A STUDY ON

DA NANG LOW CARBON CITY

Recently, major cities in Vietnam are required to localized the initiatives of the Intended Nationally Determined Contributions (INDCs) to the United Nations Framework Convention on Climate Change (UNFCCC). The aim of INDC is to reduce 8-25% of total emissions in 2030 compared to Business as Usual (BaU). In line with the target, the Vietnam Green Growth Strategy (Decision 1393/QD-TTG) aims to ensure efficient and sustainable economic growth in Vietnam while making significant contributions towards implementing the national climate change strategy. Moreover, the National Target Program for Climate Change Response (Decision 158/QD-TTG) requires local governments to develop Climate Change Action Plans (CCAP). The CCAP 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 study is one of the results of the research collaboration between Asian-Pacific Integrated Model (AIM) team in Japan including Kyoto University, E-konzal, National Institute for Environmental Studies (NIES), Mizuho Information and Research Institute (MHIR), Institute for Global Environmental Strategy (IGES), and Institute of Strategy and Policy on natural resources & environment (ISPONRE), Da Nang Climate Change Coordination Office (CCCO) in 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 Da Nang city.

Two scenarios are developed for the socio-economic vision of Da Nang by 2030, with the projection of energy consumption and CO_2 emission in energy-related categories such as Residential, Commercial, Transportation, and Industry. They are 2030BaU (Business as Usual) and 2030CM (CounterMeasures). The 2030BaU scenario, where countermeasures for GHG emission reduction are not introduced, reflects the situation in which both, the levels of commitments to climate-friendly-energy production and technological breakthroughs are relatively low. Specially, countermeasures are assumed the same level as in 2013. On the other hand, the 2030CM scenario, which additional low carbon countermeasures are introduced in order to assess the reduction effects of GHG emissions. The socioeconomic assumptions about population, industrial structure, and economic growth are common to both scenarios. Information from many domestic sources is used to calibrate the parameters for base year 2013. In target year 2030, Extended Snapshot Tool (ExSS) is applied for the projection of future energy consumption and CO_2 emission in energy-related categories.

In 2030BaU, Da Nang is expected under the rapid growth of driving forces such as population, transport demand, and industrial activities; the total GHG emissions increases 4.01 times, from 2,665 $ktCO_2eq$ in 2013 to 13,563 $ktCO_2eq$.

In 2030CM, the total GHG emissions reduction is 16%, accounting for 2,226 $ktCO_2eq$. Da Nang can reduce such emissions reductions by implementing 30 projects grouped in five actions.

By implementing five climate change actions, namely; Smart Building, Smart Industry, Energy Efficiency, Smart Transport and Green Energy, Da Nang can reduce 16% total GHG emissions in 2030CM (between the 10-20% national reduction target as declared in the Green Growth strategy and within 8-25% mentioned in the Vietnam's INDC).

Table 1 GHG emissions by sectors ($ktCO_2eq$) in Da Nang city

	2013		2030 BaU		2030 CM		2030 BaU/2013	2030 CM/BaU
GHG emissions	$ktCO_2eq$	%	$ktCO_2eq$	%	$ktCO_2eq$	%		
Agricultural energy-related	2	0.1	12	0.1	12	0.1	5.67	1.00
Industry	880	33.0	5,779	42.6	4,950	43.7	6.56	0.86
Commercial	151	5.7	1,169	8.6	961	8.5	7.73	0.82
Residential	459	17.2	1,235	9.1	1,000	8.8	2.69	0.81
Passenger transport	546	20.5	1,838	13.5	1,537	13.6	3.37	0.84
Freight transport	626	23.5	3,531	26.0	2,878	25.4	5.64	0.82
Total GHG emissions	**2,665**	**100.0**	**13,563**	**100.0**	**11,338**	**100.0**	**5.09**	**0.84**
GHG emissions per GDP (tCO_2eq/bil.Dongs)	51.6		45.6		38.1		0.88	0.84
GHG emissions per capita (tCO_2eq/person)	2.7		5.4		4.5		1.99	0.84

Socio-economic scenario

Demography

Following the goal is to develop Da Nang into a major city for the economy and to make Da Nang the socio-economic centre of central Vietnam. The estimation of social and economic growth is based on the Study on Integrated Development Strategy for Da Nang City and Its Neighboring Area in the Socialist Republic of Vietnam (DaCRISS), . Table 2 shows the results of main socio-economic driving forces for base year 2013 and target year 2030.

With assumption of population growth rate of 3%, Da Nang's population in 2030 is projected to be more than 2.53 million people, which about 2.6 times increase on the base year's population 2013.

Household size in 2030 is assumed by 3 persons/household (smaller than the calculated value for 2013, which is 3.4), the total number of households increases 2.93 times, reaching about 844 thousand households in 2030.

Table 2: Main socio-economic indicators in Da Nang city

	Unit	2013	2030	2030/2013
Population	persons	992,849	2,533,190	2.55
No. of households	household	288,620	844,397	2.93
GDP per capita	mil. Dongs	52	117	2.26
GDP	bil. Dongs	51,624	297,542	5.76
Agriculture		529	2,620	4.95
Industry		17,831	100,813	5.65
Commercial		33,264	194,109	5.84
Outputs	bil. Dongs	124,446	715,160	5.75
Agriculture		821	4,066	4.95
Industry		55,592	314,093	5.65
Commercial		68,033	397,001	5.84
Final consumption	bil. Dongs	39,294	222,536	5.66
Gross fixed capital formation	bil. Dongs	25,895	146,657	5.66
Export	bil. Dongs	47,943	271,520	5.66
Import	bil. Dongs	61,508	343,171	5.58
Passenger transport demand	mil.per.km	8,642	26,770	3.10
Freight transport	mil.ton.km	2,563	14,201	5.54

Economy

Da Nang has recorded remarkable changes in economic development. The economic structure of Da Nang city continues to shift towards the industries and sevices. According to the development targets in Da Nang's development master plan, it is estimated that the GDP in 2030 will increase 5.8 times compared to 2013. In 2013, the commercial sector dominates the GDP share with 64.4%, followed by industrial sector with 34.5%. In 2030, due to the increase of growth rate in commercial compared to agricultural sectors, the share of commercial in total GDP increase to 65.2%, while the share of industry decreases to 33.9%, 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.

The GDP per capita of Da Nang in 2013 is around 52 mil. Dongs , and increases 2.3 times by 2030. The GDP per capita in 2030 reaches 117 mil. Dongs due to the rapid GDP growth (9.7% per annual).

In 2030, export and import in Da Nang expected to increase 5.7 and 5.6 times compared to those in 2013, respectively. Final consumption increases 5.7 times , in which main consumption is from households for industrial commodities and services while the government consumption is mainly for science, technology, and other services.

Transport demands

The transport demand in 2030 increases dramatically from 8,642 to 26,770 million person per kilometer (mil.per.km) of passenger transport and 2,563 to 14,201 million ton per kilometer (mil.ton.km) of freight transport compared to 2013 due to the increasing population and industrial activities.

In passenger transport, there is a rapid increase of demand on car to 3.1 times, even motorbike still dominates. The share of public transport by trip increases from 0.6% in 2013 to 10.0% in 2030BaU and reaches 24.5% in 2030CM due to the contribution of public bus system.

Freight transport relies predominantly on roads and followed by waterway. We assumed that the share of waterway by trip will increase in freight transport modes in 2030, in which road is still dominates , followed by waterway.

Table 3: Transport demand in Da Nang city

	2013	2030BaU	2030CM	BaU/2013	CM/BaU
Passenger transport (mil.per.km)	**8,642**	**26,770**	**26,978**	**3.10**	**1.01**
Walk	67	190	190	2.83	1.00
Bicycle	178	505	505	2.83	1.00
Motorbike	7,446	16,367	12,206	2.20	0.75
Car	891	6,935	7,281	7.78	1.05
Bus	60	2,774	6,796	46.09	2.45
Freight transport (mil.ton.km)	**2,563**	**14,201**	**13,919**	**5.54**	**0.98**
Car	2,168	12,227	12,227	5.64	1.00
Waterway	395	1,974	1,692	5.00	0.86

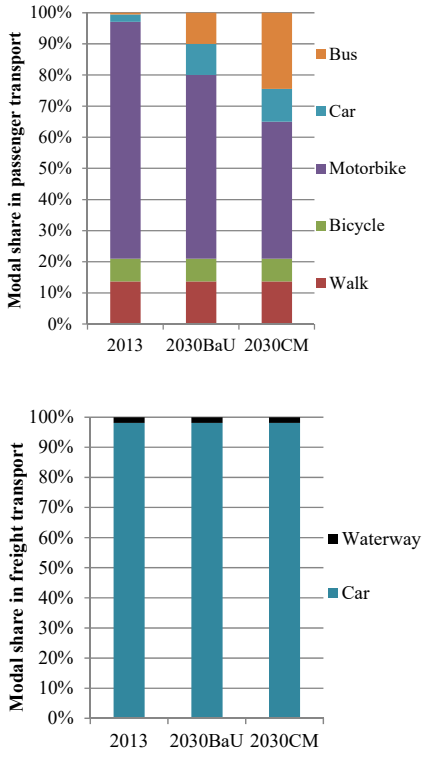


Figure 1: Modal share of transportation in Da Nang

Projection of final energy consumption and GHG emissions

Final energy consumption

The annual total final energy consumption of residential, commercial, industrial and transport sectors is expected to increase from 702 kilo tonnes oil equivalent (ktoe) in 2013 to 2432 ktoe in 2030BaU scenario and 2884 ktoe in 2030CM scenario.

The share of energy consumption by residential sector is projected to be reduced substantially from 11% in 2013 to 5.5% in 2030BaU and 5.4% 2030CM scenarios, as a result of a reduction of the traditional biomass fuels for cooking. In transport sector, energy consumptions are accounting for 53.0% and 52.0% in 2030BaU and 2030CM scenarios, respectively.

The finding shows that the energy shares of industrial and commercial sectors are expected to increase in future, while the share of residential and transport sectors decrease. This is because of continued trends of industrialization.

The energy intensity by GDP reduces from 13.6 toe/bil. Dongs in 2013 to 11.5 toe/bil. Dongs in 2030BaU and 9.7 toe/bil. Dongs in 2030CM 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".

GHG emissions

Figure 2 and table 5 shows the emissions in Da Nang.

In the year 2013, estimated GHG emission is about 2.7 $MtCO_2eq$. In 2030BaU, total GHG emission increased up to 13.6 $MtCO_2eq$, more than fourfold increase from 2013. In which, the major contributors to GHG emission include industrial sector, followed by transport, commercial and residential sectors

In 2030CM, emissions estimated reduced by 16% from the 2030BaU emissions. Breakdown of GHG emission redeuction is shown in Figure 3. In which, highest reduction is attributes to transport sector (44%), followed by industry (38%), commercial (8%) and residential (10%).

In 2013, per capita GHG emissions in Da Nang was 2.7 tCO_2eq, though, in BaU scenarios, it is projected to increase up to 5.4 $ttCO_2eq$. In 2030CM scenario it can be reduced to 4.5 tCO_2eq.

Table 1 shows the GHG emission intensity. In 2013, estimated GHG emission intensity is 51.6 tCO_2eq/bil.dongs. In 2030BaU, emission intensity decreased to 45.6 tCO_2eq/bil.dongs mainly because of greater share of tertiary industry in GDP. In 2030CM scenario, which introduces implementation of the projects and actions, emission intensity is estimated to 38.1 tCO_2eq/bil.dongs. More details of the projects and actions are described in the following pages of this report.

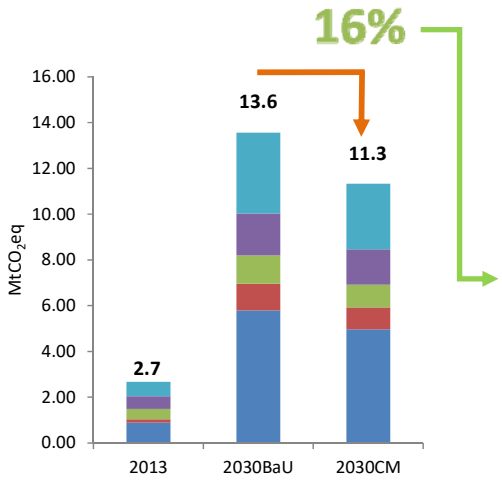


Figure 2: GHG emissions in Da Nang

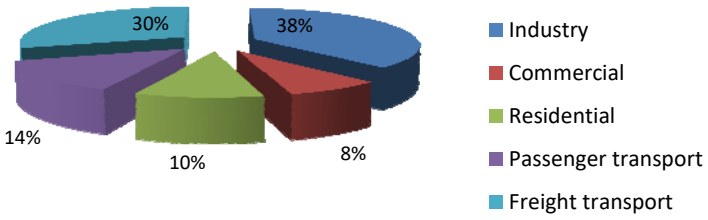


Figure 3: Share of reductions by sector

Table 4: Energy consumption

Unit: ktoe

	2013	%	2030BaU	%	2030CM	%	BaU/2013	CM/BaU
Total	**702**	**100.0**	**3,432**	**100.0**	**2,884**	**100.0**	**4.89**	**0.84**
By sector								
Agriculture	1	0.1	3	0.1	3	0.1	5.39	1.00
Industry	205	29.2	1,268	37.0	1,088	37.7	6.18	0.86
Commercial	22	3.2	154	4.5	136	4.7	6.91	0.88
Residential	77	11.0	188	5.5	156	5.4	2.43	0.83
Passenger transport	185	26.3	623	18.1	526	18.2	3.37	0.84
Freight transport	212	30.2	1,196	34.9	975	33.8	5.64	0.82
By energy type								
Coal	100	14.3	584	17.0	448	15.5	5.84	0.77
Oil	434	61.8	1,989	57.9	1,584	54.9	4.59	0.80
Gas	15	2.1	91	2.6	132	4.6	6.19	1.46
Solar	0	0.0	0	0.0	15	0.5		
Biomass	30	4.3	176	5.1	174	6.0	5.85	0.99
Electricity	124	17.6	593	17.3	530	18.4	4.79	0.89

Table 5: GHG emissions and reduction

Unit: $ktCO_2eq$

Year	Sector	Coal	Oil	Gas	Solar	Biomass	Electricity	Total
2013	Agriculture	0.1	1.2	0.0	0.0	0.0	0.8	**2.1**
	Industry	372.9	49.0	34.4	0.0	0.0	424.1	**880.4**
	Commercial	0.0	11.5	0.0	0.0	0.0	139.6	**151.2**
	Residential	38.7	46.5	0.0	0.0	0.0	374.1	**459.2**
	Passenger transport	0.0	545.9	0.0	0.0	0.0	0.0	**545.9**
	Freight transport	0.0	626.1	0.0	0.0	0.0	0.0	**626.1**
	Total	**411.6**	**1,280.1**	**34.4**	**0.0**	**0.0**	**938.7**	**2,664.8**
2030 BaU	Agriculture	0.3	6.4	0.0	0.0	0.0	5.1	**11.8**
	Industry	2,307.7	301.9	213.2	0.0	0.0	2,956.3	**5,779.2**
	Commercial	0.0	79.6	0.0	0.0	0.0	1,089.2	**1,168.8**
	Residential	94.1	113.1	0.0	0.0	0.0	1,028.0	**1,235.2**
	Passenger transport	0.0	1,837.8	0.0	0.0	0.0	0.0	**1,837.8**
	Freight transport	0.0	3,530.8	0.0	0.0	0.0	0.0	**3,530.8**
	Total	**2,402.2**	**5,869.6**	**213.2**	**0.0**	**0.0**	**5,078.6**	**13,563.5**
2030 CM	Agriculture	0.3	6.4	0.0	0.0	0.0	5.1	**11.8**
	Industry	1,773.1	265.8	186.6	0.0	0.0	2,724.4	**4,949.9**
	Commercial	0.0	62.0	0.0	0.0	0.0	899.5	**961.4**
	Residential	70.9	73.6	0.0	0.0	0.0	855.6	**1,000.1**
	Passenger transport	0.0	1,387.8	123.9	0.0	0.0	25.2	**1,536.8**
	Freight transport	0.0	2,877.8	0.0	0.0	0.0	0.0	**2,877.8**
	Total	**1,844.3**	**4,673.4**	**310.5**	**0.0**	**0.0**	**4,509.6**	**11,337.8**

GHG emission reduction by Actions

Action 1. Smart Industry

Low carbon projects regarding promotion of energy efficient equipment and fuel shift in the industry sector is included in Action 1. Total reduction of GHG emissions by this action is 829 $ktCO_2eq$. Improvement of kiln and furnace technology such as waste heat recovery is one of the main project in Action 1. This project contributes to reduce 272 $ktCO_2eq$ (see next page).

Action 2. Smart Building

Action 2 covers low carbon projects related with diffusion of low-energy houses and buildings. This action reduce 106 $ktCO_2eq$. Energy demand in houses and buildings through projects such as diffusion of energy management system and installation of insulated glasses. Introduction of insulating material to houses is a project that reduce the largest GHG emission in this action. Introduction of solar water heater to houses and buildings is also main projects in this action to reduce fuel demand. CO2 emission from houses is reduced by 23 $ktCO_2eq$ through 20% diffusion of solar water heater.

Action 3. Energy Efficiency

Projects about promoting energy efficient device and appliance like lighting and air conditioners for houses and buildings are covered in Action 3. Total reduction of GHG emission by this action is 298 $ktCO_2eq$. For instance, replacement of conventional lighting by high efficient one such as LED lighting in houses and buildings contributes to reduce about 87 $ktCO_2eq$.

Action 4. Smart transport

It is estimated that projects in Action 4 can reduce 954 $ktCO_2eq$ in total, which is the largest reduction among all actions. This action covers variety of projects regarding both passenger and freight transportation. Not only improvement of fuel efficiency of vehicles but also promotion of modal shift to public transportation and deployment of CNG bus are listed. Projects for freight transport such as promotion of energy-efficient trucks have large potential to reduce GHG emissions, because GHG emission from freight transport sector is more than twice as high as that from passenger transport sector. Development of water freight transport system is aimed to shift freight transportation from truck to ship. Meanwhile, projects like introduction of electric motorbike and CNG bus contribute to reduce GHG emission from passenger transport.

Action 5. Green energy

This action covers projects for increasing electric power generation by renewable energy including photovoltaic power, wind power and small-scale hydropower. Total reduction of GHG emission by Action 5 is 39 $ktCO_2eq$. Photovoltaic power generation systems are assumed to install on rooftop of houses and buildings. Hydropower generation is introduced to public facilities such as water distribution station.

Table 1: Climate change actions ($ktCO_2$) for Da Nang city

Climate change actions	Industry	Commercial	Residential	Passenger Transport	Freight Transport	**Total ($ktCO_2eq$)**
Action 1. Smart Industry Promotion of energy efficient equipment and fuel shift	829					**829**
Action 2. Smart Building Diffusion of low-energy building (EMS, Insulation, Fuel shift)		55	51			**106**
Action 3. Energy Efficiency Promotion of energy efficient device/appliance		118	180			**298**
Action 4. Smart Transport Energy efficient vehicle and modal shift				301	653	**954**
Action 5. Green Energy deployment of renewable electricity		34	5			**39**
Total ($ktCO_2eq$)	**829**	**207**	**235**	**301**	**653**	**2,226**

Mitigation projects in Da Nang LCC's study

Action		Project	Sector	Emission reduction ($ktCO_2eq$)
1 Smart Industry	1-01	ESCO (Energy Saving COmpany) project for industries	Industry	225.8
	1-02	Installation high energy efficiency facilities (such as compressors and motors)	Industry	204.3
	1-03	Regional energy supply system	Industry	127.1
	1-04	Improvement of kiln and furnace technology	Industry	272.0
		Total		**829.3**
2 Smart Building	2-01	Installation of insulated glasses to commetcial buildings	Commercial	6.6
	2-02	Installation of insulated glasses to households	Residential	7.0
	2-03	Introduction of incentive to low energy buildings	Commercial	2.1
	2-04	Introduction of insulating material to houses	Residential	28.6
	2-05	Energy efficiency technology applied to buildings	Commercial	5.7
	2-06	Introduction of solar water heater to commercial buildings	Commercial	18.9
	2-07	Introduction of solar water heater to households	Residential	36.8
	2-06	ESCO (Energy Saving COmpany) project for commercial buildings	Commercial	33.1
		Total		**138.8**
3 Energy Efficiency	3-01	ESCO (Energy Saving COmpany) project for commercial buildings	Commercial	33.1
	3-02	High efficiency lighting in public lighting	Commercial	4.3
	3-03	High efficiency lighting in commercial buildings	Commercial	50.5
	3-04	High efficiency lighting in households	Residential	36.1
	3-05	High efficiency air conditioners (such as air conditioners with inverter controllers) in commercial buildings	Commercial	37.1
	3-06	High efficiency air conditioners (such as air conditioners with inverter controllers) in commercial households	Residential	37.2
	3-07	Promotion of energy-efficient appliances	Residential	99.7
		Total		**298.1**
4 Smart Transport	4-01	Promotion of eco-driving with digital tachographs	Transport	46.6
	4-02	Wide-range traffic control	Transport	4.9
	4-03	Expansion of frequencies and routes of bus transportation	Transport	10.5
	4-04	Development of Bus Rapid Transit (BRT)	Transport	5.2
	4-05	Shift to CNG bus	Transport	11.9
	4-06	Introduction of electric motorbikes	Transport	62.6
	4-07	Promotion of energy-efficient vehicles (cars for passenger)	Transport	102.5
	4-08	Promotion of energy-efficient vehicles (motorbikes)	Transport	143.5
	4-09	Promotion of energy-efficient vehicles (trucks)	Transport	566.2
		Total		**954.0**
5 Green Energy	5-01	Introduction of photovoltaic power generation to commercial buildings	Commercial	32.4
	5-02	Introduction of photovoltaic power generation to households	Residential	4.6
	5-03	Introduction of small-scale hydropower generation (at water distribution stations)	Commercial	1.6
		Total		**38.7**
Total				**2,258.8**

Work procedure

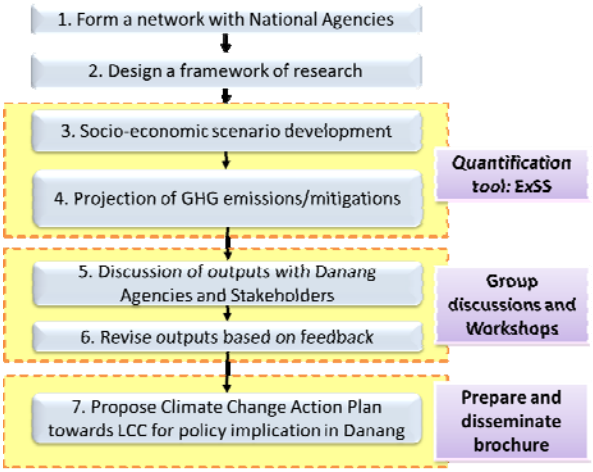
In order to identify the necessary actions, an "integrated modeling" based on "back-casting" approach is used.

The back-casting approach sets a vision of the future society as a goal, and then seeks a pathway towards achieving that goal.

We used ExSS (Extended Snapshot tool) for socio-economic indicators, energy related sectors. Information collection is the first step in the modeling work.

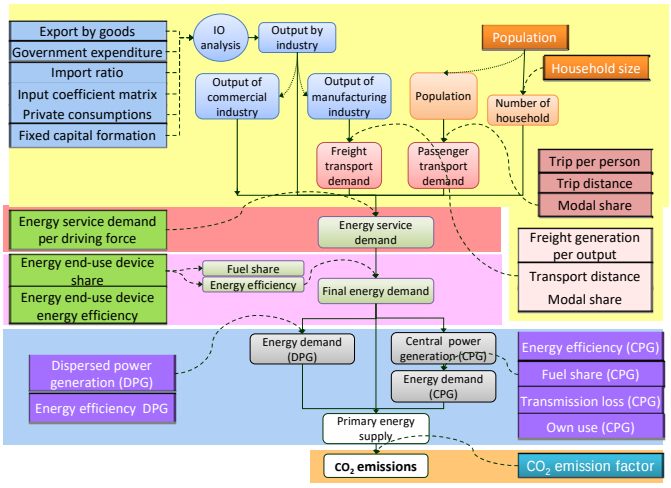
Socio-economic information as well as environmental information for the base year (2013) was collected and analyzed in order to estimate current carbon emissions. Besides this, feasible low carbon measures for Da Nang low carbon 2030 were also collected.

For the future projection, information is based on planned developments, as the model estimates socio-economic activity levels including population, number of households, land area, transport demand and other variables. Based on the collected information, GHG emissions are calculated with or without countermeasures.



ExSS tool

ExSS is a simplified simulation model for low carbon study and projects socio-economic activity, energy demand and supply, GHG emissions and emission reduction by measures. While each part of the tool is relatively simple, it can describe whole picture of future society as a LCS in a quantitative and consistent manner with a greater flexibility than many other models. It also can consider most of the low carbon measures existing and expected in near future. In this simulation model, population is decided by demand from outside of the region, labor participation ratio, demographic composition and relationship of commuting with outside of the region. To determine output of industries, input-output approach is applied. Passenger transport demand is estimated from the population and freight transport demand whereby it is a function of output by manufacturing industries. Floor area of commerce is determined from output of tertiary industries. Other than driving force, activity level of each sector, energy demand by fuels determined with three parameters. One is energy service demand per driving force, energy efficiency and fuel share. Diffusion of counter measures changes the value of these parameters, and so GHG emissions.



Team Information

KYOTO UNIVERSITY (KU)

Yuzuru MATSUOKA

NGUYEN Thai Hoa*

DA NANG CLIMATE CHANGE COORDINATION OFFICE (CCCO)

DINH Quang Cuong

VU Thi Mai Huong

Phu Chi Thinh

INSTITUTE OF STRATEGY AND POLICY ON NATURAL RESOURCES & ENVIRONMENT (ISPONRE)

NGUYEN Tung Lam

NATIONAL INSTITUTE FOR ENVIRONMENTAL STUDIES, JAPAN (NIES)

Junichi FUJINO

Toshihiko MASUI

E-KONZAL

Yuki OCHI*

Tomoki EHARA

INSTITUTE FOR GLOBAL ENVIRONMENTAL STRATEGIES (IGES)

Shuzo NISHIOKA

Tomoko ISHIKAWA

MIZUHO INFORMATION AND RESEARCH INSTITUTE (MHIR)

Kazuya FUJIWARA

Acronyms and Abbreviations

AIM	Asia-Pacific Integrated Modeling
BaU	Business as Usual scenario
CC	Climate Change
CCAP	Climate Change Action Plan scenario
CCCO	Da Nang Climate Change Coordination Office
EBT	Energy Balance Table
ExSS	Extended Snapshot Tool
GDP	Gross Domestic Product
IEA	International Energy Agency
IGES	Institute for Global Environmental Strategies
INDCs	Intended Nationally Determined Contributions
IOT	Input-Output Table
ktCO$_2$eq	kilo-ton Carbon dioxide
KU	Kyoto University
LCC	Low Carbon City
MHIR	Mizuho Information and Research Institute
NIES	National Institute for Environmental Studies
SYB	Statistical Yearbook
toe	ton of oil equivalent

Acknowledgement

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

***Contact address:**

NGUYEN Thai Hoa: *envi.jp@gmail.com*

Yuki OCHI: *ochi.ekonzal@gmail.com*

Oct, 2016