MOE

Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia

Final Report

Feasibility Study on developing a JCM in waste sector in Da Nang, Vietnam

March 2014

Overseas Environmental Cooperation Center, Japan(OECC)

EX Research Institute Ltd.

Summary

This research project has investigated the possibility of utilizing JCM and supported construction of a system in order to introduce incineration power plants in Da Nang with collaboration with business operators who are involved in the waste power generation business for the JICA preparation and research for environmental infrastructure maintenance project (PPP infrastructure project) in JFY2012-2013. For large scale development of JCM, cases have been discovered that contributed to the improvement of energy-savings and drainage treatment countermeasures for sectors such as industrial areas, fishery process, and drinking water, which are the main industries in Da Nang, as well as reviewing the introduction of Japanese low carbon technologies.

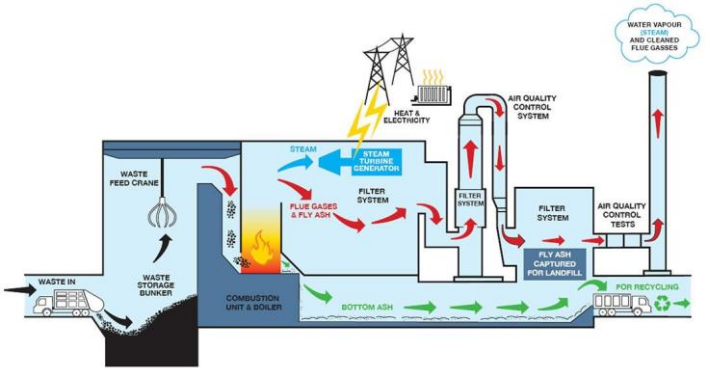
Table. list of targeted technologies to be developed as JCM projects

JCM target technologies	Details
Waste incineration power plant (assuming JICA collaboration)	To be built next to the Da Nang final waste disposal site after FY 2014. The project is to review the possibility of treating industrial, and sludge waste that is generated from sewage plants and industrial areas in addition to general solid waste from the whole of Da Nang.
Sludge dehydration facility	Attempt to collect sludge that is generated from sewage plants and centralized drainage treatment plants in industrial areas in Da Nang, and to introduce sludge dehydration facilities for utilizing it for incineration power generation instead of landfilling(to be built within the city's largest sewage plant).

(Activity result outline)

- Result 1: Implemented the quantification of GHG reduction and develop MRV method related to the project activities shown below

＜Target project activities＞

Title	Waste to Energy
Image picture	
Outline of	Although the investment cost for waste incineration and power generation is high, it

technology	can greatly reduce waste (80 to 90%) and suppress methane generation as well as contributing to the suppression of CO2 generation by utilizing the power of incineration energy.

<Estimate of GHG emission reduction at Khanh Son disposal site in Da Nang>

Estimated reduction effect

	Project base	After large scale development
Waste power generation	Approx. 120,000 tons CO_2	-

■ Results2:Estimation of GHG reduction potential in accordance with power generated from incineration of industrial and urban waste, sludge generation in sewage plants and industrial areas that are in the waste and drainage sectors

■ Results3: Formation of JCM cases and support to improve capabilities for implementation

Together with Yokohama city, EXRI, DUT and Da Nang Department of Foreign Affair (DOFA), workshops and working groups were organized to introduce outline of JCM scheme and benefits of introducing low carbon technologies under the scheme to the relevant stakeholders in Da Nang city.

(Schedule for JCM commercialization)

Below table shows the schedule for relevant actions to implementation of the JCM potential project Detailed investigation will take place in the first half of FY 2014 and the JCM project is scheduled to start from FY 2014 and run to the first half of FY 2015.

	FY 2014	FY 2015	FY 2016	FY 2017
Waste incineration power generating equipment	Design details	Construction, foundations		Start operation
Sledge dehydrating equipment	Design details	Start construction and operation		
Scheduled transportation route of sludge treatment	Design details	Implementation		
MRV system establishment	Design details	Implementation		

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Chapter 1: Outlines of the Object Country/ Object City

1.1 Social/ Economical Situation in Vietnam

The Socialist Republic of Vietnam (hereinafter called Vietnam) has long coast line ranging to 3,400km and extensive delta area. Based on the survey by the World Bank, etc., Vietnam, for her geographical conditions, is pointed as one of the most influenced countries by climate change, the increasing/ escalation of disaster occurrence frequency went with climate change is becoming the cause of serious risk for the continuous development of country. Three quarters of the national land is consisting of mountain terrain, hillside and highland, and a wide variety of agricultural crops is produced by the climate which is rich in variation.

Fig.-1: Topographical Map of Vietnam

Source: http://www.tulip.sannet.ne.jp/t-） takeoka/

The population of country is 88.78 million people (World Bank statistical data) as of 2012 and is the 3rd rank after Indonesia and Philippines. The industrial structure of Vietnam is rapidly changing from agriculture to industry and labor population ratio reduced by 13% in agriculture, increased by 9.6% in industry and by 3.4% in service business in the past 10 years.

Vietnam is promoting market-oriented economic reform under the socialist government and realized high economic growth in 1990s. Nominal GDP as of 2012 was 1,555 hundred-million dollars which was 5 times over 311.8 hundred-million dollars as of 2000.

Per capita GDP also increased to the level exceeding 1,000 dollars in 2008 from about 400 dollars at 2000. Based on the IMF prediction as of April 2013, Vietnam is one of the countries for which high economic growth is expected in future because of prospect indication that 9.0% annual rate increasing of economic growth will be accomplished by 2018, etc.

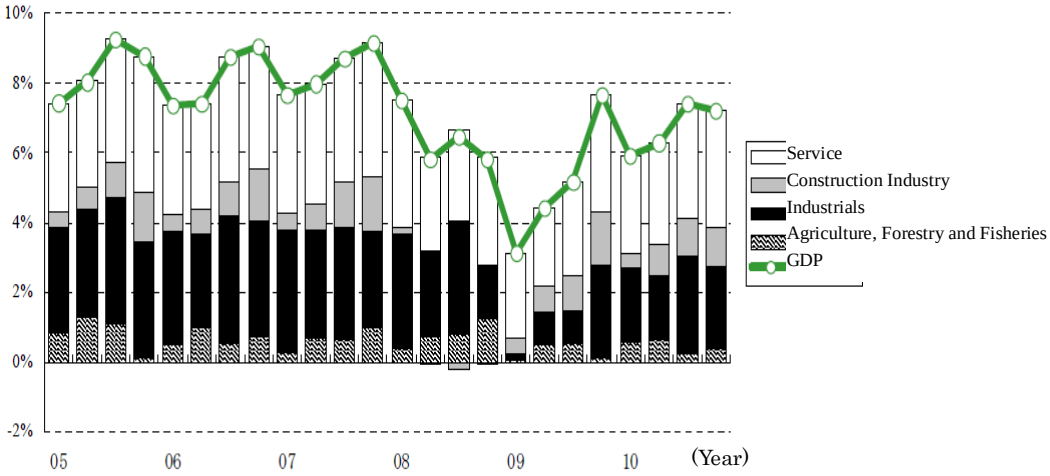


Fig.–2: Trend of Vietnam Real GDP and Contribution Degree by Industry

Source: CEIC

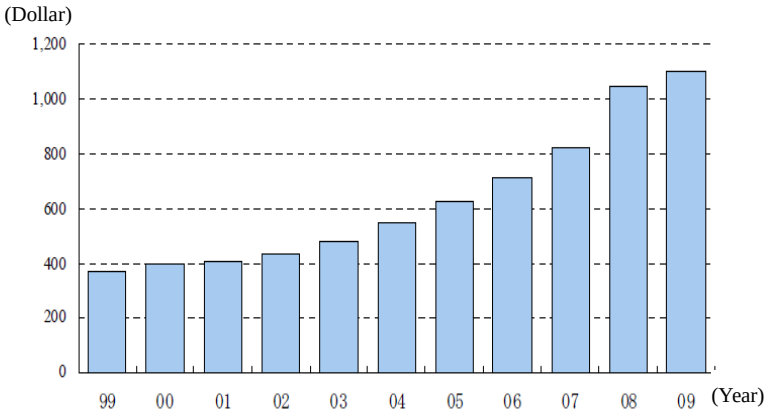


Fig.–3: Trend of Per capita GDP, Vietnam

Source: IMF

(2) Social / Economical situation in Da Nang city

Da-Nang city, the object city of this research service, is one of the largest harbor cities getting abreast of HO-CHI-MINH city and HAI-PHONG city, and is the largest city in southern Vietnam facing the mouth of HAN-River and South China Sea. Da-Nang city, located at about 760km south from HANOI, at about 960km north from HO-CHI-MINH city, has the 4th rank of domestic economic size (regional gross production) after HANOI city, HO-CHI-MINH city, and HAI-PHONG city. Da-Nang city is attracting the attention as the gateway for manufacturing/ logistics connecting Japan and ASEAN countries because the city is locating at the east base point of ASEAN economic corridor via Laos, Thailand and Myanmar, and urbanization and industrialization in future are prospective.

Based on the population census performed in 2009, the population of Da-Nang city is about 8.874 million people which are the 5th rank in Vietnam. The annual population growth rate is 2.6% and is

indicating the 6th rank in growth rate after HO-CHI-MINH and other cities. In addition, urban population of Da-Nang city is the highest in domestic Vietnam and its rate reached to 86.9% in 2009.

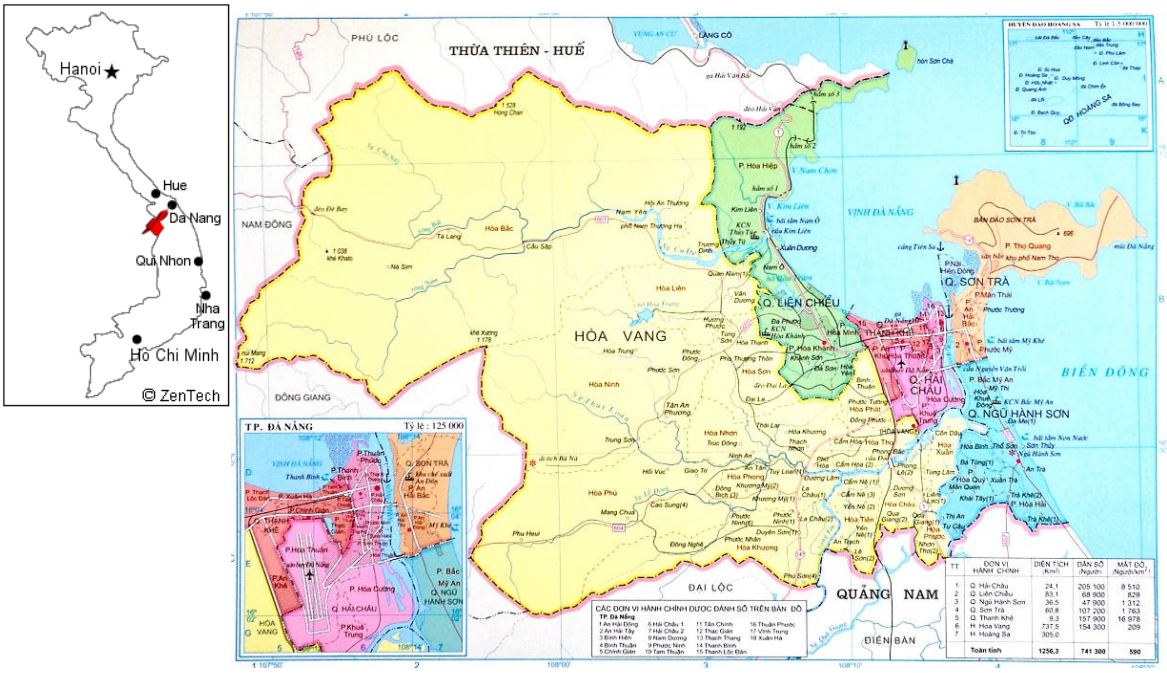


Fig.–4: Da-Nang Location Map

1.2 Energy Consumption/ Greenhouse Gas Emission Status in Vietnam

(1) Political Measure Concerning to Climate Change in Vietnam

The development of legal systems concerning to environment is promoted since the environment protection framework was set up by the Article 29 of the Constitution of Vietnam established in 1992. They ratified UN Framework Convention on Climate Change (UNFCCC) in 1994 and the Kyoto Protocol Treaty in 2002, and addressing the Climate Control Issues. They submitted the Initial National Report (INC) in 2003 and wrote about Greenhouse Gas (GHG) Emission Reduction Measures and the report which analyzed technical needs for Climate Control Measures in 2005. In addition, they submitted the Second National Report (SNC) in 2010 and presented GHG Mitigation Option which targets three major sectors of emission amount based on the GHG inventory as of 2000.

As the typical approach concerning to climate change mitigation in Vietnam, [National Target Program to Respond to Climate Change (hereinafter called NTP-RCC), Prime Minister's Directive No. 158] issued in December 2008 is existing. NTP-RCC is intending the development of effective and feasible activity plan for the climate change influence and sustainable development, and building up low carbon society, wrapping up activity goal necessary for domestic streamlining which urges sufficient international grants-in-aid and technical transfer.

National Strategy on Climate Change: Decision No. 2139 was issued in December 2011, while NTP-RCC is intending guideline preparation and building up of donor supporting relationship, NSC is directing mid-long term strategy vision to each sector intending climate change measures more effective. NSC was established based on MONRE suggestion as well as NTP-RCC and MONRE is assuming the leadership of activity included.

Table-1: Major Strategic Tasks of NCCS (Abstracted GHG reduction related matters)

Energy	• Reviewing the Plan for Hydroelectric Power Plant by 2020 • Investigation and Development on Renewable Energy (Making 5% of the Primary Energy Consumption to be New/ Renewable Energy by 2020; 11% by 2050 in the same manner) • Energy Saving (prepare roadmap by 2015) • Substitution for Fossil Fuel (including the application to traffic sector) • Streamlining of Thermal Power Plant (Technology Upgrade) • Research on the Application of Low Carbon Technology • Plan Preparation Including the Development of Public Transportation (will be completed by 2050)
Agriculture	• Waste Management and Proper Implementation of Disposal • 20% Reduction of GHG Emission
Solid Waste	• Preparation of Solid Waste Management Plan for GHG Emission Reduction, Management Ability Upgrade, Solid Waste Reduction and Recycling • Capacity Upgrade of Wastewater Disposal from Industry/ Home: Accomplishment of Urban Garbage (waste from home) Recovery/ Disposal Rate of 90% by 2020 and 3R is Performed on 85% for Energy Recovery

(Source: Prepared by OECC Based on NCCS)

At the Vietnam Green Growth Strategy (VGGS) approved by the prime minister in September 2012, targeting 2011 ~ 2020 while having a view of 2050, contributing to NSCC realization, bringing green growth concept, sustainable development (SD) which assures high growth into shape, and strategic goal, realization method, implementation system for realization are indicated.

Table-2: Action Plan (Draft) for the Implementation of Green Growth Strategy

	Group	No. of Cases
1	System Building Up for VGGS Implementation	7
2	Preparation of Green Strategic Action Plan of Local Version and Implementation of Small Size Pilot Project	3
3	Improvement of Energy Usage Effect and Efficiency at Energy Consumption	8

	Industry Sector, and Implementation of GHG Reduction	
4	Improvement of Energy Usage Effect and Efficiency at Traffic Sector, and Implementation of GHG Reduction	3
5	Improvement of cultivation technique at agroforestry/ aquaculture; Implementation of GHG Reduction	6
6	Promoting Effective Usage of Renewable Energy and New energy	3
7	Planning/ Preparation of Program Concerning to Development Strategy, Development Master Plan and Shifting to Low Carbon Economy	8
8	Effective and Sustainable Usage of Natural Resources and the Development of Green Economic Sector	9
9	Development of Sustainable Infrastructure	3
10	Promotion of Sustainable Industry, Human Resource Cultivation toward Green Growth, and Development of Technology and Management Service	3
11	Development of Green as well as Sustainable City	7
12	Promoting Ecological Life Style	6

(2) Energy Consumption Status in Vietnam

Energy demand is rapidly increased went with the expansion of Vietnam economy and the primary energy consumption amount in Vietnam increased with 6.5% of annual average in 2000 ~ 2007, and the energy consumption in the period increased by 1.5 times from 32.235 million tons (converted to oil) to 50.221 million tons (converted to oil) based on the Second National Report. The ratios by sector at 2000 for industrial, traffic, agriculture, home and commercial were 30.6%, 14.7%, 1.5%, 48.8% and 4.4% respectively but consumption amount for industrial, traffic and agriculture sectors in 2007 had strong increasing trend and showed 34.4%, 21.2% and 1.6% respectively.

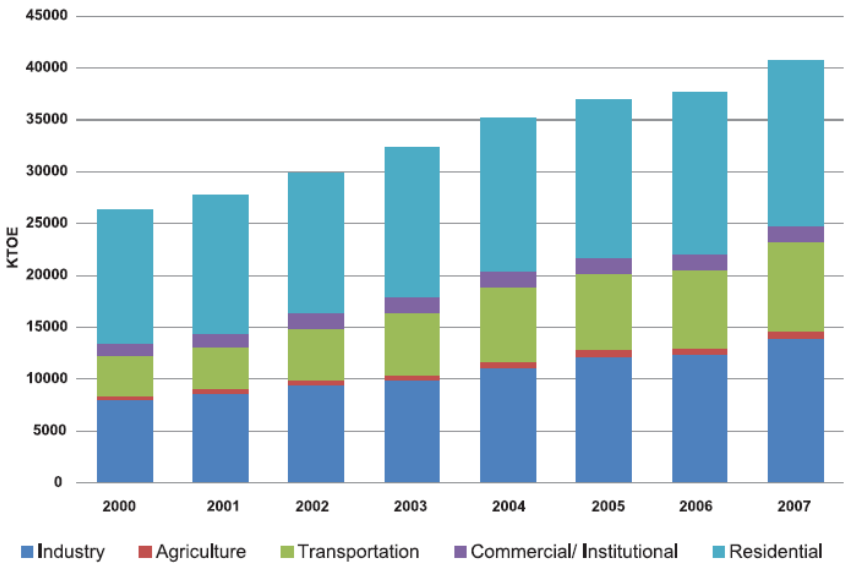


Fig.–5: Energy Consumption Ratios by Sector in Vietnam

Source: The Second National Report, Vietnam

(3) Status of Greenhouse Gas Emission in Vietnam

During 1990 ~ 2006 when rapid economic growth was accomplished in Vietnam, energy demand (final consumption amount) increased about 5 times, therefore GHG emission amount from energy sector is increasing, taking action gear up for renewable energy development/ usage toward GHG emission reduction, promotion of energy saving, enhancement of waste management, sustainable forest management, etc., become imperative.

According to the Second National Report (SNC) announced in 2010, GHG emission amount from Vietnam was 1.5 hundred-million tons as of 2000, and CO_2 occupies 44.9% of total, CH4 occupies 44% and NO2 occupies the rest, 11.1%.

By sectors, the largest GHG emission amount was 43.1% of total from agriculture sector as of 2000, next was 35% from energy sector, 10% from LULUCF sector, 6.6% from manufacturing sector and 5.3% from waste, and the rate of GHG emission amount from agriculture sector was extremely large. However, as the result of watching the increasing rate from 1994, that of agriculture in the same period stayed only 1.2 times of rise while the increasing rates for manufacturing and energy sectors resulted 2 times or more and for waste sector showed 3 times. In addition, when seeing through emission amount in 2020 ~ 2030 at SNC, it is estimated that increasing rates at agriculture and LULUCF sectors will keep leveling out while almost 3 times rise at energy sector. The reason why emission amount increasing trend in energy and waste sectors are large is assumed that those are caused by the industrial size expansion and population increasing in Vietnam, and it is understand that those are sectors where needs for mitigation countermeasure is large.

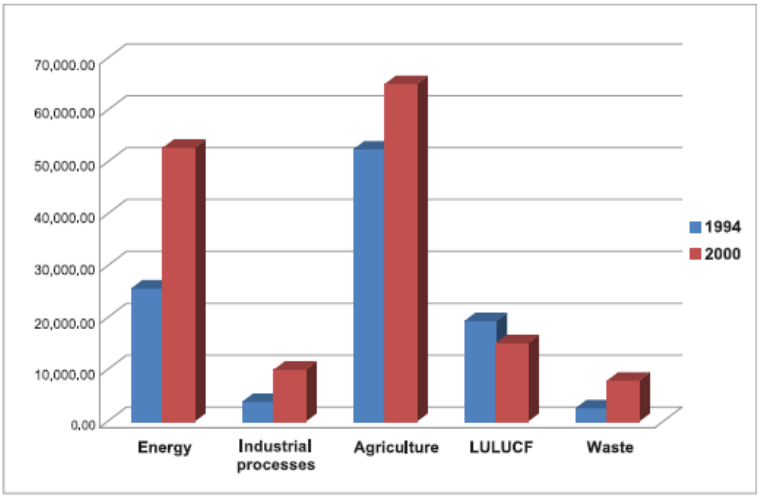


Fig.–6: Trend of GHG Emission Amount by Sector in Vietnam

Source for Fig.-4 – Fig.–6: The Second National Report, Vietnam (SNC)

As for the latest GHG emission amount in Vietnam, it is estimated that inventory data concerning to GHG emission amount as of 2005 will be presented in 2014 under the GHG inventory preparation performance improving project by JICA now and GHG emission amount as of 2010 will also be indicated through this cooperation.

(4) Reduction Approach for Greenhouse Gas Emission in Vietnam

Vietnam ratified the Kyoto Protocol Treaty in September 2002, established Designated National Authority (DNA) under MONRE in 2003 and promoted the implementation of Clean Development Mechanism (CDM). Total 257 cases of CDM projects were registered upon approval by CDM Governing Board in Vietnam as of February 21, 2014. Among those, 198 cases are the hydroelectric power generation project. After that, in order of descending, 21 cases of biogas projects, 15 cases of biomass, 7 cases of wind power project, 6 cases of methane recovery/ usage, 2 cases of methane avoidance, 2 cases of emission gas emission heat usage, respective 1 case of planting and energy saving and 3 cases renewable energy (solar heat, etc.). Possible GHG emission amount in case of those projects implemented as scheduled is 17.54 million tons/ year.

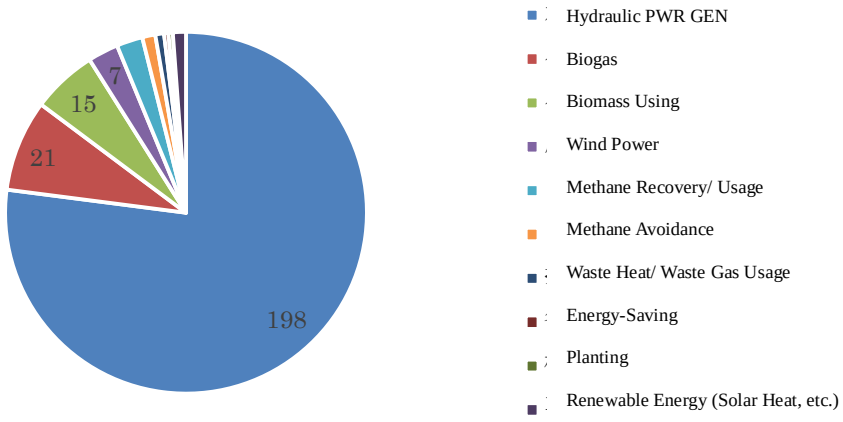


Fig.–7: The Project Registered to CDM Governing Board, Vietnam (as of February 21, 2014)
Source: Prepared by OECC based on UNFCCC

Also in Vietnam, in addition to CDM, all kinds of approaches such as donor support through the World Bank, ADB, ODA, etc., are implemented. Furthermore in the policy aspect, at the [Program on Management of Greenhouse Gases Emissions; Management of Carbon Credit Trading Activities to World Market: MGG&CC] recently established in September 2012, GHG emission reduction target and policy by sector were directed as one of the purposes that contributing national target

accomplishment at sustainable expansion and utilizing low carbon economics and green growth as the chance of expansion (Refer to Table-3).

Table-3: GHG Emission Reduction Target* and Measures (* Reduction target /2005)

Reduction Target by Sector	Measures
Energy and Traffic: 8%	● Energy Efficiency Improvement and Energy Saving ● Development of Renewable Energy ● Changeover of Fossil fuel at Power Generation ● Usage of Coal Related Gas ● Usage of Public Transportation ● Changeover to LPG from gasoline and diesel at passenger transportation ● Upgrading Building Material and Infrastructure
Agriculture: 20%	● Water and Cost Saving by Rice Cropping with Advanced Technology ● Reduction of N2O Emission Amount at Rice Cropping by the Application of Efficiency Improvement Technology Utilization of Pesticides ● Application of Energy/ Fuel Suppression Measures at Soil Upgrading and Watering, Development and Application of Minimum Cultivation Method in order to Reduce GHG Emission ● Agricultural By-Product Collection, Recycle, Reuse, and Development and Application of Organic Drainage Treatment at the Cultivation of Vegetables, Sugarcane and Industrial Crops ● Change of Feed for Farm Animal and Domestic Fowl, Feeding Multiple Nutrition Block to Dairy Cows ● Application of Vietnam Good Agriculture Practice (VIETGAP) in Live Stock Science ● Utilization of Antibiotic Substance against Intestinal Bacteria in order to Reduce GHG Emission Level from Farm Animal ● Development of Biogas Technology and Recovery System, Stock and Management of Manure from Farm Animal and Domestic Fowl
LULUCF：20%	● Forest Protection ● Planting and Re-Planting ● Promoting Re-Planting and Natural Regeneration ● Restriction on Tree Trimming and Forest Reduction, Continuous Management to Keep Forest Resources, Securing and Promotion of Forest Carbon Stock
Waste: 5%	● Methane Recovery from Waste Repository and Usage ● Industrial Drainage Treatment

Source: Ministry of Environment (Data: The Prime Minister Decision No. 1775/QD-TTg)

Chapter 2: Project Outline

2.1 Purpose of this project

Da Nang City has the fourth highest individual income level behind Ho Chi Minh, Binh Duong Province, and Hanoi, and is located on the eastern side of the ASEAN economic route that travels through Laos, Thailand, and Myanmar. For this reason, Da Nang City attracts attention as the production and logistics gateway that connects Japan and the ASEAN nations, and a rapid increase in the volume of waste is forecast in accordance with future urbanization and industrialization. Furthermore, Da Nang, along with Hue and Hoi An, is a world heritage listed sightseeing city, and a busy summer resort with more than three million tourists every year from all over the world. Fisheries are stable and the GDP for sightseeing, fishery, and the retail sectors of the city has grown by nearly seven times in the past 10 years. On the other hand, problems with waste treatment and water pollution have become serious due to urbanization, active sightseeing, and fisheries, and there is an urgent need to introduce technological countermeasures and review the system.

Under these circumstances, this research project has collaborated with business operators who are involved in the waste power generation business, which was investigated based on the JICA preparation and research for environmental infrastructure maintenance project (PPP infrastructure project) in 2013. The research project has also investigated the possibility of utilizing JCM and supported construction of a system in order to introduce incineration power plants in Da Nang. For large scale development of JCM, cases have been discovered that contributed to the improvement of energy-savings and drainage treatment countermeasures for sectors such as industrial areas, fishery process, and drinking water, which are the main industries in Da Nang, as well as reviewing the introduction of Japanese low carbon technologies.

2.2 Applicable technologies/systems

This project has investigated the possibilities of JCM project formation targeting technologies in Table 4 and reviewed the structure of MRV methodologies.

Table 4. List of technologies that are targeted for investigation

JCM target technologies	Details
Waste to energy technology (assuming JICA collaboration)	To be built Waste to energy technology facility next to the Da Nang final waste disposal site after FY 2014. The project is to review the possibility of treating industrial, and sludge waste that is generated from sewage plants and industrial areas.
Sludge dehydration facility	Attempt to collect sludge that is generated from sewage plants and centralized drainage treatment facilities in industrial zone

	areas in Da Nang, and to introduce sludge dehydration facilities (to be built within the city's largest sewage plant).

Chapter 3: Research result

3.1 Result of research activities

The following is the result of each activity of this project.

Table 5. Activity results

Period	Operation contents		
	(1) Investigate the possibility to form JCM cases in the waste and drainage sectors	(2) Review the MRV methodology in the waste and drainage sectors	(3) Support to improve capabilities to form and implement JCM cases
May	Review implementation policy and consult principles with the partner country		
June	**First on-site survey**: Survey on target case, interviews; On-site survey and interviews, C/P consultation	Market research, data gathering	Visits for local affiliated agencies; Consultation with CC/P affiliated parties,, interviews
July	Sort the on-site survey, create a technical list draft; Information gathering for nominated technologies in the country	Documentation research	Review the on-site survey results; Create a draft of the partner country implementation system
August			
September	**Second on-site survey**: Technical survey, matching session	Sort related systems, data gathering	Hold WS, consultation with related parties, establish work groups
October			
November	Basic survey for technologies and facilities that is specific for second on site survey; Specify technologies, consult for details	**Third on-site survey**	Implement second WS and WG
December			
2014 January	**Fourth on-site survey**: Review survey for next financial year and work plan policy	Final survey	Implement survey for local capital scheme; Hold WS, consultation with affiliated parties
February	**Fifth on-site survey**: Sort the four survey results and reports from the affiliated local parties		

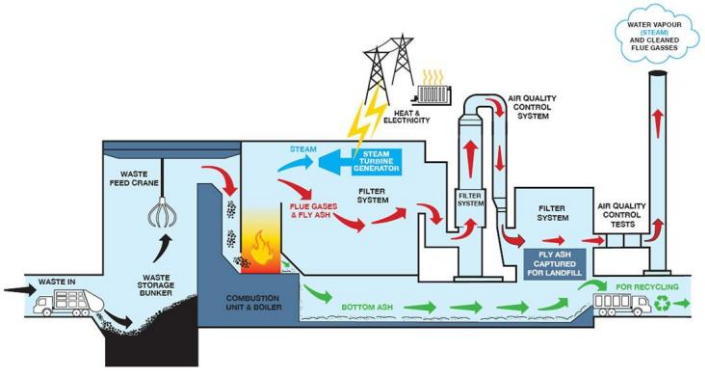
March	Create operation report				

3.2 Activity result outline

(Activity result outline)

■ Result 1: Implemented the quantification of GHG reduction and develop MRV method related to the project activities shown below

＜Target project activities＞

Title	Waste to Energy
Image picture	
Outline of technology	Although the investment cost for waste incineration and power generation is high, it can greatly reduce waste (80 to 90%) and suppress methane generation as well as contributing to the suppression of CO2 generation by utilizing the power of incineration energy.

＜Preconditions for estimating GHG emission reduction＞

item	details
Waste treatment volume（※１）	1,000 tons/day (310,000 tons/year)
Kinds of waste（※１） Waste composition?	food waste (42%), tree/tree related waste (7%), paper (11%), fibers (2%), plastic waste (18%), other inorganic waste (20%)
Selling power volume derived from waste incineration（※１）	94,000MWh/yr
CO2 emission coefficient of system power supply in Vietnam（※２）	0.60 tons of CO2/MWh

※１：Based on the JICA PPP infrastructure project

※２：Based on the IGES

＜Composition of project generation sources and GHG type＞

Emission sources	GHG type
Emission volume from power generated at project facilities (waste incineration and power generating facilities) and fossil fuel consumption	CO_2

<Estimate of GHG emission reduction at Khanh Son disposal site in Da Nang>

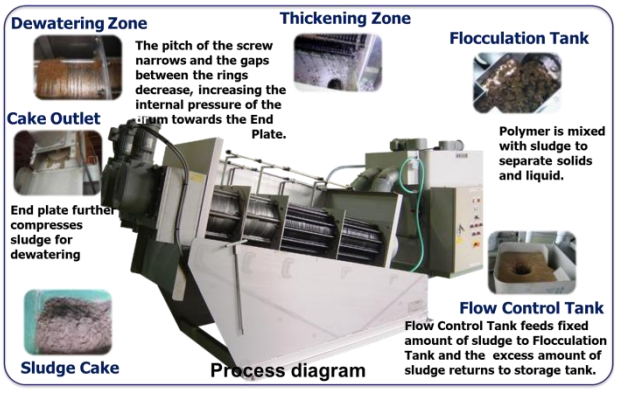
Estimated reduction effect

	Project base	After large scale development
Waste power generation	Approx. 120,000 tons CO_2	-

■ Results2:Estimation of GHG reduction potential in accordance with power generated from incineration of industrial and urban waste, sludge generation in sewage plants and industrial areas that are in the waste and drainage sectors

In order to review the sludge generated at sewage plants and industrial areas, and the potential for GHG reduction in accordance with power generated from incineration of industrial and urban waste, sludge generation in sewage plants and industrial zone areas that are in the waste and drainage sectors was estimated based on collaboration with Da Nang URENCO, Da Nang Drainage and Wastewater Management Company , and Da Nang IPs and EPZ Authority , and also review the possibility of introducing Japanese low carbon technology and collaboration with the project of waste incineration power generation.

＜Target project activities＞

Title	Countermeasures of sludge dehydration and incineration power generation
Image picture	
GHG emission Reduction method	The sludge that is generated from sewage plants and industrial zone area is landfilling (or leave) in anaerobic condition, and methane is emitted from it. By drying the sludge to be used as power feedstock, GHG emission reduction can be

	realized.

■ Results3: Formation of JCM cases and support to improve capabilities for implementation

Together with Yokohama city, EXRI, DUT and Da Nang Department of Foreign Affiar(DOFA), workshops and working groups were organized to introduce outline of JCM scheme and benefits of introducing low carbon technologies under the scheme to the relevant stakeholders in Da Nang city.

≪Workshop≫

1st workshop: August 2013

2nd workshop: November 2013

≪Working group≫

1st working group: August 2013

2nd Working group; January 2014

3.3 Results of review on quantification and MRV method for the effect of greenhouse gas reduction in the waste field

MRV methodologies (draft) were reviewed in the waste field through this project. The following shows the review results for MRV methodologies (draft).

(1) Referenced MRV methodologies

Table 6. Referenced MRV methodologies and default values

CDM	Related methodologies (AMS-III.F Version 11.0, AMS-III.G Version 7.0 and related tools)
IPCC	Methodologies that are related to the GHG emission estimation on waste sector of IPCC guideline (2006) (AMS-III.F Version 11.0, AMS-III.G Version 7.0 and related tools)

(2) Calculation of GHG emissions reducti0on method

(i) How to set default values

The following default values were set to estimate GHG emission and reduction volumes.

(a) Waste composition

This research took advantage of the waste composition data obtained from Da Nang URENCO.

Table 7. Urban waste composition in Da Nang City (2010)

No.	Type of waste	(%)

1	Leftover food	42
2	Wood and gardening waste	7
3	Paper	11
4	Cloth, textile and garment products	2
5	Plastic waste	18
6	Others inorganic waste	20
	Total	100

(Source: Da Nang URENCO)

(b) Sales of power volume at incineration power generation plants

The following factor, which is the result of the JICA PPP study, is used for calculating sales of power volume,

Sales of power volumes at incineration power generation plant：94,000MWh/yr

(c) Grid coefficient

The grid coefficient is regularly updated and published by IGES. This research utilized the coefficient issued by IGES, which was 0.6.

Source: List of Grid Emission Factor (created by IGES)

URL: http://pub.iges.or.jp/modules/envirolib/view.php?docid=2137

Apart from the (a), (b) and (c), the following factors are used for the calculation.

(d) Carbon contents from fossil fuel related waste: IPCC 2006 guideline default value

(e) Methane emission coefficient of MSW: 0.2kgCH_4/Gg waste incinerated(wet base): IPCC 2006 guideline default value

(f) N2O emission coefficient of MSW: 47gN_2O/ton waste incinerated (wet base):IPCC 2006 guideline default value

(3) Method to reduce greenhouse gas emission

Calculation of the reduction of GHG emission volume

$ER_{y,estimated} = BE_y - PE_y$

$ER_{y,estimated}$	Estimated emission reduction volume in the year y (tons CO_2)
BE_y	Baseline emission volume in the year y (tons CO_2)
PE_y	Project emission volume in the year y (tons CO_2)

Baseline scenario

- Baseline scenario: Dispose of all the waste at anaerobic landfill disposal sites.

Baseline emission volume

The baseline emission volume can be obtained from the total methane generated at anaerobic landfill disposal sites and CO_2 emission volume accompanied by grid power generation that is avoided by waste power generation and selling its grid power (system power supply) in case the waste incineration and power generating business were not implemented.

$$BE_y = BE_{CH4,SWDS,y} * GWP\_CH_4 + BE_{CO2,Grid\ emission\ avoided,y}$$

BE_y	Reference emission volume in the year y (tons CO_2/year)
$BE_{CH4,SWDS,y}$	Methane generated from waste treated by the project activities based on the baseline scenario (tons CH_4)
GWP_CH_4	Global warming coefficient of methane (tons CO_2e/tons CH_4) ▪ Default value (21:IPCC)
$BE_{CO2,grid\ emission\ avoided,y}$	CO_2 emission amount accompanied with grid power generation that is avoided by waste power generation and selling its grid power (system power supply) by this project activities (tons CO_2/yr)

Here, $RE_{CH4,SWDS,y}$ can be obtained with the following formula.

$$RE_{CH4,SWDS,y} = \varphi_y * GWP_{CH4} * (1 - OX) * \frac{16}{12} * F * DOC_{f,y} * MCF_y * \sum_{x=1}^{y} \sum_{j} W_{j,x} * DOC_j * e^{-k_j(y-x)} * (1 - e^{-k_j})$$

$RE_{CH4,SWDS,y}$	Methane generated from waste treated by the project activities based on the baseline scenario (tons CH_4)
φ_y	Correction coefficient ▪ Default value (0.75:IPCC）
GWP_{CH4}	Global warming coefficient of methane (tons CO_2e/tons CH_4) ▪ Default value (21 ： IPCC)
OX	Oxidation coefficient (ratio of methane that becomes oxidized on the surface layer of disposal sites) ▪ Default value (0.1: IPCC)
F	Methane ratio in LFG ▪ Default value (0.5: IPCC)
$DOC_{f,y}$	Ratio of degradable carbon that is degraded under certain conditions at disposal sites in the year y ▪ Default value (0.5: IPCC)
MCF_y	Methane correction coefficient in the year y

	▪ Default value (0.4: IPCC)
$W_{j,x}$	The amount of waste j in the year x (tons/year)
DOC_j	Weight ratio of degradable carbon in waste j ▪ Default value (IPCC Guidelines)
k_j	Corrosion coefficient of waste j ▪ Default value (IPCC Guidelines)
j	Kinds of waste
x	Specific years in credit period (1 – y)
y	Credit period

Table 8. Waste categories *DOCj, kj*

Relational table for volume of each waste, weight ratio of degradable carbon, and corrosion coefficient:

Waste categories	Wj,x	DOCj	kj
Food waste	Waste disposal volume x 42%	0.15	0.40
Tree and related waste	Waste disposal volume x 7%	0.20	0.07
Paper	Waste disposal volume x 11%	0.40	0.07
Fibers	Waste disposal volume x 2%	0.24	0.07

Source: Waste disposal volume: 310,000 ton/year (accept 1,000 tons/day of waste under 310 days/year of operation days)

Waste quality: set based on the data supplied by Da Nang URENCO

Moreover, $BE_{CO2,grid\ emission\ avoided,y}$ can be obtained with the following formula:

$$BE_{CO2,grid\ emission\ avoided,y} = EF_{CO2,grid,y} * EG_{\text{substituted,y}}$$

$BE_{CO2,grid\ emission\ avoided,y}$	CO_2 emission amount accompanied by grid power generation that is avoided by waste power generation and selling its grid power (system power supply) through this project activities (tons CO_2/yr)
$EF_{CO2,grid,y}$	Grid emission coefficient (default value: 0.60 tons CO_2/MWh)
$EG_{substituted,y}$	Grid power generation that is replaced with the power sold by project activities (MWh/yr)

Project scenario

- Project scenario: 1,000 tons a day of waste will be incinerated to generate power. Required power for waste incineration and power generating plants will be supplied by in-house power generation, which is waste power generation within the plants, and no additional power

consumption is anticipated.

Project emission volume

$PE_y = PE_{y,power} + PE_{y,fuel}$

PE_y	Project emission volume in the year y (tons CO_2/yr)
$PE_{y,power}$	Emission volume accompanied by power consumption from project activities in the y (tons CO_2/yr)
$PE_{y,fuel}$	Emission volume accompanied by fossil fuel consumption from project activities in the year y (tons CO_2/yr)

Now:

$PE_{y,power} = EC_{pj,y} * EC_{CO2,pj,EG}$

$PE_{y,power}$	Emission volume accompanied by power consumption from project activities in the y (tons CO_2/year)
$EC_{pj,y}$	Electricity consumption volume accompanied by power consumption from project activities in the y (MWh/y) ▪ Set based on monitoring
$EF_{CO2,PJ,EG}$	Emission coefficient involved in electricity consumption (tons CO_2/MWh) ▪ Default value: 0.6 tons CO_2/MWh (grid coefficient)
$FC_{pj,y}$	Fossil fuel consumption volume from project activities in the year Y (volume or mass/year) ▪ Set based on monitoring
$EF_{CO2,PJ,FC}$	Emission coefficient involved in fossil fuel consumption (tons CO_2/volume or mass) ▪ Default value: IPCC guidelines

Also:

$PE_{y,fuel} = FC_{pj,y} * EF_{CO2,pj,FC}$

$PE_{y,fuel}$	Emission volume involved in fossil fuel consumption from project activities in the year y (tons CO_2/year)
$FC_{pj,y}$	Fossil fuel consumption volume from project activities in the year y (volume or mass/year) ▪ Set based on monitoring
$EF_{CO2,pj,FC}$	Emission coefficient involved in fossil fuel consumption (tons CO_2/volume or mass) ▪ Default value: IPCC guidelines

Also:

$$PE_{y,incineration,FCF} = \sum_i (SW_i * dm_i * CF_i * FCF_i * OF_i) * 44/12$$

PEy,incineration,FCF= annual amount of CO2 emissions from burning fossil-fuel related fuels (including plastic)

SW_i	=	total amount of solid waste of type *i* (wet weight) incinerated or open-burned, Gg/yr
dm_i	=	dry matter content in the waste (wet weight) incinerated or open-burned, (fraction)
CF_i	=	fraction of carbon in the dry matter (total carbon content), (fraction)
FCF_i	=	fraction of fossil carbon in the total carbon, (fraction)
OF_i	=	oxidation factor, (fraction)
44/12	=	conversion factor from C to CO_2
i	=	type of waste incinerated/open-burned specified as follows:

Also:

$$PE_{y,CH4,incineration} = \sum_i (IW_i * EF_i) * 10^3 * \mathrm{GWP_{CH4}}$$

PEy,CH4,ncineration,= annual amount of CH4 emissions from burning waste as power fuels

IW_i	=	amount of solid waste of type *i* incinerated or open-burned, Gg/yr
EF_i	=	aggregate CH_4 emission factor, kg CH_4/Gg of waste
10^{-6}	=	conversion factor from kilogram to gigagram
i	=	category or type of waste incinerated/open-burned, specified as follows: MSW: municipal solid waste, ISW: industrial solid waste, HW: hazardous waste, CW: clinical waste, SS: sewage sludge, others (that must be specified)

Also:

$$PE_{y,N2O,incineration} = \sum_i (IW_i * EF_i) * 10^3 * \mathrm{GWP_{N2O}}$$

PEy,CH4,ncineration,= annual amount of N2O emissions from burning waste as power fuels

IW_i	=	amount of incinerated/open-burned waste of type *i* , Gg/yr
EF_i	=	N_2O emission factor (kg N_2O/Gg of waste) for waste of type *i*
10^{-6}	=	conversion from kilogram to gigagram
i	=	category or type of waste incinerated/open-burned, specified as follows: MSW: municipal solid waste, ISW: industrial solid waste, HW: hazardous waste, CW: clinical waste, SS: sewage sludge, others (that must be specified)

(4) Estimate of GHG emission reduction at Khanh Son disposal site in Da Nang

1. Estimated reduction effect

	Project base	After large scale development
Waste power generation	Approx. 120,000 tons CO_2	-

2. Method to calculate reduction

<Project base>

・CO2 reduction = reduction of methane emission from waste disposal + reduction of fuel used to generate power

(approx. 160,000 tons CO2/year) (approx. 100,000 tons CO2/year) (approx. 60,000 tons CO2/year)

Supplemental: As all the power for incineration and electricity to be consumed will be supplied by in-house power generation from incineration heat, in principle the generation of GHG is anticipated to be extremely low, but 10% of emission volume in the reference scenario shall be removed.

・Reduction of methane emission from waste disposal =

$$\varphi_y * GWP_{CH4} * (1 - OX) * \frac{16}{12} * F * DOC_{f,y} * MCF_y * \sum_{x=1}^{y} \sum_{j} W_{j,x} * DOC_j * e^{-k_j(y-x)} * (1 - e^{-k_j})$$

⇒ Approx. 100,000 tCO2/year

・Reduction of fuel used for power generation = Selling power volume from waste power generation x emission coefficient

(approx. 60,000 tCO2/year) (94,000MWh/year) (0.6tCO2/MWh)

Source: Power generated from waste: Calculate the scale of waste power generation facilities and its operation volume

Emission coefficient: Grid power emission coefficient in Vietnam in 2010 (Ministry of Natural Resources and Environment, December 2011)

Further more, the following GHG emissions is derived from the above-mentioned total project emissions reduction.

・CO2 emissions from burning plastic waste at incarnation plant： Approx. 40,000ton/yr

Meanwhile, emissions of CH4 and N2O from burning waste at incarnation plan is not counted due to the amount is relatively small.

■ Results3: Formation of JCM cases and support to improve capabilities for implementation

Together with Yokohama city, EXRI, DUT and Da Nang Department of Foreign Affiar(DOFA), workshops and working groups were organized to introduce outline of JCM scheme and benefits of introducing low carbon technologies under the scheme to the relevant stakeholders in Da Nang city.

≪Workshop≫
1st workshop: August 2013
2nd workshop: November 2013

≪Working group≫
1st working group: August 2013
2nd Working group; January 2014

Chapter 4: Review for commercialization

4.1 Challenges for commercialization

The following challenges need to be investigated for the JCM commercialization of specific cases in the future.

(1) Support to improve project profitability

JICA preparation and research for environmental infrastructure maintenance project in FY 2013 implied the possibility to secure project profitability by targeting general waste when JCM aid and JICA investments and loans are utilized. Therefore it is necessary to improve project profitability further, secure financially stable operations, and propose project implementation scenarios to contribute more to environmental improvement for Da Nang by targeting additional countermeasures for sludge and industrial waste.

(2) Support to improve capabilities of waste collecting public corporations

A part of industrial waste and sludge generated in Da Nang is transported and treated by corporations based in Hanoi or Ho Chi Minh. Under the principle of "treat and dispose within the area" for appropriate treatment and disposal of industrial waste and sludge generated in the city, it is necessary that Da Nang URENCO (local counterpart of the above PPP project) and the PPP project collaborate. It is then possible to take a role to realize Da Nang eco city initiatives and reduce CO_2 that is generated by long distance transportation to Hanoi and Ho Chi Minh by establishing a system to appropriately treat and dispose of this waste.

(3) Legal enforcement to control drainage, sludge, and waste treatment

Currently, regulations to control industrial waste generated in sewage plants and industrial areas are set with various levels, and the overall regulation and responsible organizations for control and treatment are not clear. This is creating many corporations that continue to illegally treat and dispose of the waste. Therefore, it is necessary to clarify procedures and responsible organizations.

4.2 Schedule for JCM commercialization

This table shows the schedule for commercialization. Detailed investigation will take place in the first half of FY 2014 and the JCM project is scheduled to start from FY 2014 and run to the first half of FY 2015.

	FY 2014	FY 2015	FY 2016	FY 2017
Waste incineration power generating equipment	Design details	Construction, foundations		Start operation
Sledge dehydrating equipment	Design details	Start construction and operation		
Scheduled transportation route of sludge treatment	Design details	Implementation		
MRV system establishment	Design details	Implementation		