for CH_4 emissions from underground mines, CH_4 emissions from post-mining activities in underground mines, Tier 1 method was used for fugitive emissions from surface mines, and Tier 3 method was used for CH_4 emissions from abandoned underground mines. Tier 1 and Tier 3 methods were used for fugitive CH_4 emissions from oil and natural gas system.

1.3 Industrial Processes and Product Use (IPPU)

The NGI2020 on IPPU covers the GHG emissions from mineral industry, chemical industry, metal industry, non-energy products from fuels and solvent use, electronics industry, product uses as substitutes for ozone depleting substances (ODS), and other product manufacture and use. With reference to the 2006 IPCC Guidelines, the carbon mass balance method was used for methanol, iron and steel production, and the emission factor method was mainly used for other emission sources. With regard to the selection of specific methodological tiers and emission factors, Tier 2 method was used for emissions from cement, lime, ammonia, nitric acid, adipic acid, calcium carbide, petrochemicals and carbon black, and HFCs as by-products in fluorochemical production, as well as emissions from iron and steel production, aluminum production, semiconductor manufacturing, refrigeration and air conditioning, and SF_6 use in electrical equipment. Tier 1 method was used for other emission sources, as detailed in Table 1-1.

1.4 Agriculture

The NGI2020 on Agriculture covers CH_4 emissions from enteric fermentation, CH_4 and N_2O emissions from manure management, CH_4 emissions from rice cultivation, N_2O emissions from agricultural soils, and CH_4 and N_2O emissions from field burning of agricultural residues. CH_4 emissions from enteric fermentation were calculated using Tier 2 method of the 2006 IPCC Guidelines for major sources such as beef cattle, dairy cattle, buffalo, sheep and goats, and Tier 1 method for other sources. CH_4 and N_2O emissions from manure management were calculated using Tier 2 method of the 2006 IPCC Guidelines for major sources such as swine, beef cattle, dairy cattle, poultry, buffalo, sheep and goats, and Tier 1 method for other sources. With regard to CH_4 emissions from rice cultivation, the CH_4MOD model (Tier 3) was used for single cropping rice, early rice and late rice of double cropping rice in rice growing season, and empirical models (Tier 2) were used for winter-flooding paddy fields in non-rice growing season. N_2O emissions from agricultural soils were calculated using the IAP-N model. Based on the Chinese crop farming system, direct and indirect N_2O emissions from different types of agricultural soils were calculated, of which direct N_2O emissions were calculated using Tier 2 method, and indirect N_2O emissions were calculated using a combination of Tier 1 and Tier 2 methods. Direct and indirect N_2O emissions from soils mineralization and grazing animals, and CH_4 and N_2O emissions from field burning of agricultural residues were calculated using Tier 1 method, as shown in Table 1-1.

1.5 Land Use, Land-Use Change and Forestry (LULUCF)

The NGI2020 on LULUCF covers GHG emissions and removals from 6 land-use types including forest land, cropland, grassland, wetlands, settlements, and other land. For each type of unchanged land by category and land converted to other land-use categories, carbon stock changes based on the estimation of 6 carbon pools: above-ground biomass, below-ground biomass, litter, dead wood, soil organic matter and harvested wood products, as well as carbon stock changes in other biomass, and GHG emissions and removals resulting from fires, were calculated separately on a case-by-case basis. Tier 3 method was used for the

calculation of the changes of carbon stock of soil organic carbon. The changes of carbon stock of harvested wood products were estimated by the Tier 2 method "Production Accounting Approach." The "Stock Change Approach" and Tier 2 method were used to estimate changes of carbon stock of above-ground biomass, below-ground biomass, litter, dead wood and soil organic matter on other types of land. Wetland CH_4 emissions were estimated by Tier 2 method. Emissions from forest and grassland fires were calculated by Tier 1 method.

1.6 Waste

The NGI2020 on Waste covers CH_4 emissions from landfill, CH_4 and N_2O emissions from biological treatment of solid waste, CO_2, CH_4 and N_2O emissions from incineration of waste, and CH_4 and N_2O emissions from wastewater treatment and discharge. Incineration was reported only for CO_2, CH_4 and N_2O emissions from the incineration of hazardous and medical waste under Waste, as well as CH_4 and N_2O emissions from the incineration of sludge; CH_4 and N_2O emissions from MSW incineration, and fossil CO_2 emissions were reported under Energy, and biogenic CO_2 emissions were reported as memo items. Tier 1 and Tier 2 methods were used for Waste. CH_4 emissions from landfill were calculated using the first order decay (FOD) method, and other emission sources were calculated using the emission factor method, as shown in Table 1-1.

Chapter 2 Data Sources

2.1 Energy

The activity data on fossil fuel combustion in NGI2020 were mainly from the National Bureau of Statistics (NBS) and other relevant departments. In 2020, consumption of coal, oil and natural gas were 2,835 Mtce, 937 Mtce and 419 Mtce, as shown in Table 1-2.

Table 1-2 Major Activity Data on Energy in 2020

	Activity Data		**Activity Data**
Coal consumption (Mtce)	2,835	Coal production (Mt)	3,902
Oil consumption (Mtce)	937	Natural gas production (Bcm)	199.49
Natural gas consumption (Mtce)	419	Crude oil production (Mt)	195

The activity data of fugitive emissions from solid fuels were mainly from the China Energy Statistical Yearbook 2021 and the Research Report on the Development of Global Coal Industry 2022. The activity data of fugitive emissions from oil and natural gas system were mainly sourced from NBS, General Administration of Customs of the People's Republic of China (GACC) and major oil and gas groups in China.

The carbon content per unit calorific value and carbon oxidation rate of coal combustion in the electricity sector were based on the measured data of power companies in the national carbon market. The carbon content per unit calorific value of natural gas and liquefied natural gas was based on measured data on major oil and gas fields and imported natural gas in China. The nationally averaged CH_4 emission factors for underground mines and post-mining activities were based on the national coal mine gas classification identification information

while other emission factors were the same as those in the NGI2018 or the default emission factors in the 2006 IPCC Guidelines.

2.2 Industrial Processes and Product Use (IPPU)

The data on production of ammonia, methanol, ethylene, calcium carbide, iron and steel, ferroalloys, aluminium and magnesium in 2020 were mainly from the China Industry Statistical Yearbook. The data on production of cement clinker and lime was from China Building Materials Federation (CBMF); lead and zinc from China Nonferrous Metals Industry Association (CNIA); nitric acid and titanium dioxide from affiliated units of China Petroleum and Chemical Industry Federation (CPCIF); and soda ash and adipic acid mainly from enterprise statistics, etc. Major activity data on IPPU are detailed in Table 1-3. The emission factors of cement clinker, ammonia, adipic acid, calcium carbide, methanol, ethylene, iron and steel production, and HFCs as by-products in fluorochemical production were country-specific data obtained through typical enterprise surveys. The emission factors for aluminium, magnesium and lead production are the same as those in the NGI2018, other sources used the default emission factors from the 2006 IPCC Guidelines.

Table 1-3 Major Activity Data on IPPU in 2020

	Activity Data		Activity Data
Cement clinker production (Mt)	1,580	Methanol production (Mt)	55
Pig iron production (Mt)	888.976	Aluminium production (Mt)	37.08
Ammonia production (Mt)	51.171	HCFC-22 production (Mt)	0.689

2.3 Agriculture

Activity data of Agriculture in 2020 were mainly from the China Statistical Yearbook 2021, the China Rural Statistical Yearbook 2021, the China Animal Husbandry and Veterinary Science Yearbook 2021, the Second National Pollutant Census, China Animal Husbandry Industry Statistics, and research data from the Rural Energy and Environment Agency, Ministry of Agriculture and Rural Affairs (MARA), etc. The main activity data of Agriculture are shown in Table 1-4. Country-specific CH_4 emission factors were used for enteric fermentation by dairy cattle, beef cattle, buffalo, sheep and goats, and for manure management of swine, beef cattle, dairy cattle, goats and sheep. The CH_4 emission factors were estimated using models for single cropping rice, early rice and late rice of double cropping rice in rice growing season, and for winter-flooding paddy fields in non-rice growing season. The direct N_2O emission factors for 10 types of agricultural soils, including drylands, paddy fields with different crop rotations, vegetable fields, orchards and tea gardens, etc., were obtained from field observation data and datasets developed by the National Key Research Project. Other emission factors were the default emission factors of the 2006 IPCC Guidelines.

Table 1-4 Major Activity Data on Agriculture in 2020

	Activity Data		Activity Data
Cattle in stock(M)	95.621	Harvest area with grain crops (Mha)	116.768
Swine in stock(M)	406.505	Harvest area with rice (Mha)	30.075

Poultry in stock(M)	6784.286	Nitrogen fertilizer consumption (Mt nitrogen)	18.339
Sheep in stock(M)	173.095	Compound fertilizer net consumption (Mt)	22.210
Total harvest area of crops (Mha)	167.487		

2.4 Land Use, Land-Use Change and Forestry (LULUCF)

The NGI2020 on LULUCF used data from previous continuous forest resources inventories, the 2021 nationwide comprehensive ecology monitoring of forest and grassland， and first, second and third national territorial spatial surveys. For provinces (autonomous regions, municipalities directly under the central government), interpolation or aggregation methods according to the actual year of inventories were used to calculate national activity data in 2020, as shown in Table 1-5. The emission factors of forest land inventory and agricultural soil carbon adopted the country-specific data in the current year.

Table 1-5 Major Activity Data on LULUCF in 2020 (Mha)

Land Type	Area	Land Type	Area
Forest Land	303.5287	Wetlands	54.0261
Cropland	127.1189	Settlements	43.7785
Grassland	263.1230		

Note: Original activity data for land use was sourced from the Ministry of Natural Resources (MNR), and reclassified according to the IPCC land use categories.

2.5 Waste

Activity data on Waste in 2020 were from the China Urban Construction Statistical Yearbook 2020 and the China Environment Statistical Yearbook 2021. Main activity data of Waste is shown in Table 1-6. Part of the emission factors of landfill, incineration and wastewater treatment and discharge were based on country-specific data, other emission factors and relevant parameters were referred to the default emission factors of the 2006 IPCC Guidelines.

Table 1-6 Major Activity Data on Waste in 2020 (Mt)

	Activity Data
MSW landfill	77.715
MSW incineration	146.076
MSW biological treatment	10.732
Wastewater chemical oxygen demand (COD) discharge	9.686

Chapter 3 National GHG Inventory 2020

3.1 Overview

In 2020, China's total GHG emissions (with LULUCF) were approximately 12,463 $MtCO_2eq$ (Table 1-7), of which CO_2, CH_4, N_2O, HFCs, PFCs and SF_6 accounted for 79.1%, 13.6%, 4.2%, 2.2%, 0.2% and 0.7% respectively (Emissions and removals of GHGs by category are detailed in Table1-8). The GHG removals from LULUCF were 1,303 $MtCO_2eq$, and total GHG emissions were 13,766 $MtCO_2eq$ without LULUCF. The 100-year time-horizon GWP values were from IPCC AR5 (Table 1-9). GHG emissions and removals in 2020 are detailed in Table 1-10 and Table 1-11.

Table 1-7 China's Total GHG Emissions in 2020 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	9,661	782	117				10,560
IPPU	1,532	0	130	273	22	93	2,049
Agriculture		664	251				915
LULUCF	-1,343	39	0				-1,303
Waste	9	207	27				242
Total (without LULUCF)	11,202	1,653	524	273	22	93	13,766
Total (with LULUCF)	9,859	1,692	524	273	22	93	12,463

Notes: 1). Shaded cells do not require entries;
2). 0 indicates that the value is less than 0.5.
3). Due to rounding, the aggregation of various items may be slightly different from the total.

Table 1-8 China's GHG Emissions by Gas in 2020

GHGs	With LULUCF		Without LULUCF	
	Emissions($MtCO_2eq$)	Proportion (%)	Emissions($MtCO_2eq$)	Proportion (%)
CO_2	9,859	79.1	11,202	81.4
CH_4	1,692	13.6	1,653	12.0
N_2O	524	4.2	524	3.8
Fluorinated gases (F-gases)	387	3.1	387	2.8
Total	12,463	100.0	13,766	100.0

Table 1-9 GWP Values Used in the Inventory

GHG	GWPs	GHG	GWPs
CO_2	1	**HFC-152a**	138
CH_4	28	**HFC-227ea**	3350
N_2O	265	**HFC-236ea**	1330
HFC-23(CHF_3)	12400	**HFC-236fa**	8060
HFC-32	677	**HFC-245fa**	858
HFC-41	116	**HFC-365mfc**	804
HFC-125	3170	**PFC-14(CF_4)**	6630
HFC-134a	1300	**PFC-116(C_2F_6)**	11100
HFC-143a	4800	**SF_6**	23500

Note: HFCs include HFC-23, HFC-32, HFC-41, HFC-125, HFC-134a, HFC-143a, HFC-152a, HFC-227ea, HFC-236ea, HFC-236fa, HFC-245fa, HFC- 365mfc; PFCs includes CF4 and C2F6.

Energy is the major source of GHG emissions in China. In 2020, Energy accounted for 76.7% of the national total GHG emissions (without LULUCF), while IPPU, Agriculture and Waste accounted for 14.9%, 6.6% and 1.8% respectively, as shown in Figure 1-1.

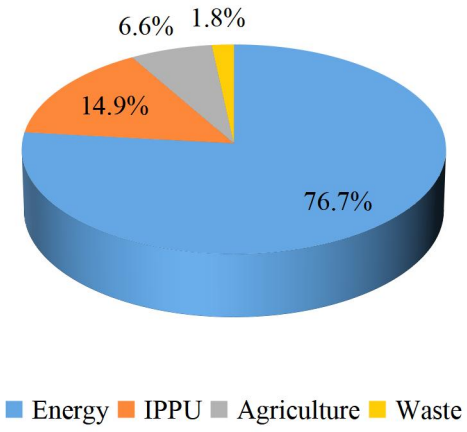

Figure 1-1 China's GHG Emissions by Category in 2020 (without LULUCF)

3.1.1 Carbon Dioxide (CO_2)

In 2020, China's CO_2 emissions (with LULUCF) were 9,859 Mt. Without LULUCF , China's CO_2 emissions in 2020 were 11,202 Mt, of which 9,661 Mt were from Energy, accounting for 86.2%; 1,532 Mt from IPPU, accounting for 13.7%; and 9 Mt from Waste, accounting for 0.1%, as shown in Table 1-7. LULUCF, as sinks, removed 1,343 Mt CO_2. In addition, in 2020, international aviation emitted 22.069 Mt CO_2, international navigation emitted 35.868 Mt CO_2, biomass combustion emitted 292 Mt CO_2, which were all reported as memo items and not counted in the total emissions, as shown in Table 1-10.

3.1.2 Methane (CH_4)

In 2020, China's CH_4 emissions (with LULUCF) were 60.426 Mt, of which 27.922 Mt were from Energy, accounting for 46.2%; 5 kt were from IPPU, accounting for less than 0.05%; 23.720 Mt were from Agriculture, accounting for 39.3%; 1.398 Mt were from LULUCF, accounting for 2.3%; 7.380 Mt were from Waste, accounting for 12.2%.

3.1.3 Nitrous Oxide (N_2O)

In 2020, China's N_2O emissions (with LULUCF) were 1.979 Mt, of which 0.442 Mt were from Energy, accounting for 22.3%; 0.489 Mt were from IPPU, accounting for 24.7%; 0.946 Mt were from Agriculture, accounting for 47.8%; 31 t were from LULUCF; 0.103 Mt were from Waste, accounting for 5.2%.

3.1.4 F-gases

China's F-gas emissions amounted to 387 $MtCO_2eq$, all of which were sourced from IPPU. To be specific,chemical industry emitted 17 $MtCO_2eq$, accounting for 4.3%; metal industry emitted 21 $MtCO_2eq$, accounting for 5.4%; electronics industry emitted 1 $MtCO_2eq$, accounting for 0.2%; product uses as substitutes for ODS emitted 258 $MtCO_2eq$, accounting

for 66.7%; and other product manufacture and use emitted 91 $MtCO_2eq$, accounting for 23.4%. F-gas emissions are detailed in Table 1-11.

3.2 Energy

In 2020, China's GHG emissions from Energy were 10,560 $MtCO_2eq$. To be specific, emissions from fuel combustion were 9,818 $MtCO_2eq$, accounting for 93.0%; fugitive emissions were 742 $MtCO_2eq$, accounting for 7.0%.

To be specific, CO_2 emissions were 9,661 Mt, all of which were from fuel combustion. CH_4 emissions were 27.922 Mt, of which 5.1% were from fuel combustion, and 94.9% were from fugitive emissions; and N_2O emissions were 0.442 Mt, all from fuel combustion. The Inventory team also adopted the Reference Approach to estimate the CO_2 emissions from fossil fuel combustion; the variance between the results of Sectoral and Reference approaches was 2.5%. The variances exist for two reasons: first, energy transportation losses, coal washing and screening losses, "balance differences", and changes in energy inventory in end-use sectors lead to discrepancies between the apparent energy consumption in the reference approach and the final combustion amount in the sectoral approach; second, regarding emission factors, in case of oil products, the reference approach mainly calculates crude oil, while the sectoral approach mainly calculates refined oil products consumed by end-use sectors, and there are certain differences in carbon content per unit calorific value between crude oil and various refined oil products.

Table 1-10 China's CO_2, CH_4 and N_2O Emissions in 2020 (Mt)

GHG Source/Sink Categories	CO_2	CH_4	N_2O
Total (without LULUCF)	11,201.668	59.028	1.979
Total (with LULUCF)	9,859.040	60.426	1.979
1. Energy	9,660.879	27.922	0.442
1.A Fuel combustion activities	9,660.879	1.429	0.442
1.A.1 Energy industries	4,780.030	0.129	0.326
1.A.2 Manufacturing industries and construction	3,322.931	0.298	0.080
1.A.3 Transport	910.499	0.140	0.022
1.A.4 Other sectors	647.419	0.861	0.014
1.B Fugitive emissions from fuels		26.493	
1.B.1 Solid fuels		24.863	
1.B.2 Oil and natural gas system		1.630	
2. IPPU	1,532.118	0.005	0.489
2.A Mineral industry	1,034.947		
2.B Chemical industry	315.761		0.489
2.C Metal industry	178.933	0.005	NO
2.D Non-energy products from fuels and solvent use	2.477		
2.E Electronics industry			
2.F Product uses as substitutes for ODS			

GHG Source/Sink Categories	CO_2	CH_4	N_2O
2.G Other product manufacture and use			
3. Agriculture		23.720	0.946
3.A Enteric fermentation		11.242	
3.B Manure management		3.447	0.222
3.C Rice cultivation		8.849	
3.D Agricultural soils			0.719
3.F Field burning of agricultural residues		0.182	0.005
4. LULUCF	-1,342.629	1.398	0.000
4.A Forest land	-895.592	0.000	0.000
4.B Cropland	-98.018		
4.C Grassland	-72.707	0.000	0.000
4.D Wetlands	-29.788	1.398	NE
4.E Settlements	-2.396		
4.F Other land	2.641		
4.G Harvested wood products	-103.863		
4.H Other biomass	-142.906		
5. Waste	8.671	7.380	0.103
5.A Solid waste disposal		5.055	
5.B Biological treatment of solid waste		0.043	0.003
5.C Incineration of waste	8.671	0.002	0.011
5.D Wastewater treatment and discharge		2.280	0.088
1.D Memo items			
1.D.1.a International aviation	22.069	0.000	0.001
1.D.1.b International navigation	35.868	0.003	0.001
1.D.3 CO_2 emissions from biomass	292.306		

Notes: 1). Shaded cells do not require entries;

2). 0.000 indicates that the value is less than 0.0005.

3). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). Due to rounding, the aggregation of various items may be slightly different from the total.

6). Memo items are not counted in the total emissions.

3.3 Industrial Processes and Product Use (IPPU)

In 2020, China's total GHG emissions from IPPU were 2,049 MtCO_2eq, of which 1,035 Mt were from mineral industry, accounting for 50.5%; 462 Mt from chemical industry, accounting for 22.5%; 200 Mt from metal industry, accounting for 9.8%; 2 Mt from non-energy products from fuels and solvent use, accounting for 0.1%; 1 Mt from electronics industry, accounting for less than 0.05%; 258 Mt from product uses as substitutes for ODS, accounting for 12.6%; and 91 Mt from other product manufacture and use, accounting for 4.4%.

To be specific, CO_2 emissions were 1,532 Mt, of which 67.6% were from mineral industry, 20.6% from chemical industry, 11.7% from metal industry, and 0.2% from non-energy products from fuels and solvent use; CH_4 emissions were 5 kt, all from metal industry; N_2O emissions were 489 kt, all from chemical industry; HFCs emissions were 273 $MtCO_2eq$, of which 5.2% were from chemical industry, and 94.8% from product uses as substitutes for ODS; PFCs emissions were 22 $MtCO_2eq$, of which 96.4% were from metal industry, 3.0% from electronics industry, and 0.6% from chemical industry; SF_6 emissions were 93 $MtCO_2eq$, of which 97.5% were from other product manufacture and use, and 2.5% from chemical industry.

Table 1-11 China's F-gas Emissions in 2020 (kt)

Source/Sink Categories	HFCs												PFCs		SF_6
	HFC-23	HFC-32	HFC-41	HFC-125	HFC-134a	HFC-143a	HFC-152a	HFC-227ea	HFC-236ea	HFC-236fa	HFC-245fa	HFC-365mfc	CF_4	C_2F_6	
Total emissions	0.7	55.5	0.0	45.3	50.3	1.2	2.1	2.9	0.0	0.1	0.8	0.0	2.7	0.3	4.0
Energy															
IPPU	0.7	55.5	0.0	45.3	50.3	1.2	2.1	2.9	0.0	0.1	0.8	0.0	2.7	0.3	4.0
- Mineral Industry															
- Chemical Industry	0.7	1.1	0.0	0.7	1.0	0.2	0.2	0.2	0.0	0.0	0.1	NO	0.0	0.0	0.1
- Metal Industry													2.6	0.3	NO
—Non-energy Products from Fuels and Solvent Use															
- Electronics Industry													0.1	0.0	
- Product Uses as Substitutes for ODS	0.0	54.4	0.0	44.6	49.4	1.1	1.9	2.8	NO	0.1	0.7	0.0			
- Other Product Manufacture and Use															3.9
3. Agriculture															
4. LULUCF															
5. Waste															

Notes: 1). Shaded cells do not require entries;
2). 0.0 indicates that the value is less than 0.05.
3). "NO" (not occurring) indicates that a particular source or sink category do not occur.
4). Due to rounding, the aggregation of various items may be slightly different from the total.

3.4 Agriculture

In 2020, China's total GHG emissions from Agriculture were 915 $MtCO_2eq$, of which the emissions from enteric fermentation were 315 $MtCO_2eq$, accounting for 34.4%; the emissions from manure management were 155 $MtCO_2eq$, accounting for 17.0%; the emissions from rice cultivation were 248 $MtCO_2eq$, accounting for 27.1%; the emissions from agricultural soils were 191 $MtCO_2eq$, accounting for 20.8%; and the emissions from field burning of agricultural residues were 6 $MtCO_2eq$, accounting for 0.7%.

To be specific, CH_4 emissions were 23.720 Mt, of which 47.4% were from enteric fermentation, 14.5% from manure management, 37.3% from rice cultivation, and 0.8% from field burning of agricultural residues. N_2O emissions were 0.946 Mt, of which manure management accounted for 23.5%, agricultural soils for 76.0%, and field burning of agricultural residues for 0.5%.

3.5 Land Use, Land-Use Change and Forestry (LULUCF)

In 2020, China's LULUCF removed absorbed 1,343 $MtCO_2$, and emitted 1.398 $MtCH_4$ and 31 tN_2O, resulting in a net removals of 1,303 $MtCO_2eq$. Forest land, cropland, grassland, settlements, harvested wood products and other biomass removed absorbed 896 $MtCO_2eq$, 98 $MtCO_2eq$, 73 $MtCO_2eq$, 2 $MtCO_2eq$, 104 $MtCO_2eq$ and 143 $MtCO_2eq$, respectively. Wetlands and other land emitted 9 $MtCO_2eq$ and 3 $MtCO_2eq$, respectively.

3.6 Waste

In 2020, the total GHG emissions from Waste were 242 $MtCO_2eq$, of which 142 $MtCO_2eq$ were from MSW landfill, accounting for 58.4%; 87 $MtCO_2eq$ were from wastewater treatment, accounting for 36.0%; 12 $MtCO_2eq$ were from incineration, accounting for 4.8%; and 2 $MtCO_2eq$ were from biological treatment, accounting for 0.8%. Besides, MSW incineration emitted 30 $MtCO_2eq$, which were reported under the Energy.

To be specific, CO_2 emissions were 8.671 Mt, accounting for 3.6%, all from incineration; CH_4 emissions were 7.38 Mt, accounting for 85.2%, of which 68.5% were from landfill, 30.9% from wastewater treatment, 0.6% from biological treatment of solid waste, and less than 0.05% from incineration of sludge; N_2O emissions were 0.103 Mt, accounting for 11.2%, of which 85.9% were from wastewater treatment and discharge, 11.0% from incineration, and 3.1% from biological treatment of solid waste.

Chapter 4 Quality Assurance and Quality Control

4.1 Efforts to Reduce Uncertainties

In preparing NGI2020 and recalculating NGI2005, NGI2010, NGI2012, NGI2014, NGI2017 and NGI2018, to improve the quality of inventory compilation and reduce uncertainties, the inventory team paid much attention to quality assurance and quality control.

In terms of methods, the inventory team carried out key category analysis, the results of which were used to help choose the methods adopted in the compilation of NGI2020. Key categories of the national GHG inventory were estimated using as many higher-tier methods and country-specific emission factors as possible, thus improving the accuracy of the inventory.

Regarding the activity data, NBS established a statistical reporting system for addressing climate change, which increased the types of energy statistics in a detailed way to gradually incorporate the activity data required by the compilation of GHG Inventory into the government statistical system. The inventory team also conducted verification using facility-level data from China's national carbon market.

In terms of emission factors, the inventory team and other relevant departments conducted research on carbon content per unit calorific value and carbon oxidation rate of coal combustion in coal-firing power plants, and typical surveys on animal production characteristics and manure management by main livestock and poultry and corresponding percentage to obtain country-specific emission factors and related domestic parameters. In preparing NGI2020, the inventory team gave first priority to country-specific emission factors.

Regarding inventory management, China emphasized the management of data files. Materials supporting the inventory compilation were archived in a timely manner. Meanwhile, to improve the electronic management of inventory-related data, China has established a database system for categories of the national GHG inventories.

During the compilation of inventory, China organized a number of technical seminars for academic exchanges and discussions with other domestic research institutions and experts to fully learn from their research results. In addition, the leading department invited experts who were not involved in the compilation of the inventory to carry out independent analysis and review of the inventory methods and results as a strong support to the assurance of the inventory result quality.

4.2 Uncertainty Analysis

Based on the uncertainty analysis of activity data and emission factors of Energy, IPPU, Agriculture, LULUCF, and Waste, the overall uncertainties were calculated according to the error propagation approach in the 2006 IPCC Guidelines, the overall uncertainty of the NGI2020 was from -4.1% to 4.4%, as shown in Table 1-12.

Table 1-12 Results of Uncertainty Analysis of NGI2020

	Emission/Sink ($MtCO_2eq$)	Uncertainties (%)
Energy	10,560	-5.4~5.7
IPPU	2,049	-3.8~3.8
Agriculture	915	-13.6~20.2
LULUCF	-1,303	-12.5~12.5
Waste	242	-28.2~28.2
Overall uncertainty	-4.1~4.4	

Chapter 5 Recalculation of Previous National GHG Inventories

China has submitted its national GHG inventories for the years 1994, 2005, 2010, 2012, 2014, 2017 and 2018 in its four previous NCs and three previous BURs. In order to ensure the comparability of inventories, necessary recalculations has been made to previous national GHG inventories other than NGI1994. It should be noted that due to the availability of underlying data, China has not yet recalculated the NGI1994, and its emission sources covered, calculation methods and GWPs adopted are not entirely consistent with those of the NGI2020.

5.1 Improvements in the Updates to Previous National GHG Inventories

In response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data, the current inventory has recalculated previous national GHG inventories using the same methods of NGI2020[2].

Newly added sources include CH_4 emissions from post-mining activities of surface mines, direct and indirect N_2O emissions from soils mineralization, and indirect N_2O emissions from N volatilization and re-deposition from animal manure.

In terms of calculation methods, the methodology for aviation was upgraded to Tier 3, and the methodology for the exploration was updated to further refine the distinction between oil and gas wells.

Activity data on production processes such as lime, ammonia, methanol, ethylene, titanium dioxide, aluminium, lead and zinc smelting were refined according to the availability of activity data sources. Data on animal feeding was adjusted based on revised data from the Third Agricultural Census. Activity data on area of managed grasslands, COD and BOD of domestic wastewater and industrial wastewater were updated.

In terms of emission factors, the N content of the crop residues and the straw/grain ratios were updated with the data from the A Chronicle of Organic Fertilizer Nutrients in China and the national survey of crop residues conducted by the MARA. The crop residues returning rates were also updated. For Waste, the degradable organic carbon content of wastes was updated through machine learning analysis and literature review, which improved the accuracy of solid waste disposal data.

[2] The methods for NGI 2005, 2017, and 2018 are not entirely consistent with NGI 2010, 2012, and 2014. For improvements to the NGI 2010, 2012, and 2014, further reference can be made to the 3BUR.

As for the reporting format, in accordance with the implementing rules of the Paris Agreement, Parties should use the 100-year time-horizon GWP values from IPCC AR5. Consequently, the GWPs of the various GHGs were updated from those in IPCC AR2 to those in IPCC AR5.

5.2 National GHG Inventory 1994

In 1994, China's total GHG emissions (with LUCF) were about 3,650 $MtCO_2eq$ (Table 1-13), of which CO_2, CH_4 and N_2O accounted for 73.1%, 19.7%, and 7.2% respectively; the net removal of GHGs in LUCF was about 407 $MtCO_2eq$. Without LUCF, China's total GHG emissions in 1994, were around 4,057 $MtCO_2eq$, of which CO_2, CH_4 and N_2O accounted for 75.8%, 17.7% and 6.5% respectively.

Table 1-13 China's Total GHG Emissions in 1994 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	2,795	197	15				3,008
Industrial Processes	278	NE	5	NE	NE	NE	283
Agriculture		361	244				605
LUCF	-407	NE	NE				-407
Waste	NE	162	NE				162
Total (without LUCF)	3,073	720	264	NE	NE	NE	4,057
Total (with LUCF)	2,666	720	264	NE	NE	NE	3,650

Notes: 1). Shaded cells do not require entries;

2). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

5.3 National GHG Inventory 2005

In 2005, China's total GHG emissions (with LULUCF) were about 7,644 $MtCO_2eq$ (Table 1-14), of which CO_2, CH_4, N_2O and F-gases accounted for 75.9%, 17.4%, 5.0% and 1.7% respectively. GHG removals from LULUCF were 711 $MtCO_2eq$. Without LULUCF, China's total GHG emissions in 2005 were around 8,355 $MtCO_2eq$, of which CO_2, CH_4, N_2O and F-gases accounted for 78.2%, 15.7%, 4.6% and 1.5% respectively.

Table 1-14 China's Total GHG Emissions in 2005 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	5,784	622	69				6,475
IPPU	749	0	29	117	5	7	906
Agriculture		598	260				859
LULUCF	-729	18	0				-711
Waste	1	91	24				116
Total (without LULUCF)	6,533	1,311	382	117	5	7	8,355
Total (with LULUCF)	5,805	1,329	382	117	5	7	7,644

Notes: 1). Shaded cells do not require entries;

2). 0 indicates that the value is less than 0.5.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

5.4 National GHG Inventory 2010

In 2010, China's total GHG emissions (with LULUCF) were about 9,845 $MtCO_2eq$ (Table

1-15), of which CO_2, CH_4, N_2O and F-gases accounted for 78.8%, 15.0%, 4.4% and 1.7% respectively. GHG removals from LULUCF was 857 $MtCO_2eq$. Without LULUCF, China's total GHG emissions in 2010 were around 10,703 $MtCO_2eq$, of which CO_2, CH_4, N_2O and F-gases accounted for 80.8%, 13.6%, 4.0% and 1.6% respectively.

Table 1-15 China's Total GHG Emissions in 2010 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	7,565	727	81				8,372
Industrial Processes	1,079	0	54	133	10	27	1,303
Agriculture		612	274				886
LULUCF	-884	27	0				-857
Waste	2	114	25				141
Total (without LULUCF)	8,646	1,454	433	133	10	27	10,703
Total (with LULUCF)	7,762	1,480	433	133	10	27	9,845

Notes: 1). Shaded cells do not require entries;

2). 0 indicates that the value is less than 0.5.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

5.5 National GHG Inventory 2012

In 2012, China's total GHG emissions (with LULUCF) were about 11,171 $MtCO_2eq$ (Table 1-16), of which CO_2, CH_4, N_2O and F-gases accounted for 79.4%, 14.2%, 4.2% and 2.1% respectively. GHG removals from LULUCF was 972 $MtCO_2eq$. Without LULUCF, China's total GHG emissions in 2012 were around 12,143 $MtCO_2eq$, of which CO_2, CH_4, N_2O and F-gases accounted for 81.2%, 13.0%, 3.9% and 2.0% respectively.

Table 1-16 China's Total GHG Emissions in 2012 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	8,638	816	95				9,550
Industrial Processes	1,219	0	69	187	12	38	1,526
Agriculture		607	280				887
LULUCF	-985	13	0				-972
Waste	2	153	25				180
Total (without LULUCF)	9,860	1,576	470	187	12	38	12,143
Total (with LULUCF)	8,875	1,589	470	187	12	38	11,171

Notes: 1). Shaded cells do not require entries;

2). 0 indicates that the value is less than 0.5.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

5.6 National GHG Inventory 2014

In 2014, China's total GHG emissions (with LULUCF) were about 11,757 $MtCO_2eq$ (Table 1-17), of which CO_2, CH_4, N_2O and F-gases accounted for 79.3%, 14.0%, 4.2% and 2.5% respectively. GHG removals from LULUCF was 1,026 $MtCO_2eq$. Without LULUCF, China's total GHG emissions in 2014 were around 12,783 $MtCO_2eq$, of which CO_2, CH_4, N_2O and F-gases accounted for 81.0%, 12.8%, 3.9% and 2.3% respectively.

Table 1-17 China's Total GHG Emissions in 2014 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	9,002	862	97				9,962
Industrial Processes	1,354	0	86	231	17	46	1,733
Agriculture		612	285				897
LULUCF	-1,036	11	0				-1,026
Waste	2	164	26				192
Total (without LULUCF)	10,358	1,638	494	231	17	46	12,783
Total (with LULUCF)	9,321	1,649	494	231	17	46	11,757

Notes: 1). Shaded cells do not require entries;

2). 0 indicates that the value is less than 0.5.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

5.7 National GHG Inventory 2017

In 2017, China's total GHG emissions (with LULUCF) were about 11,878 $MtCO_2eq$ (Table 1-18), of which CO_2, CH_4, N_2O and F-gases accounted for 79.4%, 14.3%, 4.2% and 2.1% respectively. GHG removals from LULUCF were around 1,158 $MtCO_2eq$. Without LULUCF, China's total GHG emissions in 2017 were around 13,036 $MtCO_2eq$, of which CO_2, CH_4, N_2O and F-gases accounted for 81.5%, 12.7%, 3.9% and 1.9% respectively.

Table 1-18 China's Total GHG Emissions in 2017 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	9,240	796	100				10,136
IPPU	1,381	0	116	163	21	66	1,747
Agriculture		668	262				930
LULUCF	-1,193	35	0				-1,158
Waste	4	195	25				223
Total (without LULUCF)	10,625	1,659	503	163	21	66	13,036
Total (with LULUCF)	9,431	1,694	503	163	21	66	11,878

Notes: 1). Shaded cells do not require entries;

2). 0 indicates that the value is less than 0.5.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

5.8 National GHG Inventory 2018

In 2018, China's total GHG emissions (with LULUCF) were about 12,078 $MtCO_2eq$ (Table 1-19), of which CO_2, CH_4, N_2O and F-gases accounted for 79.4%, 14.0%, 4.2% and 2.5% respectively. GHG removals from LULUCF was 1,187 $MtCO_2eq$. Without LULUCF, China's total GHG emissions in 2018 were around 13,265 $MtCO_2eq$, of which CO_2, CH_4, N_2O and F-gases accounted for 81.5%, 12.5%, 3.8% and 2.2% respectively.

Table 1-19 China's Total GHG Emissions in 2018 ($MtCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	9,407	792	108				10,307
IPPU	1,398	0	117	203	23	72	1,813
Agriculture		657	255				912
LULUCF	-1,224	36	0				-1,187
Waste	5	204	25				233
Total (without LULUCF)	10,810	1,653	505	203	23	72	13,265
Total (with LULUCF)	9,586	1,689	505	203	23	72	12,078

Notes: 1). Shaded cells do not require entries;

2). 0 indicates that the value is less than 0.5.

3). Due to rounding, the aggregation of various items may be slightly different from the total.

Part II Mitigation Actions and Effects

The Chinese government attaches great importance to mitigation policies and actions. A number of top-level design documents such as the *Outline of the 14th Five-Year Plan for National Economic and Social Development and Long-Range Objectives Through the Year 2035 of the People's Republic of China*, the *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy*, and the *Action Plan for Carbon Dioxide Peaking Before 2030*, were released to boost comprehensive green transition of economic and social development. Moreover, a series of policies and actions to mitigate the GHG effects in terms of Energy, Industry, Construction, Transportation, Carbon Sinks and Synergies Actions for Pollution-Carbon Reduction have been introduced. All authorities concerned have formulated Implementation plans and policies in different fields and sector; provinces (autonomous regions and municipalities directly under the central government) have all mapped out plans for peaking carbon emissions in their territory to promote GHG emission reductions. Meanwhile, China has achieved positive progress in terms of Monitoring, Reporting and Verification (hereinafter referred to as "MRV"), which works as the important groundwork for climate change control.

Chapter 1 Key Mitigation Actions, Policies and Effects

Guided by the State's low-carbon development strategies and the "top-level design" philosophy, China has managed to significantly reduce CO_2 emission intensity, effectively controlled non-energy GHG and non-CO_2 GHG emissions, actively increased forest carbon sinks and as a result outperformed its 2020 GHG emission reduction target. Measures adopted in this regard include adjusting industrial structure, optimizing energy structure, promoting energy conservation and higher efficiency, enhancing carbon sink capacity of ecological systems, controlling non-CO_2 GHG emissions and pursuing synergies of pollution-carbon reduction. Based on the results of NGI2020 submitted in this report, in 2020, China's carbon emissions per unit of GDP were reduced by 49.1% compared to that of 2005, over-fulfilled China's pledge to the international community to reduce 40%-45% by 2020. Key mitigation actions and effects are analysed in Table 2-1, and specific descriptions of mitigation actions can be found in the 1BTR.

Chapter 2 Domestic MRV on Mitigation Actions

China has steadily improved its carbon emission statistical accounting and accelerated the development of a monitoring system for GHGs emissions. In terms of system development, efforts have been made to set up a carbon emission statistics and accounting working group, initially developed a multi-level carbon emission statistics and accounting system covering national, local, industry, enterprise, facility, and product levels; formulate an implementation plan for establishing a unified and standardized carbon emission statistical accounting system; regularly prepare national GHG inventories; establish a verification system for carbon

emission accounting reports of enterprises in key industries; develop a national database of GHG emissions factors; and publish annual China Greenhouse Gas Bulletins.

In terms of monitoring, carbon monitoring and assessment pilot projects have been implemented in five key industries including thermal power, steel, oil and natural gas extraction, coal mining, and waste disposal, as well as at city and regional levels. A total of 93 online monitoring devices have been installed across the five pilot industries, along with 63 high-precision and 95 medium-precision urban monitoring stations.

In terms of standards and technical specifications, 12 technical guidelines for GHG EIAs have been issued; 11 national measurement benchmarks, 71 types of standard measurement devices, and 134 types of reference materials related to carbon emissions have been approved; and guidelines for the construction of carbon peaking and carbon neutrality standard systems have been released.

In terms of developing the national carbon market, supporting systems have been established for carbon emission allowance registration, trading, settlement, and verification of corporate GHG emission accounting reports. Specialized teams have been organized to provide supervision and support for the quality of carbon emission reports from power generation enterprises under emission control. A joint regulatory mechanism at national, provincial and municipal levels have been established, to strengthen daily supervision of enterprise emissions. A National Carbon Market Information Platform has been developed. China has implemented online operations across all business functions including carbon emission data reporting, daily supervision, third-party verification, allowance allocation, transaction performance, and analysis & decision-making, achieving unified data management and centralized coordination.

Table 2-1 Overview of Mitigation Actions and Effects

No.	Action	Objectives or Main Contents	Sectors/GHGs Covered	Timescale	Nature of Actions	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
1	Nationwide mitigation action	By 2025, CO_2 emissions per unit of GDP will be reduced by 18% compared to 2020; by 2030, CO_2 emissions per unit of GDP will be reduced by more than 65% compared to 2005.	Energy/CO_2	2006-2030	Mandatory/Government	MEE	Under progress	In 2021, China's CO_2 emissions per unit of GDP decreased by 3.8% compared to 2020, and showed a cumulative reduction of 50.8% compared to 2005; in 2022, China's CO_2 emissions per unit of GDP decreased by more than 51% compared to 2005.	CO_2 emissions are calculated by multiplying consumption of coal, oil, and natural gas by their corresponding average emission factors across different industries and types.	/	Support from the central finance，the local finance etc.
Energy Structure Optimization											
2	. Developing non-fossil energy	By 2025, non-fossil energy will account for 20% of primary energy consumption; by 2030, non-fossil energy will account for about 25% of primary energy consumption.	CO_2 and other gases	2021-2030	Mandatory/Government	National Development and Reform Commission (NDRC), National Energy Administration (NEA) and other relevant departments	Under progress	In 2021, the total primary energy consumption reached 5,260 Mtce, with non-fossil energy accounting for approximately 16.7% of total, an increase of about 4.7 percentage points compared to 2015. In 2021, China's non-fossil power generation capacity exceeded coal power for the first time, reaching 1120 GW and accounting for 47.0% of the total installed capacity.	Emission reductions = (Non-fossil energy consumption in the current year - Non-fossil energy consumption in 2005) × Composite emission factor of fossil energy consumption in 2005, i.e. 2.53 tCO_2/tce	Compared to 2005, CO_2 emissions were reduced by 1.73 billion tons in 2021.	Support from the central finance, the local finance etc.

No.	Action	Objectives or Main Contents	Sectors/GHGs Covered	Timescale	Nature of Actions	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
3	Developing Natural gas	By 2025, annual natural gas production will reach over 230 billion m^3; by 2030, efforts will be made to increase natural gas's share in primary energy consumption to around 15%.	CO_2 and other gases	2021-2030	Government	NEA, NDRC and other relevant departments	Under progress	In 2021, the total primary energy consumption reached 5260 Mtce, with natural gas accounting for approximately 8.8% of the total, an increase of about 3 percentage points compared to 2015. In 2021, the national natural gas production reached 207.6 billion m^3.	Emission reductions = (Natural gas consumption in the current year - Natural gas consumption in 2005) × (Composite emission factor of fossil energy consumption in 2005, i.e. 2.53 tCO_2/tce - Natural gas emission factor, i.e. 1.56 tCO_2/tce)	Compared to 2005, CO_2 emissions were reduced by 390 million tons in 2021.	Support from the central finance, the local finance etc.
4	Controlling coal consumption	To strictly and reasonably control coal consumption growth during the "14th Five-Year Plan" period	CO_2 and other gases	2021-2025	Government	NDRC, NEA and other relevant departments	Under progress	In 2021, the total primary energy consumption reached 5,260 Mtce, with coal accounting for approximately 55.9% of total, a decrease of about 7.9 percentage points compared to 2015.	Emission reductions are calculated based on the substitution of coal with non-fossil fuels and natural gas.	The actual emission reductions come from switching to non-fossil fuels, natural gas, and other low-carbon energy sources (no double counting here).	Support from the central finance, the local finance etc.

No.	Action	Objectives or Main Contents	Sectors/GHGs Covered	Timescale	Nature of Actions	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
5	. Developing hydropower	By 2025, conventional hydropower installed capacity will reach around 380 GW, and the total pumped storage capacity put into operation will exceed 62 GW; by 2030, the installed capacity of pumped storage power stations will reach approximately 120 GW.	CO_2 and other gases	2021-2030	Government	NEA, NDRC and other relevant departments	Under progress	In 2021, total power generation reached 8,534.25 TWh. Hydropower capacity stood at 391 GW, of which 36 GW was pumped hydro. Hydropower generation amounted to 1,339 TWh, accounting for 15.7% of the total.	Emission reductions = (Hydropower generation in the current year - Hydropower generation in 2005) × CO_2 emission factor of fossil power in 2005, i.e. 1.02 tCO_2/MWh	Compared to 2005, CO_2 emissions were reduced by 960 Mt in 2021.	Support from the central finance, the local finance etc.
6	. Developing wind power	By 2025, wind and solar power generation will double; by 2030, the total installed capacity of wind and solar power will reach over 1200 GW.	CO_2 and other gases	2021-2030	Government	NEA, NDRC and other relevant departments	Under progress	In 2021, the total power generation was 8,534.25 TWh. The installed capacity of wind power reached 328 GW, with power generation of 656.1 TWh. Wind power generation accounted for 7.7% of the total, an increase of 4.5 percentage points compared to 2015.	Emission reductions = (Wind power generation in the current year - Wind power generation in 2005) × CO_2 emission factor of fossil power in 2005, i.e. 1.02 tCO_2/MWh	Compared to 2005, CO_2 emissions were reduced by 670 Mt in 2021.	Support from the central finance, the local finance etc.

No.	Action	Objectives or Main Contents	Sectors/GHGs Covered	Timescale	Nature of Actions	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
7	. Developing solar power	By 2025, wind and solar power generation will double; by 2030, the total installed capacity of wind and solar power will reach over 1200 GW.	CO_2 and other gases	2021-2030	Government	NEA, NDRC and other relevant departments	Under progress	In 2021, the total power generation was 8,534.25 TWh. The installed capacity of solar power reached 307 GW, with power generation of 325.9 TWh, representing a YoY increase of 25.1%.	Emission reductions = (Solar power generation in the current year - Solar power generation in 2005) × CO_2 emission factor of fossil power in 2005, i.e. 1.02 tCO_2/MWh	Compared to 2005, CO_2 emissions were reduced by 330 Mt in 2021.	Support from the central finance, the local finance etc.
8	. Developing nuclear power	By 2025, the installed capacity of operating nuclear power will reach about 70 GW.	CO_2 and other gases	2021-2025	Government	NEA, NDRC and other relevant departments	Under progress	In 2021, the total power generation was 8,534.25 TWh. The installed capacity of nuclear power reached 53 GW, with power generation of 407.52 TWh. Nuclear power generation accounted for 4.8% of the total, an increase of 1.8 percentage points compared to 2015.	Emission reductions = (Nuclear power generation in the current year - Nuclear power generation in 2005) × CO_2 emission factor of fossil power in 2005, i.e. 1.02 tCO_2/MWh	Compared to 2005, CO2 emissions were reduced by 360 Mt in 2021.	Support from the central finance, the local finance etc.
Energy Conservation and Efficiency Improvement											
9	Nationwide energy conservation action	By 2025, energy consumption per unit of GDP will decrease by 13.5% compared to 2020.	All sectors/ CO_2	2021-2025	Mandatory/Government	NDRC and other relevant departments	Under progress	Compared to 2015, energy savings amounted to over 960 Mtce in 2021.	/	/	Support from the central finance, the local finance etc.

No.	Action	Objectives or Main Contents	Sectors/GHGs Covered	Timescale	Nature of Actions	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
10	Energy conservation action in industrial sector	By 2025, energy consumption per unit of value added for industrial enterprises above a designated size will decrease by 13.5% compared to 2020.	Industry[3] /CO_2 and other gases	2021-2025	Government	NDRC, MIIT and other relevant departments	Under progress	In 2021, energy consumption per unit of added value in industrial enterprises above designated size decreased by 5.6%, and in 2022, energy consumption per unit of added value in industrial enterprises above designated size decreased by 1.4% year-on-year.	Emission reductions = Energy savings × Composite emission factor of fossil energy consumption in 2005, i.e. 2.53 tCO_2/tce	Compared to 2005, CO_2 emissions were reduced by 5100 Mt in 2021.	Support from the central finance, the local finance etc.

Note: The emission factor unit tCO_2/tce means "tons of carbon dioxide per ton of standard coal"; the emission factor unit tCO_2/MWh means "tons of carbon dioxide per megawatt-hour".

[3] Here, industry specifically includes three major categories: mining, manufacturing, and production and supply of electricity, heat, gas, and water.

Part III Other Information

As a non-Annex I Party to the UNFCCC and a responsible major developing country, China attaches great importance to addressing climate change. It stays firmly committed to green development, and promotes international collaboration to create a community of harmony between humanity and nature. In accordance with decision 2/CP.17 adopted in 2011 at the COP17 of the UNFCCC, non-Annex I Parties are required to report in their BURs, in addition to information on national GHG inventories, mitigation actions and effects, on national circumstances and institutional arrangements, and on financial, technology and capacity-building needs and received. As this report is submitted simultaneously with the 1BTR, the content of national circumstances and institutional arrangements, financial, technology and capacity-building needs and received have already been introduced in the 1BTR. Therefore, the relevant content can refer to the 1BTR, and will not be repeated in this report.

Part IV Information of HKSAR on Climate Change

HKSAR is a special administrative region of the People's Republic of China. It is a vibrant city featuring mild climate, with limited land and natural resources, high population density and highly-developed service industries. It is also an eminent international financial, trading and shipping hub.

Chapter 1 HKSAR's GHG Inventory

HKSAR's GHG emissions inventory is compiled with reference to the GPG 2000 and the 2006 IPCC Guidelines. The report covers the year 2020 and encompasses five major sectors: Energy, IPPU, Agriculture, LULUCF and Waste. The reported GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6).

1.1 HKSAR's GHG Inventory 2020

In 2020, HKSAR's net total GHG emissions (with LULUCF), amounted to about 34,436.1 ktCO_2eq, of which carbon sinks from LULUCF were about 465 ktCO_2eq. In 2020, HKSAR's total GHG emissions (without LULUCF), amounted to about 34,901.2 ktCO_2eq, in which CO_2 emissions were about 29,433.7 kt (84.33%); CH_4 emissions were about 3,796.6 kt (10.88%); N_2O emissions were about 459.4 kt (1.32%); and F-gas[4] emissions were about 1,211.5 kt (3.47%) (See Table 4-1). Table 4-2 presents the CO_2, CH_4 and N_2O emissions in 2020 by sector. Table 4-3 presents the F-gas emissions in 2020.

Table 4-1 HKSAR's Total GHG Emissions in 2020 (ktCO_2eq)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	28,835.1	122.4	268.6				29,226.1
IPPU	575.9	NO	NO	1,131.4	NO	80.1	1,787.4
Agriculture		16.2	14.8				31.0
LULUCF	-465.0	NE	NE				-465.0
Waste	22.7	3,657.9	176.0				3,856.6
Total (without LULUCF)	29,433.7	3,796.6	459.4	1,131.4	NO	80.1	34,901.2
Total (with LULUCF)	28,968.6	3,796.6	459.4	1,131.4	NO	80.1	34,436.1

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

[4] F-gases include HFCs, PFCs, and SF_6.

Table 4-2 HKSAR's CO_2, CH_4 and N_2O Emissions in 2020 (kt)

GHG Source/Sink Categories	CO_2	CH_4	N_2O
Total (without LULUCF)	29,433.7	135.6	1.7
Total (with LULUCF)	28,968.6	135.6	1.7
Energy	28,835.1	4.4	1.0
- Fuel combustion	28,835.1	2.7	1.0
♦Energy industry	20,253.3	1.0	0.6
♦Manufacturing and construction	710.4	0.1	0.0
♦Transport	6,107.1	1.6	0.4
♦Other sectors	1,764.3	0.0	0.0
- Fugitive emissions		1.6	
♦Solid fuel		NO	
♦Oil and natural gas systems		1.6	
IPPU	575.9	NO	NO
- Cement production	575.9		
- Production of halocarbons and SF_6			
- Consumption of halocarbons and SF_6			
Agriculture		0.6	0.1
- Enteric fermentation		0.2	
- Manure management		0.4	0.0
- Rice cultivation		NO	
- Agricultural land		NO	NO
- Agricultural soils		0.0	0.0
- Prescribed burning of savannas		0.0	0.0
LULUCF	-465.0	NE	NE
- Changes in forest and other woody biomass stocks	-465.0		
- Forest conversion	0.0	NE	NE
Waste	22.7	130.6	0.7
- MSW disposal	22.7	125.6	NO
- Wastewater treatment		5.0	0.7
Memo items			
- Special regional aviation	540.4	0.0	0.0
- Special regional marine	9,988.2	0.9	0.3
- International aviation	7,660.8	0.1	0.2
- International marine	12,621.4	1.2	0.3

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

6). Memo items are not counted in the total emissions.

7). "Special regional aviation" and "special regional marine" represent aviation and marine between HKSAR and other parts of China (including Macao SAR and Taiwan).

Table 4-3 HKSAR's F-gas Emissions in 2020 (t)

GHG Source Categories	HFCs					PFCs	SF_6
	HFC -32	HFC -125	HFC -134a	HFC -143a	HFC -227ea		
Total	4	7	793	3	19	NO	3
Energy							
IPPU	4	7	793	3	19	NO	3
- Non-metallic mineral products							
- Chemical industry							
- Metal smelting						NO	
- Production of halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO
- Consumption of halocarbons and SF_6	4	7	793	3	19	NO	3
Agriculture							
LULUCF							
Waste							

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0 indicates that a calculation is available but is displayed as 0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

Energy is the major source of GHG emissions in HKSAR. In 2020, Energy accounted for 83.74% of the total GHG emissions (without LULUCF), while Waste, IPPU and Agriculture accounted for 11.05%, 5.12% and 0.09%, respectively (see Figure 4-1).

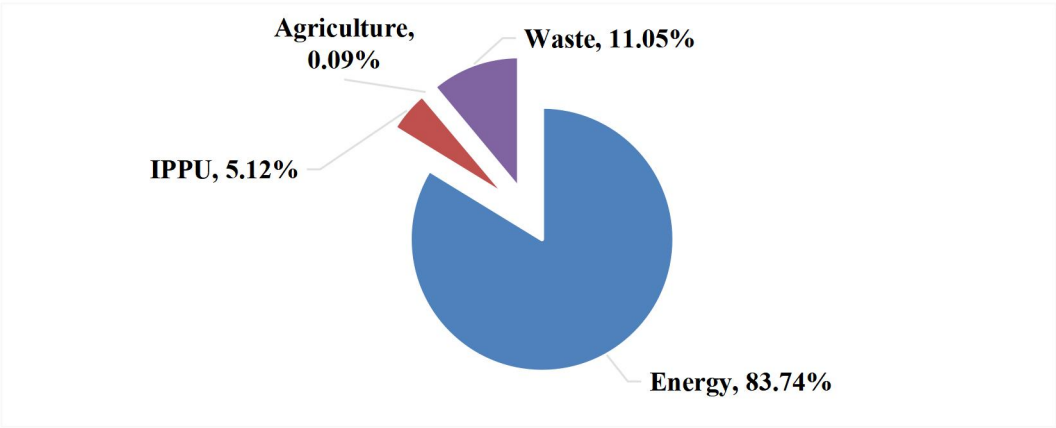

Figure 4-1 HKSAR's GHG Emissions by Sector in 2020 (without LULUCF)

The GHG emissions in HKSAR are primarily CO_2. In 2020, CO_2 accounted for 84.33% of the total emissions, while CH_4, F-gases and N_2O accounted for 10.88%, 3.47% and 1.32% of the total emissions respectively (See Figure 4-2).

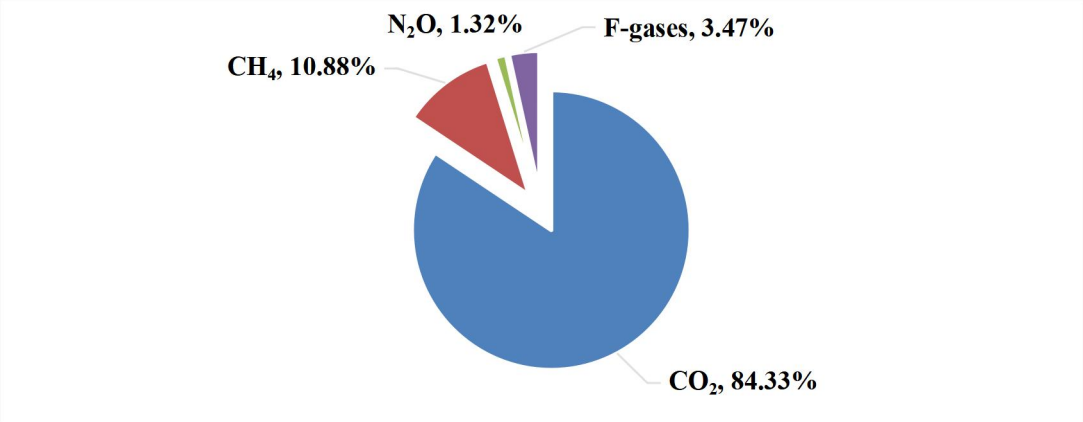

Figure 4-2 HKSAR's GHG Emissions by Gas in 2020

In 2020, the GHG emissions from special regional and international bunkers (aviation and marine) amounted to about 31,098.5 $ktCO_2eq$, including about 10,629.2 $ktCO_2eq$ from special regional marine and aviation, and about 20,469.2 $ktCO_2eq$ from international marine and aviation. These emissions were listed separately as memo items and not acounted into HKSAR's total emissions.

1.1.1 Energy

The Inventory of Energy sector mainly covers CO_2, CH_4 and N_2O emissions from fossil fuel burning in the energy industry, manufacturing and construction industries, transport and other sectors, as well as fugitive CH_4 emissions from oil and gas systems.

The calculation of emissions from Energy sector in HKSAR was based on the 2006 IPCC Guidelines. Tier 3 method was used for CO_2, CH_4 and N_2O emissions from electricity generation. Tier 2 method was used for CO_2 emissions while Tier 1 method was used for CH_4 and N_2O emissions from Towngas production. Tier 2 method was used for the calculation of CO_2 emissions while Tier 1 method was used for the calculation of CH_4 and N_2O emissions in utilizing landfill gas for energy purposes. Tier 2 method was used for the calculation of CO_2 emissions while Tier 1 method was used for the calculation of CH_4 and N_2O emissions from manufacturing and construction industries and other sectors.

Tier 1 and 2 methods were used for the calculation of CO_2, CH_4 and N_2O emissions from local aviation and marine transport, rail, non-road transport and road transport mobile sources. Special regional transport refers to the aviation and marine transport departing from HKSAR with destinations in other parts of the Chinese mainland (including Macao SAR and Taiwan) while international transport refers to aviation and marine transport departing from HKSAR with destinations in places other than the Chinese mainland (including Macao SAR and Taiwan). Tier 3(a) method was used for the calculation of CO_2, CH_4 and N_2O emissions from special regional and international aviation. Tier 1 method was used for the calculation of CO_2, CH_4 and N_2O emissions from special regional and international marine transport.

Tier 1 method was used for the calculation of fugitive CH_4 emissions from gas transmission while Tier 3 method was used for the calculation of other fugitive CH_4 emissions.

In 2020, GHG emissions from Energy in HKSAR were about 29,226.1 $ktCO_2eq$, accounting for 88.42%. Of these, CO_2 emissions amounted to about 28,835.1 kt; CH_4 and N_2O emissions amounted to about 122.4 $ktCO_2eq$ and 268.6 $ktCO_2eq$, respectively. CO_2 emissions from Energy accounted for 97.97% of HKSAR's total CO_2 emissions.

Among the emissions from Energy section in HKSAR in 2020, the energy industry (electriocity generation and gas production) emitted 20,429.6 $ktCO_2eq$, accounting for 69.90%; transport emitted 6,270.3 $ktCO_2eq$, accounting for 21.45%; other fuel combustion (including commercial and residential) emitted 1,766.2 $ktCO_2eq$, accounting for 6.04%; manufacturing and construction industries emitted 714 $ktCO_2eq$, accounting for 2.44%; and fugitive CH_4 emissions were about 45.9 $ktCO_2eq$, accounting for about 0.16%.

1.1.2 IPPU

The Inventory of IPPU mainly covers CO_2 emissions from cement production; HFCs and PFCs emissions from refrigeration, air-conditioning and fire-fighting equipment; and SF_6 emissions from electrical equipment.

Based on cement clinker production data and related information, Tier 2 method was used for the calculation of CO_2 emissions from cement production; Tier 2 method was used for the calculation of emissions from HFCs consumption in refrigeration and air-conditioning; Tier 1 method was used for the calculation of PFCs emissions from solvents; Tier 1 method was used for the calculation of HFCs and PFCs emissions from fire-fighting equipment; and Tier 3 method was used for the calculation of emissions from the use of SF_6 in electrical equipment.

In 2020, GHG emissions from IPPU in HKSAR were around 1,787.4 $ktCO_2eq$, accounting for 5.12%. Of these, CO_2 emissions from cement production were about 575.9 kt; HFCs and SF_6 emissions from refrigeration, air-conditioning, fire-fighting and electrical equipment were about 1,131.4 $ktCO_2eq$ and 80.1 $ktCO_2eq$ respectively.

1.1.3 Agriculture

The Inventory of Agriculture mainly covers CH_4 and N_2O emissions from livestock enteric fermentation and manure management, N_2O emissions from agricultural soils, and CO_2, CH_4 and N_2O emissions from grassland burning.

Tier 1 method was used for the calculation of CH_4 emissions from enteric fermentation; direct and indirect N_2O emissions from agricultural land; and CH_4 and N_2O emissions from prescribed grassland burning.

In 2020, emissions from Agriculture in HKSAR were about 31 $ktCO_2eq$, accounting for 0.09%. CH_4 and N_2O emissions from enteric fermentation and manure management amounted to about 19.7 $ktCO_2eq$, while N_2O emissions from agricultural land wereabout10.9 $ktCO_2eq$.

1.1.4 LULUCF

The Inventory of LULUCF mainly covers the changes in biomass carbon stock caused by the

conversion of forest land, cropland and grassland.

CO_2 emissions from the conversion of forest land, cropland and grassland were calculated using the Tier 1 method with reference to the relevant emission factors; CO_2 emissions and removals from changes in carbon stocks in forests and other woody biomass were also calculated using the Tier 1 method.

In 2020, net CO_2 removals from LUCF as carbon sinks were about 465 kt, all resulting from changes in carbon stocks in forests and other woody biomass due to conversion of forest land and grassland.

1.1.5 Waste

The Inventory of Waste sector mainly covers CH_4 emissions from solid waste landfills, CH_4 and N_2O emissions from treatment of domestic sewage and industrial wastewater, and CO_2 emissions from waste incineration.

GHG Emissions from Waste sector were mainly calculated based on the 2006 IPCC Guidelines. Tier 2 method was used for the calculation of CH_4 emissions from solid waste landfill, and Tier 1 method was used for the calculation of CH_4 and N_2O emissions from wastewater treatment, as well as for CO_2 emissions from chemical waste disposal.

In 2020, emissions from Waste sector in HKSAR were about 3,856.6 kCO_2eq, accounting for 11.05%, most of which were CH_4 emissions, amounting to about 3,657.9 ktCO_2eq, accounting for 96.35%.

1.2 Recalculation of Previous GHG Inventories of HKSAR

HKSAR's GHG emissions inventories will be updated as appropriate in response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data. The GHG emission inventories for 2010, 2012, 2014, 2017 and 2018 were updated using the same compilation methods as for 2020. The updated total emissions increased by 3.13%, 3.03%, and 3.09% respectively, mainly due to the adoption of GWP values from the IPCC AR5. Updated 2005 emissions inventory may refer to the First Biennial Transparency Report.

1.2.1 HKSAR's GHG Inventory 2010

In 2010, HKSAR's updated total net GHG emissions (with LULUCF) were about 41,363 ktCO_2eq, with CO_2, CH_4, N_2O, and F-gases accounting for 89.98%, 6.79%, 0.87%, and 2.36% respectively; the carbon sinks from LULUCF were about 421.3 ktCO_2eq. In 2010, HKSAR's total GHG emissions (without LULUCF) were about 41,784.3 ktCO_2eq, with CO_2, CH_4, N_2O, and F-gases accounting for 90.08%, 6.72%, 0.86% and 2.34%, respectively (see Table 4-4). Table 4-5 presents the updated CO_2, CH_4 and N_2O emissions in 2010 by sector. Table 4-6 presents the updated F-gas emissions in 2010.

Table 4-4 HKSAR's Total GHG Emissions in 2010 (ktCO$_2$eq)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	37,012.9	108.5	202.7				37,324.2
IPPU	610.0	NO	NO	917.0	NO	60.3	1,587.3
Agriculture		15.8	14.6				30.4
LULUCF	-421.3	NE	NE				-421.3
Waste	16.6	2,684.6	141.3				2,842.5
Total (without LULUCF)	37,639.5	2,808.9	358.7	917.0	NO	60.3	41,784.3
Total (with LULUCF)	37,218.2	2,808.9	358.7	917.0	NO	60.3	41,363.0

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Table 4-5 HKSAR's CO_2, CH_4 and N_2O Emissions in 2010 (kt)

GHG Source/Sink Categories	CO_2	CH_4	N_2O
Total (without LULUCF)	37,639.5	100.3	1.35
Total (with LULUCF)	37,218.2	100.3	1.35
Energy	37,012.9	3.9	0.8
- Fuel combustion	37,012.9	2.4	0.8
♦Energy industry	27,262.2	0.8	0.3
♦Manufacturing and construction	742.8	0.1	0.0
♦Transport	6,889.2	1.5	0.5
♦Other sectors	2,118.7	0.0	0.0
- Fugitive emissions		1.5	
♦Solid fuel		NO	
♦Oil and natural systems		1.5	
IPPU	610.0	NO	NO
- Cement production	610.0		
- Production of halocarbons and SF_6			
- Consumption of halocarbons and SF_6			
Agriculture		0.6	0.1
- Enteric fermentation		0.2	
- Manure management		0.4	0.0
- Rice cultivation		NO	
- Agricultural land		NO	NO
- Agricultural soils		0.0	0.0
- Prescribed burning of savannas		0.0	0.0
LULUCF	-421.3	NE	NE

GHG Source/Sink Categories	CO_2	CH_4	N_2O
- Changes in forest and other woody biomass stocks	-421.3		
- Forest conversion	0.0	NE	NE
Waste	16.6	95.9	0.5
- MSW disposal	16.6	92.1	NO
- Wastewater treatment		3.8	0.5
Memo items			
- Special regional aviation	1,473.9	0.0	0.0
- Special regional marine	10,945.6	1.0	0.3
- International aviation	11,454.6	0.1	0.4
- International marine	18,545.8	1.7	0.5

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). “NO” (not occurring) indicates that a particular source or sink category do not occur.

5). “NE” (not estimated) indicates that a particular source or sink category has not been estimated.

6). Memo items are not counted in the total emissions.

7). "Special regional aviation" and "special regional marine" represent aviation and marine between HKSAR and other parts of China (including Macao SAR and Taiwan).

Table 4-6 HKSAR's F-gas Emissions in 2010 (t)

GHG Source Categories	HFCs					PFCs	SF_6
	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea		
Total	4	6	637	2	17	NO	3
Energy							
IPPU	4	6	637	2	17	NO	3
- Non-metallic mineral products							
- Chemical industry							
- Metal smelting						NO	
- Production of halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO
- Consumption of halocarbons and SF_6	4	6	637	2	17	NO	3
Agriculture							
LULUCF							
Waste							

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0 indicates that a calculation is available but is displayed as 0 because the number is too small.

4). “NO” (not occurring) indicates that a particular source or sink category do not occur.

Energy is the major source of CO_2 emissions in HKSAR. In 2010, HKSAR's CO_2 emissions (without LULUCF) were about 37,639.5 kt, of which 37,012.9 kt or 98.34% were from

Energy, while 16.6 kt from Waste. In 2010, LULUCF in HKSAR removed about 421.3 kt of CO_2, and CO_2 emissions (with LULUCF) were about 37,218.2 kt.

CH_4 emissions were mainly sourced from Waste, followed by Energy and Agriculture. In 2010, HKSAR emitted 100.3 kt of CH_4, equivalent to 2,808.9 ktCO_2eq, of which Waste accounted for 95.58%, Energy accounted for 3.86%, and Agriculture accounted for 0.56%.

N_2O emissions were mainly sourced from Energy, Waste and Agriculture. In 2010, HKSAR emitted 1,350 t of N_2O, equivalent to 358.7 ktCO_2eq, of which Energy accounted for 56.53%, Waste accounted for 39.40%, and Agriculture accounted for 4.07%.

F-gas emissions were sourced from product use processes, amounting to about 977.3 ktCO_2eq.

1.2.2 HKSAR's GHG Inventory 2012

In 2012, HKSAR's updated total net GHG emissions (with LULUCF) were about 43,124.9 ktCO_2eq, with CO_2, CH_4, N_2O, and F-gases accounting for 89.79%, 6.90%, 0.88%, and 2.43% respectively; the carbon sinks from LULUCF were approximately 465.7 ktCO_2eq. In 2012, HKSAR's total GHG emissions (without LULUCF) were about 43,590.6 ktCO_2eq, with CO_2, CH_4, N_2O, and F-gases accounting for 89.90%, 6.82%, 0.87% and 2.41%, respectively (see Table 4-7). Table 4-8 presents the updated CO_2, CH_4 and N_2O emissions in 2012 by sector. Table 4-9 presents the updated F-gas emissions in 2012.

Table 4-7 HKSAR's Total GHG Emissions in 2012 (ktCO_2eq)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	38,565.6	107.7	213.7				38,886.9
IPPU	606.7	NO	NO	980.4	NO	68.9	1,656.0
Agriculture		15.9	14.7				30.6
LULUCF	-465.7	NE	NE				-465.7
Waste	16.5	2,851.1	149.5				3,017.1
Total (without LULUCF)	39,188.7	2,974.6	377.9	980.4	NO	68.9	43,590.6
Total (with LULUCF)	38,723.0	2,974.6	377.9	980.4	NO	68.9	43,124.9

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Table 4-8 HKSAR's CO_2, CH_4 and N_2O Emissions in 2012 (kt)

GHG Source/Sink Categories	CO_2	CH_4	N_2O
Total (without LULUCF)	39,188.7	106.2	1.43
Total (with LULUCF)	38,723.0	106.2	1.43
Energy	38,565.6	3.8	0.8
- Fuel combustion	38,565.6	2.3	0.8
♦Energy industry	29,314.9	0.6	0.3

GHG Source/Sink Categories	CO_2	CH_4	N_2O
♦Manufacturing and construction	749.2	0.1	0.0
♦Transport	6,636.0	1.6	0.5
♦Other sectors	1,865.5	0.0	0.0
- Fugitive emissions		0.15	
♦Solid fuel		NO	
♦Oil and natural systems		1.5	
IPPU	606.7	NO	NO
- Cement production	606.7		
- Production of halocarbons and SF_6			
- Consumption of halocarbons and SF_6			
Agriculture		0.6	0.1
- Enteric fermentation		0.2	
- Manure management		0.4	0.0
- Rice cultivation		NO	
- Agricultural land		NO	NO
- Agricultural soils		0.0	0.0
- Prescribed burning of savannas		0.0	0.0
LULUCF	-465.7	NE	NE
- Changes in forest and other woody biomass stocks	-465.7		
- Forest conversion	0.0	NE	NE
Waste	16.5	101.8	0.6
- MSW disposal	16.5	99.3	NO
- Wastewater treatment		2.5	0.6
Memo items			
- Special regional aviation	1,699.8	0.1	0.1
- Special regional marine	9,701.7	0.9	0.3
- International aviation	12,347.7	0.1	0.4
- International marine	16,793.7	1.5	0.4

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). “NO” (not occurring) indicates that a particular source or sink category do not occur.

5). “NE” (not estimated) indicates that a particular source or sink category has not been estimated.

6). Memo items are not counted in the total emissions.

7). "Special regional aviation" and "special regional marine" represent aviation and marine between HKSAR and other parts of China (including Macao SAR and Taiwan).

Table 4-9 HKSAR's F-gas Emissions in 2012 (t)

GHG Source Categories	HFCs					PFCs	SF_6
	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea		
Total	5	9	663	5	18	NO	3
Energy							
IPPU	5	9	663	5	18	NO	3
- Non-metallic mineral products							
- Chemical industry							

GHG Source Categories	HFCs					PFC	SF_6
- Metal smelting						NO	
- Production of halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO
- Consumption of halocarbons and SF_6	5	9	663	5	18	NO	3
Agriculture							
LULUCF							
Waste							

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0 indicates that a calculation is available but is displayed as 0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

Energy is the major source of CO_2 emissions in HKSAR. In 2012, HKSAR's CO_2 emissions (without LULUCF) were about 39,188.7 kt, of which 38,565.6 kt or 98.41% were from Energy, while 16.5 kt from Waste. In 2012, LULUCF in HKSAR removed about 465.7 kt of CO_2, and CO_2 emissions (with LULUCF) were about 38,723 kt.

CH_4 emissions were mainly sourced from Waste, followed by Energy and Agriculture. In 2012, HKSAR emitted 106.2 kt of CH_4, equivalent to 2,974.6 ktCO_2eq, of which Waste accounted for 95.85%, Energy accounted for 3.62%, and Agriculture accounted for 0.53%.

N_2O emissions were mainly sourced from Energy, Waste and Agriculture. In 2012, HKSAR emitted 1,430 t of N_2O, equivalent to 377.9 ktCO_2eq, of which Energy accounted for 56.56%, Waste accounted for 39.57%, and Agriculture accounted for 3.88%.

F-gas emissions were sourced from IPPU, amounting to about 1,049.3 ktCO_2eq.

1.2.3 HKSAR's GHG Inventory 2014

In 2014, HKSAR's updated total net GHG emissions (with LULUCF) were about 45,074.5 ktCO_2eq, with CO_2, CH_4, N_2O, and F-gases accounting for 89.59%, 7.10%, 0.88%, and 2.42% respectively; the carbon removals from LULUCF were about 459.3 ktCO_2eq. In 2014, HKSAR's total GHG emissions (without LULUCF) were about 45,533.8 ktCO_2eq, with CO_2, CH_4, N_2O, and F-gases accounting for 89.70%, 7.03%, 0.87% and 2.40%, respectively (see Table 4-10). Table 4-11 presents the updated CO_2, CH_4 and N_2O emissions in 2014 by sector. Table 4-12 presents the updated F-gas emissions in 2014.

Table 4-10 HKSAR's Total GHG Emissions in 2014 (ktCO_2eq)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	40,289.0	114.6	226.3				40,629.9
IPPU	538.6	NO	NO	1,022.6	NO	69.0	1,630.2
Agriculture		15.7	14.8				30.5
LULUCF	-459.3	NE	NE				-459.3
Waste	15.8	3,071.4	156.1				3,243.3
Total (without LULUCF)	40,843.4	3,201.7	397.1	1,022.6	NO	69.0	45,533.8
Total (with LULUCF)	40,384.1	3,201.7	397.1	1,022.6	NO	69.0	45,074.5

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Table 4-11 HKSAR's CO_2, CH_4 and N_2O Emissions in 2014 (kt)

GHG Source/Sink Categories	CO_2	CH_4	N_2O
Total (without LULUCF)	40,843.4	114.3	1.5
Total (with LULUCF)	40,384.1	114.3	1.5
Energy	40,289.0	4.1	0.9
- Fuel combustion	40,289.0	2.4	0.9
♦Energy industry	31,094.6	0.6	0.4
♦Manufacturing and construction	656.8	0.0	0.0
♦Transport	6,669.9	1.7	0.5
♦Other sectors	1,867.8	0.0	0.0
- Fugitive emissions		1.7	
♦Solid fuel		NO	
♦Oil and natural systems		1.7	
IPPU	538.6	NO	NO
- Cement production	538.6		
- Production of halocarbons and SF_6			
- Consumption of halocarbons and SF_6			
Agriculture		0.6	0.1
- Enteric fermentation		0.2	
- Manure management		0.4	0.0
- Rice cultivation		NO	
- Agricultural land		NO	NO
- Agricultural soils		0.0	0.0
- Prescribed burning of savannas		0.0	0.0
LULUCF	-459.3	NE	NE
- Changes in forest and other woody biomass stocks	-459.3		
- Forest conversion	0.0	NE	NE
Waste	15.8	109.7	0.6
- MSW disposal	15.8	104.9	NO
- Wastewater treatment		4.8	0.6
Memo items			
- Special regional aviation	1,848.7	0.1	0.1
- Special regional marine	9,173.3	0.8	0.2
- International aviation	13,094.5	0.1	0.4
- International marine	14,953.8	1.4	0.4

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

6). Memo items are not counted in the total emissions.

7). "Special regional aviation" and "special regional marine" represent aviation and marine between HKSAR and other parts of China (including Macao SAR and Taiwan).

Table 4-12 HKSAR's F-gas Emissions in 2014 (t)

GHG Source Categories	HFCs					PFCs	SF_6
	HFC-32	HFC-125	HFC-134a	HFC-143a	HFC-227ea		
Total	8	11	697	3	19	NO	3
Energy							
IPPU	8	11	697	3	19	NO	3
- Non-metallic mineral products							
- Chemical industry							
- Metal smelting						NO	
- Production of halocarbons and SF_6	NO	NO	NO	NO	NO	NO	NO
- Consumption of halocarbons and SF_6	8	11	697	3	19	NO	3
Agriculture							
LULUCF							
Waste							

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

Energy is the major source of CO_2 emissions in HKSAR. In 2014, HKSAR's CO_2 emissions (without LULUCF) were about 40,843.4 kt, of which 40,289 kt or 98.64% were from Energy, while 15.8 kt from Waste. In 2014, LULUCF in HKSAR removed about 459.3 kt of CO_2, and CO_2 emissions (with LULUCF) were about 40,384.1 kt.

CH_4 emissions were mainly sourced from Waste, followed by Energy and Agriculture. In 2014, HKSAR emitted 114.3 kt of CH_4, equivalent to 3,201.7 ktCO_2eq, of which Waste accounted for 95.93%, Energy accounted for 3.58%, and Agriculture accounted for 0.49%.

N_2O emissions were mainly sourced from Energy, Waste and Agriculture. In 2014, HKSAR emitted 1,500 t of N_2O, equivalent to 397.1 ktCO_2eq, of which Energy accounted for 56.98%, Waste accounted for 39.31%, and Agriculture accounted for 3.72%.

F-gas emissions were sourced from IPPU, amounting to about 1,091.6 ktCO_2eq.

1.2.4 HKSAR's GHG Inventory 2017

In 2017, HKSAR's total net GHG emissions (with LULUCF), amounted to about 41,055.9 ktCO_2eq, of which removals from LULUCF were about 463.9 ktCO2eq. In 2017, HKSAR's

total GHG emissions (without LULUCF) were approximately 41,519.7 ktCO2eq. Of these, CO_2 emissions were about 36,351.8 kt (87.55%); CH_4 emissions were about 3,564.2 kt (8.58%); N_2O emissions were about 495.3 kt (1.19%); and F-gas[5] emissions were about 1,108.5 kt (2.67%) (see Table 4-13).

Table 4-13 HKSAR's Total GHG Emissions in 2017 ($ktCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	35,713.4	123.2	312.4				36,149.0
IPPU	606.8	NO	NO	1,042.5	NO	66.0	1,715.3
Agriculture		15.1	14.2				29.3
LULUCF	-463.9	NE	NE				-463.9
Waste	31.6	3425.9	168.6				3626.1
Total (without LULUCF)	36,351.8	3,564.2	495.3	1,042.5	NO	66.0	41,519.7
Total (with LULUCF)	35,888.0	3,564.2	495.3	1,042.5	NO	66.0	41,055.9

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

1.2.5 HKSAR's GHG Inventory 2018

In 2018, HKSAR's total net GHG emissions (with LULUCF), amounted to about 34,440.6 $ktCO_2eq$, of which removals from LULUCF were about 463.2 $ktCO_2eq$. In 2018, HKSAR's total GHG emissions (without LULUCF) were approximately 42,056.2 $ktCO_2eq$. Of these, CO_2 emissions were about 36,608.1 kt; CH_4 emissions were about 3,824.7 kt; N_2O emissions were about 495.7 kt; and F-gas[6] emissions were about 1,127.7 kt (see Table 4-14).

Table 4-14 HKSAR's Total GHG Emissions in 2018 ($ktCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	36,022.4	123.7	320.7				36,466.8
IPPU	557.8	NO	NO	1,062.1	NO	65.6	1,685.2
Agriculture		15.3	14.1				29.4
LULUCF	-463.2	NE	NE				-463.2
Waste	27.8	3,685.8	160.9				3,874.6
Total (without LULUCF)	36,608.1	3,824.7	495.7	1,062.1	NO	65.6	42,056.2
Total (with LULUCF)	36,144.9	3,824.7	495.7	1,062.1	NO	65.6	34,440.6

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). 0.0 indicates that a calculation is available but is displayed as 0.0 because the number is too small.

4). "NO" (not occurring) indicates that a particular source or sink category do not occur.

5). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

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[5] F-gases include HFCs, PFCs, and SF_6.

[6] F-gases include HFCs, PFCs, and SF_6.

1.3 Quality Assurance, Quality Control

1.3.1 Efforts in Reducing Uncertainty

The HKSAR Government has put effort in strengthening the QA/QC work during the compilation of 2020 GHG emissions inventory and the updates of 2005, 2010, 2012, 2014, 2017 and 2018's emissions inventories.

The 2006 IPCC Guidelines was adopted to the compilation of GHG emissions inventories for all reporting years to ensure the scientific rigor, comparability, and transparency. Furthermore, the HKSAR Government invited the compilation team of China's emissions inventory a non-inventory team as a third independent party to review the inventory.

1.3.2 Uncertainty Analysis

Emissions from coal combustion in electricity generation were the major source of uncertainty in the inventory among sub-sectors of Energy, mainly due to limitations in statistical data such as the variety and quantity of coal consumed by power plants. In the sectors of Energy, IPPU, Agriculture, LULUCF and Waste, the level of uncertainty for sectors was calculated according to the corresponding methodology in the basis of the level of activity and the source of emission factors (See Table 4-15). Based on the error propagation method in the 2006 IPCC Guidelines, the overall uncertainty of HKSAR's GHG inventories for 2020 was about 5.99%

Table 4-15 Result of Uncertainty Anaysis of 2020's HKSAR GHG Emissions Invenotry

	GHG Emissions ($ktCO_2eq$ kt)	Uncertainty
Energy	2922.61	1.55%
IPPU	178.74	0.85%
Agriculture	3.10	0.04%
LULUCF	-46.5	0.13%
Waste	385.66	5.62%
Overall uncertainty	5.99%	

Chapter 2 Mitigation Actions and Effects

2.1 Key Mitigation Actions, Policies and Effects

The HKSAR Government has been committed to implementing various policy measures to mitigate GHG emissions, and announced the "Hong Kong's Climate Action Plan 2030+" in January 2017. The HKSAR Government has pledged to achieve carbon neutrality before 2050 and is pursuing the interim target of halving GHG emissions before 2035 as compared with the 2005 level. The HKSAR Government further announced the "Hong Kong's Climate Action Plan 2050"[7] in October 2021. Focusing on the three major GHG emission sources, namely power generation, transport and waste, the HKSAR Government sets out four major decarbonization strategies, i.e. "net-zero electricity generation", "energysaving and green

[7] Hong Kong's Climate Action Plan 2050, https://cnsd.gov.hk/wp-content/uploads/pdf/CAP2050_booklet_tc.pdf

buildings", "green transport" and "waste reduction", to lead HKSAR towards carbon neutrality.

To achieve the above targets, the HKSAR Government has implemented various energy-saving and renewable energy measures, promoted electric vehicles, and introduced modern waste-to-energy and waste-to-resources facilities.

In the energy sector, HKSAR has gradually reduced coal-fired power generation, and increased the use of natural gas and zero-carbon energy for electricity generation. Furthermore, HKSAR has vigorously promoted renewable energy (RE) sources, including installing RE systems in various government facilities wherever possible, developing more advanced waste-to-energy facilities, introducing Feed-in Tariffs and facilitating the connection of distributed RE to the grid, as well as introducing facilitation measures to encourage the uptake of distrubted RE by the private sector and the general public. Through joint efforts by the private sector and relevant government departments, the share of solar energy in the fuel mix for electricity generation is expected to increase from about 0.5% in 2022 to about 1% in 2028. The HKSAR Government's medium-term targets are cease using coal as a fuel for daily electricity generation by 2035, increase the share of RE in fuel mix for electricity generation to 7.5%-10%, and further increase to 15% in the future. The HKSAR Government will also try out the use of new energy and strengthen cooperation with neighbouring regions, thereby striving to increase the share of zero-carbon energy to 60%-70% before 2035, with a view to relising the long-term target of achieving "net-zero electricity generation" before 2050.

The HKSAR Government has been continuously enhancing the energy efficiency of buildings through promoting "Energy Saving and Green Buildings".This includes implementing the Buildings Energy Efficiency Ordinance in 2012; setting clear electricity-saving targets for government buildings and conducting energy audits for major government buildings; enhancing electrical appliance energy efficiency through the Mandatory Energy Efficiency Labeling Scheme (MEELS); and carrying out GHG emissions accounting for buildings and issuing building carbon audit guidelines. Currently, buildings in HKSAR account for approximately 90% of total electricity consumption. Promoting green buildings, improving building energy efficiency, and adopting low-carbon lifestyles can help reduce electricity consumption and power generation demands, while also lessening the financial burden on citizens resulting from the transition to cleaner energy sources for power generation. The HKSAR Government aims to reduce electricity consumption in commercial buildings by 30-40% and residential buildings by 20-30% by 2050 or earlier, compared to 2015 levels; and to achieve half of these targets by 2035 or earlier. On this, the HKSAR Government will expand the scope of regulation to more categories of buildings by amending the Buildings Energy Efficiency Ordinance; mandate the disclosure of certain information in the energy audit report to allow public access to building energy performance data; and shorten the energy audit cycle from the current 10 years to 5 years. Meanwhile, it will explore the construction of District Cooling Systems in more new development areas and utilize green innovation and technology to enhance the performance of these systems. The HKSAR Government will continue to improve the MEELS and explore establishing minimum energy

efficiency requirements for various regulated appliances.

In the transport sector, the railway network continues to serve as the backbone of the public transport system in HKSAR. To respond to transport demands, ensure economic efficiency, and align with the development needs of new development areas and other new development projects, and considering the potential housing supply that railway development may bring, the HKSAR Government continues to implement the new railway projects recommended in the "Railway Development Strategy 2014" in an orderly manner. In addition, the HKSAR Government published the "Hong Kong Major Transport Infrastructure Development Blueprint" in 2023, outlining the strategic railway and major road networks that can meet transport and logistics demand up to 2046 and beyond. Upon completion of ongoing and planned railway projects, the total length of the railway network in expected to increase from currently about 270 km to nearly 390 km, and smart and green mass transit system will also be introduced. The HKSAR Government strives to promote the use of electric vehicles, with policy measures including first registration tax concessions for electric vehicles, etc. To achieve carbon neutrality before 2050, developing "green transport" is a key carbon reduction strategy for mitigating climate change. The HKSAR Government will achieve the long-term target of attaining zero vehicular emissions and zero carbon emissions in the transport sector before 2050, through the electricification of vehicles and ferries, the expansion of electric vehicle charging network, development of new energy transport, and measures to enhance traffic management. Also, the HKSAR Government announced in 2021 the target to cease new registrations of fuel-propolled and hybrid private cars by 2035 or earlier. Taking into account the local conditions, the HKSAR conducted trials of hydrogen fuel cell double-decker buses in an orderly manner in 2023 and will trial hydrogen fuel cell heavy vehicles for street cleansing in 2024 to test their operational performance in the local environment. At the same time, the first public hydrogen refueling station will start operating, supplying hydrogen fuel for heavy vehicles.

In the waste treatment sector, the HKSAR Government has promoted waste reduction, encouraging waste reduction at source, and advocating for recycling and reuse. It has boosted resource recovery and recycling. All active landfills use landfill gas as a fuel for power generation to supply their own infrastructure and provide heat to the leachate treatment facility. After treatment, the remaining landill gas is either transferred to the gas company's pipeline network or used for electricity generation supplied to the public power grid. The three active waste-to-energy facilities that turn the heat from processing organic waste and sludge into electricity, using some to run the plants themselves and sending the rest to the public grid. Moreover, the HKSAR Government has increased the recycling of waste materials and strengthened the planning research for future waste management and transfer facilities. To achieve carbon neutrality in the waste sector by 2050, the HKSAR Government has set an interim goal of " Waste Reduction". The HKSAR Government is committed to developing sufficient waste-to-energy facilities by 2035 or earlier to refrain from reliance on landfills for disposal of household waste and support the development of circular economy. Through various waste reduction and recycling measures, the goal is to gradually reduce the daily per capita disposal rate of solid waste by 40%-45%, while increasing the recycling rate

from 32% in 2022 to approximately 55%, and advancing the implementation of the first phase of the regulation on disposable plastic tableware and other plastic products earlier than 2025 as originally planned.

Through the above policies and actions to control GHG emissions, HKSAR has achieved significant results in controlling GHG emissions, with total GHG emissions gradually decreasing. Per capita carbon emissions decreased from 6.27 tCO_2e in 2005 to 4.73 tCO_2e in 2022, with carbon intensity dropping by 44% compared to 2005. To achieve carbon neutrality, the HKSAR Government announced in the "Hong Kong Climate Action Plan 2050" in October 2021 that it would invest approximately HK$240 billion over the next 15 to 20 years to implement various mitigation and adaptation measures. These include renewable energy, energy saving and green buildings, green transport and waste management, strengthening coastal defenses, slope reinforcement, and drainage system improvement works. As this report is submitted simultaneously with the 1BTR, the specific mitigation measures and their effects across various sectors have already been detailed in the 1BTR. Therefore, the relevant content can refer to the 1BTR, and will not be repeated in this report.

2.2 HKSAR's MRV on Mitigation Actions

Regarding mitigation actions, the HKSAR Government set up the Steering Committee on Climate Change (SCCC), chaired by the Chief Secretary for Administration, in 2016 to strengthen the steering and co-ordination of the Government's cross-departmental efforts in addressing climate change. To strive for carbon neutrality before 2050, the HKSAR Government upgraded the SCCC to become the Steering Committee on Climate Change and Carbon Neutrality (SCCC&CN) in 2021. Chaired by the Chief Executive, the SCCC&CN is responsible for formulating the overall strategy and oversees implementation and coordination of the climate actions. Subsequently, the Office of Climate Change and Carbon Neutrality was set up under the Environment and Ecology Bureau (EEB) to strengthen the co-ordination and promotion of deep decarbonisation. The EEB also formed a dedicated advisory committee to encourage active participation of all sectors of the community, including young people, in actions to address climate change.

In December 2012, to facilitate the development of the GHG validation and verification, the HKSAR introduced licensing service for GHG validation and verification bodies, which allows the accredited validation/verification bodies to validate and verify GHG emission reports in accordance with the ISO 14064 standard.

Part V Information of MSAR on Climate Change

Macao is a special administrative region of China. It is a vibrant city featuring mild climate, limited natural resources, high population density and a highly-developed gaming industry. It is also a world-renowned destination for tourism and entertainment[8].

Chapter 1 MSAR's GHG Inventory

MSAR's GHG Inventory 2020 was mainly prepared, with reference to the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines. Based on the actual situation in MSAR and the availability of relevant data, MSAR's GHG Inventory 2020 primarily covers GHG emissions from Energy and Waste, and GHGs including CO_2, CH_4, and N_2O. For details on MSAR's GHG Inventory 2005, please refer to the 1BTR, and the relevant content will not be repeated in this report.

1.1 MSAR's GHG Inventory 2020

In 2020, MSAR's total GHG emissions were 1,071.9 $ktCO_2eq$ (see Table 5-1), with Energy and Waste accounting for 94.2% and 5.8%, respectively (see Figure 5-1). Of these, CO_2 emissions were approximately 987.9 kt, accounting for about 92.2%; CH_4 emissions were approximately 17.0 $ktCO_2eq$, accounting for about 1.6%; and N_2O emissions were approximately 67.0 $ktCO_2eq$, accounting for about 6.3% (see Figure 5-2).

Table 5-1 MSAR's Total GHG Emissions in 2020 ($ktCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	984	8	19				1,010
Industrial Processes	NE	NO	NE	NE	NO	NE	NE
Agriculture		NO	NO				NO
LULUCF	NE	NE	NE				NE
Waste	4	9	48				62
Total (without LULUCF)	988	17	67	NE	NO	NE	1,072
Total (with LULUCF)	988	17	67	NE	NO	NE	1,072

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). "NO" (not occurring) indicates that a particular source or sink category do not occur.

4). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Table 5-2 MSAR's GHG Emissions in 2020 (100t)

GHG Source/Sink Categories	CO_2	CH_4	N_2O
Total (without LULUCF)	9879.2	6.1	2.5
Energy	9837.3	2.7	0.7
- Fuel combustion	9837.3	2.7	0.7

[8] Parts of the SAR's regional circumstances and institutional arrangements have already been introduced in the 1BTR. The relevant content can be found in the 1BTR, and will not be repeated in this report.

GHG Source/Sink Categories	CO_2	CH_4	N_2O
♦Energy industry	4149.8	1.7	0.4
♦Manufacturing and construction	944.1	0.0	0.0
♦Transport	3245.1	1.0	0.3
♦Other sectors	1498.3	0.0	0.0
- Fugitive emissions		NE	
Industrial Processes	NE	NO	NE
Agriculture		NO	NO
LULUCF	NE	NE	NE
Waste	41.9	3.4	1.8
- Solid waste disposal	41.9	0.0	0.0
- Wastewater treatment		3.3	1.8
Memo items			
- Special regional aviation	1301.2	0.0	0.0
- Special regional marine	121.5	0.0	0.0
- International aviation	602.1	0.0	0.0
- International marine	NO	NO	NO
- Biomass combustion	2636.6		

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). “NO” (not occurring) indicates that a particular source or sink category do not occur.

4. “NE” (not estimated) indicates that a particular source or sink category has not been estimated.

5). The data of HFCs, PFCS and SF6 related activities that are not collected and estimated under the IPPU are presented as NE in total.

6). Fugitive emissions from fuels and LULUCF cannot be estimated due to the in-progress statistics system.

7). Values given in ‘Memo items’ are not counted in the total emissions, and CO2 emissions from biomass combustion only include those from biogenic waste incineration.

8). "Special regional aviation" and "special regional marine" represent aviation and marine between MSAR and other parts of China (including HKSAR and Taiwan).

9). 0.0 indicates that the value is less than 0.05.

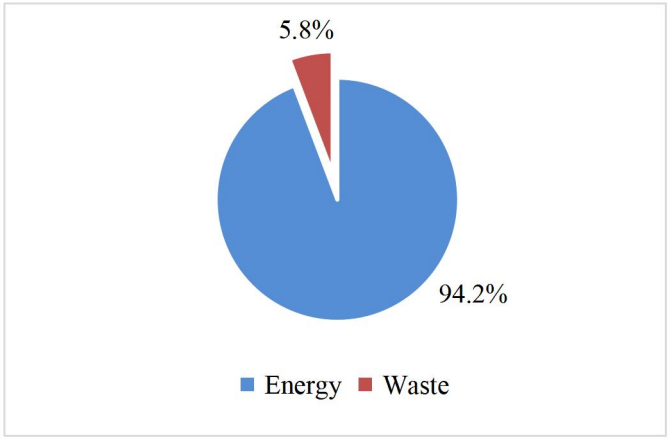

Figure 5-1 MSAR's GHG Emissions by Sector in 2020

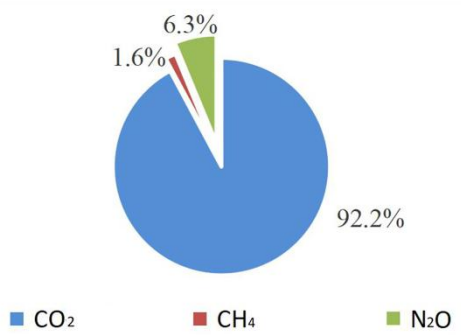

Figure 5-2 MSAR's GHG Emissions by Gas in 2020

In 2020, GHG emissions from international aviation and special regional aviation in MSAR were approximately 191.8 ktCO_2eq, special regional marine emissions were approximately 12.3 ktCO_2eq, and CO_2 emissions from biomass combustion under Waste were approximately 263.7 kt. The total GHG emissions from the above activities amounted to approximately 467.7 ktCO_2eq, which were listed separately as memo items in accordance with relevant requirements, and not included in MSAR's total emissions.

1.1.1 Energy

For Energy, MSAR's GHG Inventory mainly covers the CO_2, CH_4 and N_2O emissions from fossil fuel combustion in energy industry, manufacturing and construction, road transport and other sectors. Considering the fact that incineration is the major approach for MSW disposal in MSAR, and the heat generated in the incineration process is retrieved to generate electricity and transmitted to MSAR's power grid, the GHG emissions from incineration of fossil-derived waste (such as clothing and plastics) were counted under Energy. While CO_2 emissions from biomass combustion under Waste were not counted in the total emissions but only listed as memo items.

Regarding fugitive emissions from Energy, MSAR has no coal, oil, or natural gas producers. This section only involves minor fugitive emissions during oil and natural gas distribution processes. These emissions were not estimated as no statistics are available.

For Energy, due to the lack of detailed activity data and local emission factors, CO_2, CH_4 and N_2O emissions from fossil fuel combustion in energy processing and conversion, manufacturing and construction, road transport, other sectors, and special regional water transport were calculated using Tier 1 method and default emission factors in the 2006 IPCC Guidelines. Due to the availability of detailed flight activity data, CO_2, CH_4 and N_2O emissions from international aviation and special regional aviation were calculated using Tier 2 method.

The activity data were the statistical and sectoral data released by the MSAR Government. Both sector and fuel categories are basically the same as those given in the 2006 IPCC Guidelines.

The selection of emission factors data is consistent with the national GHG inventory, primarily referring to the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC

Guidelines.

In 2020, MSAR's GHG emissions from Energy amounted to approximately 1010.2 $ktCO_2eq$, accounting for 94.2%. This comprised approximately 983.7$ktCO_2eq$ of CO_2 emissions, 7.6 $ktCO_2eq$ of CH_4 emissions, and 18.8 $ktCO_2eq$ of N_2O emissions. Energy accounted for 99.6% of total CO_2 emissions in MSAR.

In 2020, among MSAR's emissions from Energy, approximately 430.2 $ktCO_2eq$ from energy processing and conversion, accounting for 42.6%; about 335.2 $ktCO_2eq$ from road transport, accounting for 33.2%; roughly 150.0 $ktCO_2eq$ from other sectors (including commercial, food and beverage, hotels, and residential), accounting for 14.9%; and approximately 94.7 $ktCO_2eq$ from manufacturing and construction, accounting for 9.4%.

1.1.2 Waste

For Waste, MSAR's GHG Inventory mainly covers the CH_4 and N_2O emissions from urban wastewater treatment, and CO_2, CH_4 and N_2O emissions from waste incineration.

Due to the lack of detailed activity data and local emission factors, Tier 1 method provided in the 2006 IPCC Guidelines and 2019 Refinement to the 2006 IPCC Guidelines was used to calculate GHG emissions from waste disposal in MSAR.

Activity data of N_2O emissions from wastewater treatment were based on the total population provided by Statistics and Census Service (DSEC), as well as MSAR's per capita annual protein consumption in 2020 provided by the FAO. The N_2O emission factors were based on IPCC default values; CO_2, CH_4 and N_2O emissions from waste incineration were estimated using the activity data provided by DSEC and Environmental Protection Bureau (DSPA), as well as the IPCC default values.

In 2020, MSAR's GHG emissions from Waste were 61.8 $ktCO_2eq$, accounting for 5.8%. Of these, emissions from wastewater treatment and solid waste disposal were 57.5 $ktCO_2eq$ and 4.3 $ktCO_2eq$, accounting for 93.1% and 6.9%.

1.2 Recalculation of Previous GHG Inventories in MSAR

This section reports the recalculated results of greenhouse gas inventories for the years 2010, 2012, 2014, 2017, and 2018, prepared using the same methodology as the 2020 inventory. The recalculated results of the 2005 greenhouse gas inventory can be found in the *First Biennial Transparency Reports*.

1.2.1 MSAR's GHG Inventory 2010

In response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data, MSAR's GHG Inventory 2010 was updated using the same methods as for 2020. GWPs for CH_4 and N_2O were updated to the GWP 100 values from the IPCC AR5.

For Waste, CH_4 emissions from waste incineration were added to the updated GHG Inventory 2010.

In 2010, MSAR's total GHG emissions amounted to approximately 1266.2 $ktCO_2eq$ (Table 5-3), with CO_2, CH_4, and N_2O accounting for 94.7%, 1.1%, and 4.2% respectively.

Table 5-3 MSAR's Total GHG Emissions in 2010 ($ktCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	1,197	5	12				1,215
Industrial Processes	NE	NO	NE	NE	NO	NE	NE
Agriculture		NO	NO				NO
LULUCF	NE	NE	NE				NE
Waste	2	8	41				52
Total (without LULUCF)	1,199	13	53	NE	NO	NE	1,266
Total (with LULUCF)	1,199	13	53	NE	NO	NE	1,266

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). "NO" (not occurring) indicates that a particular source or sink category do not occur.

4). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Energy is the major source of CO_2 emissions in MSAR. In 2010, CO_2 emissions were 1199.4 kt, including 1197.3 kt from Energy and 2.1 kt from fossil-derived solid waste incineration.

CH_4 emissions were mainly sourced from Waste. In 2010, MSAR emitted 481 t of CH_4, equivalent to 13.5 $ktCO_2eq$, of which Waste accounted for 59.4%, and Energy accounted for 40.6%.

N_2O emissions were mainly sourced from Waste. In 2010, MSAR emitted 201 t of N_2O, equivalent to 53.3 $ktCO_2eq$, of which Waste accounted for 77.8%, and Energy accounted for 22.2%.

1.2.2 MSAR's GHG Inventory 2012

In response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data, MSAR's GHG Inventory 2012 was updated using the same methods as for 2020. GWPs for CH_4 and N_2O were updated to the GWP 100 values from the IPCC AR5.

For Waste, CH_4 emissions from waste incineration were added to the updated GHG Inventory 2012.

In 2012, MSAR's total GHG emissions amounted to approximately 1,103.4 $ktCO_2eq$ (Table 5-4), with CO_2, CH_4, and N_2O accounting for 93.1%, 1.3%, and 5.5% respectively.

Table 5-4 MSAR's Total GHG Emissions in 2012 ($ktCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	1,025	6	15				1,046
Industrial Processes	NE	NO	NE	NE	NO	NE	NE
Agriculture		NO	NO				NO
LULUCF	NE	NE	NE				NE
Waste	2	9	46				57
Total (without LULUCF)	1,027	15	61	NE	NO	NE	1,103
Total (with LULUCF)	1,027	15	61	NE	NO	NE	1,103

Notes: 1). Shaded cells do not require entries;
2). Due to rounding, the aggregation of various items may be slightly different from the total.
3). “NO” (not occurring) indicates that a particular source or sink category do not occur.
4). “NE” (not estimated) indicates that a particular source or sink category has not been estimated.

Energy is the major source of CO_2 emissions in MSAR. In 2012, CO_2 emissions were 1,027.5 kt, including 1,025.1 kt from Energy and 2.4 kt from fossil-derived solid waste incineration.

CH_4 emissions were mainly sourced from Waste. In 2012, MSAR emitted 532 t of CH_4, equivalent to 14.9 ktCO_2eq, of which Waste accounted for 58.8%, and Energy accounted for 41.2%.

N_2O emissions were mainly sourced from Waste. In 2012, MSAR emitted 230 t of N_2O, equivalent to 61.0 ktCO_2eq, of which Waste accounted for 75.2%, and Energy accounted for 24.8%.

1.2.3 MSAR’s GHG Inventory 2014

In response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data, MSAR’s GHG Inventory 2014 was updated using the same methods as for 2020. GWPs for CH_4 and N_2O were updated to the GWP 100 values from the IPCC AR5.

For Waste, CH4 emissions from waste incineration were added to the updated GHG Inventory 2014.

In 2014, MSAR's total GHG emissions amounted to approximately 1261.6 ktCO_2eq (Table 5-5), with CO_2, CH_4, and N_2O accounting for 92.9%, 1.3%, and 5.7% respectively.

Table 5-5 MSAR’s Total GHG Emissions in 2014 (ktCO_2eq)

	CO_2	**CH_4**	**N_2O**	**HFCs**	**PFCs**	**SF_6**	**Total**
Energy	1,170	7	19				1,196
Industrial Processes	NE	NO	NE	NE	NO	NE	NE
Agriculture		NO	NO				NO
LULUCF	NE	NE	NE				NE
Waste	2	10	53				65
Total (without LULUCF)	1,172	17	72	NE	NO	NE	1,262
Total (with LULUCF)	1,172	17	72	NE	NO	NE	1,262

Notes: 1). Shaded cells do not require entries;
2). Due to rounding, the aggregation of various items may be slightly different from the total.
3). “NO” (not occurring) indicates that a particular source or sink category do not occur.
4). “NE” (not estimated) indicates that a particular source or sink category has not been estimated.

Energy is the major source of CO_2 emissions in MSAR. In 2014, CO_2 emissions were 1,172.4 kt, including 1,170.0 kt from Energy and 2.4 kt from fossil-derived solid waste incineration.

CH_4 emissions were mainly sourced from Waste. In 2014, MSAR emitted 602 t of CH_4, equivalent to 16.9 ktCO_2eq, of which Waste accounted for 56.9%, and Energy accounted for 43.1%.

N_2O emissions were mainly sourced from Waste. In 2014, MSAR emitted 273 t of N_2O, equivalent to 72.3 ktCO_2eq, of which Waste accounted for 73.8%, and Energy accounted for 26.2%.

1.2.4 MSAR's GHG Inventory 2017

In response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data, MSAR's GHG Inventory 2017 was updated using the same methods as for 2020. GWPs for CH_4 and N_2O were updated to the GWP 100 values from the IPCC AR5.

In 2017, MSAR's total GHG emissions were 1,745.1 ktCO_2eq (see Table 5-6), with CO_2, CH_4 and N_2O emissions accounting for 94.5%, 1.1%, and 4.4% respectively.

Table 5-6 MSAR's Total GHG Emissions in 2017 (ktCO_2eq)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	1,646	9	20				1674
Industrial Processes	NE	NO	NE	NE	NO	NE	NE
Agriculture		NO	NO				NO
LULUCF	NE	NE	NE				NE
Waste	4	10	57				71
Total (without LULUCF)	1,649	19	77	NE	NO	NO	1,745
Total (with LULUCF)	1,649	19	77	NE	NO	NO	1,745

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). "NO" (not occurring) indicates that a particular source or sink category do not occur.

4). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Energy is the major source of CO_2 emissions in MSAR. In 2017, CO_2 emissions were 1,649.2 kt, including 1,645.5 kt from Energy and 3.6 kt from fossil-derived solid waste incineration.

CH_4 emissions were mainly sourced from Waste. In 2017, MSAR emitted 668 t of CH_4, equivalent to 18.7 ktCO_2eq, of which Waste accounted for 54.1%, and Energy accounted for 45.9%.

N_2O emissions were mainly sourced from Waste. In 2017, MSAR emitted 291 t of N_2O, equivalent to 77.2 ktCO_2eq, of which Waste accounted for 74.4%, and Energy accounted for 25.6%.

1.2.5 MSAR's GHG Inventory 2018

In response to updated estimation methods, expanded scope of calculation and necessary updates of underlying data, MSAR's GHG Inventory 2018 was updated using the same methods as for 2020. GWPs for CH_4 and N_2O were updated to the GWP 100 values from the IPCC AR5.

In 2018, MSAR's total GHG emissions were 1,328.5 ktCO_2eq (see Table 5-7), with CO_2, CH_4 and N_2O emissions accounting for 92.6%, 1.4%, and 5.9% respectively.

Table 5-7 MSAR's Total GHG Emissions in 2018 ($ktCO_2eq$)

	CO_2	CH_4	N_2O	HFCs	PFCs	SF_6	Total
Energy	1,228	9	20				1,257
Industrial Processes	NE	NO	NE	NE	NO	NE	NE
Agriculture		NO	NO				NO
LULUCF	NE	NE	NE				NE
Waste	2	10	59				72
Total (without LULUCF)	1,231	19	79	NE	NO	NO	1,329
Total (with LULUCF)	1,231	19	79	NE	NO	NO	1,329

Notes: 1). Shaded cells do not require entries;

2). Due to rounding, the aggregation of various items may be slightly different from the total.

3). "NO" (not occurring) indicates that a particular source or sink category do not occur.

4). "NE" (not estimated) indicates that a particular source or sink category has not been estimated.

Energy is the major source of CO_2 emissions in MSAR. In 2018, CO_2 emissions were 1,230.7 kt, including 1,228.2 kt from Energy and 2.5 kt from fossil-derived solid waste incineration.

CH_4 emissions were mainly sourced from Waste. In 2018, MSAR emitted 679 t of CH_4, equivalent to 19 $ktCO_2eq$, of which Waste accounted for 54.8%, and Energy accounted for 45.2%.

N_2O emissions were mainly sourced from Waste. In 2018, MSAR emitted 297 t of N_2O, equivalent to 78.8 $ktCO_2eq$, of which Waste accounted for 74.8%, and Energy accounted for 25.2%.

1.3 Quality Assurance, Quality Control

1.3.1 Efforts to Reduce Uncertainties

To reduce uncertainties of the inventory, methods from the 2006 IPCC Guidelines and the 2019 Refinement to the 2006 IPCC Guidelines were adopted, ensuring scientific rigor, comparability, and consistency in inventory preparation. Based on available activity data, the higher-tier methods were used where possible. For example, the more detailed Tier 2 method was used for international aviation and special regional aviation. As for activity data, to ensure data authority, official data verified by MSAR government departments were used whenever possible, including data from government departments such as DSEC, Civil Aviation Authority (AACM), DSPA and Transport Bureau (DSAT). During the inventory preparation process, the national GHG inventory team was invited as independent third-party experts to review the inventory.

1.3.2 Uncertainty Analysis

During the preparation of the 2020 greenhouse gas inventory for the Macau SAR, the inventory compilation agency adopted the error propagation method provided in the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* and referred to the emission factor uncertainties from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories* and the *2019 Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas*

Inventories. The overall uncertainty in MSAR's GHG Inventory 2020 was approximately 13.9%, with uncertainties of 11.7% and 147.5% in energy and waste sectors, respectively. See Table 5-8.

Table 5-8 Results of Uncertainty Analysis of MSAR's GHG Inventory 2020

	Emissions ($ktCO_2eq$)	Uncertainty
Energy	1,010	11.7%
Waste	62	147.5%
Overall uncertainty	13.9%	

Chapter 2 Mitigation Actions and Effects

2.1 Key Mitigation Actions, Policies and Effects

In 2016, the MSAR Government formulated the "Five-Year Development Plan of Macao Special Administrative Region (2016-2020)", which clearly outlined active support for the national green development strategy and vigorous promotion of civilized and healthy lifestyles characterized by green, low-carbon, and emission reduction practices. In 2021, the MSAR Government announced the "Second Five-Year Plan for Economic and Social Development of the Macao Special Administrative Region (2021-2025)", further establishing GHG control targets: by 2025, GHG emissions per unit of GDP will be reduced by 55% compared to 2005 levels, with the aim of peaking carbon emissions by or before 2030.

To achieve the above targets, the MSAR Government has implemented a series of mitigation actions. In the energy sector, the MSAR Government has gradually increased the share of natural gas power generation, continuously raised the share of clean electricity in imported power, and promoted the adoption of renewable energy (RE) such as photovoltaic (PV) power generation to improve its energy consumption structure. The share of natural gas power generation in MSAR increased significantly from 57.1% in 2020 to 93.3% in 2022, with natural gas having replaced heavy oil as the main source of power generation. The construction of the main natural gas pipeline network in Cotai area has been essentially completed. The undersea gas pipeline connecting Taipa and Macao Peninsula was completed in 2022, extending the gas supply network to the southern part of Macao Peninsula. In the future, the coverage of pipeline network in Macao Peninsula will continue to expand, and large hotels, tourist facilities, and businesses will be encouraged to prioritize the use or switch to natural gas.

In the transport sector, MSAR has actively reduced energy consumption and carbon emissions from land transport by implementing a public transit priority policy for land transport. In 2022, the MSAR Government announced the "General Planning of Macao Land Traffic and Transportation (2021-2030)", which lays out plans to further develop green transport options like light rail, buses, and walking. It encourages eco-friendly commuting, improves connections between green transport modes, and promotes the use of eco-friendly vehicles to boost green transport development in MSAR. It also proposes targets to increase the public transit modal share from 52.1% in 2019 to 55-60% by 2030, and to achieve a green

travel modal share of 70-75%. As of 2022, a total of 5,031 electric vehicles had been introduced, representing a 2.8-fold increase compared to 2020. Among these, 416 were range-extended electric buses, showing a 42-fold increase from 2020. In addition, public car parks had installed 2,116 public light vehicle charging spaces and 500 electric motorcycle charging spaces, with 30 light vehicle charging spaces available on public streets.

In terms of energy conservation and efficiency improvement, the MSAR Government has comprehensively implemented an energy management mechanism, formulated energy-saving plans for public departments and institutions, and monitored and managed energy usage to enhance energy efficiency in the public sector. Meanwhile, taking into account the energy consumption limits of neighboring regions, appropriate energy consumption standards have been established for MSAR, providing various departments with clearer energy-saving targets, to continuously improve and optimize energy management work. As of 2022, a total of 46 departments participated, with approximately 80% of departments meeting the standards. The "LED Street Light Replacement Plan" has been largely completed, with approximately 14,000 standard high-pressure sodium street lights across Macao replaced with LED lights. Currently, all new street lights installed are also LED lights.

Since 2007, the "Macao Green Hotel Award" has been held annually to promote energy conservation in the hotel and tourism industry, encouraging hotels and related industries to achieve environmentally friendly, low-carbon, and clean development. As of 2022, award-winning hotels accounted for approximately half of the total in Macao. In 2022, the award-winning hotels were equipped with more than 200 electric vehicle charging facilities, an increase of nearly 50% compared to 2021, with some facilities open for public use. About 30% of these were charging facilities for electric motorcycles. Additionally, 40% and 20% of the award-winning hotels used electric vehicles and natural gas vehicles, respectively.

In terms of urban greening, the MSAR Government continues to plant new trees, actively increasing the share of green areas and expanding vertical greening spaces in MSAR. From 2020 to 2022, over 6,000 trees were planted in parks, recreational areas, and roadside green belts. More than 12,000 mangrove seedlings were planted along the coastal recreational area of Taipa, and approximately 4,000 tree seedlings were planted in Coloane and Taipa as part of forest transformation efforts. In addition, forest restoration work was initiated in 2018 to address typhoon damage, with approximately 55,000 tree seedlings planted between 2018 and 2022.

Through actively promoting environmental protection, energy conservation, low-carbon Macao, and green lifestyle concepts, along with implementing a series of emission reduction policies and related measures, MSAR's per capita GHG emissions in 2020 decreased by approximately 21.2% compared to 2018; GHG emissions decreased by approximately 19.3% compared to 2018. See Table 5-9 for detailed mitigation actions and their effects.

Table 5-9 Overview of Mitigation Actions and Effects in MSAR

No.	Action	Objectives or Main Elements	Sectors/GHGs Covered	Timescale	Nature	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
1	Increase the share of gas power generation	Gas power generation was introduced in 2008, with its share gradually increasing	Energy/CO_2	2008 to present	Government	DSPA	Under progress	Local power generation primarily relies on natural gas, while heavy oil units are maintained only for emergency backup purposes and undergo regular testing or dispatching.	Emission reductions =Gas power generation × (Heavy oil power generation emission factor - Gas power generation emission factor) Base Year: 2008	From 2008 to 2022, GHG emissions were reduced by 370 kt CO_2	MSAR Government
2	Reduce carbon emissions per aircraft taking-off/ landing	Carbon emissions per aircraft landing and takeoff will be reduced by 30% in 2028 compared to 2018 Improving energy efficiency, replacing lighting systems and utilizing eco-friendly vehicles, implementing energy control in airport buildings, and enhancing waste management and recycling to reduce carbon emissions	Energy, Waste/CO_2, CH_4, N_2O	2018 to present	Voluntary	AACM	Under progress	Carbon emissions per aircraft landing and takeoff decreased in 2019, but due to the significant reduction in aircraft landing and takeoff at Macao International Airport between 2020 and 2022, carbon emissions per aircraft landing and takeoff increased during 2020-2022	Carbon emission reductions per aircraft landing and takeoff = Carbon emissions per aircraft landing and takeoff in the current year - Carbon emissions per aircraft landing and takeoff in the base year Base Year: 2018 Emission Boundary: Calculated based on direct and indirect emissions according to the requirements of Level 2 certification in the Airport Carbon Accreditation Program	Airport carbon emissions in 2022 decreased by 6.6% compared to 2018	Macau International Airport Co. Ltd.

No.	Action	Objectives or Main Elements	Sectors/GHGs Covered	Timescale	Nature	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
3	Promoted the use of environment -friendly vehicles	Providing tax incentives for new vehicles that meet environmental emission standards The main objective is to encourage citizens to use eco-friendly vehicles to reduce CO_2 and exhaust pollutant emissions	Energy /CO_2	2012 to present	Government/ Voluntary	DSPA	Under progress	Providing tax incentives for new vehicles that meet environmental emission standards in accordance with relevant laws	Emission reductions = Fuel savings × Gasoline emission factor Base Year: 2012	Total emission reductions from 2012 to 2022: 130 kt CO_2	MSAR Government
4	Urban gas distribution network supply	Promoting clean energy usage through urban gas introduction	Energy /CO_2	2013 to present	Government	DSPA	Under progress	Further improving the natural gas pipeline network. In 2022, the undersea gas pipeline connecting Taipa and the Macao Peninsula was completed, extending the gas supply network to the southern part of the Macao Peninsula.	Emission reductions = Gas consumption × Unit calorific value × (Petroleum gas emission factor - Natural gas emission factor) Base Year: 2013	Total emission reductions from 2013 to 2022: 33 kt CO_2	MSAR Government
5	Energy efficient and energy saving plan for public sectors and institutions	Public sector/institutions manage daily energy consumption through self-developed energy-saving plans	Energy /CO_2	2007 to present	Government/ Voluntary	DSPA	Under progress	As of 2022, a total of 46 departments participated, with approximately 80% of departments meeting the standards	Emission reductions = Power savings × Power generation emission factor Base Year: 2007	Total emission reductions from 2008 to 2022: 17 kt CO_2	MSAR Government
6	LED public outdoor lighting applications	Replacing and installing LED street lights	Energy /CO_2	2010 to present	Government	DSPA	Under progress	Completed the replacement of approximately 14,000 high-pressure sodium street lights across Macao with LED lights, and	Emission reductions = Power savings × Power generation emission factor Base Year: 2010	Total emission reductions from 2010 to 2022: 5 kt CO_2	MSAR Government

No.	Action	Objectives or Main Elements	Sectors/GHGs Covered	Timescale	Nature	Regulatory Authorities	Status	Progress	Methodologies and Assumptions	Estimated Emission Reductions	Support Received
								new street lights are also LED lights			
7	LED public local lighting applications	Replacing LED lighting fixtures for pedestrian overpass, parks and public toilets	Energy /CO_2	2015 to present	Government	Municipal Affairs Bureau (IAM)	Under progress	/	Emission reductions = Power savings × Power generation emission factor Base Year: 2015	Total emission reductions from 2015 to 2022: 10 kt CO_2	MSAR Government
8	Applications of solar PV technology	Application of solar PV technology in social housing and government departments	Energy /CO_2	2010 to present	Government	DSPA	Under progress	Solar PV systems will be installed in public housing and public building projects launched in Zone A of Macao New Urban Area. In addition to continuing to take the lead, the government will also promote the use of green energy by individuals and businesses through cross-departmental cooperation and simplifying application and approval processes.	Emission reductions = Power savings × Power generation emission factor Base Year: 2010	Total emission reductions from 2010 to 2022: 596 tCO_2	MSAR Government

2.2 MSAR’s MRV on Mitigation Actions

The MRV work of the MSAR Government is still in its initial stages. A preliminary statistical and accounting system for GHG inventory has been established in MSAR. Over the past few years, under national guidance, MSAR has completed and submitted GHG inventories for six years in accordance with the 2006 IPCC Guidelines, which have been reviewed by both national and international expert panels. In terms of enterprise inventory, in 2020, the MSAR Government conducted surveys among large-scale enterprises to prepare for promoting carbon audits in the hotel industry. It also studied operational rules and implementation plans for carbon audits specifically tailored to Macao's hotels, referencing domestic and international standards for carbon accounting and information disclosure.

In the future, the MSAR Government will move forward with MRV-related work in an orderly manner. On one hand, it will continue to optimize and improve the basic statistical and accounting system, strengthen statistical foundations in sectors such as Energy, IPPU, LULUCF, and Waste, and update accounting methods when appropriate. On the other hand, it will actively expand corporate carbon audit work, explore and develop carbon audit guidelines for different industries, and assist enterprises in establishing comprehensive basic statistical systems, to ensure that MSAR's MRV work foundation meets relevant national and international requirements.