

# GHG emissions reduction potential of Ho Chi Minh City's Climate Change Action Plan 2020



In September 2015, Vietnamese Government submitted the Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC), in which the target is to reduce 8-25% of total emissions in 2030 compared to Business-as-Usual (BaU). Under the national context, Ho Chi Minh City (HCMC) is developing the "Climate Change Action Plan (CCAP) in the 2016-2020 period, with a vision towards 2030" (follows Decision 1474/QĐ-TTg, 2012).

Based on the targets in "Master Plan for Socio-economic Development of HCMC till 2020 with vision to 2025" (Decision 2631/QĐ-TTg, 2013) and "Master Plan for Transportation Development of HCMC by 2020 and vision beyond 2020" (Decision 568/QĐ-TTg, 2013), two scenarios are developed for the socio-economic vision of HCMC by 2020, with the projection of energy consumption and CO<sub>2</sub> emission in energy-related categories such as Power generation, Transportation, Residential, Commercial, Agriculture and Industry. Moreover, the GHG emissions from non-energy-related categories such as land-use change, waste management, and water management are also estimated. In which, in BaU scenario we do not consider the GHG emissions reduction target. Meanwhile, in CCAP scenario, mitigation projects in the above mentioned categories will be implemented in order to meet the GHG emissions reduction target as declared in the Vietnam's INDCs. To meet this target, the project-based reduction potential is shown in Figure 1 and Table 1.

Information from many domestic sources is used to calibrate the parameters for base year 2013. In target year 2020, Extended Snapshot

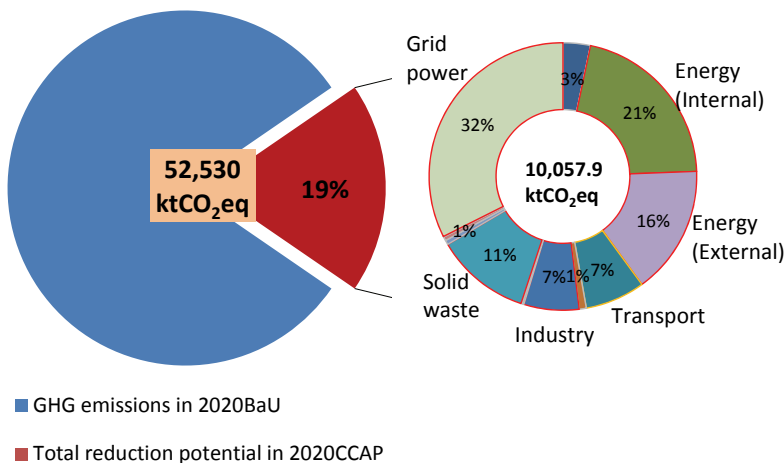


Figure 1: GHG emissions reduction potential in Ho Chi Minh City in 2020

Tool (ExSS) is applied for the projection of future energy consumption and CO<sub>2</sub> emission in energy-related categories. Moreover, Intergovernmental Panel on Climate Change (IPCC) guidelines are applied to estimate the GHG emissions from non-energy-related categories.

In 2020BaU, under the rapid growth of driving forces such as population, transport demand, and industrial activities; the total final energy consumption increases 1.73 times and GHG emissions increases 1.75 times, from 30,012 ktCO<sub>2</sub>eq in 2013 to 52,530 ktCO<sub>2</sub>eq.

In 2020CCAP, the total GHG emissions reduction in HCMC is 10,057.9 ktCO<sub>2</sub>eq. In which, HCMC can reduce 9.7% total emissions by implementing the current projects by internal effort (without international supports). With 6.2% reduction potential is from grid power, if considering this project into "internal" group, then HCMC can increase the reduction target to 15.9%. Moreover, projects in "external" group (with international supports) can contribute to reduce 3.2% of total emissions.

In conclusion, by implementing all projects ("internal", "external") and GHG emissions reduction from grid power, in 2020CCAP HCMC can reduce 19.1% total GHG emissions in 2020BaU (between the 10-20% national reduction target as declared in the Green Growth strategy and within 8-25% mentioned in the Vietnam's INDC submitted to UNFCCC).

Table 1: GHG emissions reduction potential in Ho Chi Minh City in 2020

	ktCO <sub>2</sub> eq	%
<b>1. GHG emissions in 2020BaU</b>	<b>52,530.0</b>	<b>100.0</b>
<b>2. GHG emissions reduction potential in 2020CCAP</b>	<b>10,057.9</b>	<b>19.1</b>
<b>a. Reduction by projects</b>	<b>Effort</b>	<b>Total Share</b>
	<b>Internal External</b>	<b>by sector by sector</b>
<i>Land-use planning</i>	333.7 0.3	<b>333.9 0.6</b>
<i>Energy</i>	2,119.7 1,564.0	<b>3,683.7 7.0</b>
<i>Transportation</i>	729.2 86.7	<b>816.0 1.6</b>
<i>Industry</i>	669.8 0.0	<b>669.8 1.3</b>
<i>Water management</i>	19.4 17.2	<b>36.6 0.1</b>
<b>Sector</b>		
<i>Solid waste management</i>	1,150.7 0.0	<b>1,150.7 2.2</b>
<i>Construction</i>	53.1 46.8	<b>99.9 0.2</b>
<i>Healthcare</i>	0.0 0.0	<b>0.0 0.0</b>
<i>Agriculture</i>	0.0 7.9	<b>7.9 0.0</b>
<i>Tourism</i>	0.0 0.0	<b>0.0 0.0</b>
<b>Total by effort</b>	<b>5,075.6 1,722.9</b>	<b>6,798.6 12.9</b>
<b>Share by effort (%)</b>	<b>9.7 3.3</b>	<b>12.9</b>
<b>b. Reduction from grid power</b>	<b>3,259.3</b>	<b>6.2</b>



## Socio-economic vision

The estimation of social and economic growth is based on the master development plan (Decision 2631/QĐ-TTg). Table 2 shows the results of main socio-economic driving forces for base year 2013 and target year 2020.

Table 2: Main socio-economic indicators in HCMC

	Unit	2013	2020	2020/2013
Population	persons	7,939,752	9,200,000	1.16
No. of households	household	1,277,338	1,840,000	1.44
GDP per capita	mil. Dongs	96	159	1.66
GDP	bil. Dongs	764,560	1,467,160	1.92
Agriculture		7,769	11,036	1.42
Industry		302,257	533,504	1.77
Commercial		454,534	922,621	2.03
Outputs	bil. Dongs	1,891,385	3,539,032	1.87
Agriculture		15,064	21,399	1.42
Industry		1,098,972	1,939,759	1.77
Commercial		777,348	1,577,874	2.03
Final consumption	bil. Dongs	400,533	800,858	2.00
Gross fixed capital formation	bil. Dongs	223,014	402,173	1.80
Export	bil. Dongs	723,138	1,316,629	1.82
Import	bil. Dongs	582,125	1,052,499	1.81
Passenger transport demand	mil.per.km	75,357	108,281	1.44
Freight transport demand	mil.ton.km	57,434	101,107	1.76
Solid waste generation	thous. ton	2,446	4,249	1.74

*Export and Import include both international and domestic*

## Population and households

As shown in Table 2, the registered population (night-time population) in HCMC increases 1.16 times compared to 2013, reaching 9.2 mil. people in 2020 (same as the projection in Master plan - Decision 2631/QĐ-TTg).

By assuming the household size in 2020 is 5 persons/household (smaller than the calculated value for 2013, which is 6.2), the total number of households increases 1.44 times, reaching more than 1.8 mil. households in 2020.

## Macro economy

Following the development targets in the master plan, it is estimated that the GDP of HCMC in 2020 will increase 1.92 times compared to 2013. In 2013, the commercial sector dominates the GDP share with 59.5%, followed by industrial sector with 39.5%. In 2020, due to the rapid growth rate in commercial compared to other sectors, the share of commercial in total GDP increases to 62.9%, while the share of industry reduces to 36.4%, with a small share of less than 1% of total GDP is from agriculture. This economic structure follows the current trend and future vision of Vietnam towards the tertiary industrial economy.

As the biggest city in Vietnam, the GDP per capita of Ho Chi Minh in 2013 is around 96 mil. Dongs (more than twice of national average), and increases 1.66 times compared to 2013. Thus, the GDP per capita reaches 159 mil. Dongs in 2020 due to the rapid GDP growth.

As a result of income increase, the final consumption in 2020 also increases 2.00 times compared to 2013, in which main consumption is from households for industrial commodities and services while the government consumption is mainly for science, technology, and other services.

The increasing population and consumption leads to 1.74 times increase of municipal solid waste generation, from 2,446 thous. ton (in 2013) to 4,249 thous. ton (in 2020). The main management options for solid waste are disposal (80.2%), composting (11.2%), incineration (6.6%) and recycling (2.0%) (Source: Solid waste treatment plan, 2012).

## Outputs

As shown in Table 2, total output in 2020 increases 1.87 times compared to 2013, in which the industrial sector still dominates with more than 58.1% in 2013 and 54.8% in 2020. However, due to the higher growth rate compared to other sectors, the share of commercial sector increases from 41.1% in 2013 to 44.6% in 2020. Agriculture still keeps a small share of less than 1%.

In industry, food-tobacco, construction, machinery, chemical-petrochemical, and rubber-plastic are main activities contributing to 17.7%, 14.5%, 11.8%, 9.1%, and 7.7% of industrial output, respectively (Figure 2).

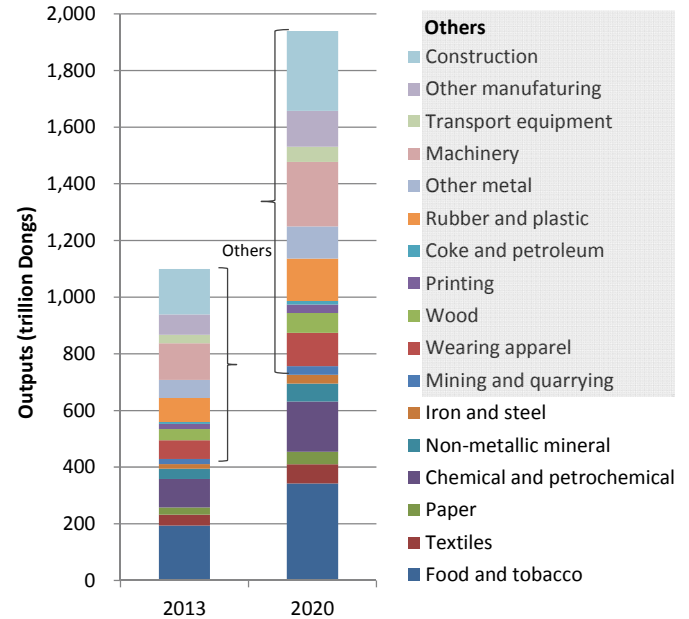


Figure 2: Outputs by industrial sub-sectors

## Transport demands

Due to the increasing population and industrial activities, the transport demand in 2020 also increases rapidly with 1.44 times of passenger transport demand and 1.74 times increase of freight transport demand compared to 2013 (Table 2).

In passenger transport, there is a rapid increase of demand on car (including taxi) to 2.89 times, even motorbike still dominates. The share of public transport (bus, train and MRT) increases from 4.9% in 2013 to 21.0% in 2020BaU and reaches 26.0% in 2020CCAP due to the contribution of BRT and MRT system as urban transport planning.

In freight transport, the demand increases mainly in truck and waterway. Since we have no information about the plan for freight transport, we assume that the shares of freight transport modes in 2020 are the same as in 2013, in which truck contributes to more than 66.6%, followed by waterway with 33.1% contribution, and a very small part is from train.

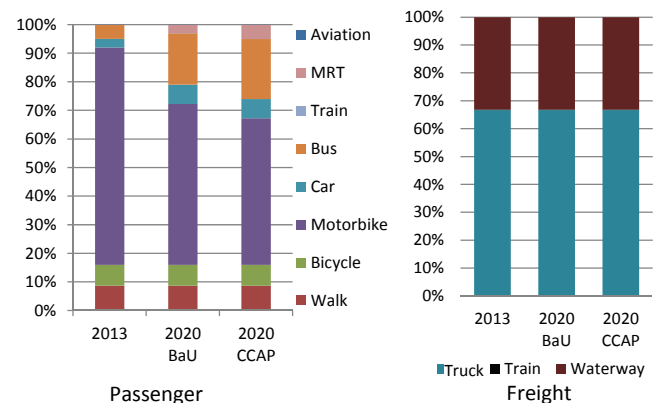


Figure 3: Modal share in transport sector

## Projection of final energy consumption

The energy intensity by GDP reduces from 9.1 toe/bil. Dongs in 2013 to 8.2 toe/bil. Dongs in 2020BaU and 7.4 toe/bil. Dongs in 2020CCAP due to the lower increasing rate of energy consumption compared to the rapid growth of GDP. This reduction follows the target to reduce 1% to 1.5% per year as mentioned in Decision 1393/QD-TTg for “National Green Growth Strategy”.

In 2020BaU, the total energy consumption is 1.73 times higher than 2013 (Table 3), increasing from 6,972 ktoe to 12,056 ktoe. In which, industry is still the main energy consumer with 59.4% (1.83 times increase), followed by transport sector with 20.4%. Commercial has the highest speed of energy consumption with 2.18 times increase and its share is 10.1%.

In term of energy consumption mix, there is a switch from coal and oil consumption to natural gas and electricity. However, coal and gas are still main energy sources with the share of coal and oil consumption from 68.2% in 2013 to 67.0% in 2020BaU, especially for industrial activities. A small share of total final energy consumption is from biomass for some purposes in residential and commercial sectors.

Figure 4 shows the final energy consumption in industrial sector, in which group “Others” (non-classified in IEA’s EBT) is the biggest consumer with 42.5%, followed by non-metallic mineral with 25.1%, and paper production with 8.1%. The other energy consumers are textiles, food-tobacco, chemical, and iron-steel with the shares are 7.8%, 7.4%, 7.1% and 2.1%, respectively.

Table 3: Final energy consumption by sectors (ktoe)

	2013	2020BaU	2020CCAP	BaU/2013	CCAP/BaU
Agriculture	8	11	11	1.47	1.00
Industry	3,921	7,166	6,569	1.83	0.92
Commercial	561	1,221	1,101	2.18	0.90
Residential	786	1,198	1,060	1.52	0.89
Passenger transport	1,256	1,684	1,438	1.34	0.85
Freight transport	441	776	670	1.76	0.86
<b>Total</b>	<b>6,972</b>	<b>12,056</b>	<b>10,849</b>	<b>1.73</b>	<b>0.90</b>

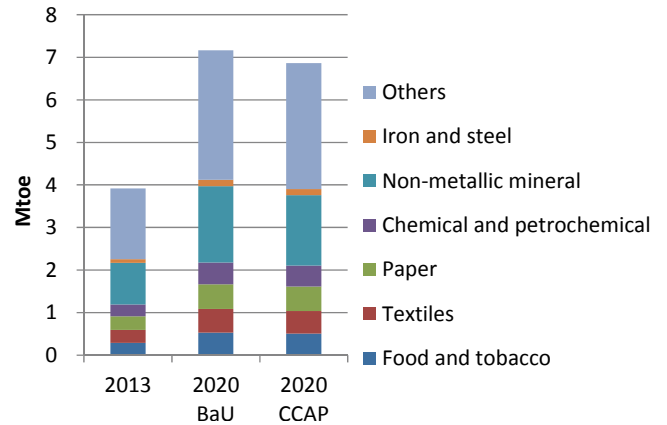


Figure 4: Final energy consumption by industrial sub-sectors

## Projection of GHG emissions

In 2020BaU, the total GHG emissions increases 1.75 times compared to 2013. In which, the share of energy-related GHG emissions increases from 93.6% in 2013 to 95.1% in 2020BaU and the remaining share is from non-energy-related GHG emissions.

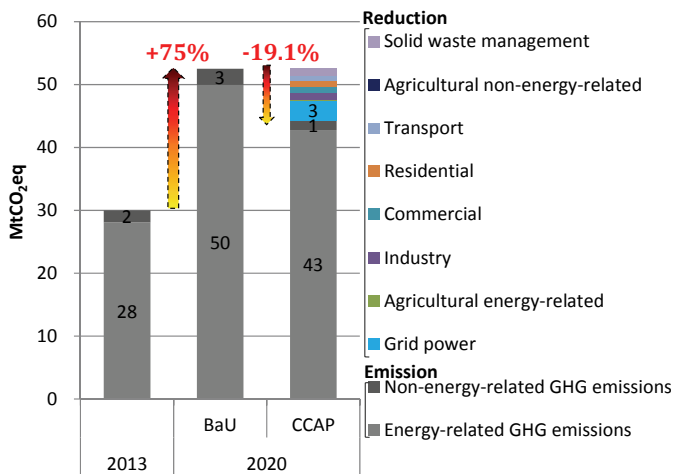


Figure 5: GHG emissions and reduction

Table 4: GHG emissions by sectors (ktCO<sub>2</sub>eq)

	2013		2020 BaU		2020 CCAP		2020 BaU/2013		2020 CCAP/BaU	
	ktCO <sub>2</sub> eq	%	ktCO <sub>2</sub> eq	%	ktCO <sub>2</sub> eq	%	Ratio	%	Ratio	
<b>GHG emissions</b>										
<b>Energy-related GHG emissions</b>	<b>28,094</b>	<b>93.6</b>	<b>49,947</b>	<b>95.1</b>	<b>41,381</b>	<b>97.4</b>	<b>1.78</b>	<b>95.1</b>	<b>0.83</b>	<b>0.83</b>
Agricultural energy-related	26	0.1	38	0.1	36	0.1	1.48	0.1	0.95	0.95
Industry	15,001	50.0	27,811	52.9	23,940	56.4	1.85	52.9	0.86	0.86
Commercial	2,988	10.0	6,717	12.8	4,914	11.6	2.25	12.8	0.73	0.73
Residential	5,074	16.9	8,047	15.3	6,054	14.3	1.59	15.3	0.75	0.75
Transport	5,006	16.7	7,333	14.0	6,436	15.2	1.46	14.0	0.88	0.88
<b>Non-energy related GHG emissions</b>	<b>1,918</b>	<b>6.4</b>	<b>2,583</b>	<b>4.9</b>	<b>1,425</b>	<b>3.4</b>	<b>1.35</b>	<b>4.9</b>	<b>0.55</b>	<b>0.55</b>
Agricultural non-energy related	635	2.1	406	0.8	399	0.9	0.64	0.8	0.98	0.98
Solid waste management	1,283	4.3	2,177	4.1	1,026	2.4	1.70	4.1	0.47	0.47
<b>CO<sub>2</sub> absorption</b>										
Total GHG emissions	30,012	100.0	52,530	100.0	42,472	100.0	1.75	100.0	0.81	0.81
<b>GHG emissions per GDP (tCO<sub>2</sub>eq/bil.Dongs)</b>	<b>39.3</b>		<b>35.8</b>		<b>28.9</b>		<b>0.91</b>		<b>0.81</b>	
<b>GHG emissions per capita (tCO<sub>2</sub>eq/person)</b>	<b>3.8</b>		<b>5.7</b>		<b>4.6</b>		<b>1.51</b>		<b>0.81</b>	

Detail GHG emissions by categories is summarized in Table 4.

In energy-related categories, the biggest CO<sub>2</sub> emitter is still industry with 1.85 times increase, contributing to 52.9% of total emissions. Residential and commercial sectors contribute to 15.3% (1.59 times of 2013) and 12.8% (2.25 times of 2013) of total emissions, respectively. Meanwhile, emission from transport increases 1.46 times compared to 2013 (14.0% of the total emissions). The agricultural energy-related activity contributes 0.1% of total emissions.

As the main energy consumers in industrial sub-sectors, group “Others” (mainly manufacturing, construction, machinery, etc.) shares 34.6% of emissions from industry. Moreover, emissions from non-metallic mineral and paper production have 1.84 times increase compared to 2013, contributing to 27.5% and 10.3%, respectively. Textiles, food-tobacco, and chemical production also contribute to 9.2%, 8.0%, and 7.8% of the emission from industry, respectively. Meanwhile, Iron and steel has the smallest amount of CO<sub>2</sub> emission since this is not the main industrial activity in HCMC.

In non-energy-related categories, solid waste is the main emitter with 1.70 times increase, contributing to 4.1% of total emissions. Meanwhile, the agricultural non-energy-related activity contributes 0.8% of total emissions.



## GHG emissions reduction by categories

Among the categories, energy has the largest reduction potential, followed by solid waste management and transport. The fourth reduction potential is from industry, even though this is the main source of GHG emissions.

The fifth reduction potential is from land-use planning, since Ho Chi Minh City has several priority projects, such as the construction of regulation ponds and the increase of greenery. Construction is the sixth reduction potential, followed by water management and agricultural non-energy related activities.

The below explanation follows the order of categories in the Ho Chi Minh City's CCAP. In which, the reduction potential of categories (VIII) - Health care and (X) - Tourism are not quantified. GHG emissions reduction potential by project is summarized in Table 6.

### [I] Reduction in Land-use planning: 333.9 ktCO<sub>2</sub>eq

The main mitigation project is afforestation and greening, particularly the planting of 10 million tree in parks, along roads and pedestrian spaces, riparian and coastal areas as planned in the Decision 05/QD-UBND on the approval of afforestation and planting in HCMC 2011-2015 with vision to 2020. This project contributes to reduce 333.7 ktCO<sub>2</sub>eq. Moreover, wind channels (green corridors) project implemented in commercial buildings reduces the electricity consumption for cooling, thus reduce 0.2 ktCO<sub>2</sub>eq.

### [II] Reduction in Energy: 6,943.0 ktCO<sub>2</sub>eq

This category covers all activities related to the production and consumption of energy. In the Energy Saving Company (ESCO) project, with the assumed diffusion rate is 20% and the energy saving rate is 13-14%, the reduction amount is 1,123.7 ktCO<sub>2</sub>eq. The replacement to high efficiency lighting (such as LED) in public lighting (160,000 lights), commercial building (8 million lights) and residential buildings (10 million lights) contributes to reduce 688.1 ktCO<sub>2</sub>eq.

By using energy saving devices (such as air conditioners with 25% diffusion rate), energy saving glasses (with 5% diffusion rate), and technology (with 10% diffusion rate) in residential and commercial buildings, the reduction amount is 176.1 ktCO<sub>2</sub>eq, 129.5 ktCO<sub>2</sub>eq and 55.2 ktCO<sub>2</sub>eq, respectively. The promotion of energy-efficient appliances has the potential to reduce 275.2 ktCO<sub>2</sub>eq. Besides, the installation of energy efficiency improvement facilities in small-medium enterprises (450 furnaces) reduces the oil consumption and thus reduce 603.6 ktCO<sub>2</sub>eq.

Renewable energies (including photovoltaic power at 4-5 MW installed capacity, solar water heater with 20% diffusion rate, small-scale hydropower with 2,000 MWh capacity, 4 wind power units with 3,000MWh capacity/unit) contributes to reduce 330.9 ktCO<sub>2</sub>eq. Moreover, the regional energy supply system with 10% diffusion rate at industry helps to reduce 301.3 ktCO<sub>2</sub>eq. Furthermore, by improving the generation efficiency and reducing the transmission loss, grid power can reduce 3,259.3 ktCO<sub>2</sub>eq.

### [III] Reduction in Transport: 816.0 ktCO<sub>2</sub>eq

This category covers both passenger and freight transport. The improvement of transport management system such as promotion of eco-driving with digital tachographs (with 20% diffusion rate), wide-range traffic control (1,000 integrated control traffic lights will be installed), and expansion of frequencies and routes for bus transport (assuming that additional 3% shift from motorbike to bus) contributes to reduce 20.3 ktCO<sub>2</sub>eq, 17.6 ktCO<sub>2</sub>eq, and 69.7 ktCO<sub>2</sub>eq, respectively.

The modal shift to subway (additional 2%), BRT (additional 3%), CNG bus (30% diffusion rate), and electric vehicles (5% diffusion rate) reduces 174.2 ktCO<sub>2</sub>eq. On the other hand, promoting energy-efficient vehicles has the potential to reduce 534.3 ktCO<sub>2</sub>eq.

### [IV] Reduction in Industry: 669.8 ktCO<sub>2</sub>eq

This category covers all manufacturing and producing activities, including the production of agricultural products. By improving the kiln operation techniques, the heat can be recovered. With 1,000 heat recovery units being installed, this project reduces 669.8 ktCO<sub>2</sub>eq (assuming one unit can reduce 669.8 tCO<sub>2</sub>eq).

### [V] Reduction in Water management: 36.6 ktCO<sub>2</sub>eq

By constructing the regulation ponds (total area is 800 ha), rain water storage facility (4 ha), as well as improving the water distribution system (water saving and reduce leakage), water management sector can reduce 36.6 ktCO<sub>2</sub>eq.

### [VI] Reduction in Waste management: 1,150.7 ktCO<sub>2</sub>eq

This category only covers the municipal solid waste management activities. In which, the reduction of waste generation and change of management option reduce 178.1 ktCO<sub>2</sub>eq and 40.3 ktCO<sub>2</sub>eq, respectively. Moreover, the waste-to-energy (biogas, power generation from incineration, methane recovery) has the potential to reduce 932.3 ktCO<sub>2</sub>eq.

### [VII] Reduction in Construction: 99.9 ktCO<sub>2</sub>eq

This category covers the activities at construction sites, while the production of material is included in Industry category.

By assuming 10% diffusion rate for environmentally-sound building and energy-efficient building material, the reduction potential is 55.9 ktCO<sub>2</sub>eq. Furthermore, the introduction of energy-efficient construction machine with 20% diffusion rate can reduce 44.1 ktCO<sub>2</sub>eq.

### [IX] Reduction in Agriculture: 7.9 ktCO<sub>2</sub>eq

This category covers non-energy related activities in agriculture, such as rice cultivation and animal husbandry. The biogas-based electric power generation from livestock manure has the potential to reduce 6.3 ktCO<sub>2</sub>eq. Moreover, reducing fertilizer usage and reduce energy consumption help to reduce 1.6 ktCO<sub>2</sub>eq.

## Comparison of the 2020CCAP's performance and related targets prescribed in "Decisions"

Table 5 shows the comparison of the reduction targets of HCMC based on the implementation of CCAP's project and the related targets prescribed in Decision 1393/QD-TTg for "National Green Growth Strategy", Decision 2631/QD-TTg, 2013 for "Master Plan for Socio-economic Development of HCMC till 2020 with vision to 2025", and the Vietnam's INDCs submitted to the UNFCCC.

Table 5: GHG emissions reduction in HCMC's CCAP and related decisions

Index	Performance of the proposed Scenarios in 2020		Quantified GHG emissions objectives and related targets based on Decisions		Reference
	BaU	CCAP	2020	2030	
GHG emissions	1.8 <sup>(1)</sup>	1.4 <sup>(1)</sup>	2.3 <sup>(2)</sup> - 2.4 <sup>(2)</sup>	2.0 <sup>(2)</sup>	Decision 1393/QD-TTg Decision 2631/QD-TTg
GHG emissions intensity	0.91 <sup>(1)</sup>	0.74 <sup>(1)</sup>	0.90 <sup>(2)</sup> - 0.92 <sup>(2)</sup>	0.70 <sup>(3)</sup> - 0.80 <sup>(4)</sup> 0.70 <sup>(3)</sup> - 0.80 <sup>(4)</sup>	Decision 1393/QD-TTg Vietnam's INDCs
GHG emissions from energy-related activities compared to BaU	1.00 <sup>(6)</sup>	0.83 <sup>(6)</sup>	0.80 <sup>(3)</sup> - 0.90 <sup>(4)</sup>	0.70 <sup>(3)</sup> - 0.80 <sup>(4)</sup> 0.92 <sup>(6)</sup> - 0.75 <sup>(6)</sup>	Decision 1393/QD-TTg Vietnam's INDCs
GDP	1.9 <sup>(1)</sup>	1.9 <sup>(1)</sup>	2.5 - 2.7 <sup>(5)</sup>	5.7 <sup>(5)</sup> - 6.3 <sup>(5)</sup>	Decision 2631/ QD-TTg
Energy Intensity	0.90 <sup>(1)</sup>	0.85 <sup>(1)</sup>	0.80 <sup>(5)</sup>	-	Decision 1393/ QD-TTg

Note:

- 1) compared with 2013
- 2) compare with 2010, with the assumption that HCMC adopts the same intensity target as national one
- 3) compare with 2010, with the assumption that HCMC adopts the same target as national one, and with internal voluntary and additional international supports
- 4) compare with 2010, with the assumption that HCMC adopts the same target as national one, and with internal voluntary effort
- 5) compare with 2010
- 6) compared with BaU

## Detail of mitigation projects in HCMC's CCAP

Table 6: Detail emission reduction by projects in each category (ktCO<sub>2</sub>eq)

Category code	Project category	Project code	Project name	Effort	Sector	Emission reduction
I	Land-use planning	I-3	Afforestation and greening (parks, roads, pedestrian spaces, riparian and coastal areas)	Internal	CO <sub>2</sub> absorption	333.7
			Build wind channels (green corridors)	External	Commercial	0.2
		<b>TOTAL (I)</b>				
II	Energy	II-1	Energy efficiency technology applied to buildings	Internal	Commercial	55.2
		II-2	ESCO (Energy Saving COmpany) Project	External	Total II-2	1,123.7
		II-2	ESCO (Energy Saving COmpany) Project for commercial buildings	External	Commercial	233.5
		II-2	ESCO (Energy Saving COmpany) Project for industries	External	Industry	890.2
		II-3	High Efficiency Lighting	Internal	Total II-3	688.1
		II-3	High Efficiency Lighting in public lighting	Internal	public lighting	3.9
		II-3	High Efficiency Lighting in commercial buildings	Internal	Commercial	397.3
		II-3	High Efficiency Lighting in households	Internal	Residential	287.0
		II-4	High Efficiency Air Conditioners (such as Air Conditioners with Inverter Controllers)	Internal	Total II-4	176.1
		II-4	High Efficiency Air Conditioners (such as Air Conditioners with Inverter Controllers) in commercial buildings	Internal	Commercial	47.7
		II-4	High Efficiency Air Conditioners (such as Air Conditioners with Inverter Controllers) in households	Internal	Residential	128.4
		II-5	Energy Efficiency Improvement Facilities to be installed at Small/Medium Enterprises (Compressors, Motors)	Internal	Industry	603.6
		II-6	Introduction of Photovoltaic Power Generation	Internal	Total II-6	6.4
		II-6	Introduction of Photovoltaic Power Generation to commercial buildings	Internal	Commercial	3.9
		II-6	Introduction of Photovoltaic Power Generation to households	Internal	Residential	2.5
		II-7	Introduction of Solar Water Heater	Internal	Total II-7	315.0
		II-7	Introduction of Solar Water Heater to commercial buildings	Internal	Commercial	199.6
II-7	Introduction of Solar Water Heater to households	Internal	Residential	115.4		
II-8	Installation of Energy Saving Glasses	External	Total II-8	129.5		
II-8	Installation of Energy Saving Glasses to commercial buildings	External	Commercial	80.1		
II-8	Installation of Energy Saving Glasses to households	External	Residential	49.4		
II-9	Regional Energy Supply System	External	Industry	301.3		
II-10	Introduction of Small-scale Hydropower Generation (at water distribution stations, canals)	External	Commercial	1.4		
II-11	Introduction of Wind Power Generation	External	Commercial	8.1		
II-12	Promotion of energy-efficient appliances	Internal	Residential	275.2		
			Improvement of generation efficiency, Reduction of transmission loss	Internal	Grid	3,259.3
<b>TOTAL (II)</b>						<b>6,943.0</b>
III	Transportation	III-2	Promotion of Eco-Driving with Digital Tachographs	Internal	Transport	20.3
		III-3	Construction of Subway	Internal	Transport	35.2
		III-7	Wide-range traffic control	Internal	Transport	17.6
		III-10	Expansion of Frequencies and Routes of Bus Transportation	Internal	Transport	69.7
		III-12	Development of Bus Rapid Transit (BRT)	External	Transport	69.7
		III-13	Shift to CNG bus	External	Transport	17.1
		III-14	Introduction of Electric Motorbikes and bicycles	Internal	Transport	52.2
					Promotion of energy-efficient vehicles	Internal
<b>TOTAL (III)</b>						<b>816.0</b>
IV	Industry	IV-1	Improvement of Kiln Operation Techniques/Technologies	Internal	Industry	669.8
<b>TOTAL (IV)</b>						<b>669.8</b>
V	Water management	V-1	Stable Water Intake Facility (regulation pond)	Internal	Total V-1	3.7
		V-1	Stable Water Intake Facility (regulation pond) [Commercial]	Internal	Commercial	2.1
		V-1	Stable Water Intake Facility (regulation pond) [Residential]	Internal	Residential	1.6
		V-6	Introduction of Rainfall Water Storage Facility	Internal	Commercial	0.0164
		V-8	Recycling of Rain Water (with Water Purification Equipment)	Internal	Commercial	0.004
		V-8	Countermeasures for water storage and flood	Internal	Commercial	0.004
		V-10	Promotion and Distribution of Water-Saving Equipment	Internal	Commercial	10.9
			Improvement of Leakage from Clean Water Pipe Network	External	Commercial	17.2
			Introduction of Water Distribution Management to Improve Water Supply System	Internal	Commercial	4.8
<b>TOTAL (V)</b>						<b>36.6</b>
VI	Solid waste management		Reduction of waste generation	Internal	SW management	178.1
			Change of management options	Internal	SW management	40.3
		VI-2	Biogas-based Power Generation	Internal	SW management	85.7
		VI-3	Electricity Generation from Solid Waste Incineration	Internal	SW management	181.0
			CH <sub>4</sub> recovery from landfill and transferred to biogas	Internal	SW management	665.6
<b>TOTAL (VI)</b>						<b>1,150.7</b>
VII	Construction	VII-1	Introduction of Incentive to Environmentally Sound Buildings	Internal	Commercial	9.1
		VII-5	Introduction of Energy Efficient Constructing Machine	Internal	Industry	44.1
			Introduction of Energy Efficient Building Materials	External	Residential	46.8
		<b>TOTAL (VII)</b>				
IX	Agriculture		Prevention of Mudslides by Planting Trees	External	Agricultural non-energy related	0.03
			Introduction of Water-saving Pumps with Utilization of Renewable Energy	External	Agricultural non-energy related	0.4
			Biogas-based Electric Power Generation from Livestock Manure	External	Agricultural non-energy related	6.3
			Reduction of Agricultural Chemicals and Fertilizers Usage	External	Agricultural non-energy related	0.8
			Photovoltaic Power Generation at Agricultural Communities	External	Agricultural non-energy related	0.4
		<b>TOTAL (IX)</b>				
<b>Total GHG emissions reduction potential in 2020CCAP</b>						<b>10,057.9</b>

Note: Table 6 only lists up projects which reduction potential can be quantified. Projects in categories (VIII) Healthcare and (X) Tourism have no direct reduction potential. In the 3rd column, projects that have project codes are CCAP's projects; and those without code are projects proposed by AIM team.

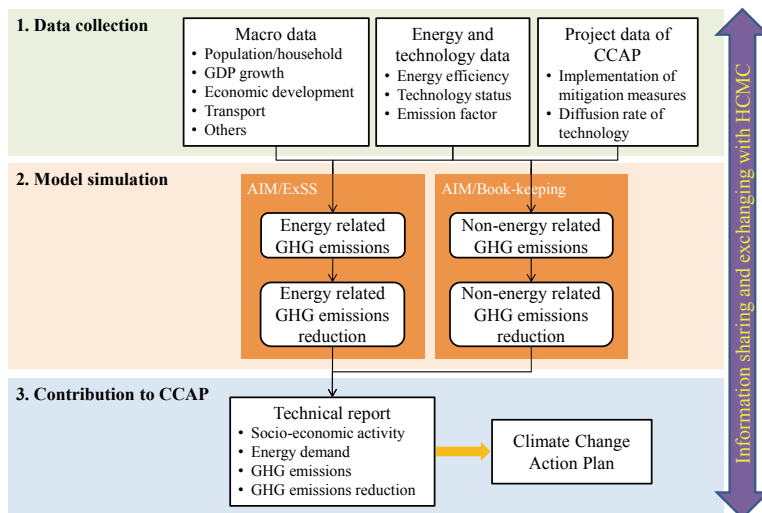
## Energy consumptions

Unit: ktoe

Year	Sector	Coal	Oil	Gas	Biomass	Electricity	Total
2013	Agriculture	0.3	6.7	0.0	0.0	0.6	<b>7.6</b>
	Industry	1,915.2	707.4	135.2	541.3	621.5	<b>3,920.7</b>
	Commercial	0.0	272.7	0.0	0.9	287.4	<b>561.1</b>
	Residential	0.0	154.3	0.0	23.8	608.2	<b>786.3</b>
	Passenger transport	0.0	1,255.6	0.0	0.0	0.0	<b>1,255.6</b>
	Freight transport	0.0	440.7	0.0	0.0	0.0	<b>440.7</b>
<b>Total</b>		<b>1,915.5</b>	<b>2,837.5</b>	<b>135.2</b>	<b>566.1</b>	<b>1,517.7</b>	<b>6,972.0</b>
2020 BaU	Agriculture	0.5	9.9	0.0	0.0	0.9	<b>11.2</b>
	Industry	3,500.5	1,293.1	247.2	989.4	1,135.9	<b>7,166.1</b>
	Commercial	0.0	593.5	0.0	2.0	625.6	<b>1,221.1</b>
	Residential	0.0	235.0	0.0	36.3	926.4	<b>1,197.6</b>
	Passenger transport	0.0	1,669.7	0.0	0.0	14.7	<b>1,684.3</b>
	Freight transport	0.0	775.8	0.0	0.0	0.0	<b>775.8</b>
<b>Total</b>		<b>3,501.0</b>	<b>4,576.9</b>	<b>247.2</b>	<b>1,027.7</b>	<b>2,703.4</b>	<b>12,056.2</b>
2020 CCAP	Agriculture	0.5	9.9	0.0	0.9	0.0	<b>11.2</b>
	Industry	3,321.3	1,238.9	236.9	2,084.3	0.0	<b>6,881.4</b>
	Commercial	0.0	500.3	0.0	568.0	59.0	<b>1,127.3</b>
	Residential	0.0	207.2	0.0	865.1	5.9	<b>1,078.1</b>
	Passenger transport	0.0	1,461.2	28.5	66.3	0.0	<b>1,556.0</b>
	Freight transport	0.0	699.2	0.0	0.0	0.0	<b>699.2</b>
<b>Total</b>		<b>3,321.7</b>	<b>4,116.6</b>	<b>265.4</b>	<b>3,584.6</b>	<b>64.9</b>	<b>11,353.2</b>

In 2020, Biomass includes the modern way of using rice husk, coconut cover, palm oil, etc.

## Work procedure



## Energy-related GHG emissions

Unit: ktCO<sub>2</sub>eq

Year	Sector	Coal	Oil	Gas	Biomass	Electricity	Total
2013	Agriculture	1.3	19.8	0.0	0.0	4.5	<b>25.6</b>
	Industry	7,877.1	2,087.8	317.4	0.0	4,719.1	<b>15,001.3</b>
	Commercial	0.0	804.9	0.0	0.0	2,182.7	<b>2,987.6</b>
	Residential	0.0	455.3	0.0	0.0	4,618.4	<b>5,073.7</b>
	Passenger transport	0.0	3,705.5	0.0	0.0	0.0	<b>3,705.5</b>
	Freight transport	0.0	1,300.5	0.0	0.0	0.0	<b>1,300.5</b>
<b>Total</b>		<b>7,878.4</b>	<b>8,373.8</b>	<b>317.4</b>	<b>0.0</b>	<b>11,524.6</b>	<b>28,094.2</b>
2020 BaU	Agriculture	2.0	29.2	0.0	0.0	6.9	<b>38.0</b>
	Industry	14,397.5	3,816.0	580.2	0.0	9,017.2	<b>27,810.9</b>
	Commercial	0.0	1,751.6	0.0	0.0	4,965.8	<b>6,717.4</b>
	Residential	0.0	693.5	0.0	0.0	7,353.9	<b>8,047.3</b>
	Passenger transport	0.0	4,927.5	0.0	0.0	116.3	<b>5,043.8</b>
	Freight transport	0.0	2,289.5	0.0	0.0	0.0	<b>2,289.5</b>
<b>Total</b>		<b>14,399.5</b>	<b>13,507.2</b>	<b>580.2</b>	<b>0.0</b>	<b>21,460.1</b>	<b>49,946.9</b>
2020 CCAP	Agriculture	2.0	29.2	0.0	0.0	5.1	<b>36.3</b>
	Industry	12,679.2	3,527.0	534.2	0.0	7,199.2	<b>23,939.5</b>
	Commercial	0.0	1,304.9	0.0	0.0	3,609.4	<b>4,914.3</b>
	Residential	0.0	550.1	0.0	0.0	5,504.1	<b>6,054.2</b>
	Passenger transport	0.0	3,880.1	133.9	0.0	444.5	<b>4,458.5</b>
	Freight transport	0.0	1,977.7	0.0	0.0	0.0	<b>1,977.7</b>
<b>Total</b>		<b>12,681.1</b>	<b>11,269.0</b>	<b>668.1</b>	<b>0.0</b>	<b>16,762.4</b>	<b>41,380.6</b>

## Non-energy-related GHG emissions

Unit: ktCO<sub>2</sub>eq

Year	Non-energy categories	GHG emissions				Reduction by power generation (waste-to-energy)	Total including waste-to-energy
		CO <sub>2</sub>	CH <sub>4</sub>	N <sub>2</sub> O	Total		
2013	Waste	95	1,162	26	1,283		<b>1,283</b>
	Agriculture	507	128	635			<b>635</b>
2020 BaU	Waste	165	1,964	48	2,177		<b>2,177</b>
	Agriculture	272	135	406			<b>406</b>
2020 CCAP	Waste	673	450	159	1,283	-257	<b>1,026</b>
	Agriculture	265	134	399			<b>399</b>

## Acronyms and Abbreviations

AIM	Asia-Pacific Integrated Modeling
BaU	Business as Usual scenario
BRT	Bus Rapid Transit
CC	Climate Change
CCAP	Climate Change Action Plan scenario
CNG	Compressed Natural Gas
EBT	Energy Balance Table
ExSS	Extended Snapshot Tool
GDP	Gross Domestic Product
HCCB	Ho Chi Minh City Climate Change Bureau
HCMC	Ho Chi Minh City
IEA	International Energy Agency
IGES	Institute for Global Environmental Strategies
INDCs	Intended Nationally Determined Contributions
IOT	Input-Output Table
ktCO <sub>2</sub> eq	kilo-ton Carbon dioxide
KU	Kyoto University
LCC	Low Carbon City
MHIR	Mizuho Information and Research Institute
MRT	Mass Rapid Transit
NIES	National Institute for Environmental Studies, Japan
PDP7	Power Development Plan 7
SYB	Statistical Yearbook
toe	ton of oil equivalent

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