Low Carbon Scenarios for Ho Chi Minh City, Vietnam 2030

Currently, Vietnamese Government responds to the challenge of climate change through a number of decisions such as "National Target Program to respond to Climate Change" (Decision 158/QD-TTg, 2008), "National Climate Change Strategy" (Decision 2139/QD-TTg, 2011), "National Green Growth Strategy" (Decision 1393/QD-TTg, 2012), and "Plan to Manage GHG Emissions and Carbon Trading Activities to the World Market" (Decision 1775/QD-TTg, 2012).

Under the national context, Ho Chi Minh City (HCMC) issued the "Climate Change Action Plan by 2015" (Decision 2484/QD-UBND, 2013). Moreover, HCMC is developing a proposal for "Climate Change Action Plan (CCAP) in the 2016-2020 period, with a vision towards 2030" (follows Decision 1474/QD-TTg, 2012). This Action Plan is necessary and should be integrated with the middle- and long-term master plan of socio-economic development, specific sectoral development plans (such as transportation, industry, power, agriculture, etc.) as well as water and waste management.

This brochure is one of the outputs of the research collaboration between Asian-Pacific Integrated Model (AIM) team in Japan and University of Natural Resources and Environment (U.NRE) with Department of Science and Technology (DOST) in HCMC, Vietnam. We expect this brochure is useful for researchers and policy-makers who are interested in developing the CCAP and can support the vision of building green growth for HCMC.

Based on the targets in "Master Plan for Socio-economic Development of HCMC till 2020 with vision to 2025" (Decision 2631/QD-TTg, 2013) and "Master Plan for Transportation Development of HCMC by 2020 and vision beyond 2020" (Decision 568/QD-TTg, 2013), two scenarios are developed for the socio-economic vision of HCMC by 2030 with the projection of energy consumption and CO_2 emission in energy sectors such as Power generation, Transportation, Residential, Commercial and Industry. In which, in Business-as-Usual scenario (BaU) we do not consider the CO_2 emission reduction target. Meanwhile, in CounterMeasure scenario (CM), some countermeasures are proposed that might be appropriate for HCMC's climate change mitigation actions in the above mentioned sectors. In CM, the target is to reduce 20% of total emission in BaU, following the national target decided in Decision 1393/QD-TTg. To meet this target, we propose 5 actions as shown in Table 1.

Information from many domestic sources is used to calibrate the parameters for base year 2011 and Extended Snapshot Tool (ExSS) is applied for the future projection in target year 2030. In BaU, under the rapid growth of driving forces such as population, transport demand, and industrial activities, the total final energy consumption increases 4 times and CO_2 emission increases 4.5 times compared to 2011.

In CM, the total direct CO_2 emission reduction in HCMC is 34.2 $MtCO_2$, without counting the reduction from grid power. In which, energy efficiency improvement is one of the main countermeasures with 69% of the total reduction. The energy saving behavior through appropriate use of energy devices contributes to reduce 13% of total direct reduction, followed by fuel shift with 11%. Moreover, the modal shift in passenger transport with the increasing share of public vehicles (bus, MRT, taxi) contributes to reduce 6%. The contribution of renewable energies (such as biofuel, CNG and solar) helps to reduce 1%.

Table 1: CO_2 emission reduction by sectors and actions ($ktCO_2$) in order to meet the 20% reduction target

Sector / Low carbon actions	Agriculture and Industry	Commercial	Residential	Passenger transport	Freight transport	**Total**
Action 1. Green agriculture and industry Energy efficient equipment and fuel shift	9,309					**9,309**
Action 2. Green house and building Energy efficient equipment and fuel shift		6,578	4,910			**11,489**
Action 3. Diffusion of energy saving behavior Appropriate use of energy device		2,181	2,339			**4,520**
Action 4. Smart transportation system Energy efficient vehicle and modal shift				3,597	4,870	**8,467**
Action 5. Growth of renewable energy Solar, biofuel, and CNG		25	24	163	159	**370**
Total	**9,309**	**8,784**	**7,273**	**3,760**	**5,029**	**34,155**

Energy consumptions

Unit: ktoe

Year	Sector	Coal	Oil	Gas	Biomass	Electricity	Total
2011	Agriculture	0.2	14.9	0.0	0.0	0.7	**15.8**
	Industry	1,697.0	1,069.9	116.6	444.7	639.5	**3,967.7**
	Commercial	63.1	582.1	0.0	0.5	199.1	**844.8**
	Residential	110.2	979.0	0.0	970.2	477.4	**2,536.7**
	Passenger transport	0.0	1,450.7	0.0	0.0	0.0	**1,450.7**
	Freight transport	0.0	588.1	0.0	0.0	0.0	**588.1**
	Total	**1,870.5**	**4,684.7**	**116.6**	**1,415.3**	**1,316.8**	**9,403.9**
2030 BaU	Agriculture	0.6	40.7	0.0	0.0	1.9	**43.2**
	Industry	7,855.3	5,556.4	615.5	2,473.9	3,170.0	**19,671.1**
	Commercial	450.7	4,158.2	0.0	3.5	1,422.6	**6,035.1**
	Residential	259.5	2,305.9	0.0	2,285.2	1,124.5	**5,975.2**
	Passenger transport	0.0	3,349.2	0.0	0.0	11.3	**3,360.5**
	Freight transport	0.0	2,808.6	0.0	0.0	0.0	**2,808.6**
	Total	**8,566.2**	**18,218.9**	**615.5**	**4,762.7**	**5,730.3**	**37,893.6**
2030 CM	Agriculture	0.2	32.0	6.7	0.0	2.4	**41.4**
	Industry	5,841.3	4,099.2	3,310.3	1,855.1	3,110.8	**18,216.6**
	Commercial	288.9	1,916.3	834.1	0.0	1,050.4	**4,089.8**
	Residential	56.1	1,196.0	741.2	1,260.8	1,139.1	**4,393.3**
	Passenger transport	0.0	2,004.3	45.9	37.4	33.9	**2,121.4**
	Freight transport	0.0	1,133.4	0.0	29.8	0.8	**1,163.9**
	Total	**6,186.6**	**10,381.2**	**4,938.1**	**3,183.1**	**5,337.3**	**30,026.3**

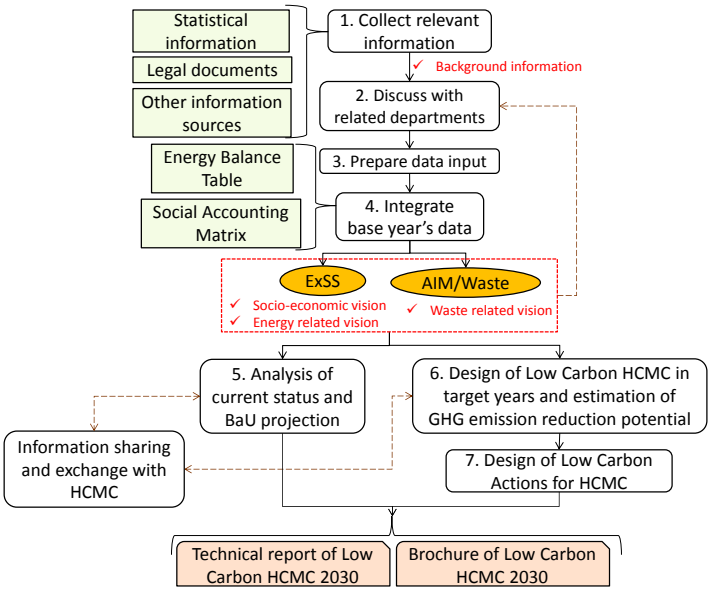
In 2030, Biomass includes the modern way of using rice husk, coconut cover, palm oil, etc.

CO_2 emission

Unit: $ktCO_2$

Year	Sector	Coal	Oil	Gas	Biomass	Electricity	Total
2011	Agriculture	0.9	44.8	0.0	0.0	4.1	**49.8**
	Industry	6,978.6	3,216.1	273.7	1,866.4	3,720.7	**16,055.5**
	Commercial	259.5	1,749.8	0.0	2.1	1,158.6	**3,169.9**
	Residential	453.1	2,942.8	0.0	4,072.2	2,777.4	**10,245.4**
	Passenger transport	0.0	4,360.9	0.0	0.0	0.0	**4,360.9**
	Freight transport	0.0	1,767.8	0.0	0.0	0.0	**1,767.8**
	Total	**7,692.1**	**14,082.1**	**273.7**	**5,940.6**	**7,660.7**	**35,649.3**
2030 BaU	Agriculture	2.5	122.3	0.0	0.0	16.7	**141.6**
	Industry	32,304.2	16,702.2	1,444.8	10,384.0	27,874.7	**88,710.0**
	Commercial	1,853.4	12,499.5	0.0	14.8	12,509.7	**26,877.4**
	Residential	1,067.3	6,931.6	0.0	9,591.9	9,888.0	**27,478.7**
	Passenger transport	0.0	10,067.5	0.0	0.0	99.8	**10,167.3**
	Freight transport	0.0	8,442.5	0.0	0.0	0.0	**8,442.5**
	Total	**35,227.5**	**54,765.6**	**1,444.8**	**19,990.7**	**50,388.9**	**161,817.6**
2030 CM	Agriculture	1.0	96.3	15.7	0.0	16.0	**129.0**
	Industry	24,021.7	12,322.0	7,770.2	7,786.5	20,583.3	**72,483.7**
	Commercial	1,188.3	5,760.5	1,957.9	0.0	6,476.5	**15,383.1**
	Residential	230.8	3,595.2	1,739.8	5,292.2	6,703.6	**17,561.6**
	Passenger transport	0.0	6,024.7	107.6	0.0	224.0	**6,356.4**
	Freight transport	0.0	3,406.9	0.0	0.0	5.1	**3,411.9**
	Total	**25,441.8**	**31,205.5**	**11,591.2**	**13,078.7**	**34,008.5**	**115,325.7**

Work procedure



This brochure has not covered the Waste sector

Acronyms and Abbreviations

AIM	Asian-Pacific Integrated Modeling
BaU	Business as Usual
BRT	Bus Rapid Transit
CC	Climate Change
CCAP	Climate Change Action Plan
CM	CounterMeasure
CNG	Compressed Natural Gas
DOST	HCMC Department of Science and Technology
EBT	Energy Balance Table
ExSS	Extended Snapshot Tool
GDP	Gross Domestic Product
HCMC	Ho Chi Minh City
IEA	International Energy Agency
IGES	Institute for Global Environmental Strategies
IOT	Input-Output Table
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
U.NRE	HCMC University of Natural Resources and Environment

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Detail of Low Carbon measures

Table 5: Detail emission reduction by countermeasures in each sector

Sector	Low carbon action	Low-carbon countermeasure	Implementation intensity	Emission reduction ($ktCO_2$)
Agriculture and Industry [1]	Action 1	Energy efficient equipment	40% of existing technology will be replaced	
		Cogeneration, vertical shaft brick kiln		3,867
		Boiler process control, waste heat recovery		1,172
		High efficiency motor		935
	Action 1	Fuel shift from coal, oil and traditional biomass to natural gas		3,335
		Total		**9,309**
Commercial [2]	Action 2	Energy efficient equipment	50% of existing technology will be replaced	
		High efficiency air conditioner		2,840
		High efficiency water heating, solar water heating		1,053
		High efficiency cooking stove		120
		Compact fluorescent, LED lighting		1,216
		High efficiency refrigerator		417
		Energy efficiency improvement of other home appliance		459
	Action 3	Appropriate use of energy device, energy management system	Energy intensity will be improved by 10% compared to BaU	2,181
	Action 2	Fuel shift from coal, oil and traditional biomass to natural gas		473
	Action 5	Solar power generation	Generating capacity will be increased to 25MW	25
		Total		**8,784**
Residential [3]	Action 2	Energy efficient equipment	50% of existing technology will be replaced	
		High efficiency air conditioner		658
		High efficiency water heating, solar water heating		819
		High efficiency cooking stove		1,651
		Compact fluorescent, LED lighting		618
		High efficiency refrigerator		412
		Energy efficiency improvement of other home appliance		740
	Action 3	Appropriate use of energy device, energy management system	Energy intensity will be improved by 10% compared to BaU	2,339
	Action 2	Fuel shift from coal, oil and traditional biomass to natural gas		12
	Action 5	Solar power generation	Generating capacity will be increased to 25MW	24
		Total		**7,273**
Passenger transport [4]	Action 4	Energy efficient vehicle		
		Fuel-efficient car, efficient load management and improvement of road system	50% of existing technology will be replaced From 1.80MJ/per.km to 0.93MJ/per.km	1,376
		Fuel-efficient bus, efficient load management and improvement of road system	50% of existing technology will be replaced From 0.41MJ/per.km to 0.19MJ/per.km	286
		Fuel-efficient train, efficient load management and improvement of road system	30% of existing technology will be replaced From 0.38MJ/per.km to 0.17MJ/per.km	3
	Action 5	Fuel shift from oil to biofuel and CNG		163
	Action 4	Modal shift to public transport	Modal share in transport demand	1,932
		Walk	12% (2011), 12% (BaU) and 12% (CM)	
		Bicycle	9.8% (2011), 9.8% (BaU) and 9.8% (CM)	
		Motorbike	71% (2011), 51% (BaU) and 34% (CM)	
		Car	4.0% (2011), 15% (BaU) and 10% (CM)	
		Bus	3.0% (2011), 10% (BaU) and 29% (CM)	
		Train	0.01% (2011), 0.05% (BaU) and 0.10% (CM)	
		MRT	0% (2011), 2.0% (BaU) and 5.0% (CM)	
		Aviation	0.03% (2011), 0.15% (BaU) and 0.15% (CM)	
		Total		**3,760**
Freight transport [5]	Action 4	Energy efficient transportation		
		Fuel-efficient car and truck, efficient load management and improvement of road system	50% of existing technology will be replaced From 4.1MJ/ton.km to 0.93MJ/ton.km	4,853
		Fuel-efficient ship and train, efficient load management and improvement of road system	30% of existing technology will be replaced From 0.76MJ/ton.km to 0.09MJ/ton.km	17
	Action 5	Fuel shift from oil to biofuel and CNG		159
		Total		**5,029**
Grid power [6]		Improvement of generation efficiency	Efficiency in coal-fired power plant will be improved from 35% (2011, BaU) to 45% (CM)	
		Reduction of transmission loss	Transmission loss will be improved from 10% (2011, BaU) to 5% (CM)	
		Change in energy mix	Using same assumption in BaU and CM	
		Total		**12,336**
Total reduction amount (without grid power) [=1+2+3+4+5]				**34,155**
Total reduction amount (with grid power) [=1+2+3+4+5+6]				**46,492**

*Note: The reduction potential from grid power is not counted for HCMC. Thus, the actual potential of CO_2 emission reduction in HCMC is **34,155 $ktCO_2$** in 2030.*

Socio-economic vision

The estimation of social and economic indicators is based on Decision 2631/QD-TTg. Moreover, we also consider the progress of implementing the urban transport master plan (Decision 568/QD-TTg), particularly the construction of Mass Rapid Transit (MRT) and Bus Rapid Transit (BRT). Therefore, we develop one Business-as-Usual in which socio-economic targets of the city can be achieved and only 50% of the urban public transport is fully constructed in the target year. In countermeasure case (CM) when proposed measures are implemented to reduce the CO_2 emission, we assume that MRT and BRT system will be constructed fully as planned. Table 2 shows the results of main socio-economic driving forces for base year 2011 and target year 2030.

Table 2: Main socio-economic indicators in HCMC

	Unit	2011	2030	2030/2011
Population	persons	7,590,138	10,869,565	1.4
No. of households	household	1,789,630	3,623,188	2.0
GDP per capita	mil. Dongs	67	256	3.8
GDP	bil. Dongs	509,334	2,783,178	5.5
Agriculture		5,671	14,076	2.5
Industry		199,184	960,547	4.8
Commercial		304,479	1,808,555	5.9
Outputs	bil. Dongs	1,432,120	7,495,140	5.2
Agriculture		11,149	27,670	2.5
Industry		863,569	4,149,719	4.8
Commercial		557,403	3,317,751	6.0
Final consumption	bil. Dongs	265,588	1,513,850	5.7
Gross fixed capital formation	bil. Dongs	192,128	1,095,127	5.7
Export	bil. Dongs	665,966	3,796,006	5.7
Import	bil. Dongs	614,347	3,621,806	5.9
Passenger transport demand	mil.per.km	68,796	145,121	2.1
Freight transport demand	mil.ton.km	73,485	350,944	4.8

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 1.4 times compared to 2011, reaching nearly 11 mil. people in 2030. By assuming the household size in 2030 is 3 persons/household (smaller than 4.2 of 2011), the total number of households increases around 2.0 times, reaching more than 3.6 mil. households in 2030.

Macro economy

Following the targets in the socio-economic master plan, it is estimated that the GDP of HCMC will increase 5.5 times in 2030 compared to 2011. In 2011, the commercial sector dominates the GDP share with 60%, followed by industrial sector with 39%. In 2030, due to the rapid growth rate in commercial compared to other sectors, the share of commercial in total GDP increases to 65%, while the share of industry reduces to 35%, with a small share of less than 1% of total GDP is from agriculture.

As the biggest city in Vietnam, the GDP per capita in 2011 is around 67 mil. Dongs (more than twice of national average), and it increases nearly 4 times to reach 256 mil. Dongs in 2030 due to the rapid GDP growth.

The final consumption in 2030 also increases nearly 6 times compared to 2011, in which main consumption is from households for industrial commodities and services while the government consumption is mainly for science, technology, and other services.

Together with the rapid growth of GDP, there is the increase in investment on industrial sector, export and import with around 6 times higher than in 2011. The main export commodities are wearing apparel, food and tobacco, manufacturing; meanwhile the main import commodities are chemical products, machinery, and coke and refined petroleum products.

Outputs

As shown in Table 2, total output increases more than 5 times in which the industrial sector still dominates with more than 60% in 2011 and nearly 56% in 2030. However, due to the higher growth rate compared to other sectors, the share of commercial sector increases from 39% in 2011 to more than 44% in 2030. Agriculture still keeps a small share of less than 1%.

In industry, the construction, food and tobacco, machinery, chemical are main sectors contributing to nearly 19%, 13%, 12%, and 9% of industrial output, respectively (Figure 1).

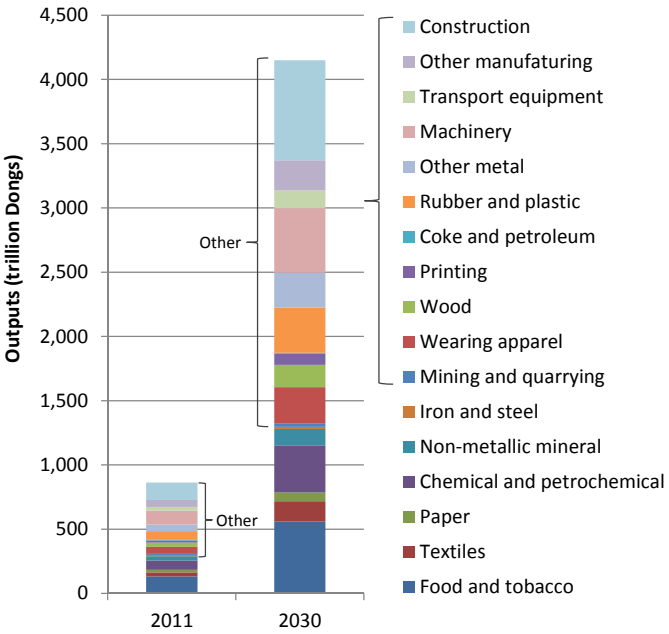

Figure 1: Outputs by industrial sub-sectors

Transport demands

Due to the increasing population and industrial activities, the transport demand in 2030 also increases rapidly with more than 2 times of passenger transport demand and nearly 5 times increase of freight transport demand compared to 2011 (Table 2).

In passenger transport, there is a rapid increase of demand on car (including taxi) to nearly 6 times, even motorbike still dominates. The share of public transport (bus and train) increases from 3% in 2011 to 12% in 2030BaU and reaches 34% in 2030CM due to the contribution of BRT and MRT system as urban transport planning (in passenger transport, car includes taxi).

In freight transport, the total demand increases to nearly 5 times compared to 2011 mainly by car and waterway. Since we have no information about the plan for freight transport, we assume that the shares of freight transport modes in 2030 are the same as in 2011, in which car contributes to more than 53%, followed by waterway with more than 46% contribution.

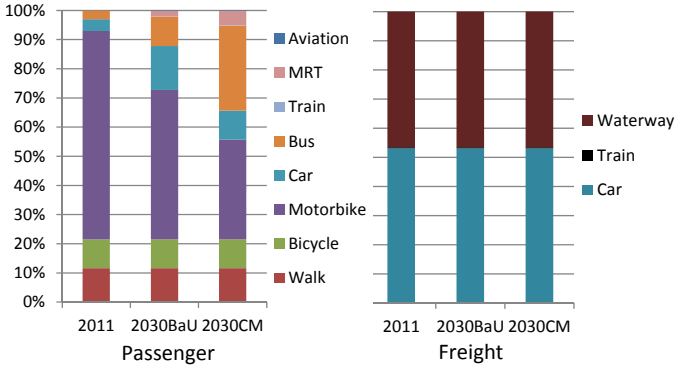

Figure 2: Modal share in transport sector

Projection of energy consumption and power generation

Final energy consumption

The energy intensity by GDP reduces from 18.5 toe/bil. Dongs in 2011 to 13.6 toe/bil. Dongs in 2030BaU and 10.8 toe/bil. Dongs in 2030CM due to the lower increasing rate of energy consumption compared to the rapid growth of GDP. This reduction follows "more than 20% reduction of energy intensity" mentioned in Decision 2631/QD-TTg ("Master Plan for Socio-economic Development of HCMC") (or 1% to 1.5% reduction per year as mentioned in Decision 1393/QD-TTg for "National Green Growth Strategy").

In 2030BaU, the total energy consumption increases 4 times compared to 2011, in which industry is still the main energy consumer with more than 60% (5 times increase), followed by residential sector (15%) with more than 2 times increase. Commercial has the highest speed of energy consumption with more than 7 times increase and its share is nearly 14%. In order to meet the target of 10% CO_2 emission reduction in energy sector, there is a huge energy consumption reduction in transport and commercial sectors, about 50% and 30% of BaU, respectively while industry only can reduce less than 10% compared to BaU (Table 3).

Figure 3 shows the final energy consumption in industrial sector, in which non-metallic mineral activity is the biggest consumer with 30%, followed by textiles with 15%. Besides main industries shown in Figure 3, other industrial activities (non-classified in IEA's EBT) accounts for nearly 40% of the total energy consumption in industry sector.

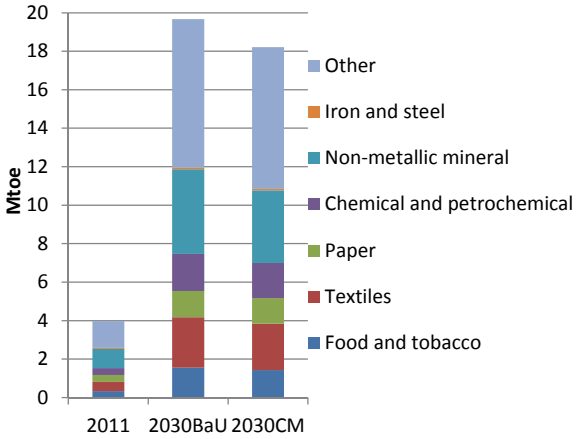

Figure 3: Final energy consumption by industrial sub-sectors

Table 3: Final energy consumption by sectors (ktoe)

	2011	2030BaU	2030CM	BaU/2011	CM/BaU
Agriculture	16	43	41	2.7	0.96
Industry	3,968	19,671	18,217	5.0	0.93
Commercial	845	6,035	4,090	7.1	0.68
Residential	2,537	5,975	4,393	2.4	0.74
Passenger transport	1,451	3,361	2,121	2.3	0.63
Freight transport	588	2,809	1,164	4.8	0.41
Total	**9,404**	**37,894**	**30,026**	**4.0**	**0.79**

Power generation mix

The power supply for HCMC is mainly from the national grid. Thus, we follow the structure of energy mix in power generation as in the National Power Development Plan 7 (PDP7) (Decision 1208/QD-TTg, 2011), in which the contribution of nuclear and wind power is around 10% and 5%, respectively. Coal-fired thermal power still dominates the mix with nearly 59% (Figure 4).

It is estimated that the power consumption will increase nearly 4.5 times compared to 2011, reaching nearly 67 GWh in 2030BaU, with the main consumer are industry (60%), residential (20%) and commercial (19%). Due to the increasing use of electric vehicles, the power consumption in transport sector increases in 2030CM compared to 2030 BaU, while other sectors reduce their consumptions to meet the emission reduction target.

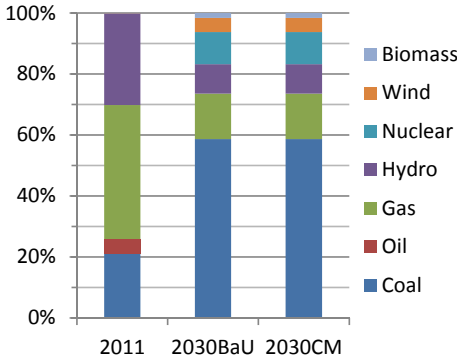

Figure 4: Power generation mix (following the PDP7)

Projection of CO_2 emission

Similar to energy consumption, the emission by GDP also reduces from 70.0 tCO_2/bil. Dongs in 2011 to 58.1 tCO_2/bil. Dongs in 2030BaU and 41.6 tCO_2/bil. Dongs in 2030CM due to the rapid GDP growth compared to the increase speed of CO_2 emission. Meanwhile, the emission per capita increases from 4.7 tCO_2/year in 2011 to 14.9 tCO_2/year in 2030BaU and reduces to 10.6 tCO_2/year in 2030CM.

In 2030BaU, the total CO_2 emission increases 4.5 times compared to 2011, in which the biggest CO_2 emitter is still industry with 5.5 times increase, contributing to 55% of total emission. Residential and commercial sectors contribute to nearly 17% (2.7 times of 2011) and 16% (8.5 times of 2011) of total emission, respectively. Meanwhile, emission from passenger transport increases more than 2 times compared to 2011 (6% of the total emission) and nearly 5 times increase of emission from freight transport (5% of the total emission).

Table 4: CO_2 emission by sectors ($ktCO_2$)

	2011	2030BaU	2030CM	BaU/2011	CM/BaU
Agriculture	50	142	129	2.8	0.91
Industry	16,055	88,710	72,484	5.5	0.82
Commercial	3,170	26,877	15,383	8.5	0.57
Residential	10,245	27,479	17,562	2.7	0.64
Passenger transport	4,361	10,167	6,356	2.3	0.63
Freight transport	1,768	8,442	3,412	4.8	0.40
Total	**35,649**	**161,818**	**115,326**	**4.5**	**0.71**

As the main energy consumers in industrial sub-sectors, non-metallic mineral and textiles are the main CO_2 emitters with nearly 5 times increase compared to 2011, contributing to 21% and 14% of total emission from industry, respectively.

Chemical, paper, food and tobacco also contribute to 10%, 8%, and 7% of the emission from industry, respectively. Meanwhile, Iron and steel has the smallest amount of CO_2 emission since this is not the main industrial activity in HCMC.

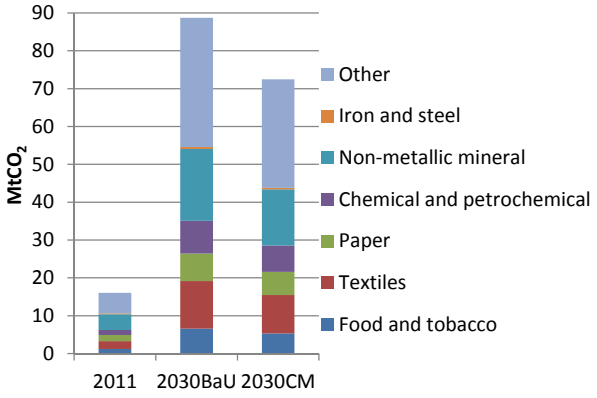

Figure 5: CO_2 emission by industrial sub-sectors

CO_2 emission reduction by sectors

Figure 6 shows the amount of CO_2 reduction in CM case by each end-use sector in which the total reduction is around 46 $MtCO_2$. Since HCMC consumes electricity provided by the national grid, reduction from grid power (12.3 $MtCO_2$) is excluded from the direct reduction by HCMC. Within the direct reduction in HCMC (34.2 $MtCO_2$), industry contributes to 28%, followed by residential and commercial sectors with 26% and 22%, respectively. Meanwhile, transport contributes to reduce 24% of the total reduction.

If considering the reduction from the viewpoint of actions/measures, then energy efficiency improvement in all sector will reduce 23.5 $MtCO_2$ (69% of total). The energy saving behavior in residential and commercial sectors contributes to reduce 4.5 $MtCO_2$ (13% of total), followed by fuel shift from coal, oil, and traditional biomass to gas with 3.8 $MtCO_2$ (11% of total). The modal shift to public transportation (taxi, bus, MRT) in passenger transport will help to reduce 1.9 $MtCO_2$ (6% of total). Moreover, the contribution of renewable energies accounts for 0.3 $MtCO_2$ (1% of total).

Detail of the reduction measures for each sector is described in Table 5.

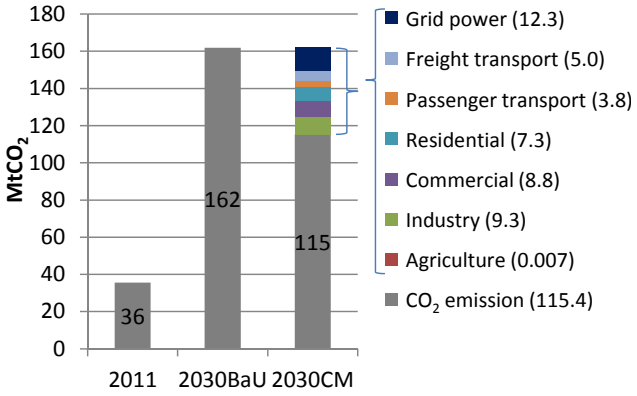

Figure 6: CO_2 emission and reduction potential

Reduction in Agriculture and Industry [1]

As shown in Figure 6, industry contributes to reduce 9.3 $MtCO_2$. In which, the main measure is the energy efficiency improvement in main activities such as cogeneration and vertical shaft brick kiln (3.9 $MtCO_2$), boiler process control and waste heat recovery (1.2 $MtCO_2$), and high efficiency motor (0.9 $MtCO_2$).

The other important measure for industrial sector is the shift in energy use from coal, oil and traditional biomass to natural gas, as well as the modern way of using biomass (rice husk, coconut cover, palm oil, etc.). This measure helps to reduce 3.3 $MtCO_2$.

Reduction in Commercial and Residential [2+3]

Assuming that 50% of existing technology will be replaced, the use of energy efficient equipment such as air conditioner, water heating, cooking stove, lightning, refrigerator, etc. contributes to reduce 6.1 $MtCO_2$ and 4.9 $MtCO_2$ in commercial and residential sectors, respectively. With 10% of energy intensity improvement compared to BaU, the emission reduction by using appropriate devices in residential and commercial are 2.3 $MtCO_2$ and 2.2 $MtCO_2$, respectively.

Fuel shift to natural gas is also one measure in these sectors in order to reduce the emission from using coal, oil, and traditional biomass in which the total reduction is nearly 0.5 $MtCO_2$. At the 25 MW generating capacity, the solar power also contributes around 25 $ktCO_2$ for each sector.

Reduction in Transport [4+5]

In both passenger and freight transport we consider the contribution of load management and improvement of road system. In which, energy efficiency improvement in car, truck, ship and train is the main measure in freight transport with more than 4.8 $MtCO_2$ reduction, under the assumption that 50% of existing technology will be replaced. Meanwhile, fuel shift from oil to biofuel contributes to reduce 0.1 $MtCO_2$.

On the other hand, in passenger transport, the main measure is the modal shift to public transport with reduction is more than 1.9 $MtCO_2$. This reduction amount can be achieved by assuming that the share of bus, MRT, taxi will be 29%, 5%, and 5%, respectively, following the urban transport development master plan (average share of public transport is around 40%). The share of motorbike reduces from 71% in 2011 to 51% in 2030BaU and reaches 34% in 2030 CM. Beside, energy efficiency improvement contributes to reduce more than 1.6 $MtCO_2$. Fuel shift to biofuel and CNG also helps to reduce nearly 0.1 $MtCO_2$.

Reduction in Grid power [6]

In grid power, we consider the improvement of generation efficiency, reduction of transmission loss, and the change in energy mix as main measures for CO_2 emission reduction. In which, the efficiency improvement in coal-fired power plants will increase from 35% (in 2011 and 2030BaU) to 45% (in 2030CM), and the transmission loss will reduce from 10% (in 2011 and 2030BaU) to 5% (in 2030CM).

Following the PDP7, the contribution of nuclear power and renewable energies (wind and biomass) in the power generation is nearly 20% in order to reduce the dependence on fossil fuels (gas and oil). However, Vietnam still depends on coal power generation with nearly 60%.The reduction of 12.3 $MtCO_2$ will be counted for the whole Vietnam (under the national grid) rather than HCMC.

Relation between proposed actions and decisions

This matrix shows the relationship between the priority programs/projects for CC mitigation in HCMC (picked from Action Plan for CC Adaptation and Mitigation towards 2015) (Decision 2484/QD-UBND, 2013), measures in the green energy program (Decision 2305/QD-UBND, 2012), and transport development plan (Decision 568/QD-TTg, 2013) for HCMC and key policy actions of our "Low Carbon Scenarios for HCMC, Vietnam 2030".

Planned actions in HCMC / 5 actions and reduction amount ($ktCO_2$) in the "***Low Carbon Scenario for Ho Chi Minh City, Vietam 2030***"		***Decision 2484/QD-UBND*** *"Action Plan for Climate Change Adaptation and Mitigation towards 2015"*				***Decision 2305/QD-UBND*** *"Approval of Green Energy Program for HCMC by 2015"*		***Decision 568/QD-TTg*** *"Approval of Adjusting the Transport Development Master Plan for HCMC by 2020 with vision beyond 2020"*	
		Applying energy efficient measures in urban life	Developing efficient use of energy in enterprises	Replacing and renovating lighting system	Renewable energy plan in HCMC	Energy savings in the residential, commercial, industry, buildings, and lighting	Development of new and renewable energies (solar power, wind, energy from waste, biofuel)	Increase the share of public transport (bus, MRT, taxi)	Improve and modernize the transport infrastructure and street lines
Action 1. Green agriculture and industry Energy efficient equipment and fuel shift	9,309		●			●			
Action 2. Green house and building Energy efficient equipment and fuel shift	11,489	●	●	●		●			
Action 3. Diffusion of energy saving behavior Appropriate use of energy device	4,520	●				●			
Action 4. Smart transportation system Energy efficient vehicle and modal shift	8,467							●	●
Action 5. Growth of renewable energy Solar, biofuel and CNG	370				●		●		