Quezon City
Low Carbon Society Scenario
2030

November, 2018

Quezon City is the largest city in Metro Manila, accounting for at least quarter of the land area of the metropolis. It is also the second largest city in the Philippines, with a total land area of more than 160 km^2. The city is also considered the most populated in the country with approximately 3 million people. Through the years, Quezon City's environmental program has evolved from adopting a mere "clean and green" strategy to a more holistic and comprehensive one taking into consideration the global challenge of addressing the impacts of climate change. The City Government, with its continuing effort to save the environment, has a vision towards a Low Carbon and Sustainable City in the hope of becoming a model for other local government units to emulate. In response to climate change and to comply with the Climate Change Act of the Philippines, Quezon City developed "Quezon City Local Climate Change Action Plan 2017-2027" (QC LCCAP). Projects, Programs, and Activities (PPAs) were identified in LCCAP in accordance with seven pillars of the National Climate Change Action Plan, namely: Food Security, Water Sufficiency, Environmental and Ecological Stability, Human Security, Climate-Friendly Industry and Services, Sustainable Energy, and Knowledge and Capacity Development.

Currently, the QC LCCAP is focused on climate change adaptation. With this said, Quezon City is now developing its climate change mitigation roadmap to be integrated in the QC LCCAP which deal with the City's protocol in Greenhouse Gas (GHG) emissions inventory and other related low carbon initiatives as well as setting the City's emissions reduction target. Moreover, a Memorandum of Understanding (MOU) on Developing Low-Carbon City in Cooperation between Quezon City and Osaka City is concluded for the realization of low carbon society in Quezon City last 30 August 2018. This research on low carbon society (LCS) scenario is also expected to contribute processes formulating various concrete measures setting the GHG emission reduction targets of Quezon City and update the QC LCCAP focused on mainstreaming both adaptation and mitigation aspects.

This research sets a framework wherein a target year of the LCS scenario for Quezon City is 2030 and a base year for estimation is 2016. Main GHG to be calculated will be Carbon Dioxide (CO_2) while energy related activities such as industry, commercial, residential and transport sectors will also be highlighted. Data and information on socioeconomic activities and energy demand for this research are collected from a variety of sources used as reference including both regional and national statistics and international reports. Said data and information are input to Extended Snapshot Tool (ExSS) to quantify socioeconomic indicators and CO_2 emissions in both the base year and the target year. ExSS was developed by Asia-pacific Integrated Model Team (AIM) and applied to a lot of cities to design LCS scenarios. Business as Usual (BaU) scenario and Low Carbon Society (LCS) scenario, are prepared to analyze reduction potential of CO_2 emissions in Quezon City. In BaU scenario, it is assumed that there is no policy or technology intervention to reduce carbon emissions, while implementation of low carbon projects to reduce emissions is assumed in LCS scenario.

CO_2 emissions in 2016 are estimated to be 6,129 ktCO_2 in Quezon City and it will double by 2030 in BaU scenario. On the other hand, CO_2 emissions in 2030 will be reduced by 50% in LCS scenario compared with BaU scenario. LCS projects by the Quezon City contributes half of the reduction while other results is from the improvement of CO_2 emission factor in national electricity grid. Various projects under four LCS actions are promoted in LCS scenario. It is concluded that Quezon City can reduce 50% of carbon emissions in 2030 due to the effort of both City and the country. Given the rapid growth of the city, it is no less ambitious than the national target of 70% reduction, which is shown in Intended National Determined Contribution (INDC) of Philippines.

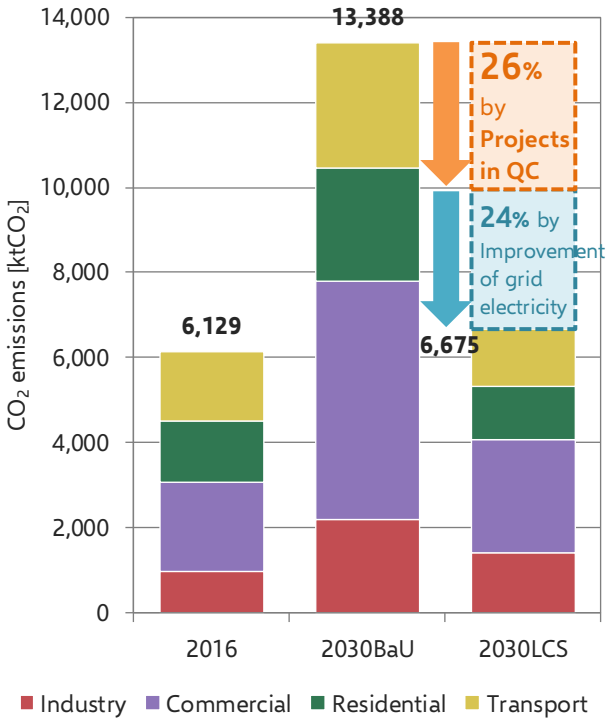

Figure 1. CO_2 Emissions and Reductions

SOCIOECONOMIC STATUS

Socioeconomic indicators such as population and gross regional domestic products (GRDP) in 2030 has been estimated as shown in Table 1 based on the collected information from the Philippine Statistical Yearbook, Regional Accounts and other sources.

Population will increase to 3.7 million in 2030 or become 1.3 times as large as that in 2016. Population growth rate is 1.17 %/year from 2016 to 2020 corresponding to population projection of Quezon City, while it is assumed to be 1.85 %/year from 2020 to 2030 following INDC of Philippines. No. of households will reach 1.2 million in 2030 or increase by 1.6 times compared to 2016. It is assumed that household size will decrease from 3.9 persons/household in 2016 to 3.0 persons/households in 2030 with economic growth and improvement of living standard.

With regard to macro economy of Quezon City, GRDP in 2016 is estimated to be 998 bil. PHP based on GRDP of National Capital Region (NCR) and the ratio of No. of establishments between Quezon City and NCR. Tertiary industry accounts for 84% of GRDP in Quezon City. GRDP will grow at an average rate of 6.5 %/year and reach 2,404 bil. PHP in 2030. The same assumption as INDC is used for GRDP growth rate. GRDP per capita in 2030 will be 643,050 PHP or 1.9 times as large as that in 2016. Commercial industries which are represented by ICT industry will lead economic growth of Quezon City, therefore share of tertiary industry will expand in the coming decade.

Table 2. Key Socioeconomic Indicators

	Unit	2016	2030	2030/ 2016
Population	persons	2,970,562	3,738,615	1.26
No. of Households	households	761,374	1,246,205	1.64
GRDP per capita	thous. PHP	336	643	1.91
GRDP	mil. PHP	997,505	2,404,116	2.41
Primary		2,169	3,733	1.72
Secondary		155,131	337,982	2.18
Tertiary		840,204	2,062,401	2.45
Final Consumption	mil. PHP	739,544	1,716,751	2.32
Gross Capital Formation	mil. PHP	185,417	430,420	2.32
Export	mil. PHP	227,765	528,724	2.32
Import	mil. PHP	267,150	599,647	2.24

Transport demand and share in 2016 is estimated as described in Table 4 mainly based on the technical report on "The Project for Capacity Development on Transportation Planning and Database Management in the Republic of the Philippines" by ALMEC Corporation and Oriental Consultants. Jeepney is the most frequently used transportation other than walking and biking in Quezon City.

Transport demand will also rise with population growth and economic growth. Passenger transport demand will increase by 1.7 times between 2016 and 2030. Figure 3 shows modal share in passenger transport. Share of private cars, and motorbikes will expand in BaU scenario as income increases. In contrast, modal shift from motorbikes and private cars to public transportation such as bus and MRT are expected in LCS scenario. Freight transport demand will grow as manufacturing production increases. The demand in 2030 will become 2.2 times as much as that in 2016.

Table 3. GRDP by Economic Activity

	2016 [mil. PHP]	2030 [mil. PHP]	2030/ 2016
Primary	2,169	3,733	1.72
Secondary	155,131	337,982	2.18
Mining and Quarrying	0	0	-
Manufacturing	105,089	222,267	2.12
Construction	50,042	115,715	2.31
Tertiary	840,204	2,062,401	2.45
Electricity, Gas and Water Supply	21,679	45,201	2.08
Transportation, Storage and Communication	30,717	79,262	2.58
Trade and Repair of Goods	277,315	665,841	2.40
Financial Intermediation	127,626	304,339	2.38
Real Estate, Renting and Business Activities	186,250	454,415	2.44
Administration and Defense; Social Security	67,979	177,001	2.60
Other Services	128,638	336,343	2.61
Total	**997,505**	**2,404,116**	**2.41**

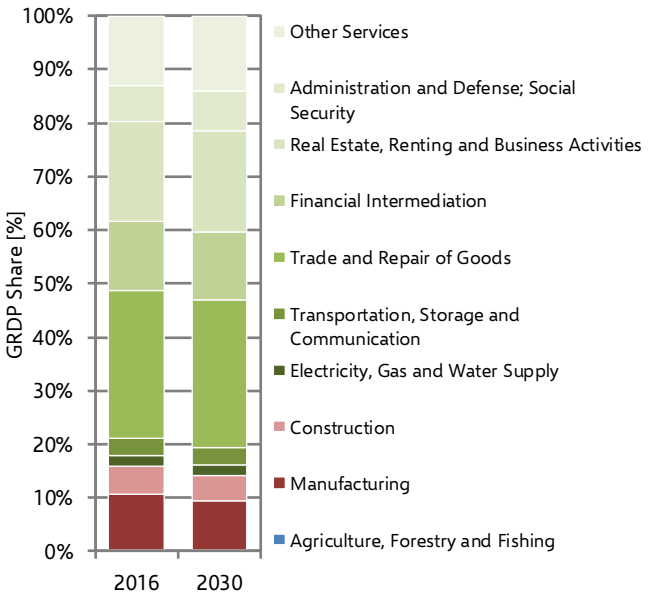

Figure 2. GRDP share by economic activity

Table 4. Transport Demand

	Unit	2016	2030BaU	2030LCS
Passenger Transport	mil.pass.km	19,852	33,623	32,974
Freight Transport	mil.ton.km	105	227	227

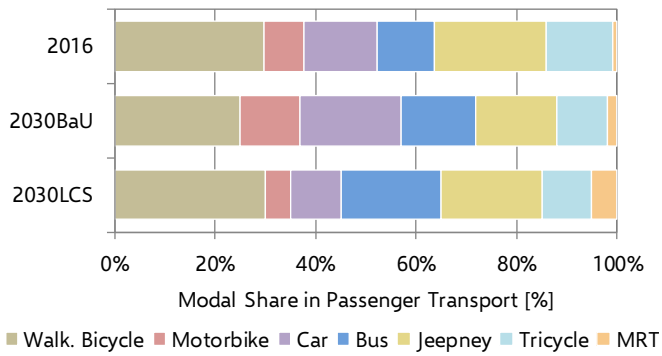

Figure 3. Modal Share in Passenger Transport

ENERGY DEMAND & SUPPLY

It is estimated that final energy consumption in Quezon City is 1,524 ktoe in 2016. Electricity consumption data can be acquired from an electric company. Other fuel consumption is estimated based on national energy consumption data prepared by Philippine Statistics Authority and an energy balance table made by International Energy Agency (IEA), because it is difficult to collect data of Quezon City. National energy consumption data is divided into the city's consumption at a ratio of socioeconomic indicators in each sector.

Final energy consumption will rise by 2.1 times from 2016 to 2030 under BaU scenario due to population and economic growth. Moreover, energy consumption in the commercial sector will grow remarkably as described in Figure 3. It is also indicated that an increase of electricity demand is the largest among fuels. In LCS scenario, end use energy demand will be 2,269 ktoe with 29% of reduction from BaU scenario. Implementation of LCS projects will lead to shifting from coal and oil to electricity and renewable energy.

Figure 4 shows energy mix in power supply in the Philippines. Coal accounts for nearly 50% in 2016. We assumed the same energy mix as 2016 for 2030 BaU scenario. On the other hand, Use of natural gas and renewable energy in energy mix will expand and it will result in improvement of CO_2 emission factor of electricity in LCS scenario. Share of renewable energy will increase to 28% except for hydropower. Philippine Energy Plan 2017-2040, Renewable Energy Plans & Programs 2011-2030 are used as reference for energy mix in LCS scenario. It is also assumed that transmission loss in electricity supply will be reduced in LCS scenario. Reduction changes can also be attributed based on the implementation of national and regional policies in the country.

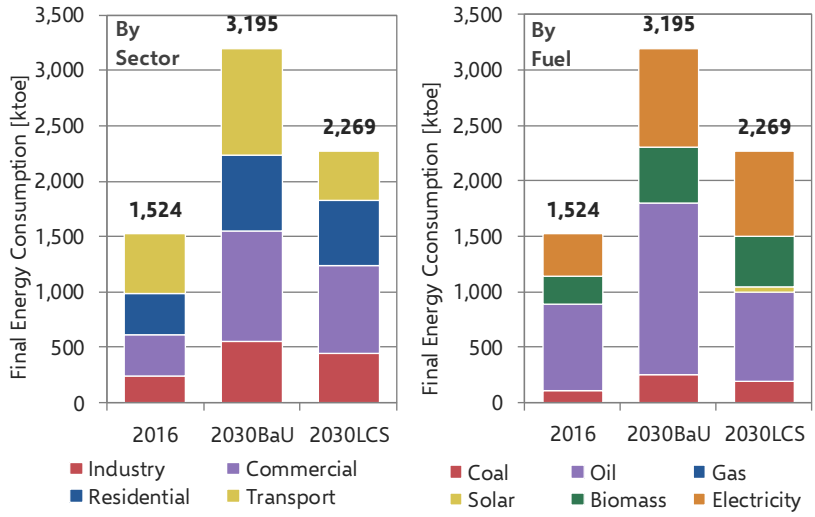

Figure 3. Final Energy Consumption

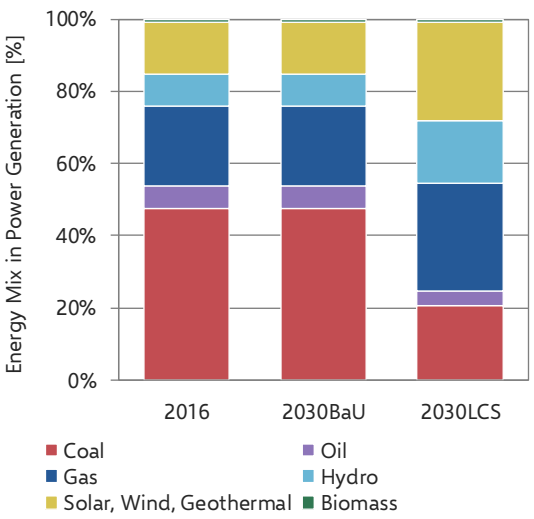

Figure 4. Energy Mix in Power Generation

CO_2 EMISSIONS & REDUCTIONS

Table 5 describes estimated CO_2 emissions in Quezon City. CO_2 emission will increase by 2.2 times from 6,129 $ktCO_2$ in 2016 to 13,388 $ktCO_2$ in 2030 BaU scenario. The largest emission source is the commercial sector both in 2016 and 2030. It is indicated that the commercial sector has a big potential to reduce CO_2 emission for Quezon City. In LCS scenario, CO_2 emission in 2030 can be reduced by 50% compared with BaU scenario. LCS actions and projects in Quezon City contributes half of the emission reductions. LCS projects are grouped by four LCS actions shown in Table 6. The amount of emission reduction by Action 4, named "Clean & Smart Transport", is the largest among the actions. Other half of the reductions results from improvement of CO_2 emission factor of electricity.

Table 5. CO_2 Emissions by Sector

	2016	2030 BaU	2030 LCS	BaU/ 2016	LCS/ BaU
CO_2 Emissions [$ktCO_2$]	**6,129**	**13,388**	**6,675**	**2.18**	**0.50**
Industry	959	2,204	1,409	2.30	0.64
Commercial	2,108	5,603	2,659	2.66	0.47
Residential	1,427	2,653	1,241	1.86	0.47
Transport	1,635	2,927	1,365	1.79	0.47
CO_2 Emissions per GDP [tCO_2/mil. PHP]	**6.1**	**5.6**	**2.8**	**0.91**	**0.50**
CO_2 Emissions per capita [tCO_2/person]	**2.1**	**3.6**	**1.8**	**1.74**	**0.50**

Table 6. Contribution to CO_2 Emission Reductions by Action and Sector [$ktCO_2$]

	Industry	Commercial	Residential	Transport	Total
Action 1. Green Energy Deployment of renewable electricity	16	220	8		**244**
Action 2. Sustainable Economy Diffusion of low-energy offices and efficient factories	435	877			**1,312**
Action 3. Smart & Eco-friendly Lifestyle Promotion of low-energy home and appliance			427		**427**
Action 4. Clean & Smart Transport Energy efficient vehicle and modal shift				1,452	**1,452**
Total of Action by Quezon City	**451**	**1,097**	**435**	**1,452**	**3,435**
Improvement of CO_2 emission factor of electricity Change of energy mix and reduction of transmission loss	344	1,847	978	110	**3,279**
Total	**794**	**2,944**	**1,412**	**1,562**	**6,713**

CO_2 EMISSION REDUCTION BY LCS ACTIONS/PROJECTS

35 LCS projects under the 4 actions will be implemented by 2030 to achieve CO_2 emission reduction in LCS scenario as shown in Table 9. These LCS projects are considered based on current climate policies in Quezon City, measures planned in "Osaka City Climate Change Action Plan" and projects described in LCS scenarios of other Asian cities which AIM team has developed. 8 projects of them has been already started as Low Carbon Development Initiative in Quezon City.

Action 1: Green Energy

LCS projects regarding introduction of renewable electricity are categorized as Action 1, which will reduce carbon emissions by 244 $ktCO_2$ in 2030. Quezon City has a pilot solar power facility in Commonwealth High School which can generate 146,000 kWh every year. The City is also supported by C40 Cities Climate Leadership Group for the solarization of 50 public schools under the Cities Finance Facility (CFF) Program. We assume these pilot projects will lead diffusion of solar power generation in households, buildings and factories in the future and will result in installation of 100MW of photovoltaics by 2030. In addition, Quezon City is promoting Waste-to-Energy project that can process and convert the city's municipal solid waste (MSW) into clean energy. The facility will be capable of processing 3,000 ton/day of MSW and converting into 42MW of renewable energy.

Action 2: Sustainable Economy

Action 2 covers LCS projects pursuing energy efficient buildings and factories. Energy consumption will be saved through behavioral change as well as installation of technologies. Reduction of CO_2 emissions by this action will account for 1,312 $ktCO_2$. Waste heat recovery in factories is one of projects promoted under the city-to-city collaboration with Osaka City.

Action 3. Smart & Eco-friendly Lifestyle

LCS projects reducing home energy consumptions are included in Action 3. A variety of low carbon technologies such as LED lighting, solar water heater and heat pump water heating system will become popular in 2030. Energy standard for houses is also important to use energy efficiently. Total CO_2 emission reduction through this action is 427 $ktCO_2$.

Action 4: Clean & Smart Transport

Action 4 is a group of LCS projects focused on transportation like modal shift to public transportation and diffusion of fuel efficient vehicles. CO_2 emission reduction by this action amounts to 1,452 $ktCO_2$, which is the largest among the actions. Quezon City has partnerships with Meralco Energy Inc. and MC Metro Transport Operation Inc. to promote electric vehicles (EV). In LCS scenario, EV will accounts for 20% of passenger cars in 2030, which is equivalent to approx. 74 thousands of EVs on the road.

REFERENCES

Table 7. Main References for Base Year

	Data	Year	Area	Source
Demography	Population	2010, 2015-2017	QC	Quezon City
		2009-2017	NCR	Regional Accounts (Philippine Statistics Authority)
			National	
	No. of Households	2010-2017	QC	Quezon City
		2010	NCR	2017 Philippine Statistical Yearbook (Philippine Statistics Authority)
			National	
Economy	Input-Output Tables	2012	National	Philippine Statistics Authority
	GRDP	1998-2017	NCR	Regional Accounts (Philippine Statistics Authority)
	GDP	2009-2017	National	National Accounts (Philippine Statistics Authority)
	No. of Establishments	2016	QC	2017 Regional Social and Economic Trends (Philippine Statistics Authority)
			NCR	
Transport	No. of Vehicles	2016	QC	Quezon City
		2015-2016	NCR	Philippine Statistics Authority
		2002-2016	National	
	No. of Trips & Modal Share	2014	QC	The Project for Capacity Development on Transportation Planning (ALMEC Corporation and Oriental Consultants Global Co., Ltd.)
		2014	NCR	
Energy	Electricity Consumption	2011-2013, 2016	QC	Quezon City
		1995-2016	National	2017 Philippine Statistical Yearbook (Philippine Statistics Authority)
	Energy Consumption	2008-2016		
	Energy Supply			
	Power Generation			
	Energy Consumption	1965-2017	National	BP Statistical Review of World Energy (BP)
	Energy Balance Table	2010-2015	National	IEA World Energy Balance (IEA)

Table 8. Main References for Future Projection

	Information	Area	Source
Socioeconomic	Population Projection	QC	Quezon City
	GDP Growth Rate	National	Intended Nationally Determined Contributions (The Philippine Government)
	Key Industries	QC	VISION OF QUEZON CITY (Quezon City)
Energy	Peak System Demand	National	Philippine Energy Plan 2017-2040 (Department of Energy)
	Installed Renewable Capacity	National	Philippine Energy Plan 2017-2040 (Department of Energy)
			Renewable Energy Plans & Programs 2011-2030 (Department of Energy)
	Installed Capacity	National	Power Development Plan 2016-2040 (Department of Energy)

Table 9. CO_2 Emission Reduction by Project

Project	Extension of Current Projects*1	Adopting Projects of Osaka City*2	Sector	Emission Reduction ($ktCO_2$)
1. Green Energy				**243.9**
1-01 Solar Energy Project (Buildings)	✓	✓	Commercial	53.4
1-02 Solar Energy Project (Factories)	✓	✓	Industry	15.3
1-03 Solar Energy Project (Households)	✓	✓	Residential	7.6
1-04 Promotion of Geothermal Heat Pumps		✓	Commercial	12.4
1-05 Waste to Energy Project	✓		Commercial	155.2
2. Sustainable Economy				**1,311.9**
2-01 Green Building Ordinance and Advanced Energy Efficiency Standards	✓	✓	Commercial	291.7
2-02 Installation of High Efficiency Lighting in Buildings		✓	Commercial	86.8
2-03 Installation of High Efficiency Air Conditioner in Buildings			Commercial	160.0
2-04 Installation of Heat Pump Water Heater in Buildings			Commercial	87.9
2-05 Introduction of Solar Water Heater to Buildings			Commercial	69.8
2-06 Implementation of Energy Management in Buildings		✓	Commercial	127.6
2-07 Promotion of Energy Saving Behaviors in Workplaces		✓	Commercial	48.6
2-08 Promotion of Energy Conservation to SMEs		✓	Industry	291.7
2-09 Introduction of Carbon Reporting Program for Large Scale Facilities			Industry	94.2
2-10 Waste Heat Recovery in Factories		✓	Industry	29.5
2-11 Energy Efficient Streetlighting Program	✓		Commercial	3.1
2-12 Green Public Procurement Project	✓		Commercial	20.9
3. Smart & Eco-friendly Lifestyle				**427.0**
3-01 Introduction of New Housing Energy Saving Standards		✓	Residential	105.0
3-02 Promotion of Energy Efficiency Retrofits of Housing		✓	Residential	8.1
3-03 Installation of Heat Pump Water Heater in Households		✓	Residential	12.3
3-04 Introduction of Solar Water Heater to Households			Residential	33.0
3-05 Installation of High Efficiency Lighting in Households		✓	Residential	30.8
3-06 Installation of High Efficiency Air Conditioners in Households			Residential	70.9
3-07 Promotion of Energy-efficient Appliances			Residential	114.0
3-08 Implementation of Energy Management in Houses		✓	Residential	35.5
3-09 Enlightenment of Energy Conservation in Households		✓	Residential	17.5
4. Clean & Smart Transport				**1,451.8**
4-01 Electric Vehicle Project	✓		Transport	323.7
4-02 Promotion of Energy-efficient Vehicles (Passenger & Commercial Cars)		✓	Transport	526.2
4-03 Introduction of Electric Motorbikes			Transport	30.8
4-04 Promotion of Energy-efficient Vehicles (Motorbikes)			Transport	19.7
4-04 Promotion of Eco-Driving with Digital Tachographs			Transport	1.5
4-06 Shift to EV bus			Transport	73.3
4-07 Promotion of Traffic Flow Management		✓	Transport	26.5
4-08 Expansion of Frequencies and Routes of Bus Transportation			Transport	301.9
4-09 Development of Public Transportation like MRT			Transport	148.1
Improvement of CO_2 Emission Factor of Electricity				**3,278.5**
TOTAL				**6,713.1**

*1 These projects are extension of current projects under Low Carbon Development Initiatives in Quezon City.
*2 These projects are considered based on measures planned in Osaka City Climate Change Action Plan.

METHODOLOGY

1. Start of the Story

First, we authorize a task force to develop LCS scenario and allocate human resource and budget for the research. We also make a schedule based on the needs and situation of a local government.

2. Framework Setting

Background research is important to set an effective framework suited with the target region. We determine framework of the scenario (the target year, the base year, types of greenhouse gases, the target activities and the number of scenarios) by reference to the background. The base year should be decided with consideration for data availability. More than one scenarios such as BaU scenario and LCS scenario should be set to analyze effects of LCS actions to reduce GHG emissions.

3. Data Preparation

Two kinds of data are needed. One is for the current status and the other is for the future vision. We collect data and information about population, No. of household, economic accounts, input-output tables, transport volume, energy balance tables and GHG emission. If some data are unavailable in the target region, it can be estimated based on other available regional and national data.

4. Design of LCS Projects and Projection of Future Scenario

Based on the collected information, GHG emission for the base year and BaU scenario are estimated by the quantification tool, ExSS. This model was developed by Kyoto University. We adopt both bottom-up approach and top-down to estimate LCS scenario. First, we list LCS projects that can be implemented in the target region by the target year, and calculate GHG emission reduction by each project from bottom up based on assumption of degree of implementation. Then, ExSS is used again to estimate GHG emission and reduction from a macro perspective in LCS scenario to remove duplication of GHG reduction among projects and to keep consistency.

5. Bridging the Output to Real World

We formulate actions by grouping projects according to themes and fields for implementation. The whole outputs are summarized to a brochure/report and reported to policy makers.

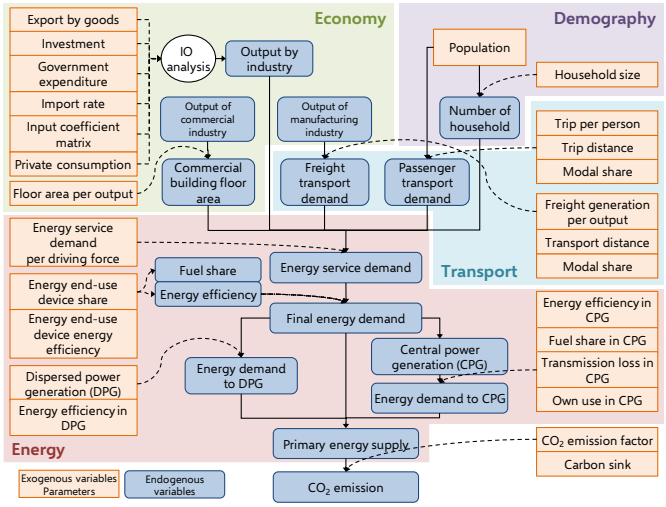

Figure 6. Structure of ExSS

ACRONYMS AND ABBREVIATIONS

AIM	Asia-Pacific Integrated Model
BaU	Business as Usual
CO_2	Carbon Dioxide
CPG	Central Power Generation
DPG	Dispersed Power Generation
EPWMD	Environmental Protection and Waste Management Department
EV	Electric Vehicle
ExSS	Extended Snapshot Tool
GDP	Gross Domestic Product
GHG	Greenhouse Gasses
GRDP	Gross Regional Domestic Product
ICT	Information and Communication Technology
IEA	International Energy Agency
IGES	Institute for Global Environmental Strategies
INDC	Intended Nationally Determined Contribution
LCCAP	Local Climate Change Action Plan
LCS	Low Carbon Society
LED	Light Emitting Diode
MOU	Memorandum of Understanding
MRT	Mass Rapid Transit
MSW	Municipal Solid Waste
NCR	National Capital Region
NIES	National Institute for Environmental Studies, Japan
pass.km	Passenger-km
PHP	Philippine Peso
PPAs	Projects, Programs, and Activities
QC	Quezon City
tCO2	Tons of Carbon Dioxide
toe	Tons of Oil Equivalent

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Acknowledgement

This research is supported by the Ministry of the Environment, Japan.