FY2014 Feasibility Studies on Joint Crediting Mechanism (JCM) Projects towards Environmentally Sustainable Cities in Asia

The Feasibility Study toward Eco-island between Kien Giang Province and Kobe City, Vietnam

March 2015

Institute for Global Environmental Strategies
Nikken Sekkei Civil Engineering Ltd.

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■ Abbreviation

ACM	Approved Consolidated Methodology
AM	Approved Methodology
BaU(BAU)	Business-as-Usual
BOCM	Bilateral Offset Credit Mechanism
C/P	Counter Part
CDM	Clean Development Mechanism
DOEs	Designated Operational Entities
GHG	Green House Gas
GGS	Green Growth Strategies
GGS/AC	Green Growth Strategies/Action Plan
IPCC	Intergovernmental Panel on Climate Change
JCM	Joint Crediting Mechanism
JICA	Japan International Cooperation Agency

MRV	Measurement, Reporting, Verification
NAMAs	Nationally Appropriate Mitigation Actions
NAPA	National Adaptation Programmes of Action
NGO	Non-Governmental Organizations
UNFCCC	UN Framework Convention on Climate Change
PDD	Project Design Document
PPP	Public Private Partnership
QA/QC	Quality Assurance/Quality Control
REDD+	Reducing Emissions from Deforestation and Forest Degradation PLUS
TOE	Ton of Oil Equivalent

（Vietnam government）

DARD	Department of Agriculture and Rural Development
DMHCC	Department of Meteorology, Hydrology and Climate Change
DOF	Department of Finance
DOH	Department of Health
DOIT	Department of Industry and Trade
DONRE	Department of National Resource and Environment
DOT	Department of transport
DPI	Department of Planning and Investment
MONRE	Ministry of National Resource and Environment
MOIT	Ministry of Industry and Trade
MOST	Ministry of Science and Technology
PC	People's Committee
PPC	Provincial People's Committee

（Kien Giang province local government）

DPC	District People's Committee
KGPPC	Kien Giang Provincial People's Committee
PQDMB	Phu Quoc Development Management Board

（organisation）

KIWACO	Kien Giang Water Supply and Drainage One Member Limited Company

（name of places）

An Thới
Rach Gia
Đảo Phú Quốc
Dương Đông
Tỉnh Kiên Giang

Chapter 1. Background and Overview of Research

1.1 Background of research

1.1.1 Overview of Phú Quốc Island

Economic development and urbanisation in recent years are striking on Phú Quốc, an island of scenic beauty referred to as the "Emerald Island", with provision of an international airport and progress in urban development as a resort island.

The largest of Vietnam's islands (589 km^2) in the Gulf of Thailand is located 40 kilometers west of mainland Vietnam and 10 kilometers offshore mainland Cambodia, at 10° 15′ 32″ N 102° 50′ 14″ E. The An Thới islands extend south of the island. The Phú Quốc District, made up of Phú Quốc and nearby islands, is part of Kiên Giang Province.

Figure 1.1.1.1 Map of Phú Quốc and photo of scenery

The island runs 50 kilometers north to south and 27 kilometers east to west, with a population of 96,940 and population density of 165 persons per km^2 (July 2014). Its largest town is Dương Đông, located in the northwest of the island.

With a tropical monsoon climate, the island's average annual precipitation is 2,879 mm, and average temperature is 27 ℃. The island is said to have 99 mountains and hills, with geographical features of all shapes and sizes, including magnificent mountains, and the Cua Can and Duong Dong rivers that flow from their sources in the northeast into the sea (Kiên Giang museum). Called the last paradise, the island boasts rich vegetation and beautiful beaches such as Long Beach (Truong Beach) and Sao Beach, some of the very few places in Vietnam where the sunset can be seen over the sea. Resorts are patronised not only by Vietnamese and overseas Chinese, but also Europeans and Americans, with villa-style hotels available. In 2007, the first five-star hotel opened for business, raising expectations for economic development and increased eco-tourism.

A dramatic increase in population and tourists is predicted for the future. Estimates for population in the year 2020 fall between 340,000 and 380,000, with the number of tourists reaching approximately two million. Concerns have arisen over the increasing load of greenhouse gas (GHG) emissions that will result from increases in electricity and energy consumption, traffic, waste emissions and waste water treatment volume.

1.1.2 The GHG reduction policy of the Government of Vietnam and initiatives on Phú Quốc Island

In order to curb global temperature rise to within 2℃, GHGs must be drastically reduced. As a long-term objective, global GHG emissions must be halved by 2050. Key to reaching this objective is realising GHG reductions by discovering and forming large-scale projects for greenhouse gas reduction in the Asia-Pacific region, currently in a period of striking growth, and the advancement of measures to build sustainable low-carbon societies. As of July 2014, the Government of Japan has signed documents for JCM with 12 countries and is working to accelerate the movement towards GHG reduction.

On 2nd July 2013, the Government of Vietnam and the Government of Japan signed documents concerning the implementation of a Joint Crediting Mechanism (JCM). A joint committee was established and preparations are underway toward implementation. The focal point of the JCM for the Government of Vietnam is the Department of Meteorology, Hydrology and Climate Change (DMHCC).

Climate change related policies in Vietnam executed sequentially after 2004 are shown in Table 1.1.2.1.

Table 1.1.2.1 Climate change related policies in Vietnam

The Oriented Strategy for Sustainable Development in Vietnam (Vietnam's Agenda 21) (Prime Minister 153/2004/QD-TTg 17/8/2004) ・National Target Program to respond to climate change (Prime Minister 158/2008/QD-TTg 2/12/2008) ・Action Plan of Ministry of Industry and Trade to respond to climate change (Ministry of Industry and Trade 4103/QD-BCT 3/8/2010) ・National Climate Change Strategy (Prime Minister 2139/QD-TTg 5/12/2011) ・National Target Program to respond to climate change (NTP-RCC), 2012-2015 (Prime Minister 1183/QD-TTg 30/8/2012) ・National Green Growth Strategy (Prime Minister 1393/QD-TTg 25/9/2012) ・Project of greenhouse gas emission management; management of carbon credit business activities to the world market (Prime Minister 1775/QD-TTg 21/11/2012) ・Guide to capital management mechanism for support program to respond to climate change, joint circulation (The Ministry of Natural Resources and Environment, Ministry of Finance, Ministry of Planning and Investment 03/2013/TTLT-BTNMT-BTC-BKHDT)

Source: Market Mechanisms Country Fact Sheets, IGES March 2014

Climate change policies adopted at the national level in Vietnam include the National Target Program to respond to climate change (Prime Minister 158/2008/QD-TTg 2/12/2008) of 2008, the National Climate Change Strategy (Prime Minister 2139/QD-TTg 5/12/2011) of 2011, the National Green Growth Strategy (Prime Minister 1393/QD-TTg 25/9/2012) of September 2012, and the National Action Plan on Climate Change for the period 2012-2020 (Prime Minister 1474/QD-TTg) of October 2012.

The National Climate Change Strategy (Prime Minister 2139/QD-TTg 5/12/2011) adopted in 2011 includes the following two objectives:

・To develop the capacity of the country to respond to the impacts of climate change and carry out mitigation measures on GHG emissions, ensuring the safety of people's lives and property, aiming to achieve sustainable development;

・To strengthen human resources and natural systems to develop a low-carbon economy in order to improve the country's capacity to adapt to climate change, preserve the quality of life and achieve sustainable development, together with the international society that protects the global climate system.

Concrete excerpts on strategic issues are shown in Table 1.1.2.2 below.

Table 1.1.2.2 Strategic issues (excerpts): greenhouse gas emission reduction to preserve the global climate system

Objective	Policy measures
a) Development of new and renewable energies	
By 2020, to reach total capacity of hydropower plants at 20,000-22,000 MW	Review the planning of multipurpose hydropower
To increase the share of new and renewable energies to 5% of the total commercial primary energies by 2020 and 11% by 2050	Step up research and development of new and renewable energies (wind, solar, tide, geothermal, bio and cosmic energies)
b) Energy conservation and production and construction of plants	
By 2020, to have 90% of industrial facilities using cleaner production and controlling consumption of energy, fuel and raw materials	Research the application of new low-carbon technologies, conversion from fossil fuels to low-emission fuels, and widely-applicable cleaner production
By 2020, to raise the production value of industries using advanced technologies, ensuring added value to reach 42-45% of the total industrial production value; to promote innovation toward advanced technologies; by 2020, to use 20% advanced technologies and equipment; by 2050, to increase the production value of industries using advanced technologies to over 80%	Research on and application of advanced technologies in major industries
・Transportation	
By 2020, to achieve a transportation system that meets societal needs; by 2050, to complete modernisation of domestic and international transportation networks	Development of transportation plan and raising of quality up to international standards; development of urban public transportation and supervision of private vehicles
To accelerate the switch to use of compressed natural gas and liquefied gas in buses and taxis to reach the target of 20% by 2020, and 80% by 2050	Promotion of use of low-carbon fuels for transportation
c) Agriculture	
Every 10 years hence, to reduce GHG emissions by 20%, while securing the sector's growth at 20% and lowering the poverty rate by 20%.	Alter agricultural practices for rationalised use of water, fertilisers and feed; manage and treat waste from livestock, use of biogas as a fuel, eliminate old inefficient agricultural machines
d) Solid waste management	
By 2020, 90% of urban household waste will be collected and treated, of which 85% will be recycled, reused and recovered for energy generation	Promote research and application of advanced waste treatment technologies; apply modern waste treatment technologies on the part of local governments and in rural areas; build capacity for treatment and recycling and create a management structure for industrial and household wastewater

Source: The Prime Minister, Decision on approval of the National Climate Change Strategy (2139/QD-TTg)

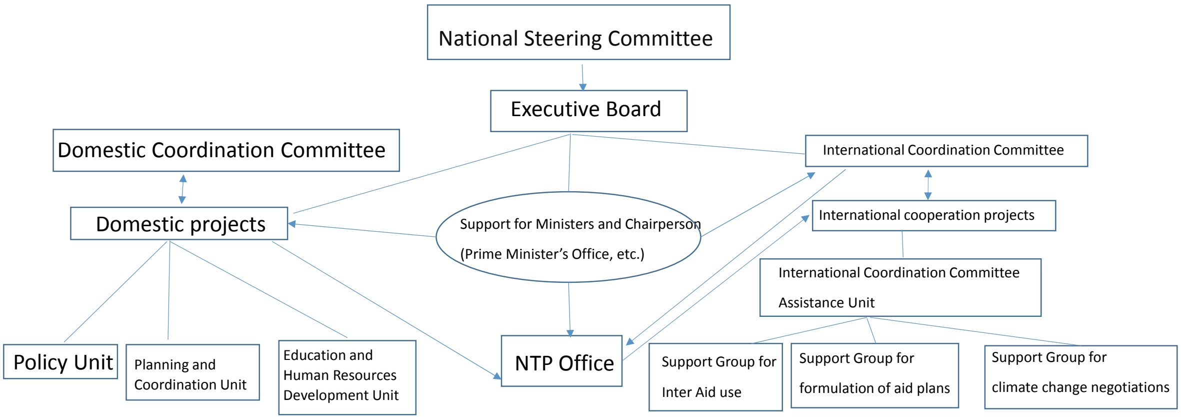
The "National Target Program to respond to climate change (NTP-RCC), 2012-2015 (Prime Minister 1183/QD-TTg 30/8/2012)", approved on 30 August 2012, states its objective as the formulation of a feasible action plan to effectively respond to climate change toward phased implementation of the National Target Program. An overview of the Program is shown in Table 1.1.2.3 below.

Table 1.1.2.3 Overview of National Target Program to respond to climate change (NTP-RCC), 2012-2015

● Formulation and proclamation of a national action plan and actions plans for government agencies and local governments regarding a climate change response
● Construction of an electronic monitoring system to assess socio-economic development plans in the case of climate change and sea level rise in Vietnam
● Creation of a geographical information system for ascertaining natural disaster risk, and coordinated creation of climate change scenarios including flood maps, weather and sea level rise
● Continued research on updating climate change scenarios, assessment of regions and sectors that will face impacts such as sea level rise, and formulation of climate change countermeasures
● Implementation of priority items, particularly urgent priority items designated in the action plan to respond to climate change
● Implementation of adaptation pilot projects on climate change and sea level rise in two provinces
● Promulgation of climate change adaptation measures and mitigation policy in priority sectors (agriculture, forestry, land-use, water resources, energy, transportation, building, poverty reduction and social security)
● Creation of institutions to provide incentives to financial institutions and mobilise overseas funding in order to promote technologies and investments in response to climate change
● Dissemination of public information to improve basic knowledge on climate change

Source: Prime Minister, Decision on approval of National Target Program to respond to climate change (NTP-RCC) 2012-2015 (1183/QĐ-TTg)

The organisational structure to implement these climate change programmes is shown in Figure 1.1.2.1 below.



Source: Ministry of Natural Resources and Environment (MONRE), Overview of NTP-RCC & SP-RCC

http://www.ntprcc.gov.vn/index.php?option=com_contents&view=category&layout=blog&id=80&Itemid=145&lang=en

Figure 1.1.2.1 Organisational structure of the National Target Program to respond to climate change

The "National Green Growth Strategy (Prime Minister 1393/QD-TTg 25/9/2012)" approved on 25 September 2012, calls for mitigation of GHG emissions and enhanced capacity for absorption of GHGs, required for green growth policies that realise low-carbon economies and enhance natural capital value. The green growth strategy has become mainstream in the development of sustainable economies and is considered to be a key indicator of socio-economic development.

The following three points are designated as objectives.

① Rebuilding of economy: to build economic institutions based on greening of existing sectors, and to promote development in the economic sector in order to efficiently utilise high added value energy and natural capital.

② Implementation of research: to promote the application of appropriate advanced technologies in order to efficiently utilise natural capital, reduce the intensity of greenhouse gas emissions and link these actions to effective measures to address climate change.

③ Improved standard of living: to create environmentally-friendly lifestyles through creation of employment in green industries, agriculture and services, investment in natural capital and green infrastructure.

As shown in Table 1.1.2.4, strategic issues include reduction of greenhouse gas emissions, and promotion of green energies and renewable energies in accordance with targets.

Table 1.1.2.4 Targets for reducing GHG concentration and use of clean and renewable energies

Period	GHG emission reduction	Reduction of GHG concentrations	Reduction of energy consumption per unit of GDP	Reduction based on domestic initiatives	Reduction based on international support
2011-2020	•10%-20% in energy sector compared to BAU	8-10% compared to 2010	1-1.5% annually	10%	10%

Up to 2030	•at least 1.5-2% annually •20-30% in energy sector compared to BAU			10%	20%
Up to 2050	•1.5-2% annually				

Green production will be advanced as follows.

• Percentage of GDP for production of high-tech and green technology products: 42-45%

• Percentage of manufacturing facilities that meet environmental standards: 80%

• Percentage of green technology application: 50%

• Promotion of investment to support the environmental protection sector

• Raising the value of natural capital to 3-4% of GDP

Major targets for 2020 related to greener lifestyles and promotion of sustainable consumption are as follows.

• Percentage of Grade III cities (installation of waste water collection and treatment systems that meet legal standards): 60%, Percentage of Grade IV and Grade V cities and craft villages: 40%

• Environmental improvements in heavily polluted areas: 100%

• Bring rate of collection and treatment of water in forest areas to the same standard as cities

• Usage rate of public transportation in major cities and mid-sized cities: 34-35%

• Applicability of greening standard in major cities and mid-sized cities: 50%

Source: Prime Minister, Decision on approval of the National Green Growth Strategy (No: 1393/QĐ-TTg)

Policies in Kiên Giang Province are shown below.

• Encourage investments both domestically and from overseas in environmentally-sound technologies and advanced low GHG emissions.

• Gather both central and local government funds to carry out thorough treatment of environmentally polluted sites in the province.

• Aim to chronologically replace old conventional technologies being used in various projects with advanced environmentally-sound technologies and low GHG-emitting alternatives.

• Implement research on and application of economic tools and production processes that effectively make practical use of GHG emission reductions from agricultural production, including seedlings, feed, agricultural materials, soil and water.

• In order to reduce GHGs, bring to commercial reality the production of animal feed, mushroom cultivation, industrial raw materials and biogas, and manufacturing technologies for organic fertiliser from agricultural waste. Kiên Giang Province has organised the adoption of an Integrated Pest Management (IPM)*1 programme and built a large-scale rice field model to comply with VietGAP*2 cultivation standards.

(The standards for the “Safe Vegetables” production programme in Vietnam are based on GAP (Good Agricultural Practices) and IPM (Integrated Pest Management), which include management of agricultural production materials and irrigation water, as well as controls on pesticide residue.)

Reference

IPM (Integrated Pest Management) *1

The IPM is a method of pest management based on information on predicted outbreaks of pests. Prevention and extermination are carried out with a combination of cropping methods, biological methods, chemical methods and physical methods to suppress outbreaks of pests to levels that do not involve economic damages, while aiming to maintain the low levels. With this management method, risks to human health and environmental burdens are reduced or kept at minimal levels.

VietGAP (Good Agricultural Practices)*2

Vietnam’s Good Agricultural Practices (GAP), namely standards for cultivation of vegetables safe for both humans and the environment, prescribed by the Ministry of Agriculture and Rural Development (MARD) in 2008.

The context for the establishment of VietGAP included the inappropriate use of pesticides and growth promoting agents in some production areas and the issue of fraudulent claiming of production place. Likewise, entry into the World Trade Organisation (WTO) is often cited. There are 71 conditions that must be met to gain certification from provincial MARD offices, including quality checks that investigate microorganisms adhered to vegetables and heavy metal content, existence of facilities for bagging and washing of vegetables, and checks on water pollution from factory effluents or other sources. Furthermore, thorough management is carried out after certification as well, including obligatory recording-keeping on cultivation.

In an effort to achieve harmony with nature and symbiosis with the natural world, and meanwhile to secure food for human survival, IPM technologies are being practiced at cultivation sites. To enable an increased yield of high quality and safe agricultural products, integrated crop management (ICM) is required. With the support of Australia (AusAID), seven projects on ICM nutrition management programmes are being deployed. Of these, in Tan Hiep district, Balasa No.1 is used in the treatment of waste from pork and poultry farms to reduce emissions of biogases in 1,200 locations (including household use).

• Speed up forestation and reforestation and raise corporate investments in forest production to reach 13.5-14% of forest coverage rate. Increase the numbers of permanent living things by improving the quality of forests, enhancing the carbon collection capacity of forests, and maintaining the amount of wood production and consumption.

Mangrove forests that run along the coast for over five kilometers at Hon Dat, Kien Luong, and An Minh Districts and Ha Tien Town have continued to grow in recent years, reducing the impacts of greenhouse gases and improving environmental performance.

• Implement GHG reduction programmes (REDD) and sustainable forest management linked with diverse means of livelihoods for local residents in order to put the brakes on forest reduction and deterioration.

Initiatives on Phú Quốc Island are very similar to the above-mentioned policies of Kiên Giang Province. Meanwhile, the four items shown below are policies executed specifically on Phú Quốc Island.

• Treat sewage and waste collected from factories and workplaces on Phú Quốc Island in conformity with environmental standards and emissions standards.
• Encourage local industries to adopt advanced technologies and conserve fossil fuels.
• Endeavor to maintain existing forests on the island of Phú Quốc.
• Actively bid for local and foreign investment to support projects in sewage and waste treatment.

1.1.3 Approach of the Government of Vietnam on JCM

The Government of Vietnam promotes the JCM in international society as an effective mechanism for low-carbon growth, and likewise has determined to give serious consideration to JCM in Vietnam and to intently develop them. Additionally, the Government of Vietnam, in particular the government administration and industries, recognise a solid understanding of the JCM mechanism to be indispensable, and intend to support this effort.

In recent years, the administration has established guidelines and policies to rebuild a green growth economy in Vietnam. Industries must simultaneously engage in sustainable development and environmental protection, including top priority reduction of greenhouse gas emissions. In 2014, the Minister of Natural Resources and Environment is expected to approve implementation and regulations of projects under the JCM mechanism in Vietnam.

1.1.4 Collaborative relationship between the Kobe City and Kiên Giang Province

On 8th July 2011, Kobe City and Kiên Giang Province signed a Memorandum of Understanding on cooperation related to the urban environment and water infrastructure sectors. With the cooperation of a local Kobe company, a feasibility study on the development of water and sewage services was carried out on Phú Quốc Island in Kiên

Photo：Signing Ceremony of Cooperation Agreement

Giang Province.

Specifically, in the “Preparatory Survey on Water Infrastructure Development Project in Kiên Giang Province, Vietnam” (JICA partnership preparatory survey, September 2011-July 2013), an improvement project in water and sewage works on Phú Quốc Island was proposed. At present, efforts are underway to implement this project and deliberations are ongoing aimed at launching the project in fiscal year 2015.

Further, also underway is a JICA “Grassroots Technical Cooperation Project” to support an improved water environment (April 2013 to March 2016). This project involves people exchanges, such as observation tours in the water infrastructure and environment sectors as well as trainings in the field.

Renewal of the Memorandum of Understanding was conducted this fiscal year on 30 July 2014 on Phú Quốc Island, Kiên Giang Province. The project is to be continued in the future based on partnership and a strengthened cooperative relationship between both parties.

1.2 Overview of study

1.2.1 Objective of study

The objective of this project to discover and form a large-scale JCM project based on made-to-order methods in the context of an inter-city cooperation initiative in the waterworks and sewage sector between Kobe City and Kiên Giang Province, and the achievements of various initiatives on Phú Quốc Island by the joint proposing group described later. The project will endeavor to expand the project’s principle to devise ideas for tourism development and economic development while realising preservation of the natural environment and low-carbon societies, to other island nations and regions. Further, in fiscal year 2014, attention will be focused on feasibility studies and foundational research toward formulation of a proposed project issue.

1.2.2 Period of study

This project is to be implemented from 18 April 2014 to 6 March 2015.

1.2.3 Procedures of study

The project will be implemented following the schedule below. As necessary, study officials will conduct coordination meetings and site visits to coordinate with counterparts in Kiên Giang Province.

As shown below, meetings were held on a total of five occasions (three times in Kobe, once on Phú Quốc Island, Kiên Giang Province, and once in Rạch Giá). Study officials and Kiên Giang officials endeavored to collaborate in sharing information at briefing sessions. The programmes, persons in attendance and presentation materials from each meeting are shown in attachments 1 to 5.

2014

16 July (Wed.)　1st Japan Participants Meeting (kick-off meeting)
Bldg. 4, 1st Fl. Conference Room, Kobe City Hall; 33 participants

30 July (Wed.)　Inception Meeting
People's Committee Conference Room, Phú Quốc Island, Kiên Giang Province; 44 participants (27 members of JCM study group, 17 participants from Kiên Giang Province)

29 Aug. (Fri.)　2nd Japan Participants Meeting (mid-term briefing session)
Bldg. 3, 2nd Fl. Conference Room 3023, Kobe City Hall; 27 participants

19 Dec. (Fri.)　3rd Japan Participants Meeting (final briefing session)
8th Floor Conference Room, Kobe Environment Bureau Research Hall; 22 participants

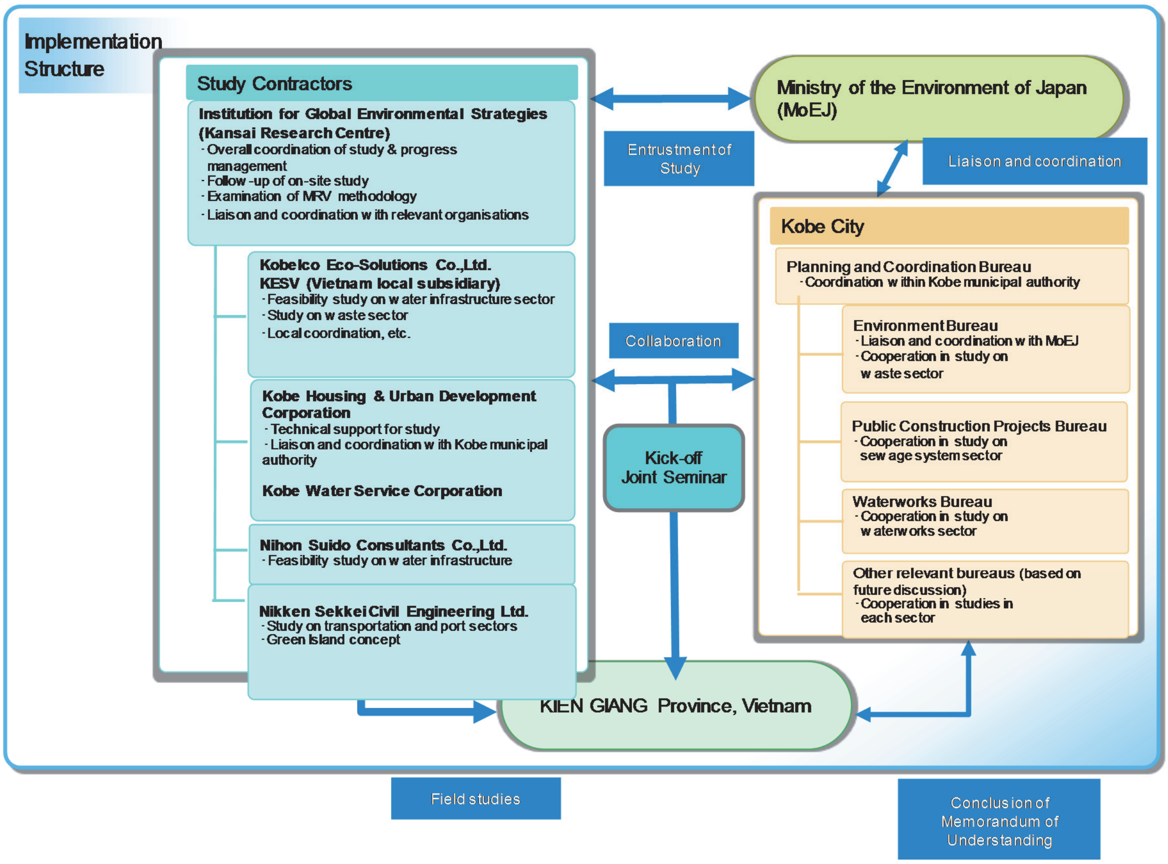
2015

4 Feb. (Wed.)　Final Report Meeting
People's Committee Conference Room, Kiên Giang Province;
30 participants (13 members of JCM study group, 17 participants from Kiên Giang Province)

	2014									2015		
	Apr.	May	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.
Creation of implementation structure		━										
Formulation of project plan		━	━									
Collaboration between local gov'ts	- -	- -	- -	Memorandum renewal 7/30 - -	- -	- -	- -	- -	- -	- -	- -	- -
Water-related FS				- -	- -	- -	- -	- -	- -	- -		
Survey on waste material/deliberations				- -	- -	- -	- -	- -	- -	- -		
Other needs assessments				- -	- -	- -	- -	- -	- -	- -		
Formulation of MRV methodology (draft)				- -	- -	- -	- -	- -	- -	- -		
Kick-off joint seminar				●							●	
Japan participants meeting				● ISAP			● SCW					
Report preparation										━	━	●
Coordination meetings		●	●	●	●		●		●	●		●
Site visits (surveys/briefings)				●			●				●	

1.2.4 Implementation structure of study

This project will be implemented based on the implementation structure below.



Division of roles is as follows.

① Kobe City has concluded a Memorandum of Understanding with Kiên Giang Province of Vietnam on exchange and technological cooperation in urban environmental improvements and water environment improvements related to agriculture, tourism, urban development and revitalisation of economic activity. Kobe City has carried out technology trainings in Japan and provided technological advice in Vietnam. For this project, it will provide cooperation and support to departments in charge of waterworks and sewage systems, waste and energy sectors.

② The Institute for Global Environmental Strategies, a public-interest incorporated foundation, carries out research activities under the topic "Business and Environment" focused on initiatives in the private sector, such as the promotion of environmental and energy conservation measures by private companies. For this project, IGES will engage in overall coordination, including progress management, ascertainment of local needs, examination of MRV methodology, and secretariat work such as liaison and coordination among participating organisations.

③ Kobelco Eco-Solutions Co., Ltd., will be in charge of the feasibility study on the water infrastructure sector and the foundational research on the waste sector. Likewise, the Kobe Housing & Urban Development Corporation and Nihon Suido Consultants Co., Ltd., will be in charge of technical support for the feasibility study on the water infrastructure sector. Nikken Sekkei Civil Engineering Ltd., will be in charge of the local needs assessment study for discovering large-scale project issues.

1.2.5 Overview of study

The Government of Vietnam has placed focus on tourism development on the island of Phú Quốc in Kiên Giang Province. Estimating two million tourists in 2020 and five million in 2030, the government is expediting development to make the island's southern region into a leading tourism location. Meanwhile, the government supports the economic development of the island, with the entire island designated a Special Economic Zone (SEZ) aimed at development of the import/export and food industries.

Further, the "National Green Growth Strategy" came into effect in 2012 for the entire nation of Vietnam, and plans are laid to undertake creation of action programmes for this strategy around the country in 2014. The present is an important period of time for the materialisation of low-carbon shifts and the adoption of green technologies. In this context, the preservation of the precious natural environment and the realisation of a low-carbon society is now called for on Phú Quốc Island.

(Initiatives to date)

In the "Preparatory Survey on Water Infrastructure Development Project in Kiên Giang Province, Vietnam" (JICA partnership preparatory survey, September 2011-July 2013), Kobe City, Kobe Housing & Urban Development Corporation and Kobelco Eco-Solutions proposed an improvement plan for the waterworks and sewage systems of Phú Quốc Island, and at present are working towards realisation. Specifically, deliberations are ongoing aimed at launching the project in fiscal year 2015. Additionally, Kobe City concluded a Memorandum of Understanding (July 2011) with Kiên Giang Province on cooperation in the waterworks and sewage system sector. Further, also underway is a JICA Grassroots Technical Cooperation Project to support an improved water environment (April 2013 to March 2016, Kobe Housing & Urban Development Corporation as the main constituent).

(The present state of affairs and issues related to low-carbon on Phú Quốc Island)

●The state of the waterworks and sewage system infrastructure on Phú Quốc Island is as follows. Improvements in waterworks and sewage infrastructure are an urgent issue for developing tourism while protecting the natural environment.

As Phú Quốc is a relatively small-scale island, good water sources of its own are scarce. Considering the impending future demand for water, there is a great need in the island's development for technologies for effective use and reuse of water sources, as well as leak prevention.

● The island is dependent on the mainland for a supply of electricity. Combined with electricity shortages around the country in Vietnam, power shortages and unstable supply are structural issues. As such, securing a source of energy on the island and reduction in energy use are long-term issues.

● At present, general waste is piled up in the open-air on a temporary site on the island. In order to maintain a good local environment and secure a final disposal site on limited island space aimed at future tourism development, the following three issues are of import: 1) reduction of final disposal volume, 2) environmental protection of the landfill site, and 3) energy recovery from waste to address electricity shortages.

● Plans are laid for development of the food industry centred on the Special Economic Zone (SEZ). However, at the present state of technological level in the country, and with environmental protection measures insufficient relative to the increase in production activities, concerns have been raised over environmental degradation of land and water areas due to increased wastewater and waste matter.

● Other concerns have arisen over increased volume of traffic, increased GHG emissions and increased traffic congestion accompanying economic development and increases in tourists and resident population. Likewise there are concerns over increased energy usage due to placement of hotels and commercial complexes, as well as an increase in harbour facilities and ships, and loss of mountains and forests due to illegal development and dumping of waste. (Numbers of tourists are expected to rise from approximately 300,000 (2009) to approximately 2 million (2020), and population from approximately 100,000 to approximately 340,000-380,000 (2020).)

(2) Objectives

This project is an inter-city cooperation initiative in the waterworks and sewage sector between Kobe City and Kiên Giang Province, in the context of the achievements of various initiatives on Phú Quốc Island by the joint proposing group described later. The objective is to discover and form a large-scale JCM project based on made-to-order methods. The project will endeavor to expand the project's principle to devise ideas for tourism development and economic development while realising preservation of the natural environment and low-carbon societies, to other island nations and regions. Further, in fiscal year 2014, attention will be focused on feasibility studies and foundational research toward formulation of a proposed project issue.

Chapter 2. Overview and Results of Field Study (FS) in the Waterworks and Sewerage System Sector

2.1. Preconditions

2.1.1 Background

Kobe City, Kobe Housing & Urban Development Corporation, Nihon Suido Consultants and Kobelco Eco-Solutions proposed an improvement project in water and sewerage works on Phu Quoc Island, entitled "Preparatory Survey on Water Infrastructure Development Project in Kiên Giang Province, Vietnam" (JICA partnership preparatory survey, September 2011-July 2013). At present, efforts are underway toward implementation and studies are being advanced aimed at launch of the project in fiscal year 2015. Further, Kobe City signed a Memorandum of Understanding with the same province on cooperation related to the urban environment and water infrastructure sectors (July 2011). Additionally, also underway is a JICA Grassroots Technical Cooperation Project to support an improved water environment (April 2013 to March 2016, Kobe Housing & Urban Development Corporation as the main constituent).

2.1.2 Waterworks

(1) Present condition of waterworks

Water supply service on Phu Quoc Island was begun by KIWACO (Kien Giang Water Supply and Drainage One Member Limited Company) in 2006 targeting only Duong Dong district for water supply. The water source is Duong Dong reservoir located approximately five kilometers northeast of Duong Dong district. The water treatment capacity of Duong Dong water treatment plant is 5,000 t/day, and the water supply rate for the Duong Dong district in 2010 was 41%. Basic information on Duong Dong waterworks as of 2010 is shown in Table 2.1.2.1, and the system flow diagram of Duong Dong waterworks is shown in Figure 2.1.2.1.

Table 2.1.2.1 Base indicators of existing waterworks on Phu Quoc Island

Indicator	Unit	2010 Value
Water treatment plant production volume	m^3/d	2,640
Water delivery (water volume demand)	m^3/d	2,194
Household water volume (water volume demand)	m^3/d	1,832
Rate of non-revenue water	%	10.8
Water treatment plant capacity	m^3/d	5,000
Water treatment plant rate of operation	%	53
Number of connected customers	-	3,699
Number of households connected	-	3,599

Duong Dong district population	persons	32,738
Population supplied	persons	16,645
Water supply rate	%	51
Household water consumption rate	lpcd	113
Number of employees	persons	20
Employees per 1,000 connections	persons	5.4
Water rates (household)	VND/m^3	5,500
Annual amount billed	VND	4,293,317,649
Annual amount collected per customer	VND/month/customer	96,722
New access charge	-	Free of charge within 5 m of water supply pipe branch pipe, actual expense for anything over

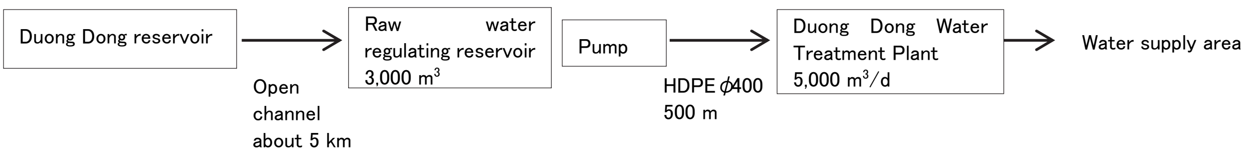


Figure 2.1.2.1 System flow diagram of Duong Dong waterworks

The Duong Dong reservoir is managed by the Department of Agriculture and Rural Development (DARD) of Kien Giang Province. Meanwhile, water supply facilities from the raw water regulating reservoir to the purification plant and water distribution facilities are administered by KIWACO.

(2) State of other waterworks projects

Other waterworks projects exist, such as an expansion plan underway for the existing water supply system financed by the World Bank with 2020 as its target year. This expansion plan intends to expand the capacity of the Duong Dong treatment plant from 5,000 m^3/d to 16,500 m^3/d, to expand the water supply network within Duong Dong, and to newly extend water supply areas to Duong To.

Table 2.1.2.2 Overview of waterworks expansion plan financed by the World Bank

Project name:	Vietnam Urban Water Supply and Wastewater Project (VWSWP)
Sub-project name:	Phu Quoc District Water Supply Project
Project owner:	Kien Giang Water Supply & Drainage One Member Limited Company (KIWACO)
Water supply target areas	Duong Dong, Duong To
Water supply capacity after expansion	16,500 m^3/d
Water demand projection by	21,497 m^3/d (2020)

World Bank for target areas	
Details of waterworks expansion and enhancement:	1) Improvements to water intake structure of Duong Dong reservoir 2) Installation of raw water pipes φ 560 mm, 3.2 km 3) Repairs to raw water regulating reservoir and pump station 4) Expansion of Duong Dong water treatment plant (from 5,000 m^3/d to 16,500 m^3/d) 5) Expansion of 500 m^3 to treated water reservoir within the water treatment plant and of conveyance pump station 6) Installation of transmission water pipes (16.5 km between Duong Dong and new installation in Suoi Lon booster pump station; total 7.5 km from new Phu Quoc Airport and Duong Dong to Cua Can) 7) Installation of 44.2 km of distribution water pipe throughout water supply areas 8) Construction of 500 m^3 distributing reservoir on hill alongside Highway 47 9) Connection of water supply pipes for households
Start of construction and period of construction	2012－June 2014
Total project cost	USD 12,872,921

With this World Bank financed project, not only will water be supplied to Duong Dong and Duong To city districts, but also to the new international airport that started operations at the end of 2012 (expected 400-900 m^3/d). It will also install distribution pipes for water supply to the Bai Trung district, a large-scale development district on the west coast of Duong To. However, projections on water demand by this World Bank project reveal that as of 2020, 21,497 m^3/d of water treatment capacity will be required for the intended water supply areas of Duong Dong and Duong To. Thus, the actual expansion to 16,500 m^3/d will be insufficient by a water supply amount of about 5,000 m^3/d.

2.1.3 Sewerage system

(1) Present condition of sewerage system

At present, there is no sewage treatment plant covering the general households of Phu Quoc Island. The raw sewage of general households is treated by septic tanks set up at each household then discharged outdoors. Further, the waste water of each household excepting raw sewage (e.g. kitchen drainage, shower drainage) is discharged outdoors untreated. Lodging facilities such as hotels are required to install treatment facilities, and must satisfy permissible discharge water quality shown in Table 2.3.3.4 for each scale facility shown in Table 2.1.3.3. However, water quality monitoring of water discharged from lodging facilities is not carried out by Kien Giang Province.

In one part of Duong Dong district, sewer culverts are in place that take in sewage and rain water. These sewer culverts were constructed in conjunction with road construction. The sewage that flows into these culverts is discharged untreated into rivers and the sea.

Table 2.1.3.3 Facility scale of lodging facilities

Lodging facility	Number of rooms	Level
Hotel	＜60	Ⅲ
	60 - 200	Ⅱ
	＞200	Ⅰ
Lodge Guesthouse	10 - 50	Ⅳ
	50 - 250	Ⅲ
	＞250	Ⅰ

Source: TCVN 6772:2000

Table 2.3.3.4 Permissible discharge water quality for lodging facilities

No	Water quality	Unit	Permissible value			
			Level Ⅰ	Level Ⅱ	Level Ⅲ	Level Ⅳ
1	pH	-	5-9	5-9	5-9	5-9
2	BOD_5	mg/l	20	30	40	50
3	SS	mg/l	50	50	60	100
4	Depositional solids	mg/l	0.5	0.5	0.5	0.5
5	TDS	mg/l	500	500	500	500
6	H_2S	mg/l	1	1	3	4
7	NH_3^-	mg/l	30	30	40	50
8	Oil (foods)	mg/l	20	20	20	20
9	PO_4^{3-}	mg/l	6	6	10	10
10	Coliform	MPN/100ml	1,000	1,000	5,000	5,000

Source: TCVN 6772:2000

(2) State of other sewerage works projects

In 2010 a plan for sewerage works for the entire island of Phu Quoc was created by the South Korean branch of the UK company Bluewater Bio, Ltd., with its partner Thuan Thao Corporation (Vietnam). The major components of this sewerage works plan made by these partners are: area targeted for treatment, number of treatment facilities, capacity of treatment facilities and culvert routes. This plan is identical to the master plan proposed by Kien Giang Province and approved by the government. Further, these partners constructed a 300 m^3/d demo plant in Duong Dong district and are conducting verification trials of sewage treatment. The treatment process employed at this trial plant is the ABC (Advanced Biological Contactor) treatment process. The data obtained at the trial plant was sent to the government for assessment, but ultimately was not adopted in Kien Giang Province.

2.2 Confirmation of low-carbon water infrastructure field study

2.2.1 Project implementation structure

The implementation structure for this project postulates the structure below combined with the outfitting plans for water and sewerage works on Phu Quoc Island described above.

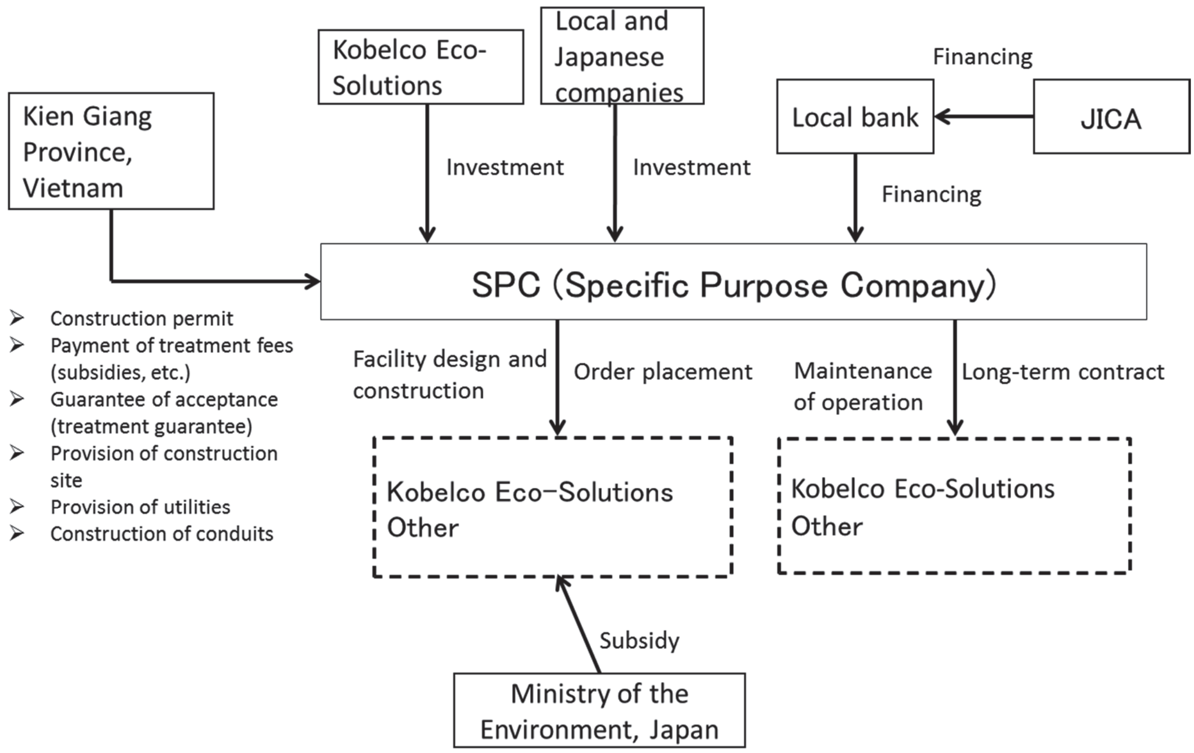


Figure 2.2.1.1 Project implementation structure

2.2.2 Project schedule

The plan proposed and discussed in the aforementioned survey report of July 2013 is a plan to advance phased improvements in water supply and sewerage facilities in light of expanding water demand and the overall expansion of users. It takes into consideration the state of other infrastructure improvements, including the progress of approval procedures by developers and the progress of road construction, to judge the level of priority of improvements. However, the schedule shown in the following figure for both water supply and sewerage facilities is postulated for the advancement of this study.

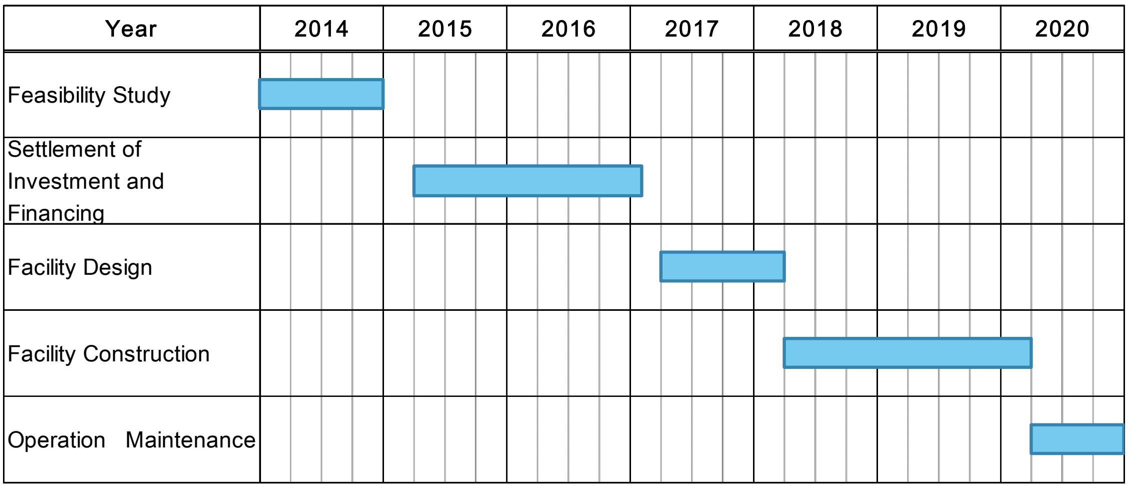


Figure 2.2.2.1 Project schedule

2.2.3 Overview of water supply and sewerage facilities

Basically, water supply and sewerage facilities will be based on the plan proposed and discussed in the aforementioned survey report of July 2013.

<Water supply facilities>

- The planned method, shown in the flowchart below, is a standard rapid filtration system.

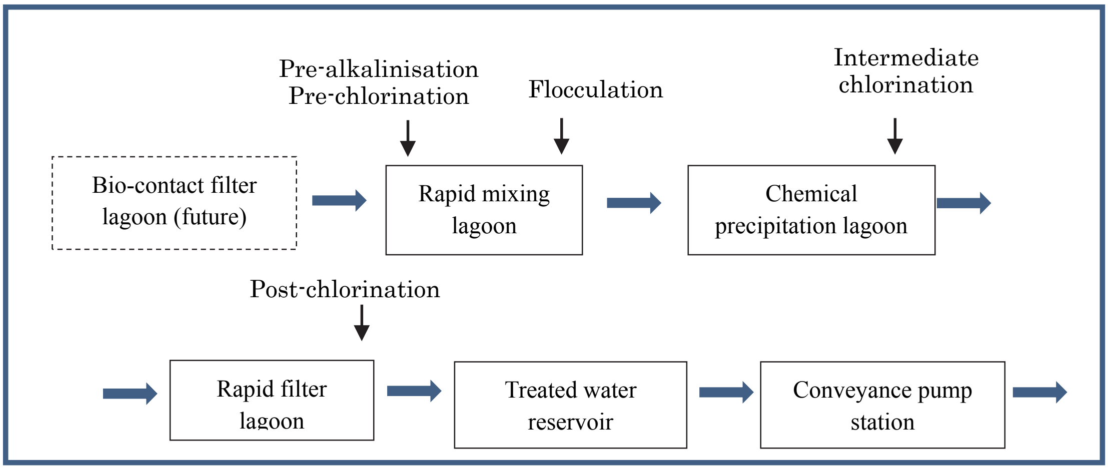


Figure 2.2.3.1 Overview of water supply facility system

- Water supply target areas and the division of phases are shown in Figure 2.2.3.2.

【Phase 1】	
Target year	2020
Planned target areas	Cua Can, Cua Duong and Duong Dong districts (service water)
Planned water volume (daily maximum)	20,000 m^3/d
【Phase 2】	
Target year	2030

Planned target areas	Incorporate Ganh Dau district into Phase 1 area
Planned water volume (daily maximum)	50,000 m^3/d

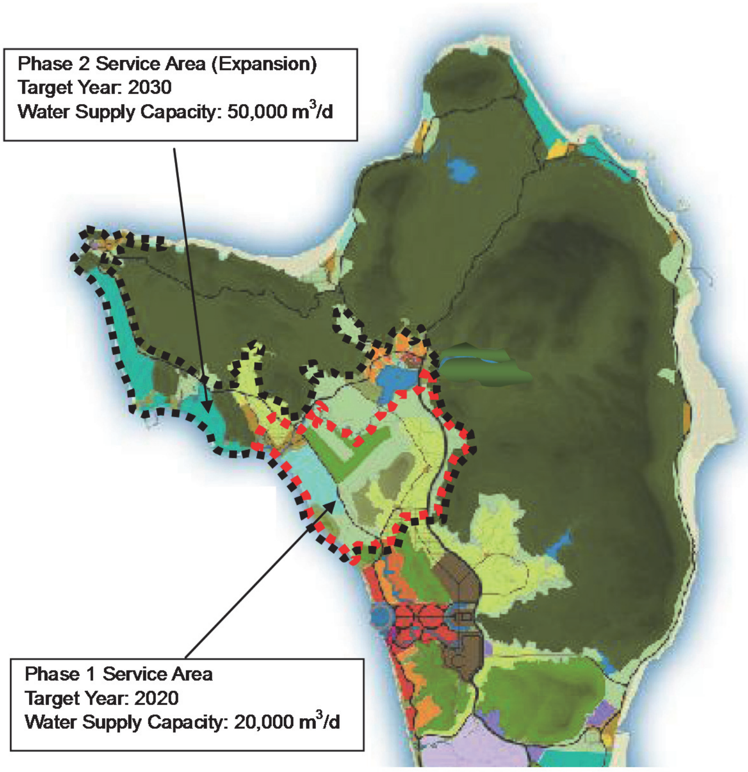
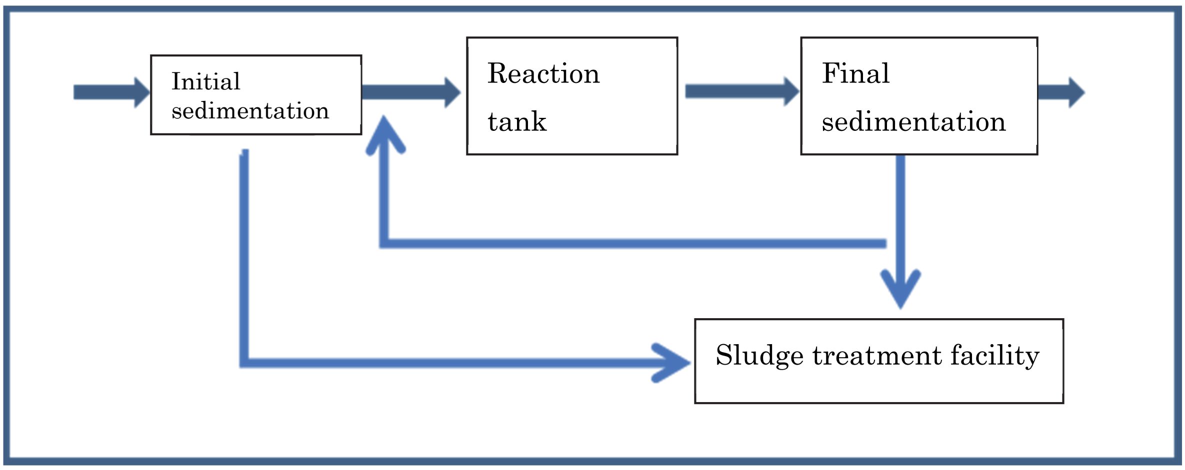


Figure 2.2.3.2 Water supply target areas and division of phases

<Sewerage facilities>

- The planned method is standard activated sludge method (Step feed multistage nitrification-denitrification).



Sewerage works target areas and the division of phases are shown in Figure 2.2.3.3.

Planned treatment volume

(unit: m^3/d)

	Phase 1	Phase 2
Target year	2020	2030
Daily average	7,500	30,000
Daily maximum	7,500	30,000
Hourly maximum	12,400	46,200

Figure 2.2.3.3 Sewerage works target areas and division of phases

Of these plans, a study on low-carbon methods was conducted limited to water supply and sewerage facilities designated as Phase 1. That is, assuming 20,000 m^3/day for the water purification plant and 7,500 m^3/day for the sewage treatment plant.

2.2.4 Measures for low-carbon water infrastructure

This study carried out deliberations on the pros and cons of employing low-carbon methods in the waterworks and sewerage works sectors within the aforementioned development plan for Phu Quoc Island.

Issues for waterworks are increase of the volume of treated water supply and expansion of the water supply network and areas. However, there are few low-carbon elements involved in the actual enhancement of water treatment plant capacity or the extension of water supply conduits. The extent of options is usage of energy-conserving pumps installed in the water treatment plant and pump stations, with the absolute amount of carbon reduction effect achieved not very large.

Meanwhile, the issue for sewerage works is the construction of a sewerage works facility. As is the case with waterworks, conventional construction of a sewerage works facility does not involve low-carbon aspects. However, energy utilisation of digester gas from the sewage treatment process can be assessed as a low-carbon approach. Accordingly, a low-carbon approach via energy utilisation of sewage sludge digester gas, based on the sewage treatment plant project, is discussed in the following section.

2.2.5 Low-carbon approach based on installation of equipment to utilize sewage sludge digester gas

(1) Treatment method of sewage sludge

Over 98% of sludge generated in the sewage treatment process is water content. Before the sewage sludge is ultimately disposed by landfill, the water content is separated to reduce volume. Separation of water content is carried out via a treatment process involving concentration and dehydration. Additionally, incineration is used as a method of completely separating water content.

A sludge-drying bed was determined to be inappropriate for this location which aims to become a tourist resort and eco-island, and removed from items under study for several reasons. These include the fact that it would require a large area within the treatment facility, would necessitate considerably more buffer zones, and would generate bad odours.

(2) Utilization of sewage sludge

Effective utilisation of digester gas contained in sewage sludge prior to sludge being ultimately transported outside the facility for disposal, was deliberated as a method of reducing sludge before transport outside the facility for disposal. Gas power generation was postulated and deliberated as a method of effective utilisation of digester gas.

(3) Verification method for carbon reduction effect

When sludge generated in the sewage treatment process is conventionally transported outside a facility for landfill disposal, GHGs continue to be emitted from the methane gas contained in the sludge. On the other hand, this methane gas contained in sludge generated in the sewage treatment process can be effectively utilised as energy if processed with installed energy conversion equipment. The GHG emissions of both scenarios are compared. The difference between the two becomes the indicator of the carbon reduction effect that can be brought about by technology for effective utilisation of sewage sludge digester gas.

Namely, when the GHG emissions that would result if sludge is transported outside the facility for landfill disposal (total of BL 1 to 3 in Figure 2.2.5.1) stand for (α), and the GHG emissions that would result if the aforesaid sewage sludge digester gas is effectively utilised as energy (the total of PJ 1 to 2 in Figure 2.2.5.1) stand for (β), the difference obtained from (α-β) reveals the extent of the said technology's contribution to carbon reduction.

Based on this study, the GHG reduction effect brought about by gas power generation technology utilising sewage sludge digester gas was determined to be an annual 216 tons of GHG reduction under the conditions of 7,500 m^3/day volume at the sewage treatment facility.

Symbol	Item	BQ	Unit
BL1	Emissions from sludge disposed at solid waste disposal site (without digester gas utilisation equipment)	**162**	tCO_2e/yr
BL2	Emissions from electricity consumption (without digester gas utilisation equipment)	**29**	tCO_2/yr
BL3	Emissions that would result assuming the volume of power generation displaced by digester gas utilisation equipment was generated by standard methods in said country	**165**	tCO_2/yr
PJ1	Emissions from sludge disposed at solid waste disposal site that was not reduced to methane with digester gas utilisation equipment (with digester gas utilisation equipment)	**-102**	tCO_2e/yr
PJ2	Emissions from electricity consumption (with digester gas utilisation equipment)	**-38**	tCO_2/yr
Reduction	GHG emission reduction total	**216**	tCO_2e/yr

GHG emission reduction amount (based on 7,500 m^3/d at sewage treatment facility), (Note) BL: Baseline scenario, PJ: Project activities

Figure 2.2.5.1 GHG emission reduction

(4) Feasibility of installation of sewage sludge digester gas utilization equipment

Unfortunately, when a comparison was carried out on the economic effect of installation, the depreciation cost of construction of the digestion facility was higher than the benefit of effective utilisation of digester gas (gas power generation). Results obtained showed an annual 25 million JPY of loss.

Facility construction cost (sludge treatment portion)	530 mil JPY UP (220→750)
① Depreciation cost (sludge treatment portion)	31 mil JPY UP/yr (15→46)
② Maintenance and operation cost (sludge treatment portion)	1 mil JPY UP/yr (10→11)
③ Power generation profit	7 mil JPY/yr
③－（①＋②）	△25 mil JPY/yr

Maximum treatment possible by design:	15,000 t/d
Planned sewage volume:	7,500 t/d
Sludge generation:	1.9 t/d
Gas generation:	400 Nm3/d
Power generation:	830 kWh/d

Figure 2.2.5.2 Profitability of digester gas power generation project

Project plan for sewage sludge digester gas utilisation facility (15 years)
Presuming 2020 Phu Quoc Island total population of 340,000 to 380,000

	Year	2017	2018	2019	2020	2021	2022	2023
Treatment volume	(t/day)				1,880	3,750	5,630	7,500
GHG reduction	(t-CO2)				27	108	162	**216**
Facility construction cost (*1)	(mil JPY)	△ 88	△ 177	△ 177	△ 88			
Maintenance and operation cost (*2)	(mil JPY)				△ 0	△ 1	△ 1	△ 1
Power generation profit	(mil JPY)				1	4	5	7
Subsidy amount	(mil JPY)	1	2	2	1			
Total	(mil JPY)	△ 87	△ 175	△ 175	△ 86	3	5	6

	Year	2024	2025	2026	2027	2028 – 34	Total
Treatment volume	(t/day)	9,790	12,080	14,370	15,000	15,000	
GHG reduction	(t-CO2)	283	347	415	432	3,024	5,014
Facility construction cost (*1)	(mil JPY)						△ 530
Maintenance and operation cost (*2)	(mil JPY)	△ 1	△ 2	△ 2	△ 2	△ 14	△ 23
Power generation profit	(mil JPY)	9	11	13	14	98	163
Subsidy amount	(mil JPY)						7
Total	(mil JPY)	8	10	12	12	84	△ 384

(*1/*2) Increased amount in facility construction cost/increased amount in maintenance and operation cost
when sewage sludge digester gas utilisation equipment is installed in sewage treatment plant

Figure 2.2.5.3 Profitability of digester gas power generation project

Moreover, the results of preliminary calculations in an examination of sewage sludge disposal during the second phase construction of a sewage treatment plant in Ho Chi Minh in the same country showed that until the cost of sludge landfill disposal were to increase by about fourfold, it was more profitable, from an economic perspective, to directly dispose of sludge at a landfill than to reuse it. Therefore, the economic efficiency of landfill disposal is greater than reuse where land is sufficient. Accordingly, the reuse of sludge will be examined only with stronger societal demand for reuse or when difficulty in securing land is faced.

Chapter 3. Feasibility Study on Introductions in Waste Sector

3.1 Preconditions

3.1.1 Present circumstances

(1) Generation and collection

At present 104 tons of waste are generated on Phu Quoc Island daily. As is the case in most areas of Vietnam, this waste is collected by the public corporation URENCO (Urban Environment Company). However, the volume collected is only 67%, or about 70 tons daily.

No particular distinction is made between general waste and industrial waste when collected, and absolutely no separation is carried out, with noncombustible and combustible materials collected mixed together.

(2) Disposal

Waste collected is conveyed to two dumpsites on the island (Bai Thom and An Thoi) where it is piled in open air. Dumpsites release extremely bad odours and are unsanitary. In the rainy season, chemicals are used to suppress the foul odour, and in the dry season open incineration is carried out with the double purpose of reducing volume.

The volume of waste at dumpsites has steadily increased compared to three years ago, but neither DONRE nor the Public Service and Facility Company ascertain or manage the detailed volume of materials handled. Also considering the use of open incineration, the amount of accumulation and remaining capacity in years of the dumpsites are unknown.

3.1.2 Expectations for the future

(1) Generation rate

Based on interviews with DONRE described below, the present volume of waste generated at 104 tons per day is expected to reach 392 tons per day in 2020, 517 tons per day in 2025, and 718 tons per day in 2030. Drastic increase in the volume of waste is assumed to accompany Phu Quoc Island's transformation as a tourist location. Further, targets for the collection rate, which at present stands at 67%, are 85% in 2020 and 100% in 2021.

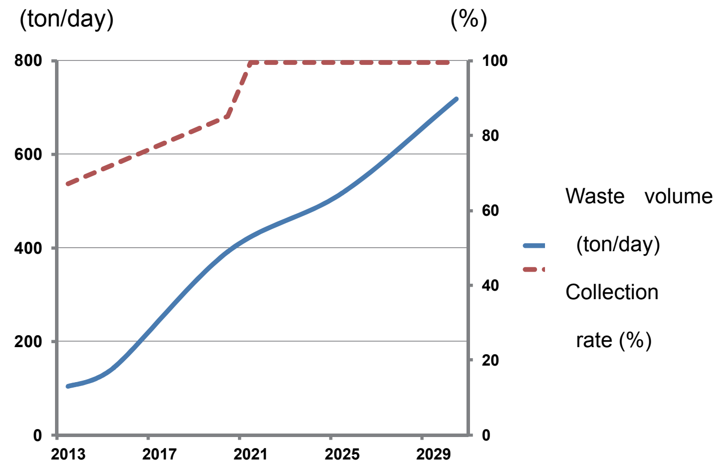


Figure 3.1.2.1 Future projection on waste volume

(2) Disposal sites

At present, two dumpsites are operated. Both of these will be closed in the near future and new disposal sites (Bai Thom; Ham Ninh near present dumpsite) are planned. However, proposals are now being accepted on disposal methods which are still to be determined, and the date of completion is undecided.

3.2 Feasibility study on introduction of low-carbon technology in the waste sector

3.2.1 Details of foundational research

Research was conducted based on site visits, interviews with related departments and agencies, and associated email and document surveys. The following are the main related departments and agencies visited.

No	Date and location of visit	Main research content
1	31 July 2014 Public Service and Facility Company	・Present state of waste on Phu Quoc Island ・Waste management method ・Operations of dumpsites ・Disposal methods ・Plans for future waste disposal facilities
2	31 July 2014 People's Committee	・Present state of waste on Phu Quoc Island ・State of proposals on waste disposal facilities currently being planned ・Disposal costs ・Electric power conditions
3	31 July 2014 DONRE	・Present state and future of waste in Kien Giang Province and Phu Quoc Island ・Recognition of environmental problems on Phu Quoc Island, points of concern and priority items ・Preferential treatment scheme if waste incineration power generation facility is constructed and operated ・Present state of tipping fees
4	21 October 2014 DONRE	・Tipping fees if waste incineration power generation facility is constructed and operated ・Planned construction site for waste incineration power generation facility (location, current condition, utility, etc.) ・Authorisation for construction and operation of waste incineration power generation facility

Figure 3.2.1.1 Major related departments and agencies visited

3.2.2 Feasibility study on introduction of low-carbon technology

(1) Low-carbon technologies for introduction

At the time of proposal, four options were proposed and discussed: ① waste incineration power generation, ② digester gas utilisation equipment based on co-treatment of raw waste and sewage sludge, ③ feasibility of material recycling based on separate collection of waste, and ④ GHG reduction entailed in these options. A description of ④ will follow in section 3.2.3 below. Here points ① to ③ will be described.

(1.1) Waste incineration power generation

This proposal involves the introduction of a waste incineration power generation facility by Kobelco Eco-Solutions Co., with a wealth of achievements in this area, to sanitarily treat and reduce volume by incineration of waste now simply being dumped, and to utilise the heat during incineration to generate power, thereby aiming to lessen environmental impacts and reduce CO2.

Results of this study revealed that there is awareness on waste incineration power generation, so-called “waste to energy”, and that there is a need on Phu Quoc Island, which aims to become a tourist location, for sanitary waste disposal. Additionally, it was confirmed that due to an existing plan for a new disposal site, land could be used at no additional cost. Therefore, waste incineration power generation was selected for consideration.

(1.2) Digester gas utilisation equipment based on co-treatment of raw waste and sewage sludge

This proposal involved the application of a technology possessed by Kobelco Eco-Solutions Co., a company with achievements in this area in Japan, to increase the yield of biogas generated from sewage sludge based on co-treatment of sewage sludge and pruned branches/food waste. The proposal examined the introduction of digester gas utilisation equipment for increasing yield of biogas based on co-treatment of sewage sludge and raw waste.

A precondition for this option is the adjacent location of a waste treatment facility and sewage treatment facility to allow co-treatment of sewage sludge and raw waste, sorted out based on pre-treatment. As stated in section 3.1.2(2), proposed sites for waste treatment facilities are the two districts of Bai Thom and Ham Ninh. Bai Thom is in the forest, and Ham Ninh is located on the opposite side from densely populated Duong Dong district, making the potential for construction of a sewage treatment facility in the area low. Based on these circumstances, this option was removed from items under examination.

(1.3) Feasibility of material recycling based on separate collection of waste

This proposal was based on contribution to reducing the environmental impact of simple dumping by separate collection and recycling of recyclable waste such as PET bottles, plastic, and aluminum and steel cans. Regarding this option, two methods are conceivable: ① achieve separation at the point of collection by separation at each household, or ② construct a recycling plaza for separation.

The results of this study revealed a lack of custom to separate waste at households on the island, as well as a lack of awareness on the necessity of separation. Residents’ awareness of the necessity of separation would be indispensable for option ①, which would place the burden of “separation” on households. Further, option ②, first collecting all waste that is completely unseparated then separating it at a recycling plaza, is unrealistic. Based on these circumstances, the construction of a recycling facility was deemed to be difficult at this stage and was removed from items under examination.

Instilling awareness in residents on the necessity of separation based on informational campaigns on waste collection and pilot surveys on separate collection, first in comparatively populated areas of the island, is a precondition of realising these initiatives in the future. The creation of rules on collection and an accompanying intervention by government is also thought to be necessary.

(2) Examination of the business feasibility and CO_2 reduction of introduction of low-carbon technologies

The low-carbon technology to be examined is waste incineration power generation as explained above. The target for incineration is waste generated on Phu Quoc Island.

The volume of waste is presumed to be the entire volume of generated waste that can be collected in 2019, the estimated year of start-up of operations at the waste incineration power generation facility, at 500 tons per day. In actuality, collection and treatment of the total volume of trash on the island is thought be difficult. Thus, future surveys on the detailed collection routes of waste, as well as coordination with related departments and agencies, including the local waste treatment enterprise, the Public Service and Facility Company, the People's Committee and DONRE, will be required.

(3) Waste incineration power generation facility

(3.1) Overview of facility

The capacity of the facility was set at 500 tons per day as stated above. The process for the incinerator was examined. While a gasification melting furnace system with a high power generation efficiency and high reduction effect for final disposal load is an option for a daily treatment volume of about 300 tons per day, here a stoker-type was adopted based on setting of treatment volume at 500 tons per day.

Further, the amount of power sold from the boiler power generation utilising the waste heat from the incinerator depends on the quantity of heat of waste inserted. Here, 8,000 kW is presumed after subtracting the electricity consumed at the facility.

(3.2) Proposed location for plant construction

The proposed site for construction of the plant is Ham Ninh, one of the two locations under consideration as new disposal sites.

According to interviews with DONRE, four points regarding this site were confirmed: ① it has an area of about 10 to 25 ha, a sufficient area for plant construction, ② utilities are supplied to nearby areas to a certain extent, ③ unlike Bai Thom, the area is equipped with access roads, and ④ the land can be leased at no charge.

Moreover, DONRE also recommends this location.

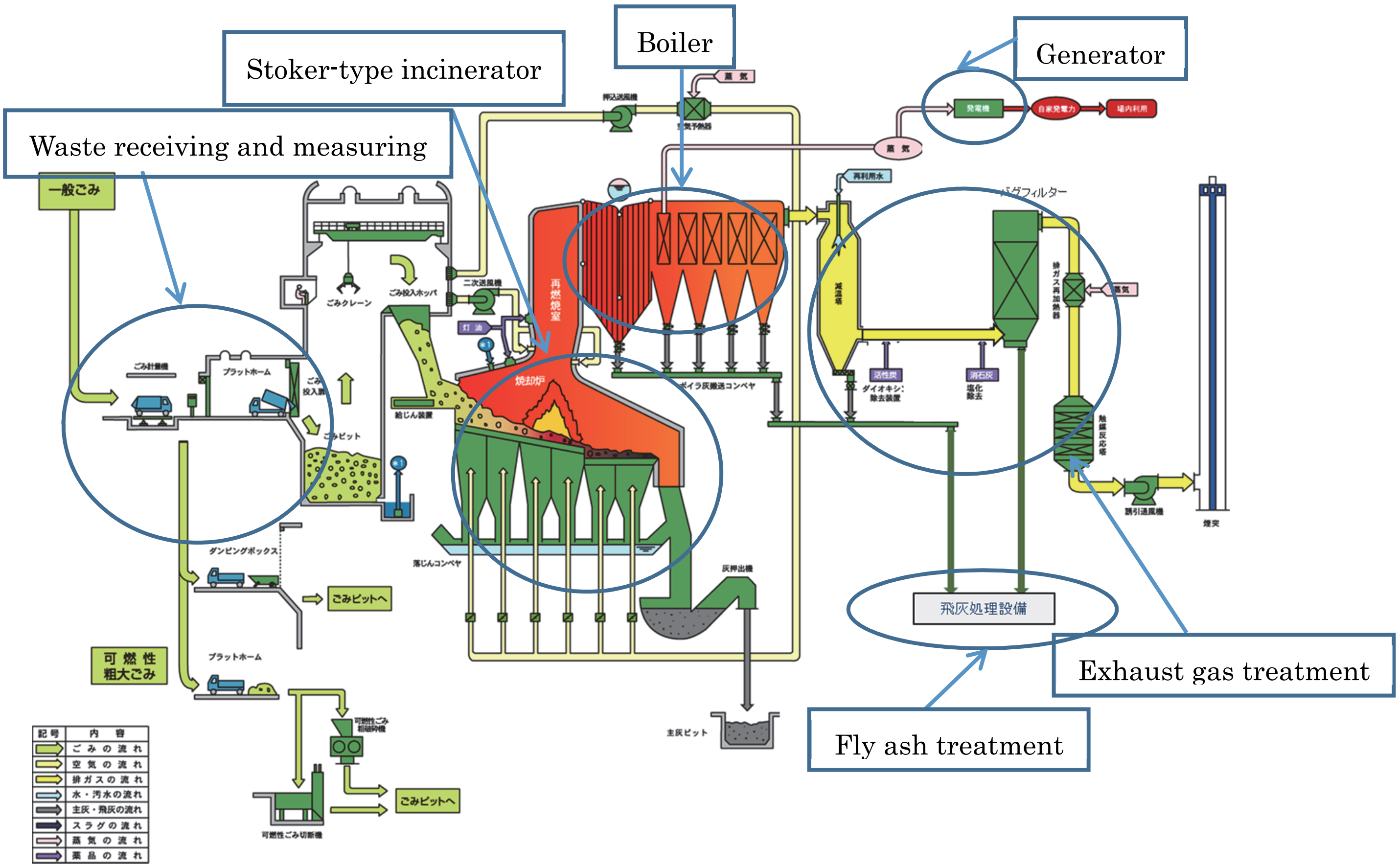


Figure 3.2.2.1 Flow chart for stoker-type incinerator

(4) Business feasibility of introduction of waste incineration power generation facility

Assessment of the economic efficiency of the project is premised on Table 3.2.2.1. According to Tham Shin Nghia, a company carrying out incineration and composting in Kien Giang Province, the tipping fee is currently about 15 dollars per ton. Here, presuming an IRR of 15% in order to have economic efficiency for this project, the tipping fee is set at 20 dollars per ton. Further, calculations were made anticipating the full amount of support (half the amount of construction cost) of the JCM facility aid.

Table 3.2.2.1 Preconditions for assessment of business feasibility

No	Item	Precondition	Notes
1	Project period	20 years	
2	Waste treatment volume	500 tons/day	
3	Annual operation time	8,000 hours annually	
4	Plant construction cost	7 billion JPY	Use local company, strive to decrease
5	JCM facility aid	3.5 billion JPY	
6	Waste treatment income	20 dollars/ton	
7	Amount of power sold	8,000 kW	
8	Unit price of power sold	10.05 cent/kWh	Based on fixed price purchase system
9	Depreciation	Fixed-installment	

		depreciation during project period	
10	Corporation tax	Corporation tax 10%	7-year tax exemption period
11	Interest rate	12.5%	

Based on these preconditions, results of the calculation of internal rate of return (IRR) gave a sufficient figure of 15.95%. Moreover, detailed income and expenditures plan is shown in Table 3.2.2.2.

3.2.3 Examination of CO2 reduction due to introduction of low-carbon technology

Below is an examination of the amount of CO2 that can be reduced based on operation of the waste incineration power generation facility. Moreover, a detailed examination is shown in Figure 3.2.3.1.

(1) CO2 that can be avoided based on operation of this facility compared to landfill disposal

As described in section 3.1.2.1, the volume of waste generated is expected to continue to increase in the future. Calculations made here are based on yearly landfill disposal of an equivalent of 500 tons per day of waste for 2019, the presumed year of operation start-up.

Here, with CO2 conversion, calculations show that 1,755,814 tons of methane gas would be generated for the total 20-year project period. Thus, a yearly average 87,791 tons of CO2 reduction is expected.

*Calculation method:

Methodological Tool “Emissions from solid waste disposal sites” version 06.0.1
By CDM executive board (Clean Development Mechanism), UNFCCC (United Nations Framework Convention on Climate Change)

(2) CO2 generated from waste incineration facility

Because CO2 is generated when waste is incinerated, this amount must be subtracted from the reduction. Moreover, an annual 90,232 tons of CO2 is generated when 500 tons per day of waste is incinerated.

(3) CO2 reduction due to power generation

The CO2 that would have been required to generate the amount of power generated at the waste incineration power generation facility is reduced.

Here, the CO2 reduction corresponding to 8,000 kW of power generated by incineration power generation is an annual average of 35,200 tons.

(4) Annual CO2 reduction

Considering (1) to (3) above, the amount of CO2 that can be reduced in one year based on operation of the waste incineration power generation facility is calculated as follows to be 32,759 tons of CO2 reduction per year.

(1) 87,791 – (2) 90,232 + (3) 35,200 = 32,759 tons

3.2.4 Future issues in the waste sector

Premised on the above, below is an enumeration on issues facing low-carbon technology introduction. The following issues must be overcome toward implementation.

(1) Volume of waste treated

A look at recent trends, including the decision on designation as a special economic zone and plans to establish an international passenger ship port, show the amount of waste to follow an increasing pattern. However, whether or not changes will take place as expected is extremely unpredictable. Thus it is necessary to keep watch on future trends.

In this assessment of business feasibility, and to be conducive to a certain level of business feasibility, a treatment volume of 500 tons per day is presumed. However, it is actually difficult to imagine that all waste will be treated at the said company plant, raising the possibility of scaling down of the plant. If it were to become so, a worsening of business feasibility is conceivable, requiring separate allowances.

(2) Waste treatment tipping fee

For this study, as with the amount of waste treated, the tipping fee was set at 20 dollars per ton in order to ensure a certain level of business feasibility. However, the current tipping fee is about 15 dollars per ton, and negotiations are required with the People's Committee and DONRE in order to bridge this gap. Moreover, in light of the aforesaid potential for scale down of the plant, the project should aim for a tipping fee of 25 to 30 dollars per ton considering business stability.

(3) Waste collection

A supply of waste is essential to carry out a waste incineration enterprise. According to this study, the waste of Phu Quoc Island is collected by URENCO and conveyed to dumpsites. These routes must be changed. Further, conclusion of a long-term (20-year) treatment consignment contract with DONRE is additionally required for stable project operation.

(4) Analysis of waste quality

As there are no results available locally on analysis of composition of waste, a future survey is required. It can be surmised that the waste of Phu Quoc has an extremely low-heat quantity, similar to that of other developing countries. In such a case, allowances for co-incineration of high calorie waste and construction of drying facilities could potentially be required.

(5) Plant site

It has been confirmed that the proposed plant site in Ham Ninh will be provided at no extra charge. However, field surveys are not yet completed for this site. Geological surveys, water quality surveys and investigation of impacts on surrounding private households will be required. Further, according to the current condition of the land, separate felling of trees and preparation would be necessary. Thus future surveys are required.

(6) Plant construction

Henceforth confirmation of plant construction costs, including local construction costs, is required. An investigation is also required into the existence of both a plant construction contractor and maintenance contractor with the capacity to construct the waste incineration facility and the capacity to carry out maintenance respectively.

(7) Partners

This study is premised on provision of 50% of construction costs by JCM related facility aid of the Ministry of the Environment. However, in addition to this, the existence of a Japanese enterprise or funding partner is advisable for implementation of the project.

Additionally, from the perspective of Japanese companies, there are many uncertain points related to the local business practices and political structures of Vietnam. The existence of a strong local partner is indispensable to the smooth operation of the project. Further investigation is required on this matter.

(8) Authorisation

The bottleneck for carrying out business in Vietnam is authorisation, and progress in authorisation considerably influences the start-up of projects. It may even wield negative impacts on business feasibility itself. This foundational research has not made contact with the Phu Quoc Investment Management & Development Authority that conducts authorisation and permission. In order to put this project into practice henceforth, frequent contact must be made with this agency to receive authorisation.

	Project year	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Profit and loss statement	Operating income	0	0	0	543,140	905,914	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392	1,132,392
	Treatment commission (T/F)	0	0	0	193,140	309,024	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280	386,280
	Power sales income (10.05 ce	0	0	0	350,000	596,890	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112	746,112
	Operating expenses	0	0	0	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768	622,768
	Labour expenses	0	0	0	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940	24,940
	Utilities cost (water + chemica	0	0	0	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828	37,828
	Maintenance and operation co	0	0	0	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000	210,000
	Depreciation cost (20 yrs)	0	0	0	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
	Operating profit and loss	0	0	0	-79,628	283,146	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624
	Non-operating income	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Non-operating expenses	0	0	0	142,500	128,250	114,000	99,750	85,500	71,250	57,000	42,750	28,500	14,250	0	0	0	0	0	0	0	0	0	0
	Interest paid (12.5%)	0	0	0	142,500	128,250	114,000	99,750	85,500	71,250	57,000	42,750	28,500	14,250	0	0	0	0	0	0	0	0	0	0
	Non-operating profit and loss	0	0	0	-142,500	-128,250	-114,000	-99,750	-85,500	-71,250	-57,000	-42,750	-28,500	-14,250	0	0	0	0	0	0	0	0	0	0
	Net income (prior to tax)	0	0	0	-222,128	154,896	395,624	409,874	424,124	438,374	452,624	466,874	481,124	495,374	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624	509,624
	Corporation tax, etc., tax rate: 10%	0	0	0	0	0	0	0	0	0	0	46,687	48,112	49,537	50,962	50,962	50,962	50,962	50,962	50,962	50,962	50,962	50,962	50,962
	Net income (after tax)	0	0	0	-222,128	154,896	395,624	409,874	424,124	438,374	452,624	420,187	433,012	445,837	458,662	458,662	458,662	458,662	458,662	458,662	458,662	458,662	458,662	458,662

(unit: 1000JPY)

	Project year	-3	-2	-1	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
2 Cash flow	Inflow	4,060,000	1,540,000	1,400,000	127,872	504,896	745,624	759,874	774,124	788,374	802,624	770,187	783,012	795,837	808,662	808,662	808,662	808,662	808,662	808,662	808,662	808,662	808,662	808,662
	Net income (after tax)	0	0	0	-222,128	154,896	395,624	409,874	424,124	438,374	452,624	420,187	433,012	445,837	458,662	458,662	458,662	458,662	458,662	458,662	458,662	458,662	458,662	458,662
	Depreciation return	0	0	0	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000	350,000
	Investment (30% ratio to net c	2,100,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Subsidy	560,000	1,540,000	1,400,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Loan	1,400,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Outflow	1,125,000	3,150,000	2,170,000	674,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	0	0	0	0	0	0	0	0	0	0
	Net loss (after tax)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Construction cost	1,120,000	3,150,000	2,170,000	560,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Other pre-operation expenses	5,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Loan repayment	0	0	0	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	114,000	0	0	0	0	0	0	0	0	0	0
	Term CF	2,935,000	-1,610,000	-770,000	-546,128	390,896	631,624	645,874	660,124	674,374	688,624	656,187	669,012	681,837	808,662	808,662	808,662	808,662	808,662	808,662	808,662	808,662	808,662	808,662

Figure 3.2.4.1 Balance sheet of income and expenditure

Amount of methane prevented at landfill

(ton-CO2/y)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Y1	29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609	504	423	360	309	268	234
Y2		29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609	504	423	360	309	268
Y3			29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609	504	423	360	309
Y4				29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609	504	423	360
Y5					29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609	504	423
Y6						29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609	504
Y7							29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746	609
Y8								29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930	746
Y9									29,590	20,397	14,158	9,909	7,005	5,010	3,631	2,672	1,998	1,521	1,179	930
Y10																3,631	2,672	1,998	1,521	1,179
Y11																5,010	3,631	2,672	1,998	1,521
Y12																7,005	5,010	3,631	2,672	1,998
Y13																9,909	7,005	5,010	3,631	2,672
Y14																14,158	9,909	7,005	5,010	3,631
Y15																20,397	14,158	9,909	7,005	5,010
Y16																29,590	20,397	14,158	9,909	7,005
Y17																	29,590	20,397	14,158	9,909
Y18																		29,590	20,397	14,158
Y19																			29,590	20,397
Y20																				29,590
total	29,590	49,987	65,145	74,054	81,059	86,069	89,700	92,372	94,370	95,891	97,070	98,000	98,746	99,355	99,859	100,283	100,643	100,951	101,219	101,453

15 Annual tot: 1,251,265 — Annual ave 83,418

20 Annual tot: 1,755,814 — Annual ave 87,791 (a)

Composition of landfilled waste

	(ton/day)
Food	312.5
Plastic	91.0
Paper	46.0
Leaves	25.5
textile clo	6.0
Metals	1.0
Stones	5.0
Diapers	12.5
Other	0.5
Total	500.00

Note)
Composition of landfilled waste
The composition data from the following study report was consulted and converted to 500 ton/day, based on the technology study of Phu Quoc Island.

Ministry of Economy, Trade and Industry FY 2011 Study on project formation in infrastructure by private sector initiatives
Investigative report on integrated waste power generation project in Malang City and surrounding areas of East Java province on Java Island, Indonesia
(Released February 2012)

Plant CO2 generation

CO2 emissions from plant operation

			Indonesia	Phu Quoc島
Feed	Wet	(ton/d)	685.0	500.0
Feed	Dry	(ton/d)	388.0	283.2
Total C		(ton/d)	198.5	144.9
Fossil C		(ton/d)	93.3	68.1
Burning Efficiency		(-)	1.0	1.0
CO2 e		(ton/d)	338.7	247.2
CO2 e		(day/y)	365	365
CO2 e		(ton/y)	123,618	90,232 (c)

注）
Indonesiaでの上記調査報告書データを、
今回のPhu Quoc島のケースに適用した。

Plant Power generation

CO2 emissions from boiler

Gross Power generation	(kW)	9400
Internal power usage	(kW)	1400
Net Power generation	(kW)	8000
Coefficient of CO2 emission	(t-CO2/MWh)	0.55
Operation Hours	(hrs/y)	8000
CO2 Reduction	(ton CO2/y)	35,200 (b)

CO2 Reduction

(1) methane prevented	(ton-CO2/y)	87,791 (a)
(2) power generation	(ton-CO2/y)	35,200 (b)
(3) CO2 emissions from plant op	(ton-CO2/y)	-90,232 (c)
Total reduction	(ton-CO2/y)	32,759

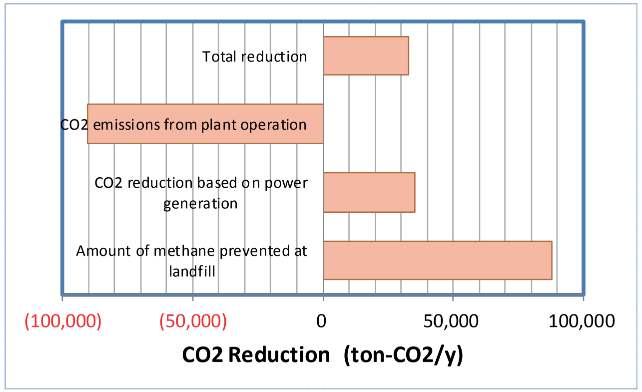


Figure 3.2.4.2 Amount of expected CO2 reduction

Chapter 4. Foundational Research on Transportation, Ports and Harbours, Production and Urban Facilities Sectors

4.1 Transportation system

4.1.1 Present and future issues

(1) Present issues

・At present, means of transportation on the island are limited to motorbikes, taxis and tour buses, with no public transportation such as transit buses.

・A clear distinction is made in Vietnam between tour buses and transit buses. Tour buses include shuttle buses that only make stops at a starting point and final point, and rental buses for tourists. Tour buses on Phu Quoc Island are mainly rental buses that cruise around the island leaving from Duong Dong town, and shuttle buses that connect boat terminals (Bai Bong Harbour) with the towns of Duong Dong and An Thoi.

・Other the other hand, transit buses differ from shuttle buses in that they conduct regular service, along set routes and according to set times. They are so-called public buses that make stops not only at starting and final points, but also at bus stops placed along routes. At present, there are no public buses.

・While at the present stage delays in road infrastructure provision have become an issue, the issue of GHG emissions and energy consumption due to the occurrence of automobile traffic congestion, for example, is not evident.

(2) Future issues

・Population on the island in the year 2030 is expected to rise from the present 95,000 to 500,000-550,000, with the number of tourists increasing from the present 416,000 to six million.

・It is unclear as to whether or not these values for shifts in population and number of tourists will be realised by 2030. However, population and tourist numbers are rapidly increasing, raising concerns on future increase in traffic volume leading to traffic congestion, air pollution from exhaust gas and mounting GHG emissions.

・Accordingly, it is necessary to introduce public transportation such as transit buses concurrent with provision of road infrastructure on the island in order to control increases in traffic volume in light of the future. Moreover, in Kien Giang Province's master city plan, a plan for introduction of a transit bus system is included as a public transportation system, but provision of funds for this introduction is a major issue.

・Further, GHG emissions from motorbikes, which are predicted to increase in the future, are also an issue.

4.1.2 Applicable low-carbon technologies from Japan

・Based on present and future issues, an examination was carried out on the applicability of low-carbon buses and rental electric motorbikes, two of Japan's low-carbon technologies, in the transportation sector.

(1) Introduction of low-carbon buses (introduction of electric buses)

- Replacement of current diesel buses running as tour buses on the island with low-carbon buses designed to reduce GHG emissions.
- As shown in Table 4.1.2.1, electric buses and CNG buses can be considered low-carbon buses. However, <u>CNG buses are not recognised to have superiority over diesel buses concerning GHG emissions. Thus, for this study, the introduction of electric buses was examined.</u>
- Introduction of electric buses utilising JCM would achieve the effects of energy conservation, air pollution control, GHG emission reduction and increased tourists due to enhanced image of the island. Accordingly, an environment would be created where electric buses are chosen over diesel buses when a transit bus system is established in the future (See Figure 4.1.2.1).

Table 4.1.2.1 Applicable low-carbon technologies of Japan in the transportation sector (low-carbon bus)

Photo image	Overview and Assessment
Electric bus  Source: Kyodo News	<Overview> ・Equipped with a large battery charged at a special charging station, runs solely on motor. ・An even further energy conservation effect can be aimed for based on utilisation of renewable energies. <Assessment> ・This vehicle emits absolutely no carbon dioxide during operation and its technology is already put into practical use. ・Due to its high-priced battery, this bus is relatively expensive, but JCM facility aid and battery rental will be used.
CNG bus  Source: Kobe City	<Overview> ・This vehicle is equipped with an internal combustion engine using natural gas as fuel. ・It is already put into practical use and has been popularised mainly for small and mid-sized trucks. <Assessment> ・Compared to diesel buses, CNG buses drastically reduce NO_x contained in exhaust gas, with an improvement effect on the air environment. ・However, it will not be adopted because the superiority of CNG concerning GHG emissions is not recognised due to the superior energy efficiency of the diesel bus.* *Evaluation of actual running mode fuel efficiency and exhaust gas of large-sized CNG buses, IEA-AMF research

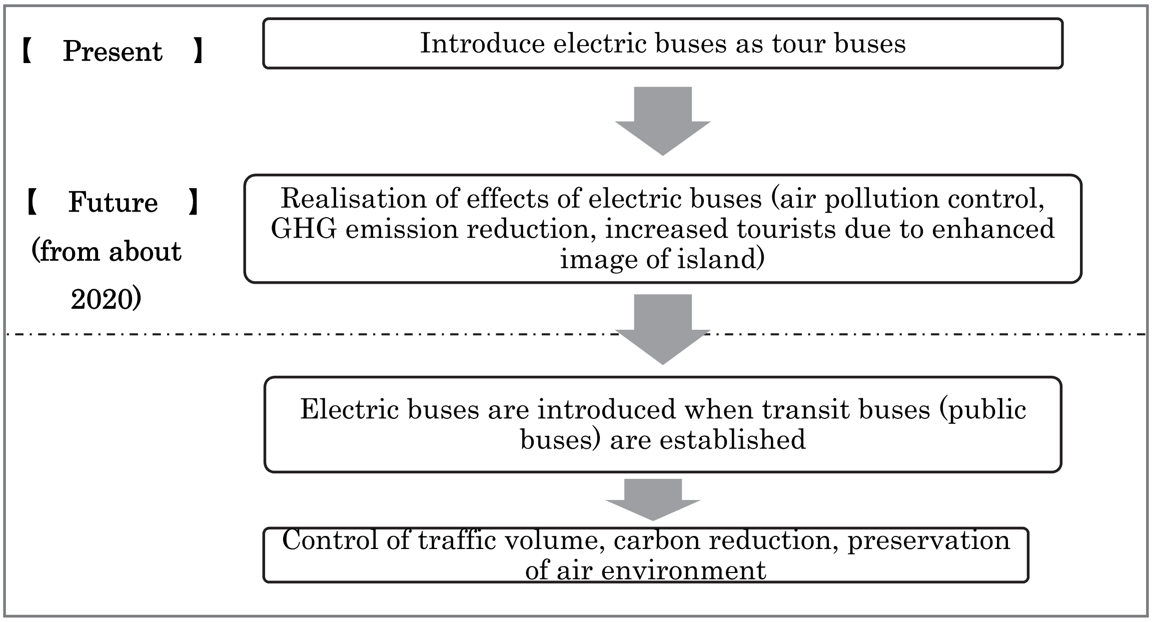


Figure 4.1.2.1 Image of electric bus introduction (present and future)

(2) Introduction of rental electric motorbikes

- Tourists on Phu Quoc Island frequently use rental motorbike services as a cheap and easy way to get around the island.
- Businesses in the rental motorbike service industry on the island are not required to register with the police authorities. Therefore the number of rental motorbikes and users cannot be ascertained, but business is mainly carried out at resort facilities, hotels and guest houses. Of these, large hotels such as the Saigon Phu Quoc, Chen Sea, La Veranda and Eden have about 10 to 20 rental motorbikes for their guests. Also, there are privately-owned rental motorbike shops on the island, each possessing about 5 to 10 motorbikes with about 5 users per day per shop.
- Introduction of electric motorbikes as rental bikes for tourists would call islanders' attention to the effects and performance of electric motorbikes (zero exhaust gas, reduced GHG emissions), thereby aiming to popularise them on the island and facilitate carbon reduction efforts on the island as a whole (see Figure 4.1.2.2).

Table 4.1.2.2 Applicable low-carbon technologies of Japan in the transportation sector (electric rental motorbike)

	<Overview> ・Electric motorbikes are equipped with batteries that can be recharged at a household power source and run solely on a motor. ・Installing solar panels at charging station enables GHG emissions to be brought to zero. <Assessment> ・This vehicle emits absolutely no carbon dioxide during operation and its technology is already put into practical use, making it easily introduced. ・However, low-priced made-in-China motorbikes are popular in Vietnam. The issue remains as to whether these motorbikes can compete based on cost reduction with JCM subsidy, performance and durability.

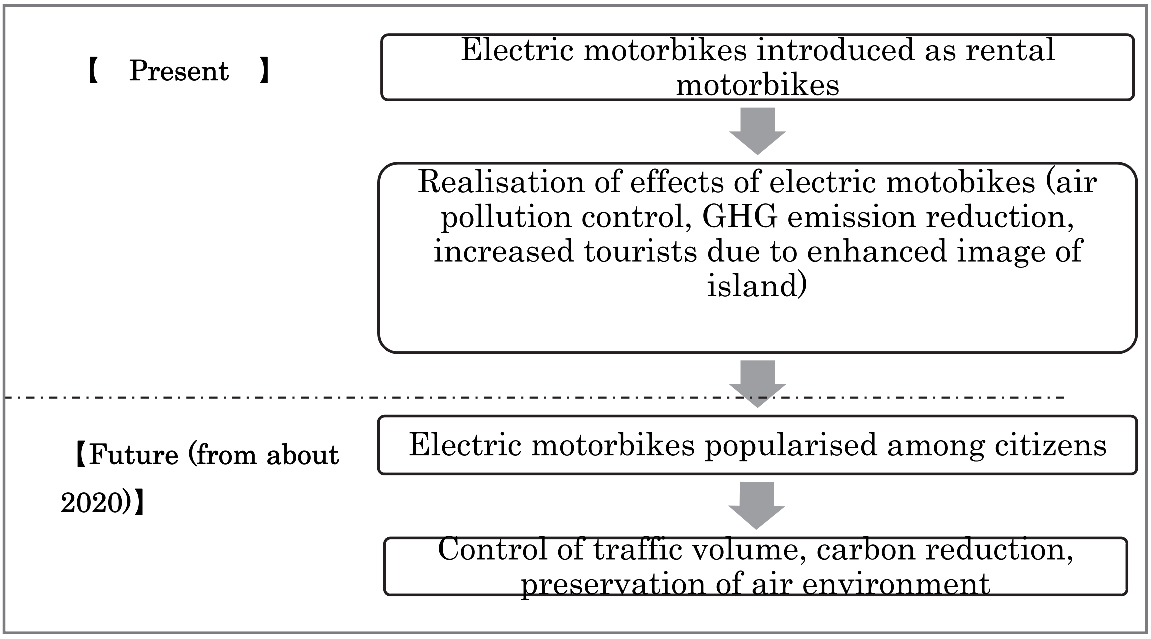


Figure 4.1.2.2 Image of electric motorbike introduction (present and future)

4.1.3 Concept for low-carbon technology introduction

(1) Electric bus

■ Introduction route

・Introduction of an electric bus as a tour bus for the route between the hotel area in Duong Dong town and the international airport (about 10 km one-way) is examined (see Figure 4.1.3.1).

・Numerous tourists are expected to use this route, with about 26 incoming and outgoing flights daily (about 13 departures and arrivals each) and an annual number of airport users at over 710,000 in 2013. Meanwhile, the number of passengers per flight averages about 75 (=710,000 people/2(arrivals portion)/365 days/13 flights).

■ Scale of introduction (number of buses, number of trips, bus specifications)

・One electric bus and one charging station are to be introduced.

・The electric bus will operate five trips daily, assuming about 50 passengers per trip (see Table 4.1.3.1). The specifications of the electric bus are shown in Table 4.1.3.3.

■ Other means of transport

・Competing means of transportation include taxis and hotel shuttle buses. Fares for taxis are high, running about 200,000 VND (approximately 1,000 JPY). Thus, setting low fares for the electric bus will make it highly competitive. In the case of hotel shuttle buses, it is likely possible to cooperate with hotels, such as setting up charging stations for the electric bus at hotels.

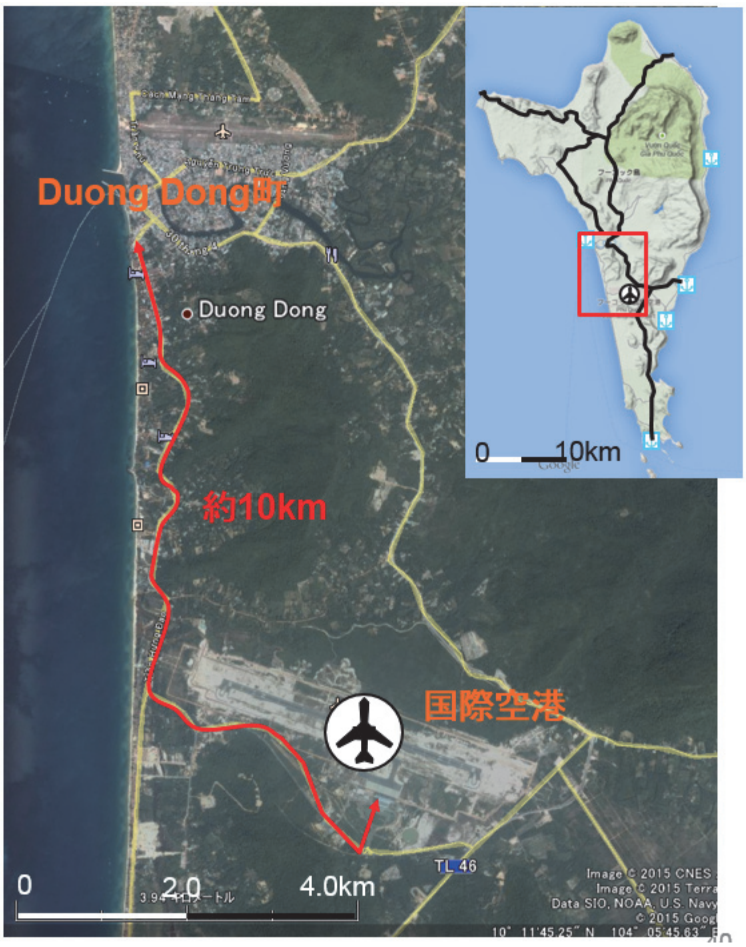


Figure 4.1.3.1 Electric bus introduction route

Table 4.1.3.1 Scale of introduction of electric buses

Item	Details
Number introduced	Buses: 1 bus, Charging station: 1 station
Bus introduction route	Airport to Duong Dong district (about 10 km one-way)
Bus travel time	About 1 hour roundtrip
Number of trips per day	5 trips (about 50 passengers per trip) There are 13 arriving flights. Assuming bus service for passengers of 5 of these (see Table 4.1.3.2)

Table 4.1.3.2 Flight number and arrival times of flights arriving at Phu Quoc International Airport*

Place of Departure	Flight no.	Airline	Arrival time	Electric bus service
SGN Ho Chi Minh City	VN 8803	Vietnam Airlines	7:35 AM	
SGN Ho Chi Minh City	VJC 320	VietJet Air	8:05 AM	○
HAN Hanoi	VN1233	Vietnam Airlines	9:05 AM	
SGN Ho Chi Minh City	VN 1825	Vietnam Airlines	10:05 AM	○
VCA Can Tho	VN 8014	Vietnam Airlines	10:25 AM	
SGN Ho Chi Minh City	VN1827	Vietnam Airlines	11:40 AM	○
SGN Ho Chi Minh City	BL 269	Jetstar Pacific	12:10 PM	
SGN Ho Chi Minh City	VJC 322	VietJet Air	12:15 PM	
SGN Ho Chi Minh City	VN 1813	Vietnam Airlines	1:50 PM	○
HAN Hanoi	VJC 451	VietJet Air	2:00 PM	
REP Siem Reap	VN 831	Vietnam Airlines	3:55 PM	
SGN Ho Chi Minh City	VJC 324	VietJet Air	6:20 PM	○
SGN Ho Chi Minh City	BL 265	Jetstar Pacific	7:00 PM	

*Arriving flights on 5 February 2015

Table 4.1.3.3 Postulated specifications for electric bus

Item	Details
Length x width x height	12,000mm×2,530mm×3,250mm
Weight	Vehicle weight: 12,000 kg, Maximum weight (including passengers): 18,000 kg
Number of passengers	About 90 (seats for about 40)
Actual travel distance per charging	360 km
Electric efficiency (travel distance per 1 kWh)	360 km/300 kWh (1.2km/kWh)
Maximum speed	80km
Actual hill-climbing capacity	8% (20 km/hour for 5 min.)
Battery type	Lithium-ion battery
Battery life	100,000 km (about 6 years)
Charging time	3-4 hours
Initial cost	Automobile: 52 mil JPY; Charging station: 6 mil JPY
Battery replacement cost	26 mil JPY (according to interview with manufacturer, an approximate 25-50% drop in price is expected 6 years hence)

*Materials provided by Soft Energy Controls Inc.

(2) Electric rental motorbike

■ Scale of introduction (number of motorbikes, motorbike specifications)

・The total number of motorbikes is 60, 20 motorbikes each introduced at three five-star hotels.

・Although they are high-priced, the motorbikes introduced are presumed to be high performance electric motorbikes with long battery lives (Type A in Table 4.1.3.5).

・Moreover, there are motorbikes in Japan of the same approximate price range as gasoline motorbikes in Vietnam (Type B in Table 4.1.3.5). However, they were excluded from this study due to the short life of their batteries.

Table 4.1.3.4 Scale of introduction of electric motorbikes

Item	Details
Number of motorbikes introduced	60 (20 motorbikes at three five-star hotel locations=60 motorbikes)
Charging station	1 at each hotel for a total of 3 locations Rechargeable at household power source

Table 4.1.3.5 Specifications for electric motorbike*

Item	Type A	【Reference】Type B
Length	1,793 mm	1,800 mm
Width	750 mm	660 mm
Height	1,275 mm	660 mm
Vehicle weight	118 kg	86 kg
Actual travel distance per charging	65 km	35 – 45 km
Electric efficiency (travel distance per 1 kWh)	30 km/kwh	25 km/kwh
Maximum speed	60 km/h	45 km/h
Actual hill-climbing capacity	15 degrees	10 degrees
Battery type	Lithium battery	Silicon battery
Battery voltage/capacity	48V40Ah	12V20Ah×4
Battery life	About 50,000 km	About 10,000 km
Charging time	For 100% charge: about 4.5 hours	For 70% charge: 2 to 3 hours For 100% charge: 7 to 9 hours
Vehicle price	About 450,000 JPY	About 100,000 JPY
Charger	About 24,000 JPY	About 20,000 JPY
Battery replacement cost	About 150,000 JPY	About 50,000 JPY

*The above table was created with reference to sources ① and ② below.

① Global Warming Mitigation Technology Promotion Project, Promotion of diffusion of electric motorbikes in Vietnam, Study on project proposal formation, February 2013, Incorporated Administrative Agency New Energy and Industrial Technology Development Organization, (consignee) Mitsubishi UFJ Morgan Stanley Securities Co., Ltd.

② Results of interviews with Terra Motors Corp. and website, http://www.terra-motors.com/jp/a4000i/specs/

4.1.4 Economic efficiency (initial cost, operation cost)

(1) Electric bus

・Based on the preconditions for the concept on electric bus introduction outlined in the previous section, the economic efficiency of electric bus introduction for the route connecting the airport and hotel area in Duong Dong town was compared to introduction of a diesel bus (see Table 4.1.4.1).

<Preconditions>

・Service 20 km round-trip x 5 trips/day x 365 days=total travel distance 36,500 km

・The initial cost of the electric bus is 58 million JPY, which is extremely high-priced compared to the diesel bus. Even if JCM is utilised for a maximum 50% subsidy for bus introduction, the figure is 29 million JPY, or approximately three times the cost of the diesel bus.

・One of the strengths of the electric bus is that fuel costs can be considerably reduced compared to the diesel bus. However, because the battery replacement fee for the electric bus included in maintenance and operation costs is high, running cost is also very high.

・The initial cost and running cost of the electric bus are high due to the high price of the battery. In order for the electric bus to gain popularity in the future, the battery price must be lower and its life longer.

・Due to the high price of the electric bus, if it is to be introduced at the present stage, economic support is required not only from JCM, but also from the Government of Vietnam and Kien Giang Province, such as from the Government of Vietnam's national energy conservation program.

Table 4.1.4.1 Comparison of economic efficiency of electric bus and diesel bus

Item		Electric bus	Diesel bus	Notes
Initial cost (JPY)		58,000,000 →29,000,000 (JCM aid)	10,000,000	・Total of the vehicle (52 mil. JPY) and charging station (6 mil. JPY) for the electric bus ・Vehicle cost for the diesel bus
Running cost (JPY)		11,404,250	3,485,500	
Breakdown of running cost	Maintenance and operation cost (JPY/year)	11,167,000	2,500,000	・For the electric bus, total is maintenance and operation costs (2.5 mil. JPY/year=maintenance and operation costs of diesel bus) and battery replacement cost (8,667,000 JPY/year) *See Reference Table-1 on the following page
	Fuel cost (JPY/year)	237,250	985,500	*See Reference Table-2 and 3 on the following page

■ Basis for calculation of maintenance and operation costs, etc.

Reference Table-1 Basis for calculation of maintenance and operation cost of electric bus

Item		Value	Notes
A	Maintenance and operation cost (JPY/year)	2,500,000	= Maintenance and operation costs for a standard diesel bus *In actuality, the electric bus, compared to the diesel bus, has simplified machinery that does not have intake and exhaust. Thus, oil and filter changes are unnecessary, lowering costs.
B	Total travel distance (km/year)	36,500	= Round-trip 20 km/trip × 5 trips/day × 365 days
C	Battery life (km)	100,000	Based on postulated specifications for electric bus
D	Battery replacement cost (JPY) per replacement	26,000,000	Based on postulated specifications for electric bus
E	Battery life (years)	3	= C / B
F	Battery replacement cost (JPY/year)	8,667,000	= D / E Battery replacement cost per year of battery life
G	Maintenance and operation cost (including battery replacement cost) (JPY)	11,167,000	= A + F

Reference Table-2 Basis for calculation of annual electricity charges for electric bus

Item		Value	Notes
H	Total travel distance (km/year)	36,500	= Round-trip 20 km/trip × 5 trips/day × 365 days
I	Electricity cost (km/kWh)	1.2	Based on postulated specifications for electric bus
J	Electricity consumption (kWh/year)	30,417	= H / I
K	Unit price for electricity charges (VND/kWh)	1,560	Electricity charge for 1 kWh in Vietnam
L	Fuel costs (electricity charges (JPY/year)	237,250	= J × K × 200 (JPY/VND)

Reference Table-3 Basis for calculation of annual fuel cost of diesel bus

Item		Value	Notes
M	Total travel distance (km/year)	36,500	= Round-trip 20 km/trip × 5 trips/day × 365 days
N	Fuel efficiency (km/L)	4	Fuel efficiency of standard diesel bus
O	Fuel consumption (L/year)	9,125	=M／N
P	Unit price of fuel (VND/L)	21,600	Price per 1L of diesel fuel in Vietnam
Q	Fuel cost (JPY/year)	985,500	= O × P / 200 (JPY/VND)

(2) Rental electric motorbike

・Based on the conditions below, the economic efficiency of electric motorbike introduction was compared to introduction of the gasoline motorbike. Moreover, the electric motorbike subject to examination is the high performance electric motorbike, with an exceedingly longer battery life than motorbikes in the low-price range.

＜**Preconditions**＞

・Daily travel distance: 30 km/day

・Operating rate of rental motorbikes: 60%

・Annual travel distance: 6,570 km (=daily travel distance 30 km/day × 365 days × operating rate 60%)

・The initial cost of the electric motorbike is 474,000 JPY, which is a higher price compared to the gasoline motorbike. However, if JCM is applied, a maximum 50% of aid can be received, bringing the price to 237,000 JPY.

・The strength of the electric motorbike is that fuel costs can be considerably reduced compared to the gasoline motorbike (potential reduction to under 1/10 according to these conditions). However, when running costs (maintenance and operation cost + fuel cost) are compared, the reduction in running costs compared to the gasoline motorbike is only an approximate 37% due to the high cost of battery replacement included in the maintenance and operation costs of the electric motorbike.

・The initial costs and running costs of the electric motorbike, similar to the electric bus, are high due to the high price of the battery. In order for the electric motorbike to gain popularity in the future, the battery price must be lower and its life longer.

・Due to the high price of the electric motorbike, if it is to be introduced at the present stage, economic support is advisable not only from JCM, but also from the Government of Vietnam and Kien Giang Province, such as from the Government of Vietnam's national energy conservation program.

Table 4.1.4.2 Comparison of economic efficiency of electric motorbike and gasoline motorbike

(per vehicle)

		Electric motorbike	Gasoline motorbike	Notes
Initial cost (JPY)		474,000 →237,000 (JCM aid)	100,000	The vehicle (450,000 JPY) and charger (24,000 JPY) for the electric motorbike
Running cost (JPY)		20,458	32,462	Running costs for the electric motorbike are about 37% cheaper than the gasoline motorbike.
Breakdown of running cost	Maintenance and operation cost (JPY/year)	18,750	11,000	・Maintenance and operation costs for the electric motorbike are battery replacement cost (18,750 JPY)* ・Total of oil change costs and oil filter costs for the gasoline motorbike (11,000 JPY) *See Reference Table-4 on the following page for maintenance and operation costs of the electric motorbike
	Fuel cost (JPY/yen)	1,708	21,462	Fuel cost for the electric motorbike are under 1/10 the gasoline motorbike. *See Reference Table-5 and 6 on the following page

■ Basis for calculation of maintenance and operation costs, etc.

Reference Table-4 Basis for calculation of maintenance and operation cost of electric motorbike

Item		Value	Notes
A	Maintenance and operation cost (JPY/year)	0	
B	Total travel distance (km/year)	6,570	= daily travel distance 30 km/day × 365 days × 60% operating rate
C	Battery life (km)	50,000	
D	Battery replacement cost (JPY) per replacement	150,000	
E	Battery life (years)	8	
F	Battery replacement cost (JPY/year)	18,750	= D / E Battery replacement cost per year of battery life
G	Maintenance and operation cost (including battery replacement cost) (JPY)	18,750	= A + F

Reference Table-5 Basis for calculation of annual electricity charges for electric motorbike

Item		Value	Notes
H	Annual travel distance (km/year)	6,570	
I	Electric efficiency (km/kWh)	30	Electric motorbike specifications
J	Electricity consumption (kWh/year)	219	= H / I
K	Unit price for electricity charges (VND/kWh)	1,560	Electricity charge for 1 kWh in Vietnam
L	Fuel costs (electricity charges (JPY/year)	1,708	= J × K / 200 (VND/JPY)

Reference Table-6 Basis for calculation of annual fuel cost of gasoline motorbike

Item		Value	Notes
M	Annual travel distance (km/year)	6,570	
N	Fuel efficiency (km/L)	30	Fuel efficiency of standard gasoline motorbike
O	Fuel consumption (L/year)	219	= M / N
P	Unit price of fuel (VND/L)	19,600	Price per 1L of diesel fuel in Vietnam
Q	Fuel cost (JPY/year)	21,462	= O × P / 200 (VND/JPY)

4.1.5 GHG reduction effect

(1) Introduction of electric bus

- Based on the conditions of the low-carbon technology introduction concept, the CO_2 emissions when an electric bus is introduced and the CO_2 reduction from the present state of frequent taxi usage, were calculated.
- Further, as a reference, the CO_2 emissions when a diesel bus is introduced, and the CO_2 reduction from the present state of frequent taxi usage, were calculated (with the same conditions as the electric bus).

- It was found that CO_2 reduction from the present state by the electric bus and by the diesel bus did not greatly differ.
- The CO_2 reduction of introduction of an electric bus is 153 t-CO_2/year, with a five-year reduction from 2016 to 2020 as follows.

  Effect of introduction of electric bus (five-year) = 153 t-CO_2/year × 5 = 765 t-CO_2/year
- Meanwhile, total initial cost: 29 mil. JPY (after 50% aid based on JCM), and running cost: 11,404,250/year, reveals the 5-year project cost to be as follows.

  Project cost (5-year) = 29,000,000 + 11,404,250 × 5 = 86,021,250 JPY
- Based on the above, the cost effectiveness (unit price of CO_2 reduction per ton) is as follows.

  Unit price of CO_2 reduction per ton = 86,021,250 JPY / 765 (t/-CO_2) = 112,400 JPY/t-CO_2

Table 4.1.5.1 Emissions and reduction of CO_2 of electric bus and diesel bus

Item		Value	Notes
Electric bus	CO_2 emissions (t-CO_2/year)	16.4	See Reference Table-7 on following page
	CO_2 reduction from present state (t-CO_2/year)	153.0	
Diesel bus	CO_2 emissions (t-CO_2/year)	23.6	See Reference Table-8 on following page
	CO_2 reduction from present state (t-CO_2/year)	145.9	
Taxi (present state)	CO_2 emissions (t-CO_2/year)	169.5	See Reference Table-9 on following page

Reference Table-7 CO_2 emissions when electric bus is introduced and reduction from present state (taxi usage)

Item		Value	Notes
A	Total travel distance (km/year)	36,500	= round-trip 20 km/trip × 5 trips/day × 365 days
B	Electric efficiency (km/kWh)	1.2	
C	Electricity consumption (kWh/year)	30,417	= A / B
D	CO_2 emissions (t-CO_2/year)	16.4	= C × 0.5408 t-CO_2/kWh
E	CO_2 reduction from taxis (t-CO_2/year)	153.0	= (S of Reference Table-9) - D

Reference Table-8 CO_2 emissions when diesel bus is introduced and reduction from present state (taxi usage)

Item		Value	Notes
F	Total travel distance (km/year)	36,500	= round-trip 20 km/trip × 5 trips/day × 365 days
G	Fuel efficiency (km/L)	4.0	
H	Fuel consumption (L/year)	9,125	= F / G
I	CO_2 emissions (t-CO_2/year)	23.6	= H × 37.7 × 0.0187 × 44/12/1000
J	CO_2 reduction from taxis (t-CO_2/year)	145.9	= (S of Reference Table-9) - I

Reference Table-9 CO_2 emissions of taxis (present state)

Item		Value	Notes
K	Number of taxi users (persons/trip)	48	Per flight
L	Number of flights (trips/day)	5	Number of flights targeted for bus service
M	Passengers per tax (persons/vehicle)	3	
N	Travel distance (km) per vehicle	20	
O	Fuel efficiency (km/L)	8	
P	Unit price of fuel (VND/L)	21,390	
Q	Total travel distance (km/year)	584,000	= K × L / M × N × 365
R	Fuel consumption (L/year)	73,000	= Q / O
S	CO_2 emissions (t-CO_2/year)	169.5	= R × 34.6×0.0183×44/12/1000

(2) Introduction of rental electric motorbikes

・The GHG reduction due to introduction of rental electric motorbikes is the CO_2 emissions that can be reduced when electric motorbikes replace the gasoline motorbikes currently used as rental motorbikes.

・Based on the conditions shown in previous sections, CO_2 emissions (per vehicle) when gasoline motorbikes are introduced, and the CO_2 emissions of electric motorbikes and CO_2 reduction (per vehicle) from gasoline motorbikes are shown respectively in Tables 4.1.4.2 and 4.1.4.3.

・Therefore, the CO_2 reduction per vehicle is 0.390 t-CO_2/year, with a five-year reduction from 2016 to 2020 as follows when 60 vehicles are introduced.

Effect of introduction of rental electric motorbikes (five-year, 60 vehicles) = 0.390 t-CO_2/year × 5 × 60 = 117 t-CO_2/year

・Meanwhile, total initial cost: 237,000 JPY/vehicle (after 50% aid based on JCM), and running cost: 20,458 JPY/year/vehicle, reveals the 5-year project cost to be as follows.

Project cost (five-year, 60 vehicles) = (237,000 + 20,458 × 5) × 60 = 20,357,400 JPY

・Based on the above, the cost effectiveness (unit price of CO_2 reduction per ton) is as follows.

Unit price of CO_2 reduction per ton = 20,357,400 JPY / 117 (t/-CO_2) = 174,000 JPY/t-CO_2

Table 4.1.4.2 Annual CO_2 emissions of gasoline motorbikes (per vehicle)

	Item	Value	Notes
A	Travel distance (km/day)	30	
B	Operation rate (%)	60	
C	Annual travel distance (km/year)	6,570	= A × 365 × B
D	Fuel efficiency (km/L)	30	
E	Gasoline consumption (L/year)	219	= C / D
F	Unit calorific value (MJ/L)	34.6	
G	Carbon emission factor (kg-C/MJ)	0.0183	
H	Molecular weight comparison of carbon dioxide and carbon	3.67	
I	Annual CO_2 emissions (t-CO_2/year)	0.508	I = e × f × g × h

Table 4.1.4.3 Annual CO_2 emissions and reduction of electric motorbikes (per vehicle)

Item		Value	Notes
J	Travel distance (km/day)	30	
K	Operation rate (%)	60	
L	Annual travel distance (km/year)	6,570	= J × 365 × K
M	Electric efficiency (kWh/km)	30	
N	Electricity consumption (kWh/year)	219	= L / M
O	Emission factor for grid power ($t\text{-}CO_2$/MWh)	0.5408	
P	CO_2 emissions ($t\text{-}CO_2$/year)	0.118	= N × O / 1,000
Q	CO_2 reduction ($t\text{-}CO_2$/year)	0.390	Difference from emissions of gasoline motorbike = I - P

4.1.6 Issues related to introduction (organisation, financing, operation, MRV, etc.)

(1) Organisation: introduction of electric bus, introduction of rental electric motorbikes

・A JCM project would be executed based on an inter-city partnership between Kobe City and Kien Giang Province forming a Japan-Vietnam joint project entity (international consortium).

・Concerning the organisational structure of the international consortium, an examination of cooperation with local hotels (on transport of tourists staying at hotels) is required to suppress the financial burden (initial cost) on the bus operator (Vietnamese company).

・Further, introducing as large a number as possible of electric motorbikes is an issue to be considered to ensure the profitability of the Japanese electric motorbike manufacturer.

・Ensuring the profitability of Japanese bus and motorbike manufacturers in an issue.

(2) Financing methods

・Funding from JCM facility aid will be used for a maximum of 50% of initial cost of facility introduction.

・Funding from the Vietnamese company operator will form the basis for the remaining 50%. However, it is imperative to seek financial support such as subsidies and low interest loans from the central government and Kien Giang Province in order to reduce the burden on this Vietnamese company as much as possible.

・Further, as stated in (1), an examination is required on encouraging many local electric motorbike operators (hotels) to participate in the international consortium scheme in order to achieve cost reduction based on volume efficiency of electric motorbikes.

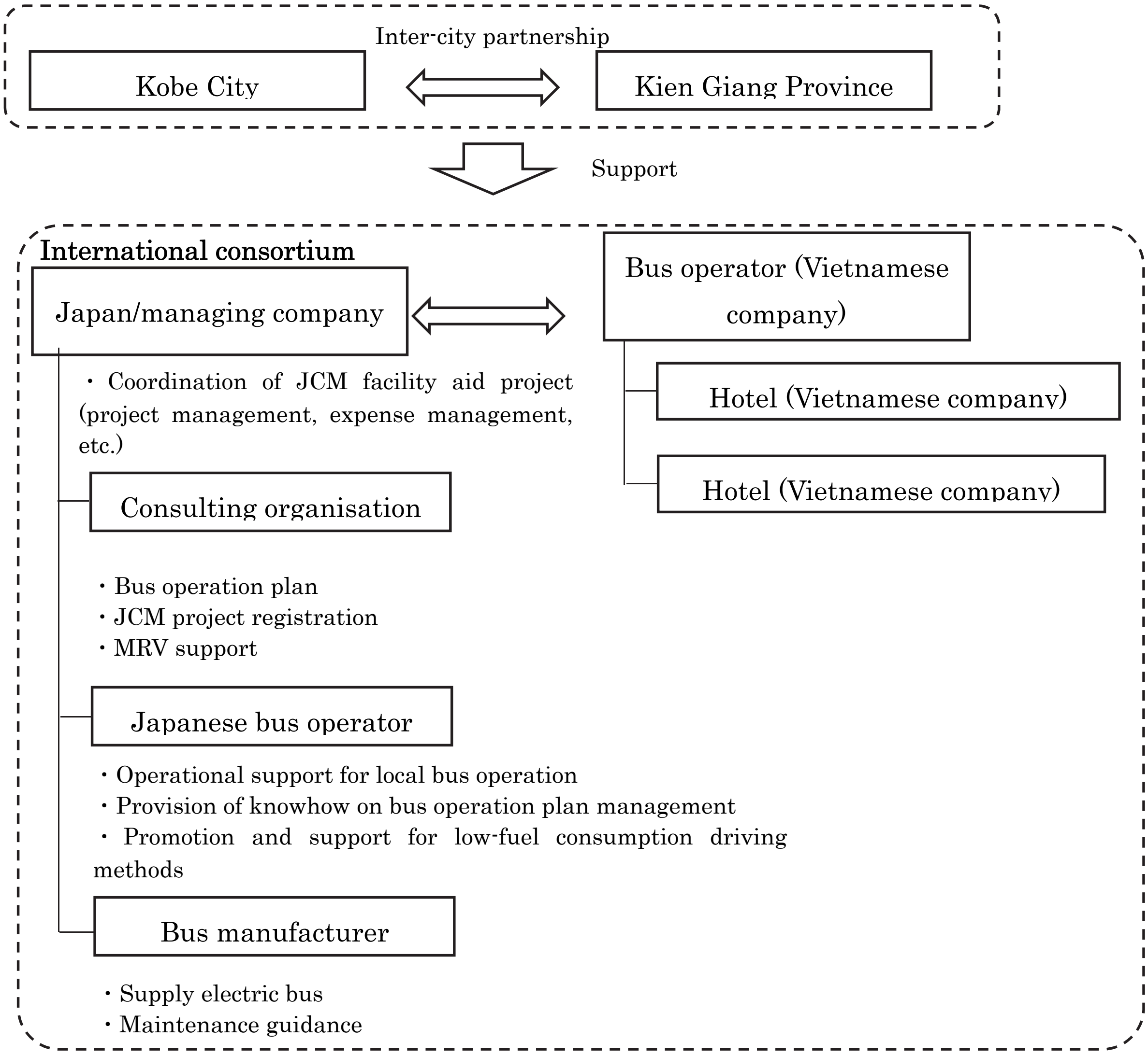


Figure 4.1.6.1 Organisation diagram (electric bus introduction)

(3) MRV

・In order to calculate reductions in greenhouse gases within JCM, it is necessary to accurately ascertain fuel consumption at present and power consumption following introduction of the electric bus and rental electric motorbikes.

・The cooperation of local companies (in the case of electric bus introduction: taxis; in the case of rental electric motorbike introduction: hotels) can be garnered to measure and record fuel consumption for determination of fuel consumption at present. Further, as the number of tourists fluctuates seasonally, it is necessary to measure the fuel consumption of taxis and gasoline motorbikes throughout the year.

・Concerning the electricity consumption of the electric bus and electric motorbikes, considerable differences occur based on driving methods. Accordingly, an examination will be carried out on automated collection and recording at regular intervals of the current location of bus and motorbikes (GPS positioning), battery information (remaining charge of battery, electrical current, voltage) via the introduction of a remote monitoring system.

4.2 Harbour and port facilities and watercraft

4.2.1 Present and future issues

(1) Present issues

1) Harbour and port facilities

・Of the major harbours on the island, studies were conducted for the largest on the island, An Thoi Harbour (An Thoi village) and Bai Vong Harbour (Ham Ninh village), with regular service to the mainland (see Chapter 2).

① An Thoi Harbour

・Fishing vessels are the main vessels to enter and anchor at An Thoi Harbour. Cargo and passenger ships only anchor a few times a month. Accordingly, at present energy consumption is limited to cargo handling times. Moreover, this harbour is not equipped with stationary crane facilities, and handling of cargo is carried out with a movable crane.

・On the wharf, about 20 paired HID* lamps (high pressure sodium or high pressure mercury lamps) are installed. According to interviews with the managing agency, the energy consumption of these lighting facilities is large and there is desire to plan for energy conservation.

* HID: High Intensity Discharge

②Bai Vong Harbour

・Bai Vong Harbour is a passenger and fishing port. Passenger boats include regular service to the city of Rach Gia and town of Ha Tien on the mainland (16 trips a day).

・Like An Thoi Harbour, it is not equipped with cargo handling facilities at present, and energy-consuming facilities are limited to lighting facilities.

Photo 4.2.1.1 Lighting facilities of An Thoi Harbour

2) Watercraft

・Figure 4.2.1.1 shows the number of vessels and fuel consumption of passenger boats, sightseeing boats and fishing boats on the island. Further, present conditions and issues, and the purchasing cost of vessels and engines are shown in Figure 4.2.1.2.

・There are about 2,700 watercraft on the island including passenger boats, sightseeing boats and fishing boats. The island as a whole consumes an annual 28,000 kL of fuel (light oil), and emits about 73,000 tons of CO_2.

・The passenger boat company is a “heavy energy consuming designated enterprise”* prescribed under the Energy Conservation Law and is obligated to formulate and implement an energy conservation plan. While the state of formulation of an energy conservation plan is unknown, its boats are new, making any enterprise based on the replacement of engines problematic.

・Sightseeing and fishing vessels have heavy wooden hulls with poor propulsion efficiency. Likewise, their engines are secondhand and manufactured over 20 years ago, with extremely poor fuel efficiency.

・As such, energy conservation is technologically possible via switching from wooden hulls to FRP (Fiber Reinforced Plastic) and switching to new engines. However, in most cases, business on the island is carried out by family-run or small-scale companies, making it difficult to promote energy conservation that comes at a high cost.

*Under the Energy Conservation Law, factories, farms, transportation agents exceeding 1,000 TOE of annual energy consumption, or offices and service facilities exceeding 500 TOE, are "designated enterprises" and are required to formulate energy conservation plans.

Photo 4.2.1.2 Passenger vessel


Photo 4.2.1.3 Sightseeing vessel

(2) Future Issues

1) Harbour facilities

・As shown in Chapter 2, there are plans for expansion of harbours and construction of new harbours on the island.

・If harbours are outfitted according to plans and the amount of cargo handled increases according to estimates, optimisation of distribution and energy conservation efforts for loading facilities such as cranes, will be necessary.

2) Watercraft

・It can be surmised that an increased demand for seafood and a rising price for seafood will result due to increase in the island's population and tourists. Meanwhile, at present, persons engaging in fisheries are on a declining trend. If further consolidation of persons engaged in fisheries continues in the future, there is potential for increase in their income.

・If the income of those engaged in fisheries becomes stable, the potential need for energy conservation may rise.

4.2.2 Applicable low-carbon technologies from Japan

・At the present stage, applicable low-carbon technologies from Japan in the harbour sector are shown in Table 4.2.2.1.

・In regard to harbours and ports, a project on conversion to LED for harbour lighting, which at present consumes the most energy, is conceivable.

・In regard to watercraft, projects on conversion to FRP for standard wooden vessels in Vietnam and popularisation of low-energy engines, are conceivable.

Table 4.2.1.1 Number and scale of vessels, navigation distance and fuel consumption of boats on Phu Quoc Island

Type (vessel material)	Details	Number of vessels	Scale of standard vessel (length × width × height m) Horsepower, etc.	Per vessel			Annual fuel consumption for entire island (light oil/kL)	Notes
				Navigation distance (km/month)	Fuel consumption (light oil)			
					Monthly (L)	Annual (kL)		
Passenger boat (steel)	Operated by Super Dong company ①Bai Vong Harbour to Rach Gia ②Bai Vong Harbour to Ha Tien	Over 6	300 passengers 30 knots (55.6 km/hr)	① 3,600km ② 1,350km	—	—	2,354	Calculated by the following formula from the 2,148 TOE annual energy consumption of Super Dong company (Kien Giang Province materials). 2,148 TOE/0.9126 (TOE/kL)=2,354 kL
Sight-seeing boat (wooden)	・Sightseeing boats that navigate nearby waters for the enjoyment of fishing and marine sports such as snorkeling. ・About 30 companies on the island	About 60	17.5 - 19 ×3.9 - 5.0 ×1.5 - 1.6 (170 – 380 horsepower)	277.8 km (150 NM)	400～600 (use 500)	6.0	216	・Results of interviews, daily travel distance: 150 NM (277.8 km), daily fuel consumption: 40-60 L ・Postulates 10 days per month operation ・Annual fuel consumption of island = fuel consumption (annual) per vessel × no. of vessels × 60% ・Postulates that about 60% of all vessels are operating
Fishing boat (wooden)	Gill-net fishing	900	Same as long-line fishing	1,850 km (1,000 NM)	1,200	14.4	7,776	・Travel distances and fuel consumption (monthly) are based on results of interviews (20 days/month operation) ・Annual fuel consumption of island = fuel consumption (annual) per vessel × no. of vessels × 60% ・Postulates that about 60% of all vessels are operating
	Pole-and-line fishing	834	11-12 × 3.8 - 4.0 × 1.5 (75 horsepower)	925 km (500 NM)	1,200	14.4	7,206	
	Round-haul fishing	226	21-22 × 7.2 × 2.7 (480 horsepower)	1,850 km (1,000 NM)	3,000	36.0	4,882	
	Long-line fishing	59	11 × 3.0 × 1.0 (30 horsepower)	1,850 km (1,000 NM)	1,200	14.4	510	
	Octopus trap fishing*	80		〃	1,200	14.4	691	・Navigation distance and fuel consumption are estimated values ・Annual fuel consumption of island = fuel consumption (annual) per vessel × no. of vessels × 60%
	Trawl/boat seine fishing*	10		〃	1,200	14.4	86	
	Dragnet fishing*	4		〃	1,200	14.4	35	
	Other*	520		〃	1,200	14.4	4,493	
	Total fishing vessels	2,633					25,678	
Total		About 2,700					28,248	
Annual CO_2 emissions		Fuel consumption for entire island × Unit calorific value × Carbon emission factor × 44/12 = 28,248 ×10^3×37.7×0.0187×44/12/1000= 73,020 t-CO_2						

*Fuel consumption for octopus trap fishing, trawl/boat seine fishing and dragnet fishing are estimated values (values were set conservatively to the smallest value of fishing methods on which interviews were carried out).

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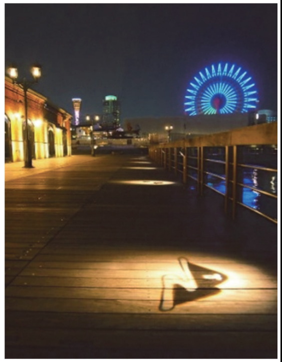
Table 4.2.1.2 Results of study on watercraft

Type (vessel material)	Details	Present conditions and issues	Price of watercraft and engines
Passenger boat (steel)	Operated by Super Dong company ① Bai Vong Harbour to Rach Gia ② Bai Vong Harbour to Ha Tien	・This company is a heavy energy-consuming "designated enterprise"* prescribed under the Energy Conservation Law and is obligated to formulate an energy conservation plan and implement an energy audit. The state of implementation is unknown. ・As passenger boats are comparatively new boats, the application of JCM for a project to replace engines is thought to be problematic. *Under the Energy Conservation Law, factories, farms, transportation agents exceeding 1,000 TOE of annual energy consumption are "designated enterprises" and are required to formulate energy conservation plans.	・Made in Malaysia
Sight-seeing boat (wooden)	Sightseeing boats that navigate nearby waters for the enjoyment of fishing and marine sports such as snorkeling.	・Boats are remodelled wooden fishing boats, equipped with heavy fuel-consuming old Japanese manufactured engines ・There are about 30 companies running sightseeing boats on the island. The majority of these are small-scale companies owning 1 to 3 boats (2 companies own 6 boats each). The monthly profit for a company with 3 boats is about 70 mil. VND (350,000 JPY). As such, they lack the financial ability to attempt energy conservation efforts.	
Fishing boat (wooden)	Gill-net fishing	・ Same level as long-line fishing	・Postulates same level as long-line fishing
	Pole-and-line fishing	・The same boats are used for pole-and-line fishing and round-haul fishing and mainly carry out squid fishing. Specifically, several pole-and-line fishing boats shine lights and round-haul fishing boats catch the squid that gather to the light. ・Both boats are made of wood and equipped with heavy fuel-consuming engines manufactured in Japan over 20 years ago. ・Employees are hired to carry out fishing in this large-scale fishing industry on the island (about 40 people including family). Fuel costs and employee salaries are subtracted from a monthly income of 500 mil. VND (2.5 mil. JPY), leaving a profit on hand of 120-130 mil. VND (about 600,000-650,000 JPY).	・Ship hull: 500-700 mil. VND (2.5-3 mil. JPY)
	Round-haul fishing		・ Ship hull: 2.5 billion VND (12.5 mil. JPYC) ・Including hull + nets, engine, machinery: 5-7 billion VND (25-30 mil. JPY)* *Nets are replaced every 10 years, engine is purchased second-hand
	Long-line fishing	・Boats are wooden and equipped with quite told engines that consume large amounts of fuel (engines are made-in-Japan). ・Family-managed businesses are the majority. After subtraction of fuel costs, etc., a monthly profit of 4 mil. VND (about 20,000 JPY) remains, showing a lack of financial ability to attempt energy conservation efforts.	・ Ship hull: 170-180 million VND (850,000-900,000 JPY) ・Engine: 45 mil. VND (230,000 JPY)

4-22

Table 4.2.2.1 Applicable low-carbon technologies of Japan in the port and harbour sector

	Photo image	Overview and Assessment
Port and harbour	a) Conversion of harbour lights to LED  	<Overview> ・Convert the high pressure sodium lamps and high pressure mercury lamps installed at the harbour to LED (light emitting diode) lamps. ・With conversion to LED, a drastic reduction in power consumption can be brought about. Further, a longer-life of lamps can also be achieved (from 12,000 hours to 40,000 hours). <Assessment> ・Projects have been carried out at the ports of Kobe and Yokohama and introduction is simple. However, because there are only about 20 floodlights at the island's largest port of An Thoi (40 HID lamps), the GHG reduction is potentially insufficient. ・Further, compared to the low-priced LED lamps popularised in Vietnam, the problem of whether Japanese-manufactured lights can compete price-wise remains (the cost of Japanese-manufactured will decrease due to JCM facility aid).
Watercraft	b) Conversion to FRP ships/hulls and introduction of energy-saving engines  Source: Kashiwagi Shipbuilding Ltd.	<Overview> ・Most boats on the island are wooden and have low propulsion efficiency. Further, the fuel efficiency of engines is poor. Accordingly, conversion to FRP (Fiber Reinforced Plastic) for fishing boats on the island and introduction of energy-saving engines could be achieved. <Assessment> ・FRP boats are lighter and stronger compared to wooden boats, bringing the merit of saving on fuel and maintenance costs. In recent years, Japanese watercraft manufacturers are actively trying to enter watercraft sector markets in Asia. ・There are over 2,600 fishing vessels on the island. If this technology were to be spread, a certain scale of GHG reduction could be expected. However, the issue of high cost of introduction remains. ・As emissions greatly differ based on navigation methods, precise calculation of reduction is an issue.

4.2.3 Concept for low-carbon technology introduction

(1) Conversion of harbour lights to LED

・Replacement of HID lamps (high pressure sodium lamps and high pressure mercury lamps) installed on the wharf at An Thoi Harbour to LED lamps.

・The number of lamps are 40, installed on 20 lampposts.

(2) Conversion to FRP ships/hulls and introduction of energy-saving engines

・Examine FRP conversion and introduction of energy-saving engines for round-haul fishing boats carrying out large-scale and large-income squid fishing on the island.

・The number of vessels is set at 60, to enable business feasibility on the part of Japanese manufacturers.

<Horsepower and size of fishing vessels targeted for energy-saving>

Horsepower: 480　Size of vessel: 21-22m×7.2m×2.7m

4.2.4 Economic efficiency (initial cost, operation cost)

(1) Conversion of harbour lights to LED

・This section is an examination of the economic efficiency of converting 40 HID lamps installed on the wharf at An Thoi Harbour to LED megalights.

・Specifically, the total of initial cost and operation cost (total of replacement cost due to lamp life and five-year electricity charges) of HID lamps and LED lamps for five-years was compared (see Table 4.2.4.2).

<Preconditions>

・The facility installation cost (light replacement cost), electricity consumed and life of both HID lamps and LED lamps are shown in the table below.

・A switch is to be made to Japanese-manufactured LED lamps aligned with times HID lamps go out, with a review period of five years (daily lighting time set at 12 hours). Accordingly, HID lamps will require one replacement (365 days × 12 hours/day × 5 years/12,000 hours) following initial installation, making a total of two installations required. Meanwhile, LED lights do not require any replacement following initial installation, making a total of one installation required. Further, JCM aid is available for 50% of the installation cost.

Table 4.2.4.1　Installation cost, electricity consumption and life of lights (per light)*1

	HID lamp	LED megalight
Initial cost*2 (light replacement cost)	6,000 JPY	100,000 JPY
Electricity consumption	200W	50W
Life	12,000 hours	40,000 hours

*1 Source: Institute of Energy Economics, Japan (IEEJ), Estimation of the electricity-saving potential and cost benefit of LED lighting

*2 Price includes price of product and fixture replacement and construction cost related to installation (in Japan).

・Results of the examination showed that even with 50% subsidised by JCM for the initial installation cost of LED lamps, LED lamps are about 4 million JPY more expensive than HID lamps.

Table 4.2.4.2 Comparison of economic efficiency of HID lamps and LED lamps (five-year)

	Item	HID lamp	LED lamp	Notes
a	Initial costs (equipment and installation)	240,000	2,000,000	HID: 6,000 JPY×40 lamps LED: 100,000 JPY×40 lamps×50% JCM aid of 50% for LED
b	Light replacement cost per replacement	240,000	4,000,000	HID: 6,000 JPY×40 lamps LED: 100,000 JPY×40 lamps
c	Number of replacements in review period	1	0	Number of lamp replacements when assessment period is set at five years (365 days×12 hours/day×5 years)
d	Light replacement cost (JPY)	240,000	0	=b×c
e	Electricity consumption of lamps (W)	200	50	See Table 4.2.4.1
f	Lighting hours (hours)	21,900	21,900	=12 hours×365 days×5 years
g	Electricity consumption during review period (kWh)	350,400	87,600	=e×f×40 lamps
h	Unit price of electricity (JPY/kWh)	8.5	8.5	Unit price of electricity in Vietnam
i	Electricity charges during review period (JPY)	1,489,200	372,300	=h×g
j	Total (JPY)	1,969,200	2,372,300	=a+d+i

(2) Conversion to FRP ships/hulls and introduction of energy-saving engines

・This section is an examination of the economic efficiency of ① implementation of both FRP conversion and engine replacement, and ② engine replacement only, targeted at round-haul fishing vessels.

・Specifically, for both ① and ②, economic efficiency is determined by finding the number of years required to get a return on initial investment by dividing the initial cost by the reduced yearly fuel costs from energy-saving.

・Preconditions, as shown below, are postulated to be the initial cost of 40 million JPY for FRP conversion and 7.5 million JPY for engine replacement per vessel. Further, the energy-saving effect (reduction rate of fuel) is set at 15% for FRP converted hulls and 5% for engine replacement.

・Results of examination showed that for both ① and ②, despite initial cost being high, fuel reduction effect is low, making the period required for recovery of initial cost long and not revealing economic efficiency.

<Preconditions>

① FRP conversion

- In order to achieve energy conservation when switching to FRP, the current shape of vessels (length: approx. 21.0 m × width approx. 7.0 m) is changed to a more slender shape (length: approx. 21.0 m × width approx. 5.3 m) (ship length is not changed, but the ratio of length to width is changed from 3:1 to 4:1).

  *Surveys must be conducted on actual load capacity and an examination conducted on the potential for problem with the smaller capacity of the vessels. For this examination, the current shape of vessels, that is wider than standard boat shape in Japan, is postulated to be for ensuring the stable navigation of boats, not for ensuring load capacity.

② Engine replacement

- Both the present engines and engines after replacement are postulated to be direct injection engines. Moreover, when present engines are compound combustion types, an approximate 15% in energy-saving effect is achieved by switching to direction injection type, making this examination conservative.
- The cost of engine replacement fluctuates in the range of 5 to 10 million JPY based on installation method and parts. This examination sets the median value of 7.5 million JPY.

① Hull conversion to FRP + engine replacement

- If FRP conversion and engine replacement are carried out, 31 years are required for return on investment, as shown in the table below, making project feasibility problematic.

Table 4.2.4.3 Years required for return on initial investment (FRP conversion + engine replacement)

	Item	Present conditions	FRP conversion + engine replacement	Notes
a	Initial cost (before subsidy, 1,000 JPY)	0	47,500	Per vessel
b	Initial cost (after subsidy, 1,000 JPY)	0	23,750	=a×50% subsidy rate
c	Annual fuel consumption (kL)	36.0	28.8	Postulates 20% fuel reduction effect targeted at round-haul fishing vessels
d	Annual fuel cost (1,000JPY)	3,888	3,110	=d×108 JPY (light oil unit price)
e	Years required for return on investment	—	31	=b/fuel reduction amount (difference from d)

② Engine replacement only

・Likewise, when engine replacement is carried out, 19 years are required for return on investment, as shown in the table below, making project realisation problematic.

Table 4.2.4.4 Years required for return on initial investment (engine replacement)

	Item	Present condition	Engine replacement	Notes
a	Initial cost (before subsidy, 1,000 JPY)	0	7,500	Per vessel
b	Initial cost (after subsidy, 1,000 JPY)	0	3,750	=a×50% subsidy rate
c	Annual fuel consumption (kL)	36.0	34.2	Postulates 5% fuel reduction effect targeted at round-haul fishing vessels
d	Annual fuel consumption (kL)	3,888	3,694	=d×108 JPY (light oil unit price)
e	Years required for return on investment	—	19	=b/fuel reduction amount (difference from d)

4.2.5 GHG reduction effect

(1) Conversion of harbour lights to LED

・CO_2 reduction accompanying conversion to LED harbour lights, and cost effectiveness were calculated.

・Results showed that CO_2 reduction was limited to 71 tons over five years due to the small scale of the project. Further, cost effectiveness (cost of one ton CO_2 reduction) was found to be about 33,000 JPY.

Table 4.2.5.1 CO2 reduction and cost effectiveness of conversion of harbour lights to LED

	Item	Value	Notes
a	Electricity consumption reduction per hour (kWh)	0.15	HID: 200Wh-LED: 50Wh
b	Lighting time (hours)	21,900	Five-year
c	Electricity consumption reduction during verification period (kWh)	131,400	=a×b×40 lights
d	Emission factor for grid power (t-CO_2/MWh)	0.5408	
e	CO_2 reduction (t-CO_2/year)	71	Five-year
f	Initial cost + light replacement cost + electricity charges (JPY)	2,372,300	See (1) of 4.2.4 Economic efficiency
h	Cost effectiveness (JPY/t-CO_2)	33,384	= f /e

(2) Conversion to FRP ships/hulls and introduction of energy-saving engines

・CO_2 reduction accompanying conversion to FRP hulls and energy-saving engines and cost effectiveness were calculated. As shown below, cost effectiveness was clearly low.

① Conversion to FRP hulls + engine replacement

・If conversion to FRP and engine replacement is carried out for 60 vessels, approximately 1,100 tons of CO_2 are reduced.

18.6 t-CO_2/year × 60 vessels = 1,116 t-CO_2/year

・The investment cost required for each ton of CO_2 reduction is about 420,000 JPY.

Table 4.2.5.2 CO_2 reduction per vessel and cost effectiveness (FRP conversion and engine replacement)

	Item	Value	Notes
a	Present fuel consumption (kL/year)	36.0	
b	Fuel reduction (kL/year)	7.2	Fuel reduction effect 20%
c	Unit calorific value (MJ/L)	37.7	
d	Carbon emission factor (kg-C/MJ)	0.0187	
e	Weight ratio of CO_2 and C (44/12)	3.67	
f	CO_2 reduction (t-CO_2/year)	18.6	=b×c×d×e
g	CO_2 reduction for 2016-2020 (t-CO_2)	93.1	=f×5 years
h	Initial cost for 2016-2020 (1,000 JPY)	39,302	=initial cost + fuel cost×5 years
i	Cost effectiveness (JPY/t-CO_2)	422,336	=g/h

② Engine replacement only

・If engine replacement only is carried out for 60 vessels, approximately 280 tons of CO_2 are reduced.

4.7 t-CO_2/year × 60 vessels=282 t-CO_2/year

・The investment cost required for each ton of CO_2 reduction is about 960,000 JPY.

Table 4.2.5.3 CO_2 reduction per vessel and cost effectiveness (engine replacement)

	Item	Value	Notes
a	Present fuel consumption (kL/year)	36.0	
b	Fuel reduction (kL/year)	1.8	Fuel reduction effect 5%
c	Unit calorific value (MJ/L)	37.7	
d	Carbon emission factor (kg-C/MJ)	0.0187	
e	Weight ratio of CO_2 and C (44/12)	3.67	
f	CO_2 reduction (t-CO2/year)	4.7	=b×c×d×e
g	CO_2 reduction for 2016-2020 (t-CO_2)	23.3	=f×5 years
h	Initial cost for 2016-2020 (1,000 JPY)	22,218	=initial cost + fuel cost×5 years
i	Cost effectiveness (JPY/t-CO_2)	955,010	=g/h

4.2.6 Issues related to introduction (organisation, financing, operation, MRV, etc.)

Based on examination through the previous sections, the project scale of conversion to LED harbour lights is small, making the CO_2 reduction also small. Regarding energy-saving conversions for boats, it is clear at this stage that energy-saving effects that are able to counterbalance initial costs (FRP conversion, engine replacement) are not obtained. Therefore, an examination of issues related to organisation, financing, operation and MRV for introduction of the low-carbon technology is not carried out. However, issues related to future introduction are as follows.

(1) Conversion of harbour lights to LED

・Compared to currently used HID lamps, the energy-saving effects of LED (Japanese manufactured), that require 1/4 the electricity consumption and have over three times longer life, are excellent. However, future issues are stated to be further reduction in cost and longer life (Made-in-China and Made-in-Vietnam LED lamps on the market in Vietnam are extremely cheap).

(2) Conversion to energy-saving vessels (conversion to FRP hulls + engine replacement)

・The unit price of CO_2 reduction is extremely high due to the high price of FRP conversion of hulls and engine replacement. Further, the energy-saving effect is only about 20%. While the engines currently used locally are rather old (about 20 years), they are Japanese manufactured and have good fuel efficiency. Thus only a 5% energy-saving effect can be obtained by switching to the latest model. This is the cause of the low energy-saving effect.

・Regarding FRP conversion, the shape of the hull differs according to fishing method. Thus, more detailed surveys are required for introduction (price fluctuation is also great).

・Further, according to local interviews, in most cases persons engaged in fisheries do not have sufficient funds, nor do they possess land that can be used as collateral for getting loans from banks. Therefore, financing is an issue.

4.3 Production facility (ice factory)

4.3.1 Current and future issues

(1) Current issues

- At present, the main industries on Phu Quoc Island include fish sauce manufacturing and pepper cultivation. There are few production facilities with heavy energy consumption. However, interviews with the development management committee of Phu Quoc District revealed the electricity consumption of the ice factory to be large.
- Hence, a survey of the island's largest ice factory (company name: Bay Hien), showed electricity consumption at this one ice-making facility to be 75,600 kWh, raising the issue of energy conservation.
- As the production scale of ice factories and climatic conditions differ between Vietnam and Japan, sweeping comparisons cannot be made. However, it was discovered that the electricity consumed per one litre of production at this factory, compared to ice factories in Japan, was 1.5 times the electric power (See Tables 4.3.1.1., 4.3.1.2).
- Further, although the ice produced at this factory is supplied to fishing boats, restaurants and hotels, the ice moulds inside the ice-making tanks were rusty, giving the impression of issues of hygiene.
- There are a total of 10 similar ice factories on the island (Duong Dong: 6 factories, An Thoi: 4 factories). By first introducing Japan's energy-saving technologies to the largest factory (company name: Bay Hien) on the island, the next phase can aim to expand to other parts of the island, enabling the realisation of a certain scale of greenhouse gas reduction on the island as a whole.
- Additionally, Vietnam with its tropical climate, has many similar ice factories around the country. The energy-saving potential for the ice manufacturing sector in this country is extremely high.

Table 4.3.1.1 Case of Phu Quoc Island, production volume and electricity consumed at ice factories (results of this study)

Classification	Item		Unit	Value	Notes
Case value	a	Monthly production	t/month	750	Daily production: 25t/day×30 days
Case value	b	Electricity consumption per month in summer	kWh/month	75,600	140 kW×18 hours×30 days
Calculated value	c	Electricity consumption per 1t production in summer	kWh/t	101	c=b/a

Table 4.3.1.2 Case of Japan, production volume and electricity consumed at ice factories

Classification	Item		Unit	Value	Notes
Case value	a	Monthly production	t/month	1,530	Daily production 51t/day×30 days
Case value	b	Electricity consumption in summer	kWh	307,158	Daily 15.7 hours operation, 92 days operation

Calculated value	c	Electricity consumption per month in summer	kWh/month	100,160	b/92×30
Calculated value	d	Electricity consumption per 1t production in summer	kWh/t	65.5	d＝c/a

(2) Future issues

・In the future, production of agriculture, forest and fisheries products is expected to increase due to improved production efficiency in the agriculture, forestry and fisheries industry and increased consumer demand for agricultural products on the island, on the Vietnam mainland and in other countries. Accordingly, the demand for ice to keep these agricultural products cool will increase. Further, demand ice for food products and drinks sold at hotels, restaurants and commercial facilities is likewise predicted to rise, leading to rise in energy consumption at ice factories.

・Projections for future electricity consumption in the service industry and agriculture, forestry and fisheries industry on Phu Quoc Island (projections by Kien Giang Province) are shown in Table 4.3.1.3. Projections on demand have not been carried out for the factory sector because at present, there are not many factories on the island. However, similar to the agriculture, forestry and fisheries industry and service industry, increase in power consumption is predicted, including ice factories. Thus, the promotion of energy-saving measures is important to prepare for the future.

Table 4.3.1.3 Future electricity consumption of various industries (Kien Giang Province projections on future demand)

Industry	Unit	2015	2020	Rate of increase
Service industry (commerce, restaurants, hotels)	MWh	76,990	200,683	161%
Agriculture, forestry and fisheries	MWh	387.9	1,000	158%

4.3.2 Applicable low-carbon technologies from Japan

・An ice-making machine (compression refrigerator) is composed of the compressor, condenser, expansion valve, and vaporizer (heat exchanger).

・Ice machines are divided into those employing a method of direct cooling of objects (a. direct expansion refrigerator) and those that employ a method of introducing a secondary coolant (brine) to cool objects (b. indirect cooling refrigerator).

・The a. direct expansion method is superior from the perspective of energy efficiency (system with highest COP), and this same method (a. direct expansion method ammonia refrigeration) is employed at ice factories on the island.

・In Japan as well, most large-scale ice factories highly prioritise energy efficiency and employ this method. However, small and mid-scale factories in Japan, where a slight decrease in energy efficiency does not result in drastic increase in costs, employ the b. indirect cooling method, which has the advantages of being highly safe and easily automated and requiring a reduced amount of coolant. Recently, the trend to eliminate CFCs has led to reforms on the demerits of ammonia refrigeration, and the c. NH_3/CO_2 cascade refrigeration system has been developed that combines a carbon dioxide coolant cycle with the ammonia coolant cycle.

・However, any introduction of b. indirect cooling method or c. NH3/CO2 cascade method locally would require large-scale modifications with high initial costs. Thus, maintenance of a. direct expansion system, while adding partial improvements, is considered to be most appropriate for energy conservation.

4.3.3 Concept for low-carbon technology introduction

・The factory targeted for introduction of low-carbon technology is postulated to be the island's largest, Bay Hien ice factory.

・While this factory employs the direct expansion method reputed to be the most energy efficient, it has not demonstrated sufficient energy saving effects (other factories also using same method).

・Accordingly, improved energy efficiency is attempted by maintaining this system while carrying out partial improvements.

・If improvements are to be actually considered, a survey on causes of energy loss is required that measures the operation conditions (e.g. compressor discharge temperature, COP) of local facilities.

・The plan for improvements conceivable at the present time is as follows.

①Replacement of existing open cooling tower with evaporative cooling tower

<Effect>

・Energy conservation can be achieved by raising the cooling capacity of the cooling tower to lower the discharge pressure of the compressor (=lower power of compressor).

②Replacement of outdated existing compressor and electric motor with energy-saving equipment.

<Effect>

・As the power consumption of the compressor is greatest, energy conservation efforts for the compressor are crucial. At present, multiple (3-5) compressors are being used, thus reducing the number of compressors is also conceivable.

③Improvement to surrounding facilities

・At this factory, the ice-making tank is open with no lid, generating energy loss as cold energy is lost. Accordingly, energy loss can be controlled by installing a lid on the ice-making tank and creating an ice-making room by surrounding the ice-making tank with partitions.

・If improvements are to be actually considered, energy conservation should be attempted not only by upgrading of equipment in ① and ②, but also by improvements to surrounding facilities and reforms in operations.

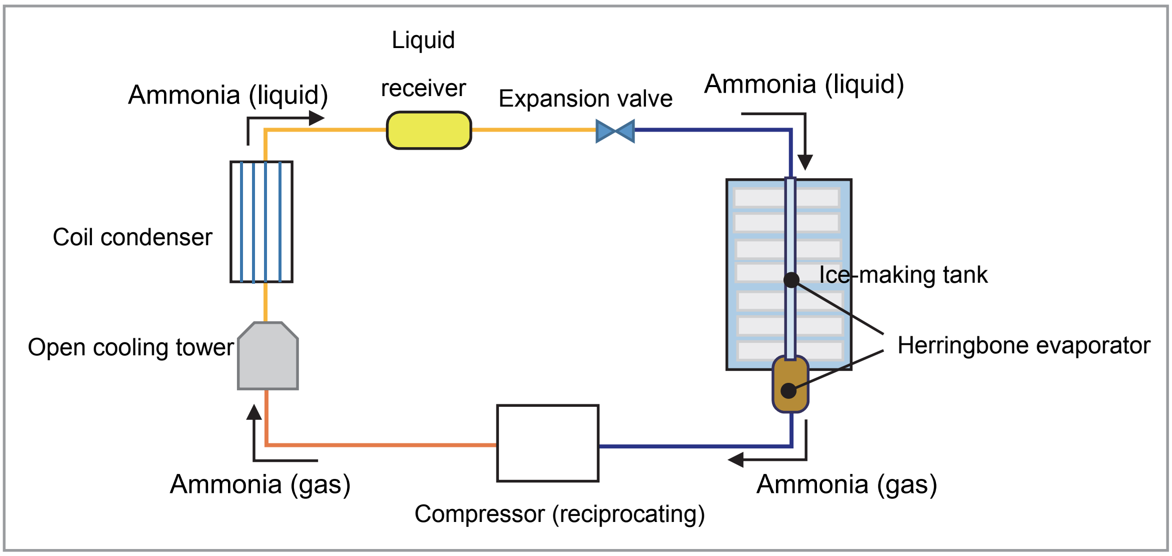


Figure 4.3.3.1 Concept for low-carbon technology introduction (Bay Hien ice factory)

4.3.4 Economic efficiency (initial cost, operation cost)

・Economic efficiency is compared based on assumption of an achieved 35% reduction in electricity charges due to partial reforms to ice-making factory facilities and improvements to surrounding facilities and operation.

・Specifically, the number of years required for return on investment when energy-saving measures are implemented for an ice factory (Bay Hien) with a monthly electricity consumption of 75,000 kWh realising a 35% reduction in electricity consumption.

・Figure 4.3.4.1 shows calculations without JCM facility aid, and Figure 4.3.4.2 for 50% JCM facility aid.

*When the local factory studied and Japanese ice factories were compared, the local factory was found to consume an approximate 1.5 times the electric power. Accordingly, the potential for a 35% (=1-1/1.5) reduction in power consumption exists when Japanese technology is introduced.

Table 4.3.4.1 Years required for return on initial investment (with no facility aid from Japan)

No.	Item	Value	Notes
A	Monthly electricity consumption	75,000 kWh	Performance value of factories on Phu Quoc Island
B	Electricity charges	1,700 VND/kWh	
C	Annual electricity charges	1,530,000,000 VND	=A×B×12 months

D	Initial cost (equipment cost + construction cost)	6,000,000,000 VND (30 mil. JPY)	Examination of further cost reduction
E	Reduction in electricity charges after facility renovation (annual)	535,500,000 VND	C×35%
F	Years required for return on investment	11.2 years	=D/E

Table 4.3.4.2 Years required for return on initial investment (with 50% facility aid from Japan)

No.	Item	Value	Notes
G	Monthly electricity consumption	75,000 kWh	Performance value of factories on Phu Quoc Island
H	Electricity charges	1,700 VND/kWh	
I	Initial cost (equipment cost + construction cost)	1,530,000,000 VND	G×H×12 months
J	Initial cost (equipment cost + construction cost)	3,000,000,000 VND (15 mil. JPY)	=D×50% When 50% facility aid is received from Japan
K	Reduction in electricity charges after facility renovation (annual)	535,500,000 VND	I×35%
L	Years required for return on investment	5.6 years	=J/K

4.3.5 GHG reduction effect

- Energy-saving efforts will be carried out at the island's largest ice factory (Bay Hien) in year one (2016), and at three other ice factories from year two (2017). Table 4.3.5.1 shows the electricity consumption of the four factories targeted for energy-saving measures.
- Annual GHG reduction is calculated assuming a 35% power consumption reduction across the board, by multiplying this reduction by the emission factor for grid power in Vietnam. Moreover, the verification period for GHG reduction effect is the five-year period from 2016 to 2020.
- As a result, CO_2 reductions are 170 t-CO_2/year in year one (2016), and 466 t-CO_2/year from year two (2017) (See Figure 4.3.5.2).
- Further, assuming a 50% subsidy based on application of JCM, initial cost is estimated to be 27 million JPY for year one (2016) and 72 million JPY for year two (2017) (selling of equipment).
- As a result, the cost effectiveness (initial cost per ton of CO_2 reduction) is:

  Year 1 (2016): 15,000,000 JPY (cumulative total)/170 t-CO_2/year=88,100 JPY/t-CO_2 (Bay Hien factory only)

  Year 2 (2017): 55,000,000 JPY(cumulative total)/636 t-CO_2/year (cumulative total)=86,500 JPY/t-CO_2

  Year 5 (2020): 55,000,000 JPY (cumulative total)/2,033 t-CO_2/year (cumulative total)=27,100 JPY/t-CO_2

Table 4.3.5.1 Electricity consumption at major ice factories

Ice factory	Unit	Value	Date of project implementation	Notes
Bay Hien factory	kWh/ month	About 75,000	2016 (year one)	Factory of local survey
Như Khoa factory	kWh/ month	About 30,000	2017 (year two)	Survey results
Thành Phước factory	kWh/ month	About 40,000		Survey results
Quoc Cuong factory	kWh/ month	About 60,000		Estimated from ice production volume
Average	kWh/ month	52,575		Average of above 3 factories

Table 4.3.5.2 CO_2 reduction at major ice factories by year

Factory	Loc Bay Thien	Như Khoa	Thành Phước	Quoc Cuong	Total	
Monthly electricity consumption (kWh/month)	75,000	30,000	40,000	60,000	205,000	
Energy-saving effect (%)	35.0%	35.0%	35.0%	35.0%		
Monthly reduction in electricity consumption (kWh/month)	26,250	10,500	14,000	21,000	71,750	
Emission factor for grid power (t-CO_2/MWh)	0.5408	0.5408	0.5408	0.5408	2.2	
Annual GHG reduction (t-CO_2/year)	170	68	91	136	466	
2016-2020 GHG reduction (t-CO2/year)						Cumulative total
2016	170	0	0	0	170	170
2017	170	68	91	136	466	636
2018	170	68	91	136	466	1,102
2019	170	68	91	136	466	1,567
2020	170	68	91	136	466	2,033
Total	852	273	363	545	2033	2,033

Table 4.3.5.3 Initial cost by year (with JCM facility aid of 50%, unit: JPY)

Factory	Loc Bay Thien	Như Khoa	Thành Phước	Quoc Cuong	Total
2016	15,000,000	0	0	0	15,000,000
2017	0	12,500,000	12,500,000	15,000,000	40,000,000
2018	0	0	0	0	0
2019	0	0	0	0	0
2020	0	0	0	0	0
Total	15,000,000	12,500,000	12,500,000	15,000,000	55,000,000

4.3.6 Issues related to introduction (organisation, financing, operation, MRV, etc.)

(1) Organisation

・A JCM project would be executed based on an inter-city partnership of Kobe City and Kien Giang Province forming a Japan-Vietnam joint project entity (international consortium).

・Concerning the organisational structure of the international consortium, issues involve minimisation of the financial burden on Vietnamese companies (initial costs) while ensuring the business profitability of the ice-making equipment manufacturers.

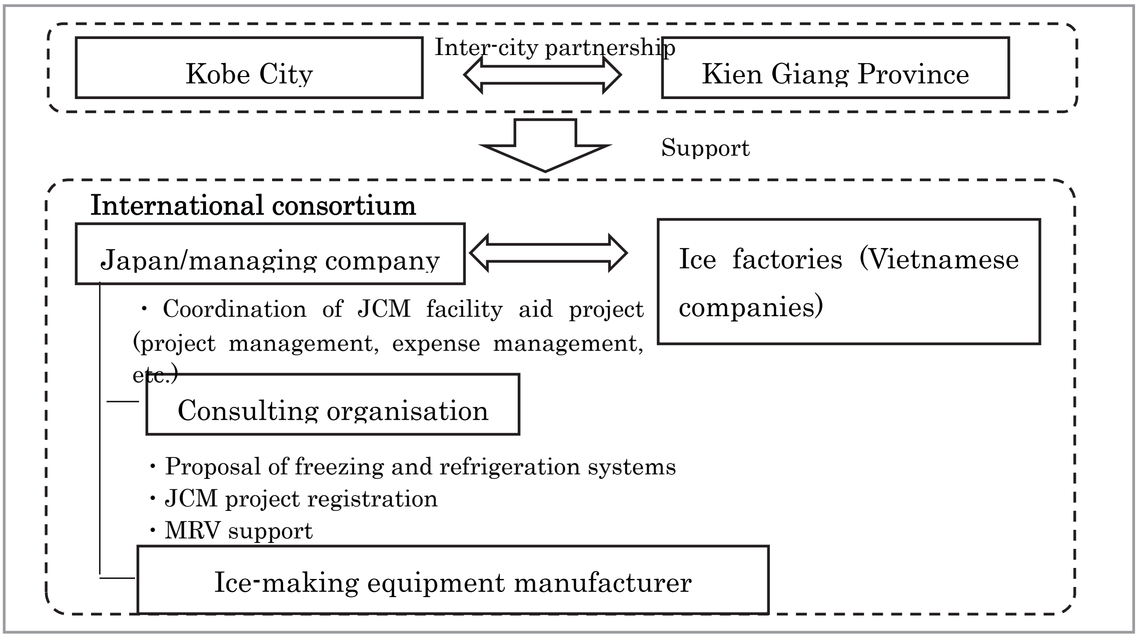


Figure 4.3.6.1 Organisation diagram

(2) Financing methods

・Funding from JCM facility aid will be used for a maximum of 50% of initial cost of facility introduction.

・Funding from the Vietnamese company operators will form the basis for the remaining 50%. However, it is imperative to seek financial support such as subsidies and low interest loans from the central government and Kien Giang Province in order to reduce the burden on the Vietnamese companies as much as possible.

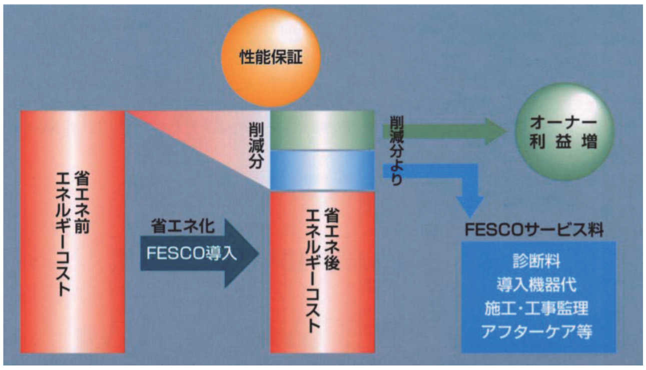


Figure 4.3.6.2 Image of finance service of ESCO project
(Source: Materials of the 2nd meeting of the Expert Committee for a Virtuous Circle for Environment and Economy)

・Further, examination is required on the application of ESCO (Energy Service Company) projects aiming to reduce the initial costs of the businesses.

(3) MRV

・In order to calculate reductions in greenhouse gases within JCM, it is necessary to accurately ascertain electricity consumption at present and after facility introduction.

・Monitoring of electricity consumption of local freezing facilities is carried out merely to check for equipment failure. Thus, rigorous monitoring is potentially not carried out (monitoring by visual observation based on analog meter). Further, it can also be presumed that adequate calibration of meters is not carried out. Therefore, the following proposal for improvements in monitoring methods is examined.

- Accurate recording of data based on introduction of analog meters, or introduction of an automated observation system (storage of freezer operation data with logger or computer)
- Improvements to monitoring frequency, recording storage methods of data→Monitoring simplification

4.4 Urban Facilities

4.4.1 Current and future issues

Of the urban facilities on Phu Quoc Island, the two most representative structures with modern functions are hotels and the airport. There are no high-energy consuming convenience stores, family restaurants and fast food shops as there are in Japan. Further, the market presumed to attract a large number of customers in the most populated Duong Dong district of the island is an open-air market without air-conditioning or refrigeration facilities. Facilities consuming a heavy amount of energy are not found. In addition, of combined house-shops, several tens of shops were found to use air-conditioning, but most storefronts were open. No particularly outstanding medium to high-rise office buildings or department stores were found.

Table 4.4.1.1 Energy consumption rate by type of industry (Japan) Unit: MJ/m^2/year

Industry type		Consumption rate
Office buildings		1,919
Wholesale and retail, including department stores and supermarkets	Department store	3,455
	Supermarket	2,943
	Wholesale, retail, etc.	2,943
Franchises and chain stores	Convenience stores	10,614
	Family restaurants	11,952
	Fast food	12,520
Hospitals		2,868
Schools		1,212
Hotels		3,039

https://www.env.go.jp/earth/report/h15-07/01_03.pdf

In contrast, there are many hotels and guesthouses supporting the tourism industry on the island. Most of these have various facilities for the comfort of guests, such as air-conditioning, hot water and lighting. Compared to town, energy consumption relative to space is estimated to be greater.

The Phu Quoc airport is an advanced building and is estimated to consume an intensive amount of energy. The floor space area of the terminal is not particularly large at about 2,000 m^2 (50m×20m×2 floors). As it is a new facility completed in 2012, any facility upgrades over the next 10 years are difficult to imagine.

Photo 4.4.1.3 Top-quality hotel on Phu Quoc Island Photo 4.4.1.4 Phu Quoc International Airport

Thus, resort hotels were targeted for this examination due to their relatively large potential for GHG reduction based on JCM and also because a future increase in their numbers is predicted in the island's master plan. Moreover, commercial complexes were removed from consideration due to lack of tangible plans for large-scale facilities.

(1) Current state of resort hotels

Here the present state and plans for resort hotels are outlined. There are 88 hotels on the island accessible from overseas. At present there are 88 number of rooms, and most of these are located on the island's western side in the Duong Dong district and surrounding areas. This coast is the only one in Vietnam where the sun can be seen setting over the ocean. Further, there are plans for construction of new hotels in the future using the advantage of the sand beaches that stretch over about 10 kilometers.

At present, the average operation rate of hotels on the island over the last three years is 75%, reaching about 80% when limited to relatively small-scale hotels (17-43 guestrooms) (from Vietnamnet, 7 June 2014). Generally, an operation rate of 60-70% is considered to be the break-even point in the hotel sector. Thus good economic conditions are estimated for the hotel industry on the island. The operation rate over the year on the island peaks between January and March, then gradually declines and remains low from mid-May to September, beginning a rising trend again from October (aforementioned Vietnamnet). This trend is presumed to be caused by avoidance of high precipitation rainy seasons and also in contrast, by travelers escaping the cold during the dry season in higher latitudes, which coincides with the winter season.

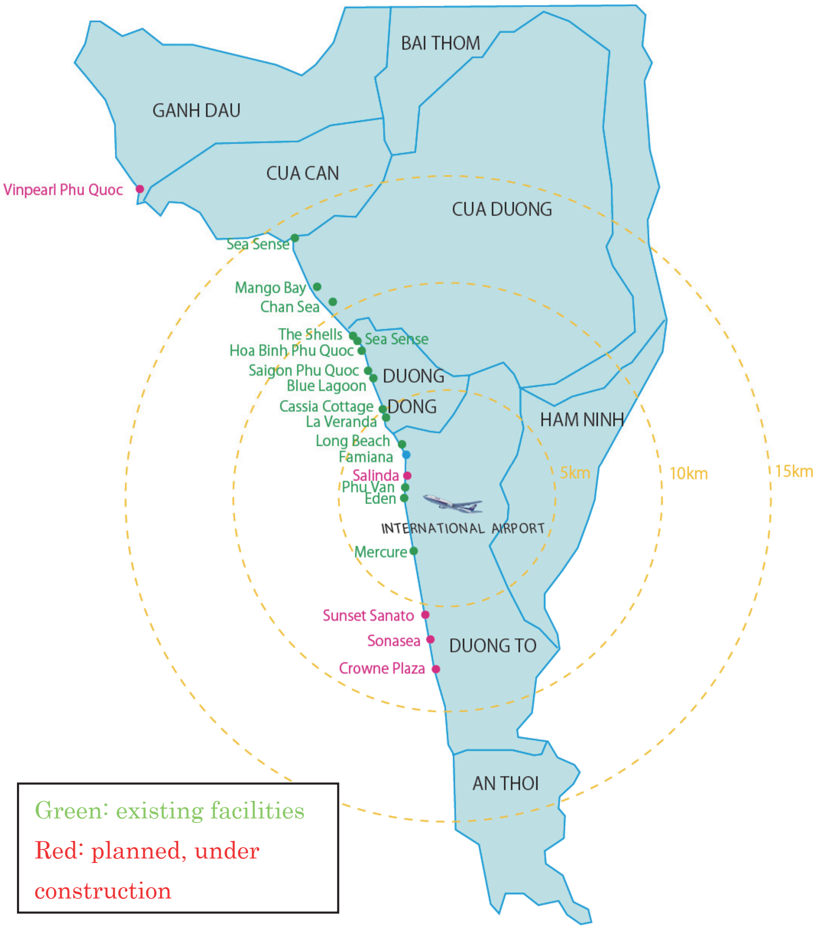


Figure 4.4.1.1 Location of major hotels on Phu Quoc Island

Materials: research group's study

Considering different energy usage modes for air-conditioning, lighting and hot water supply, resort hotels on the island are divided by type of lodging building into the major categories of bungalow type, multi-room building type and a combined type.

Further, an organisation of hotel scale focused on rank shows a trend by which the average number of rooms decreases successively from top rank down becoming smaller in scale. Further, while the bungalow type is greatest in number, when looked at individually, most bungalow types are mid-ranking two to three-star facilities, while multi-room types are split into top-ranking four to five-star or low-ranking one-star facilities. Major trends for multi-room type facilities are large-scale higher ranking facilities with total rooms exceeding 100, and low-ranking one to two-storied wooden buildings called guesthouses.

Table 4.4.1.2 Outline by type of lodging building

Hotel rank	Number of hotels	Average no. of rooms	Type		
			Bungalow	Multi-room building	Combined bungalow/multi-room building
Five-star	3	244	0	2	1
Four-star	9	72	5	1	3
Three-star	17	27	14	1	2
Two-star	22	27	11	10	1
One-star	13	14	3	10	0
No-star	25	17	8	16	1
Total	89	-	41	40	8

(2) Plan for resort hotels

The entire island of Phu Quoc was designated an SEZ (Special Economic Zone) by the central government of Vietnam, and plans are laid for the island to become an international economic and tourist hub. Focus is being put on tourism development as "Paradise Pearl Island", the island's other name. The number of tourists visiting the island in 2013 is purported to be 416,000 persons (from report by People's Committee of Kien Giang Province, 2013 Implementation of Economic Development, 363/BC-UBND). However, the island's development master plan aims for numbers to reach 2.5 million in 2020 and 6 million in 2030 (median value of projection range for each future year). The shift in numbers of tourists to date is shown below. Numbers of tourists from

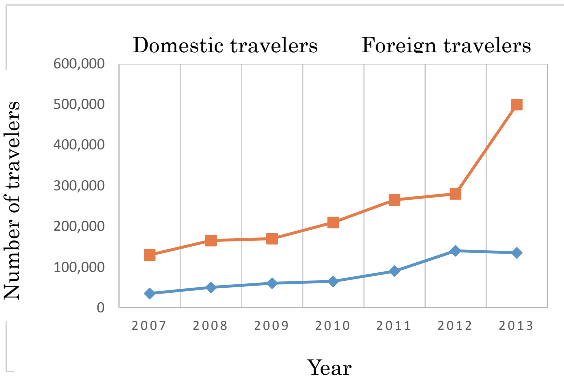


Figure 4.4.1.2 Shift in tourist numbers on the island

*Different information source for 2013

Source: research group's study

overseas in 2013 were reported to be 94,018, or 22.6% (same source as above). Foreign tourists mainly come from Europe, followed by large numbers from Australia and the USA.

Based on past shifts in tourist numbers shown below, it is unclear whether the target of 2.5 million people will be reached in 2020. Projection of tourist numbers from a realistic perspective is required in the drafting of planning measures.

Table 4.4.1.4 Present state and plans for tourist numbers on the island

Item	2013	2020 Plan	2030 Plan
Total tourist numbers	416,353	2,500,000	6,000,000
Number of foreign tourists included	94,018	－	－
Percentage of foreign tourists	22.6%	－	－

Source for 2013, "People's Committee of Kien Giang Province, 2013 Implementation of Economic Development, 363/BC-UBND", future values from "People's Committee of Kien Giang Province, Phu Quoc Island Development Master Plan"

Table 4.4.1.5 Development plan for major hotels

Business operator	Planned hotel name	Scale of development, etc.
1) CEO Group[1)]	Sonasea Villa & Resort	80 ha, 200 mil. USD Planned completion end of next year
2) Vingroup[1)]	Vinpearl Phu Quoc	304 ha, 800 mil. USD Top-scale hotel building, villas and golf course
3) Nam Cuong Group[1)]	－	150 mil. USD

1) Vietnam News 2 August 2014

According to the island's Investment Management Committee, an application for a license to develop a total of 43 ha for five hotel projects was submitted to the People's Committee of Kien Giang Province in July 2014. Meanwhile, while six licenses to develop reaching 315 mil. USD in total project cost were obtained, licenses for seven projects were cancelled. Further, licenses have been issued for a total of 19 projects to date reaching a total area of 8,700 ha. At present, 14 projects for hotels are under construction totaling 1,150 mil. USD. (from Vietnam News 24 Aug 2014). On the one hand revocation of licenses for hotel development does happen, and although numerous applications for license are submitted and insecurity exists, active plans for hotels are being advanced.

(3) Present state of energy use at hotels

1) Air-conditioning facilities

Of resort hotels, in most cases small-scale one to two-star ranked and below bungalow and guesthouse types either do not have air-conditioning or have only a minimal packaged air-conditioner. In most cases, hotels ranked three-star and above are equipped with room air-conditioners based on the style, scale and common-use space. The air-conditioning equipment of the Vinpearl Phu Quoc, a large-scale five-star multi-room building type that opened this year, is all room and packaged-type air-conditioners. This hotel's purported reason for not employing centrally controlled types is that it is not economical throughout the year due to the large decline in operation rate of guestrooms during the low tourism season. While there are some examples of hotels that employ centrally controlled air-conditioners in a similar environment in Ho Chi Minh, Vietnam, one conceivable reason for lack of employment in Phu Quoc is the small scale of both common-use areas that form the base load for resort hotels and banquet halls that require large-scale cooling.

Also, most room air-conditioners in bungalows are relatively new products that have been installed in the last five to six years due to enhancement of Phu Quoc Island's power supply system in recent years and efforts to improve the quality of the island's hotel industry to become more international.

Information garnered in interviews on equipment utilised showed use of Japan's Daikin and Panasonic, ROK's LG and Samsung, and Vietnam's Reetech. The Daikin and Panasonic models of Japanese manufacturers are produced in Malaysia and China respectively, and are considered to satisfy customers in both quality and price aspects.

Table 4.4.1.6 Results of study on air-conditioning facilities in multi-room building type three-star and above ranking hotels

Hotel name	Rank Building type	Mode of control and scale of equipment	Rough number of units	Manufacturer of equipment used
Vinpearl Phu Quoc	Five-star Multi-room building	Room and packaged types	-	-
Eden	Four-star Multi-room building and bungalow	Room and packaged types 1-2 HP	Multi-room building: 120 (bungalow: 30)	・mostly Daikin ・Reetech
Hoa Binh	Four-star Multi-room building bungalow	Room and packaged types 1-2 HP	Multi-room building: 120 (bungalow: 30)	・mostly Panasonic ・Reetech ・Daikin
Huong Bien	Three-star Multi-room	Room and packaged types	Multi-room building: 60	・LG ・Toshiba

	building bungalow	1-2 HP (Separately controlled units planned for under-construction 100-room multi-room building)		・Panasonic ・Samsung Etc.
Thien Hai Son	Three-star Multi-room building bungalow	Room and packaged types	Multi-room building: 110	・mostly Panasonic ・partially Reetech

Table 4.4.1.7 Rough division of air-conditioning facilities based on hotel type on Phu Quoc Island

Room type	Hotel rank	Air-conditioning type
1. Bungalow-style guestrooms	Mid-high range (2-5 stars)	Room air-conditioners
	Common (no to 1-star)	- (no air-conditioning)
2. Multi-room building style guestrooms, common areas	High range, mid-range (5-2 stars)	Room and packaged air-conditioners
	Common (no to 1-star)	- (no air-conditioning)

2) Hot water supply facilities

Hot water supply facilities can also be roughly divided by type of lodging and hotel ranking. Compared to hotels in the mid-range and above that have hot water supply facilities, those at the common level in most cases do not have water-heating equipment in individual rooms. For hotels with water heating facilities, bungalow type rooms have electric storage type water heaters in each room, while comparatively high-ranking hotels with multi-room building guestrooms and common buildings have centralised water-heating equipment. The remaining have individual electric storage water heaters set up in every guest room.

The majority of these electric storage water heaters are made by Italy's Ariston, a brand popularised in hotels and homes around Vietnam, not only in Phu Quoc. This manufacturer produces locally in Vietnam, and its models are reasonably priced, running from 100 to 300 USD according to scale. Electric storage type water heaters, including those of this company, are very popular in cities around Southeast Asia including Vietnam where city gas has not yet come into widespread use.

Example of electric hot water storage type water heater
Manufacturer, model: Ariston Thermo Pte. Ltd, ARI200STAB
Capacity: 200 L
Power usage: 3 kW
Voltage: 230V
Installation method: Free-standing
Tank material: Steel/titanium, enamel coating, heat insulation resin
Warranty: 5 years for tank
Price: about 170 USD (example of actual selling price)

Figure 4.4.1.3 Example of water heater (Ariston's ARI200STAB) popular in bungalow-type guestrooms

Further in recent years, usage of two types of solar water heaters, normal and vacuum pressure types, have begun to spread to some hotels. In most cases the particularly high-efficient vacuum pressure type is adopted. Domestic manufacturers include Tana, a major player in rooftop water tanks and SolarBK, and Chinese-manufactured models are also sold. The circulating price of the Chinese-made Deno brand is around 300 USD for the general home-use model.

Figure 4.4.1.4 Solar water heater installed at Eden Resort on Phu Quoc Island (manufactured by SolarBK)

Table 4.4.1.8 Rough division of water heater type based on hotel type on Phu Quoc Island

Room type	Hotel rank	Water heater type	Number of hotels
1. Bungalow-style guestrooms	Mid-high range (2-5 stars)	Electric storage water heaters for each building *Some have solar water-heaters	
	Common (no to 1-star)	- (no hot water supply)	

2. Multi-room building style guestrooms, common areas	High-range (4-5 stars)	Fuel oil-burning boilers	
	Mid-range (2-3 stars)	Electric storage water heaters at different locations	
	Common (no to 1-star)	- (no hot water supply)	

Meanwhile, the aforementioned Ariston company also manufacturers heat pump type water-heating equipment, and Australia manufactures a similar product. The market price of these is estimated to be about 1,000 to 2,000 USD. While cheaper than the price range of Japanese products, these are considerably higher priced than common water-heating equipment in Vietnam. The future spread of this type of equipment is unknown.

Example of a local heat pump type water heater (Ariston)

Model: NUOS SPLIT FS

Hot water storage capacity: 300L

Maximum 75% energy-saving potential compared to conventional types

Sale price: about 1,000-2,000 USD

Water temperature: maximum 55℃

Figure 4.4.1.5 Example of Ariston's heat pump hot water heaters

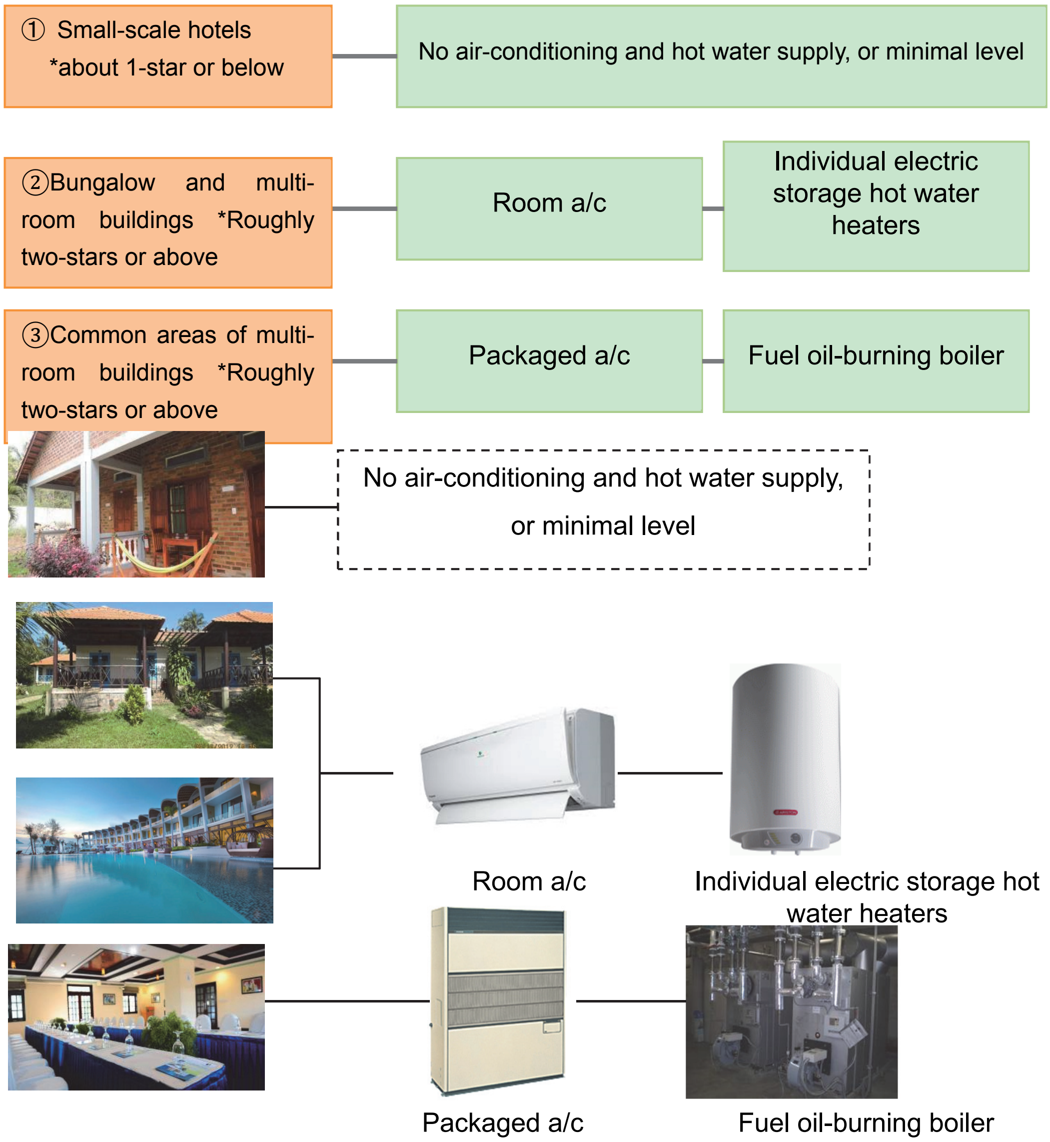


Figure 4.4.1.6 Main energy use by rank and type of hotel

(4) Special characteristics of energy consumption at Vietnam's resort hotels

The composition of electricity consumption at resort hotels in Vietnam, as shown in the table below, is reported to be 48% for air-conditioning, followed by 23% for lighting, 12% for water-heating and 17% for other power. Further, per capita energy consumption by hotel rank shows a successive decrease from four-star as hotel rank lowers. There is a particularly large gap in the average values for four-star and three-star hotels, with a difference of about double. Furthermore, variation in energy consumption at four-star hotels is great. As there are many four-star ranking hotels with comparatively large-scale capital, in some cases hotels have large common areas such as banquet facilities, and conversely have installed efficient refrigerators and boilers. The complex interaction of such factors is thought to bring about these results.

Based on these results, the volume zone targeted for GHG reduction effect in hotels, namely reduction of energy consumption, is postulated below in order.

・Energy consumption: ① air-conditioning (including ventilation), ② lighting, ③ water-heating

・Hotel rank: ① five-star, ② four-star, ③ three-star

Table 4.4.1.9 Breakdown of electricity use at hotels in Vietnam

Table 2
Electricity use in Vietnamese hotels

Electricity consumption for	Hotel categories			
	4-star	3-star	2-star	Resort
Lighting (%)	26	13	17	23
Air conditioning and ventilation (%)	53	47	46	48
Water heating (%)	17	27	25	12
Others (lifts, pumps, refrigerators, etc.) (%)	4	13	12	17

Source: Resource use and waste management in Vietnam hotel industry, Journal of Cleaner Production 13 pp.109–116, D.N. Trung, S. Kumar (2005)

Table 4.4.1.10 Energy consumption by region and rank in hotels in Vietnam

Table 6
Benchmarks for efficient use of resources in Vietnamese hotels

	Climate-based benchmarks							Overall benchmarks			
Climate category	Coastland			Highland	Inland						
Hotel category	4-star	3-star	2-star	2-star	4-star	3-star	2-star	4-star	3-star	2-star	resort
kW h/room/day (Elec.)	44–77	30–37	25–47	14–17	88–112	38–46	27–37	75–97	37–43	26–37	30–41
kW h/guest/day (Elec.)	24–43	42–62	15–27	15–17	129–178	37–45	26–44	81–127	40–50	27–41	18–24
m^3 water/room/day	2.3–2.6	1.2–1.6	0.9–1.3	1.8–2.6	1.9–2.3	1.2–1.4	1.1–1.5	5.4–20.3	2.6–8.1	0.7–11.5	4.1–16.4
m^3 water/guest/day	1.2–1.5	1.8–2.7	0.5–0.8	2.1–2.6	2.4–3.2	1.3–1.5	1.3–1.8	4.4–38.9	2.2–11	0.6–10.8	6.3–19.6
kg solid waste/guest/day	2.5–7.2	0.4–0.5	n/a	2.2–3.8	9.7–17.5	5.2–9	8.3–13.9	13.5–32.3	8.2–17.9	0.7–5.6	5.7–18.7
m^3 wastewater/guest/day	1–1.3	n/a	n/a	n/a	1.8–3.5	1.2–1.6	1.4–1.7	n/a	2.3–12	1.4–1.9	n/a

(5) Energy source of hotels on the island

The major energy used at resort facilities used to be electricity from private power generation based on fuel oil. However with connection to the mainland's grid in 2014, Phu Quoc began to receive electricity supply from the national power grid that same year. Moreover, as only a short time has passed since connection with the grid, a few power outages still occur at present. Energy costs are purported to have approximately halved with the switchover from private power generation. As such, hoteliers welcomed the 2014 grid connection in relation to the improved management environment. At present, power dependence is expected to continue its present shift.

Bungalow-type hotels depend on electric power for their major energy uses of air-conditioning and water-heating. It is assumed that water-heating and air-conditioning based on fuel oil-burning boilers and electric refrigerators is carried out in multi-room buildings of comparatively high-ranked hotels. Aside from these, in some cases LPG tanks are assumed to be used for cooking purposes.

A supply network for natural gas and use of private power generation based on renewable energies is conceivable in the future. At the present stage, the main energy source of hotels is expected to remain electric power.

Further, based on interviews with bungalow hotels, daily electricity usage per room by simple calculation is postulated to be about 40.2 kWh.

Table 4.4.1.11 Level of electricity usage at hotels

Interviewed hotel	Scale	Electricity usage
Chen Sea Resort *Rank: four-star	90 bungalows Water-heating and air-conditioning both electric *Number of rooms is assumed greater than previously mentioned, based on additions.	(from 70,000) 110,000 kWh/month* Simple maximum per room 40.7 kWh/day (60% operation rate, 67.9 kWh/day)
Saigon Phu Quoc Resort *Rank: four-star	90 villas (bungalows) Water-heating and air-conditioning both electric *partial use of solar hot-water heaters	106,140 kWh/month* (6/2014) Simple per room 39.6 kWh/day (60% operation rate, 65.6 kWh/day)
Average usage		Simple per room conversion 40.2 kWh/month*

*Including usage for common areas, one month set at 30 days.

■Research results on resort hotels ①

1. Chen Sea Resort

■Date and time 31 July 2014 (Thur.) 10:10-10:50

■Participants Manager

■ Interview results

(1) Hotel type: scale

・Bungalow, 90 rooms

(2) Energy consumption

・Electricity consumption is 70,000 kWh/month, and 110,000 kWh/month during the high season. The ratio of air-conditioning and water-heating electricity use is a/c:hot water=3:2.

・Owing to power system outfitting in February 2014, electricity charges are less than half those before outfitting, at 1.5-2 million JPY/month.

・Blackouts are frequent and a diesel generator is installed for reserve power generation. Power outages range from several hours to 2-3 days. Fuel expenses for the diesel generator are about 300,000 JPY/month.

・Energy costs account for about 10 to 15% of overall hotel expenditures.

・Air-conditioning units are Electrolux, a Swedish manufacturer.

・Each room in equipped with a 200L electric water heater (Ariston, an Italian manufacturer)

(3) Other

・The water source is ground water. Water is taken from 80m underground and treated by deposition, filtration and chlorination.

・Biological treatment is carried out for sewage, with the quality waste water emitted exceeding standards (used to water trees on grounds). The treatment facility is American-made, costing electricity fees for aeration pump. Waste water volume is 35-40 t/day.

Photo: resort exterior

■ Research results on resort hotels②

2.Saigon Phu Quoc Resort

■ **Date and time** 31 July 2014 (Thur.) 11:30-12:00

■ **Participants** Two technicians

■ **Interview results**

(1) Hotel type: scale

- Villa, 90 rooms

(2) Energy consumption

- Electricity consumption was 106,140 kWh, and electricity charges were 840 million VND (4.2 million JPY) for the previous month. Prior to power grid service, charges were about 2 billion VND (10 million JPY).
- Each room uses an electric water heater, with 30 60L-units (2,500W) and 70 30L-units (1,500W) installed. The dining hall and massage room each have two solar water heaters installed, which have been used for one year without breaking down. Both the electric and solar water heaters are made by Italy's Ariston.
- Each villa is equipped with a Panasonic cooler.

(3) Other

- The water source is ground water. 270 m^3/day (8,100m^3/month) of water is taken from 70m underground (3 pumps). A portion of water is supplied by the water purification plant (300 m^3/month).
- A 200 m^3/day capacity treatment facility is installed for sewage treatment, and waste water is used for watering (actual treatment volume is 150 m^3/day, water is discharged without watering grounds on rainy days).


Photo: resort exterior
http://www.vietventures.vn/2012/09/saigon-phu-quoc-resort-spa.html

4.4.2 Applicable low-carbon technologies from Japan

Below is an examination of Japanese technologies applicable to resort hotels.

(1) Air-conditioners, coolers

・Bungalows

Most hotels of the bungalow type on the island use room air-conditioner units. The most frequently found room air-conditioners on the island and in Vietnam in general are made by China's Haier Inc., ROK's LG Electronics and Samsung Electronics, or Japan's Daikin Industries, Ltd. and Panasonic Corporation. These Japanese electronics are produced at overseas bases. With foreign manufacturers also producing and selling inverter-type air-conditioners, the energy-saving performance of room air-conditioners when examined by energy consumption efficiency is about EER 8.6-12.0 for the Daikin KE Series, EER 11.5 for Panasonic's CS-KC12PKY in contrast to EER 13.5 for Haier's HSU-15LQA13. As such, the difference in performance of Japanese manufactured product and foreign manufactured product is small concerning air-conditioners for bungalows. Likewise, the products of multiple Japanese manufacturers are already widely used. Accordingly, the efficacy of diffusion utilising the JCM scheme was found to be low.

・Large multi-room buildings

Inverter turbo chillers are purportedly becoming widely used in Vietnam's large-scale facilities. From November 2013, employment of inverter control is required for over a certain capacity heat source.

Table 4.4.2.1 Examples of companies involved in central air-conditioning at large facilities in Vietnam

Company name	Products handled locally	Cases in Vietnam, etc.
・Viet Kim Vietnamese distributor financed 100% by Daikin Industries	Turbo chiller Screw chiller *water-cooling, air-cooling	Production bases in China, Malaysia, Japan and EU, with many past business achievements in Thailand and Vietnam.
・Mitsubishi Heavy Industries Operation headquarters for cooling, large chiller division	Turbo chiller	Air-conditioning in KLCC area of Kuala Lumpur, air-conditioning in Marina Bay area of Singapore
・Hitachi Vietnam Vietnamese corporation for sales ・Hitachi Appliances, Inc. In charge of air-conditioners in Hitachi Group	Turbo chiller Absorption chiller	(unknown)

・Trane Vietnam Local subsidiary of major US air-conditioner manufacturer	Turbo chiller Helical rotary chiller ＊water-cooling, air-cooling	Ho Chi Minh International Airport (Tan Son Nhat), Vincom Tower in Hanoi, TD Plaza in Haiphong, etc.
・Carrier Vietnam Major US air-conditioner manufacturer, affiliated with Toshiba	Various types of chillers	(unknown)
・ApplianсZ Vietnamese facility management company (Agent for York, Ebara, etc.) York is a major US air-conditioner manufacturer.	Turbo chillers, etc.	Air-conditioning system of Phu Quoc International Airport (comprised of three York-manufactured air-cooling system adjustable turbo chillers and FCU) Vincom Center in Province (7 air-cooling chillers and 764 FCU)
・AAE Vietnam Vietnamese corporation, manufacturer of heavy electrical equipment based in Thailand	Various chillers, air-conditioner works	(unknown)

Source: research group’s study

Results of the above examination are compiled in the table below.

Table 4.4.2.2 Potential for introduction of air-conditioning equipment in large-scale multi-room buildings

Target	Technology examined	Evaluation
(1) Bungalow	Room air-conditioner ・Inverter type ・High performance COP, APF	(For new installations) ・Overseas-produced units of Japanese make are already widely used at location, JCM aid cannot be applied. ・Similar models of Chinese and Korean make are also manufactured, Japanese technology does not have much uniqueness. (Replacement of existing equipment) ・Most existing units are comparatively new, thus little incentive for replacement. ・Other, same as new installations. (×)
(2) Large-scale multi-room building	Centralised air-conditioning device ・Centralised air-conditioning based on turbo type, absorption chiller	・Including the obligation to employ inverter-types, turbo-type chillers are already being employed in Vietnam. ・It is postulated that Thai, Malaysian and Chinese-made chillers are being adopted. ・Hotels have few large common areas for banquets, etc., and fluctuation in guest numbers is high, making room air-conditioner types mainstream. Thus, the demand for centralised air-conditioning units is low. (×)
	・Vacuum type solar water heater + absorption type chiller	・Although use of the local area's solar radiation for air-conditioning can be called rational, backup facilities for cloudy and rainy days would be necessary. It was determined that the cost of Japanese-made makes introduction difficult. (×)

Note: COP: coefficient of performance, APF: Annual Performance Factor is year-round energy consumption efficiency

(2) Lighting

At relatively new commercial facilities in Vietnam, use of fluorescent or LED downlights is already more common than incandescent types for spotlighting. This can be contributed to the start of production in recent years of comparatively cheap LED in Southeast Asia, including Vietnam. Further, in show windows and other places where higher intensity lighting is required, use of halogen lamps, not an LED alternative, continues in some cases. Also, for pendant lights and chandeliers, the type of light source is selected dependent on its decorativeness. Further, a partial conversion is evident for straight tube fluorescent lamps, utilised in large spaces that require illumination or where linear illumination is required, with T-8 type fluorescent lights remaining common.

The simplest method of GHG reduction related to lighting is switching to an energy-saving model of fixture. Here the potential for improvements in energy usage related to downlights and straight-tube fluorescent lights (T-8) based on application of Japanese technology is examined, albeit from a general standpoint, and results are compiled in the table below. For downlights, replacement with LED bulbs, and for straight-tube fluorescent lights, replacement with high efficiency T-5 (inverter-type) or LED, is considered. However, cheap LED are produced locally and in neighboring countries, making the overall price difference of Japanese product over double. Thus, diffusion of Japan-made products and technologies utilising the JCM scheme is considered problematic.

Table 4.4.2.3 Main targets out of lights at hotels on the island for potential application of Japanese technologies

Classification	Major uses	Applicable technology	Evaluation
(1) Downlights (fluorescent lights)	・guest rooms ・lobby, hallways ・banquet rooms	・LED downlights	・Approx. 1/2 power consumption ・Simple introduction is problematic due to price differential with locally made models. (x) *Details to be confirmed.
(2) Downlights (halogen)			・same as above
(3) Straight-tube fluorescent lights (T-8)	・banquet rooms ・backyards ・kitchen ・offices ・employee rooms, etc.	・T-5 (inverter-type) straight tube	・Approx. 30% reduction in power consumption, about ½ cost of LED ・Overall, there are few merits over LED. (x) *Details on price differential to be

			confirmed.
		・Linear LED	・Approx. 1/2 power consumption ・Simple introduction is problematic due to price differential with locally made models. (x) *Details to be confirmed.

(3) Hot water supply facilities

・Large-scale multi-room building type

Of all the water-heating facilities, conceivable alternatives to the centralised water-heating method by fuel oil-burning boiler, include heat pump-type water-heating equipment and diesel cogeneration. For the heat pump type, the quantity of heat that can be obtained exceeds the energy input. Further, for cogeneration, if site-specific private power generation facilities are introduced, they can be used as cogeneration for water-heating and power generation. In this way, economic effects based on lessened initial investment can be expected.

Table 4.4.2.4 Details on proposal for heat pump water heater for hotels

Item	Details
1.Reason for proposal	Sufficient roof area cannot be secured for use of solar hot water supply for multi-room buildings of hotels.
2.Overview of technology	The heat pump uses heat in the air to heat water. Main parts are the compressor and heat exchanger.
3.Merits	3-4 times the energy can be obtained from electricity used. Runs on automated operation, thus boiler operator unnecessary. Ideal for Phu Quoc with year-round high temperatures. Electricity rates in Vietnam are relatively cheaper than heavy oil.
4.Demerits	Initial costs are high. Specialised maintenance in required.
5.Issues	Projections on demand patterns for power generation and hot water supply at the hotel, as well as detailed analysis of facility operation efficiency, to be carried out.

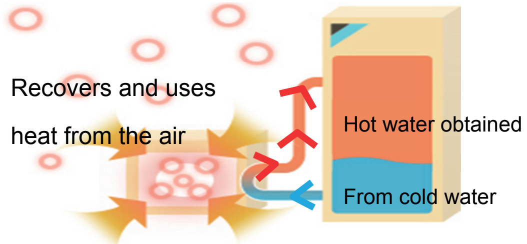


Figure 4.4.2.1 Heat pump principle

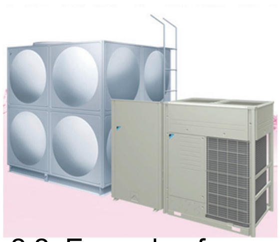


Figure 4.4.2.2. Example of commercial-use heat pump water heater

However, if introduction of this equipment is to be made, a detailed simulation that takes into account the complicated electricity rate system in Vietnam based on time and days of use, as well as the scale and planned operation rate and annual climatic conditions of the hotel where the introduction will actually be made, is required to determine the investment effect.

Table 4.4.2.5 Details on proposal for cogeneration facilities (heat and power supply) for hotels

Item	Details
1. Reason for proposal	Large hotels install large in-house power generators to use in times of blackout. Use in combination with this generator is possible.
2.Overview of technology	Exhaust heat from engine generation is utilised for water-heating. Electricity generated can be used at the hotel.
3.Merits	Overall energy efficiency is high. Installation possible with additional cost to budget for in-house generator facilities.
4.Demerits	Local electricity charges are relatively low. Initial cost is high. Specialised maintenance in required.
5.Issues	Projections on demand patterns for power generation and hot water supply at the hotel, as well as detailed analysis of facility operation efficiency, should be carried out leading up to examination of introduction.

Materials: research group's study

Bungalow type

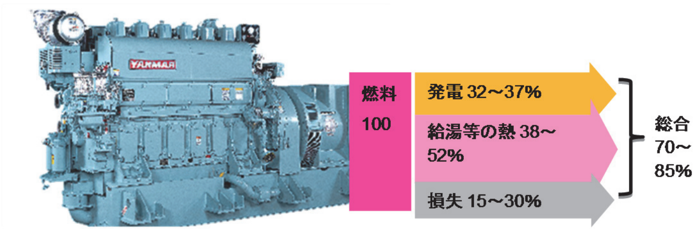


Photo 4.4.2.3 Example of diesel cogeneration equipment

For bungalow-type lodging buildings, alternatives were examined to the present standard electric water heater. These include the vacuum type solar water heater and heat pump type water-heating facilities for each buildings, as well as a combined method of vacuum type solar water heaters and electric water-heating equipment. In this case, the vacuum type water heater would utilise the plentiful solar heat of the area. The combination of the electric water heater with the solar-type hot water tank is considered ideal for hot water supply on rainy or cloudy days. However, locally made models of the main devices that make up this combined method are starting to gain popularity, and research results on Japanese models did not reveal any outstanding superiority. Thus, the potential for the diffusion of Japan-made models in the future was determined to be low and not appropriate for the implementation of a JCM project.

Table 4.4.2.6 Water heating equipment applicable to bungalows

Item	Present standard	Proposed unit 1	Proposed unit 2
External appearance			
Name	Electric water heater *1.5 - 3.0 kW	Vacuum solar water heater	Heat pump water heater
Capacity	Equipment from about 30L Diffusion type 60 to 200L	Tank capacity from 60L Diffusion of type about 60 to 200L	Japan-made: about 200L Overseas-made: from 60L
Country of manufacture	Produced in Vietnam	Produced in Vietnam	Japan, Australia, Italy, etc. Local production unknown
State of diffusion	Standard at local hotels	Starting to become popular locally	Unconfirmed
Energy efficiency	COP about 0.95	-	Japan-made: COP about 3.0 Overseas-made: unknown
Price range (200L type *FOB price	Locally-made: 200-300 USD	Japan-made: about 2,200 USD Locally-made: about 500 USD	Japan-made: about 2,500 USD Overseas-made: Details unknown

Table 4.4.2.7 Details on proposal for solar water heaters (evacuated tubular; Vietnam-made)

Item	Details
1. Reason for proposal	Efficiency of electric water heaters at hotels and households is low. Demand will increase with increase of hotels.
2.Overview of technology	Raises temperature of water in water tubes by solar heat. Energy use efficiency is high because water tubes are covered by vacuum tubes and have high heat retention.
3.Merits	Efficiency is about three times higher than solar power generation. Suited to Phu Quoc with its plentiful solar radiation. Vietnamese products are on the rise and local procurement is simple.
4.Demerits	Maintenance is required to maintain the vacuum. Measures are required to prevent damage to glass. Hot water supply capacity declines with rainy, cloudy weather.
5.Issues	Efficient design with electric hot water heater. Selection of highly reliable product that maintains vacuum.

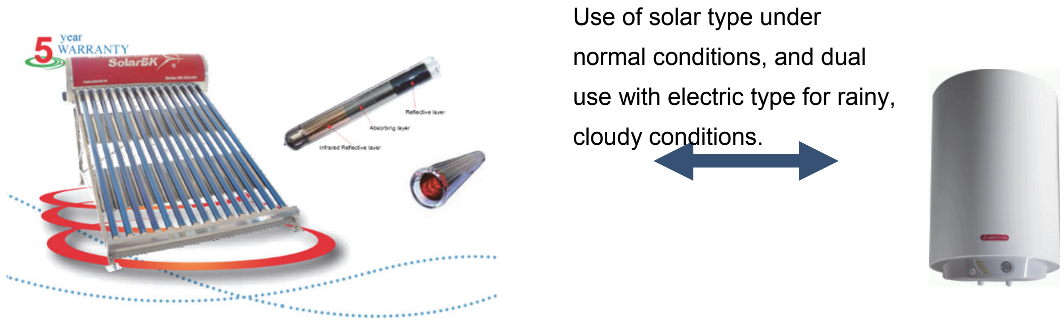


Figure 4.4.2.3 Dual use of solar and electric water heaters

4.4.3 Examination on feasibility of low carbon technology introduction

The results of examination of feasible facilities for a JCM project in the urban facilities sector within foundational research is summarised in the table below.

Table 4.4.3.1 Summary of research results on Japan's cooperation schemes (foundational research)

Examples of applicable technologies	Postulated project scale (ODA and JCM)	Potential for JCM implementation	Japanese manufacturers	Potential for JCM utilisation and issues
Solar water heaters and auxiliary electric water heater	Hotel bungalows (example: 50 structures)	(×) Problematic	Terada-Tekkosho, etc.	Inexpensive locally made models are starting to become popularised, hard to find any particularly superior points in Japanese equipment → Limited to proposal to local

				government
Heat pump water heating equipment	Hotel multi-room buildings (Example: 200 rooms)	(O) Has potential	Daikin, Toshiba, etc.	Proposal activity targeted at selection by large-scale hotel with construction start planned within 2-3 years → Planned proposals from business from local government
Diesel co-generation	Same as above (Example: 200 rooms)	(O) Has potential	Mitsubishi Heavy Industries, JFE, etc.	Proposal activity targeted at selection by large-scale hotel with construction start planned within 2-3 years *Japan side must organise an overall advantage with heat pump water heating equipment depending on facility scale and usage conditions. → Planned proposals from business from local government
High-efficiency air-conditioners	Hotel (example: 200 rooms)	(×) Problematic	Daikin, Panasonic, Toshiba, etc.	Products of multiple Japanese manufacturers already becoming widely used locally. → Limited to proposal to local government
Energy plan diagnosis	Hotel (example: 200 rooms)	(×) Problematic	Electric power-related consulting, etc.	Not facility introduction assumed by JCM → Limited to proposal to local government

4.4.4 Examination of economic efficiency

The results of an examination of the economic efficiency of the JCM related urban facilities are organised below. Moreover, items that are not expected to be feasible for JCM projects are also included.

1) Solar water heater and auxiliary electric water heater

Table 4.4.4.1 Summary of comparison with conventional methods (for one bungalow, excluding plumbing cost)

Method	Initial cost (1,000 JPY)	Maintenance cost (1,000 JPY/year)	Period until economic effectiveness obtained	Points to consider
Solar water heater + electric water heater for auxiliary use	Approx. 65 *Vietnam-made	Approx. 13	Approx. 2 years	Ideal for hotel bungalow rooms and general households

Electric water heater	Approx. 15	Approx. 44	(target for comparison)	

*150L/day of hot water supply for 1 building. Maintenance cost expected to include inspection cost for maintaining vacuum and auxiliary power during cloudy weather (supposed to be ¼ yearly)

2) Heat pump water heating equipment

Table 4.4.4.2 Comparison of approach with typical methods (Hotel 200 rooms × 150L/day/room, excluding plumbing cost)

Method	Initial cost (mil. JPY/year)	Maintenance cost (mil. JPY/year)	Period until economic effectiveness obtained	Points to consider
Countermeasure: professional-use heat pump	Approx. 10.4 *Japanese manufacturer-made	2.3	Approx. 2 years	Infrequent maintenance
Existing: electric water heater	Approx. 3.15	7.1	(target for comparison)	Frequent maintenance for cleaning of combustion parts

3) Diesel cogeneration

Table 4.4.4.3 Comparison of approach with existing methods (Example: 200 rooms × 150L/day/room)

Method	Initial cost (mil. JPY)	Maintenance cost (mil. JPY/year)	Period until economic effectiveness obtained
Countermeasure: cogeneration	Approx. 50	Approx. 5	- (Detailed analysis required)
Typical: combustion boiler	Approx. 2.5 *Presumed locally-made	Approx. 2.5	(target for comparison)

4) High efficiency air-conditioner

Table 4.4.4.4 Comparison with conventional method (for one hotel room of about $33m^2$)

Method	Initial cost (1,000 JPY/unit)	Maintenance cost	Period until economic effectiveness obtained
Example countermeasure: Exceeds COP 4.0 during air-conditioning	200 *Including installation cost	Over 30% improvement over typical	Dependent on operation conditions and temperature conditions

Typical: COP 3.0 during air-conditioning	150 Depends on number of units purchased	—	(target for comparison)

4.4.5 GHG reduction effect

GHG reductions are estimated as follows.

Table 4.4.5.1 Summary of research results

Example of applicable technology	Project scale (JCM target→future maximum value)	Reference scenario	Reference cost (mil. JPY)	CO_2 reduction (t-CO_2/y)	Initial cost (mil. JPY)	Unit price of CO_2 reduction (JPY/t-CO_2)
Heat pump water-heater (multi-room buildings)	1 hotel, 200 rooms→20 hotels	Electric water heater in each separate room	3.15	77	10.4	95,000*
Diesel cogeneration		Same as above	Same as above	-	50	-

*Symbol: Until price when simply divided by the amount increased over reference.

4.4.6 Issues for introduction

A profiling survey on local needs and the state of Japanese technologies and products was carried out as foundational research. At present, research and selection of a local enterprise suited to the JCM schedule to carry out an applicable project in the JCM scheme, is an issue within the People's Committee of Kien Giang Province. If a promising enterprise, such as a hotel, were to emerge, implementation of a detailed feasibility study on Japanese technology and products targeted at the hotel operation plan and design plan, is an issue.

For a JCM implementation scheme postulated on the hotel business as an urban facility, business dealings between the local enterprise and Japanese manufacturer would make up the core. The special establishment of a new organisation such as an SPC is considered unnecessary. Further, planning for financing would fundamentally be carried out by the hotel enterprise. For large-scale expenditures for facility introduction, a potential need for consideration of JBIC export financing would arise.

Further, a monitoring method for operation of future JCM, whereby the Japanese manufacturer confirms the operation performance of facilities recorded with ammeters and rotation meters by the local enterprise, is considered to be appropriate.

4.5 Examination of guideline related matters for Eco Island realisation

In addition to legal regulations and standards enacted by the national government for private economic activities, the establishment of guidelines, in the form of ordinances and appropriate guidance and instruction by the authority at the regional level, Kien Giang Province, is required for Phu Quoc to become an Eco Island. Ideally, these Eco Island guidelines would set forth technologies and technological standards to be employed for carbon reduction and proper treatment of sewage and waste, as well as a unified method for calculation of reduction effect.

(1) Low carbon guidelines

Low carbon guidelines cover a broad range of issues, from urban planning methods to the energy efficiency of facilities in the private sector. For proposals such as these, many resources are available among materials released by agencies of the Japanese government or local authorities. It is both efficient and effective for Japan to offer its knowledge to respond to the needs of the environmental department on Phu Quoc Island. Public documents of the Ministry of Environment of Japan that could serve as a reference are shown in Table 4.5.1.

Table 4.5.1 Reference materials for low carbon guidelines on Phu Quoc Island (Ministry of the Environment, Japan)

Title of materials	Overview
Guidebook on Sustainable Regional Development	Guidebook for advancing regional environmental initiatives
Guidelines on Sustainable Urban Redevelopment	Guidelines on mini-assessment of urban redevelopment
2050 Global Warming Project, "12 Low Carbon Measures"	Reference material for formulation of long-term vision
Indicators for Urban Planning and Operation in Response to Policy Issues C. Creation of cities with small environmental load	City planning and operation indicators for building communities with low environmental impact
Measures for Local Public Bodies on Global Warming—state of implementation and introduction of measures	Representative case studies on the global warming measures of local public bodies

The Ministry of Land, Infrastructure, Transport and Tourism has also formulated the "Basic Policy on Promoting Low Carbon Cities" and the "Low Carbon City Plan Brochure" in accordance with enforcement of the Low Carbon City Act. The "Low Carbon City Development Guidance" was also drafted and reorganised into the "Practical Handbook for Low Carbon City Development" in December 2013. Selected items from these low carbon guidelines that could be of reference to Phu Quoc Island are shown in Table 4.5.2.

Meanwhile, experience on systemisation shown in Kobe City's "Smart City Planning" could provide a reference for Phu Quoc and be utilised in the preparation of guidelines.

Table 4.5. 2 Useful measures (excerpts) from the "Low Carbon City Development Guidance" of the Ministry of Land, Infrastructure, Transport and Tourism

Item	Overview
(1) Conversion to a collective urban structure	① Public facilities at collective centres ② Inducement for locating of service facilities and housing
(2) Road infrastructure (improved driving speeds)	① Outfitting of roads for more fluid automobile traffic ② Multi-level intersections
(3) Adjustment of automobile traffic demand	② Transit malls ③ Car-sharing ④ Car-pooling ⑤ Provision of bicycle-riding environment ⑥ Telecommuting
(4) Outfitting of public transportation	① Outfitting of BRT ② Introduction of community buses ③ Outfitting of bus lanes
(5) Promotion of use of public transportation	Improved bus stop service
(6) Measures to reduce energy load	① Complete reconstruction of deteriorated buildings ② Area energy management system (AEMS)
(7) Measures to enhance efficient use of energy	① Complete use of energy a. local heating and cooling b. Heat interchanging among buildings ② Combined land-use (mixed use)
(8) Measures for utilisation of untapped energy	③ Energy from temperature difference of river and sea water ④ Energy from temperature difference of groundwater ⑤ Factory waste heat
(9) Measures for utilisation of renewable energies	① Use of solar energy a. use for power generation b. use for heat ② Use of geothermal heat ③ Use of biomass energy

Table 4.5.3. Useful knowledge (excerpts) from Kobe's "Smart City Planning"

Policy	Overview
(1) Reduction in energy consumption and enhancement of utilisation efficiency sychronised to renewal of buildings and building equipment	・Active introduction of enhanced insulation performance and energy-saving equipment in public buildings ・Promotion of enhanced energy performance in private buildings ・Introduction of environmentally sound technologies in public facilities ・Creation of rules for building energy performance in city center and multi-function locations ・Promotion of complete use of energy and introduction of advanced technologies
(2) Utilisation of untapped energies	・Information provision on untapped energies existing within the city ・Creation of rules to promote utilisation of untapped energies at the time of construction or renewal of large-scale facilities ・Transfer of untapped energies to surrounding areas sychronised with facility renewal of clean centers, etc. ・Utilisation of "Kobe Biogas"
(3) Utilisation of renewable energies	・Promotion of major introductions in public facilities, including solar power generation, use of solar heat, wind power generation and small hydropower generation ・City planning for easy use of sunlight ・Promotion of introduction of solar power generation in low-rise dwelling in foothill regions and warehouses along coasts. ・Increased effective utilisation of renewable energies based on introduction of a system utilising information and communication technologies
(4) Implementation of initiatives at the building-level	・Implementation of energy-saving audits for buildings, energy-saving based on improvement operation of facilities and equipment ・Utilisation of renewable energies
(5) Creation of rules to facilitate improved	・Compliance with energy conservation standards based on the Law Concerning the Rational Use of Energy, and

energy performance at time of construction or renewal of large-scale buildings	creation of rules for submission and release of environmental plans ・ Examination of support system for improving energy performance

(2) Guidelines for water and waste

The “Manual for formulation of prefectural concept on establishment of efficient sewage treatment facilities (draft)” of the Ministry of Land, Infrastructure, Transport and Tourism could provide reference for various types of sewage treatment planning including sewerage works plans. Furthermore, the “Rules for trash and resources” and “Rulebook on commercial waste” of the Kobe Environment Bureau contain years of accumulated knowhow on waste issues. Further, if necessary, cooperation in the creation of guidelines on separate collection of waste on Phu Quoc is possible.

Chapter 5. Creation of the Phu Quoc Eco Island Concept (draft)

Foundational research on the Phu Quoc Eco Island concept was carried out toward implementing green measures for the island in its entirety. Aims include ensuring environmental protection and economic growth on Phu Quoc Island, enactment of Vietnam's national "Green Growth Strategy (GGS)", and assisting in the establishment of policy for additional technological and financial cooperation with Japan.

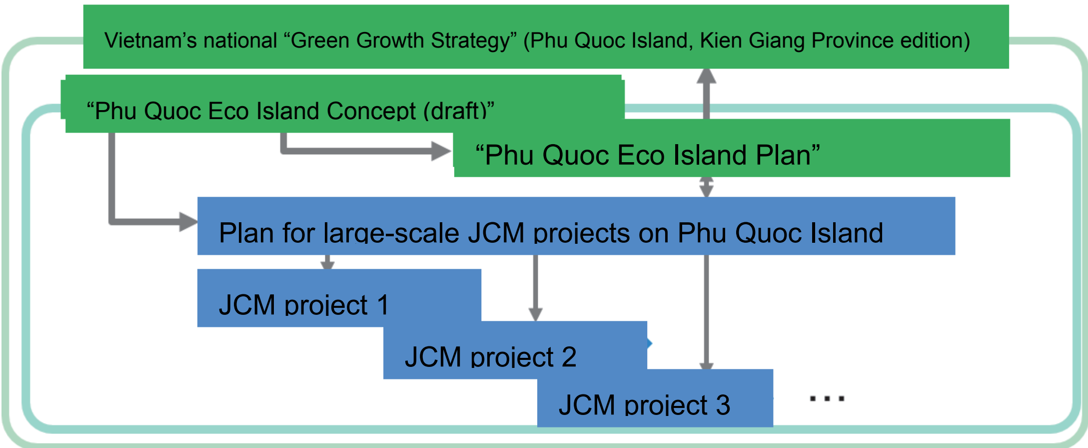


Figure 5.1 Relationships between the Eco Island concept and related plans

5.1 Present and future issues (energy supply, carbon reduction, environmental protection)

The Government of Vietnam, estimating future tourists on Phu Quoc Island to reach two million in 2020 and five million in 2030, is expediting development as a leading domestic tourism location. Meanwhile, the government has designated the entire island a Special Economic Zone (SEZ) aiming at development of the import/export and food industries. The development master plan of the island, with 2030 as its target year, plans to preserve nearly all of its protected forests and national forests while planning major increases in land for tourism, industry and districts for urban and government facilities.

In particular, land for tourism is planned at several locations, mainly in the northern part of the island, in order to promote an increase in tourists. The number of tourists planned for 2030 corresponding to this development is over ten times the current number in 2007. In connection with these trends, issues will arise concerning an increase in numbers of visitors transported from the airport to the tourist areas, as well as an increase in energy consumption due to visitor activity and a significant increase in corresponding GHG emissions.

Meanwhile, Phu Quoc is at present one of the leading home ports for fishing boats in Vietnam. A large quantity of diesel oil (light oil) is consumed on this island due to fishing boats registered here. Likewise, fish sauce and other marine products of the island are highly acclaimed around the country. Further, with the heavy-consuming cities of Can Tho and Ho Chi Minh in the vicinity, no reason can be found any decrease in the activity of these fishing boats in the future. As such, energy consumption and GHG emissions due to the activities of fishing boats on the island from the present to the future is considered an issue.

In addition, measures targeted at motorbikes, automobiles and households are also considered to be critical issues from the perspective of energy consumption and GHG emissions.

5.2 Basic Policy

(1) Basic policy on GHG reduction

Considering the impact of emissions up to this future date and the volatility of future projections, measures should be introduced that focus on emission sources with heavy GHG emissions at present that show no indication of decreasing into the future. Subsequently, focus should be placed on emission sources expected to drastically increase in the future and reduction of energy dependence on off-island sources.

1) Adopt measures for fishing boats, private-use two-wheeled vehicles, etc., with currently large GHG emissions.
2) Engage in reduction efforts for hotels and commercial vehicles (e.g. buses) expected to drastically increase in the future.
3) Adopt energy-saving technologies for planned industrial parks.
4) Actively utilise the rich renewable energies peculiar to the island in order to lessen dependence on mainland energy. (*sunlight, solar heat, wind, biogas (sugarcane refuse), waste of seafood processing)

(2) Basic policy on water and waste

Measures must be adopted on water and waste in order to protect the favorable conditions of the island's local environment into the future.

1) Adoption of water-saving and water-reuse technologies to ensure water resources that can support the island's future.
2) Proper sewage treatment for businesses, including hotels, and households.
3) Promotion of activities related to the 3 R's for waste. Promotion of utilisation of waste biomass and composting.

(3) Basic policy on preservation of a healthy natural environment

Aim for realisation of an Eco Island from the perspective of the island's native forests and rare and precious species.

1) Preservation of protected and national forests and natural topography

2) Preservation of rare species, precious species and ecosystems

5.3 Objectives

In order to become an Eco Island, an international tourist location rich in nature, targets for GHG reduction are set above the targets in Vietnam's national Green Growth Strategy (GGS). Specifically, a target to reduce energy-derived GHG emissions in the year 2030 by 50% compared to BaU, is proposed.

Table 5.3.1 GHG reduction target on Phu Quoc Island

Division	Up to 2030
GHG emission reduction	20-30% reduction from BaU in energy-related emissions

Reference Table GHG reduction targets within Vietnam's Green Growth Strategy (partial reproduction)

Division	2011 - 2020	Up to 2030
(1) GHG emission reduction	10-20% reduction from BaU in energy-related emissions	20-30% reduction from BaU in energy-related emissions, annual 1.5-2.0% reduction overall
(2) Decrease in GHG concentrations	8-10% decrease *compared to 2010 value	-

5.4 Measures toward realisation

(1) Measures to address presently high GHG emissions

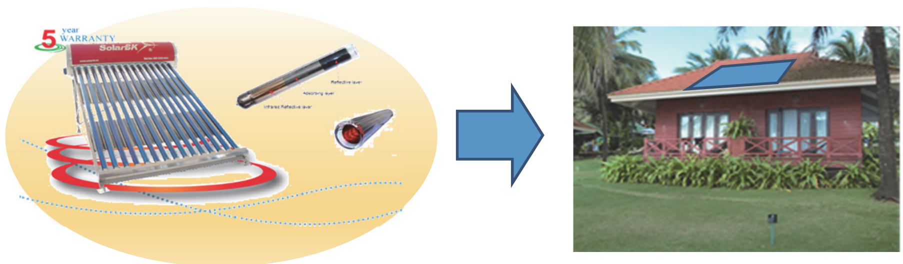
Measures include: weight reduction of hulls, decrease of ohmic loss and engine replacement with new models for fishing boats; problem analysis of entire system, improvement in efficiency of major machinery and repair work on leaks and loss at ice factories; as well as introduction of electric motorbikes as opposed to gasoline motorbikes.

(Images: energy-saving fishing boat, production efficiency at ice factory, introduction of electric vehicle)

(2) Measures to address future increasing GHG emissions

1) Hotels (hot water supply)

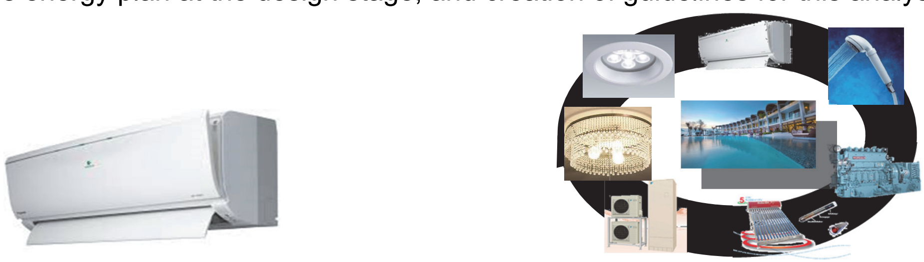
Introduction of solar heat use for water-heating equipment in bungalows, high efficiency water-heating equipment for multi-room buildings, and cogeneration (simultaneous power generation and water-heating) equipment for multi-room buildings.



(Images: utilisation of highly efficient renewable energy at hotel bungalow)

2) Hotels (air-conditioning, comprehensive)

Introduction of high performance air-conditioners, analysis and improvement of the overall facility’s energy plan at the design stage, and creation of guidelines for this analysis.



(Images: high efficiency air-conditioning equipment, analysis and improvement of energy-saving plan at hotel design stage)

3) Business-use four-wheeled vehicle

Introduction of electric buses and hybrid buses

4) Towns and industrial parks

Formulation of guidelines for efficient energy use at new towns and industrial parks

(3) Water and waste

Establish guidelines for the introduction of effective utilisation of water and water-saving facilities. Establish guidelines for the separation, recycling, re-use and volume reduction of waste. Implement utilisation of raw waste and waste generated from food processing as compost or biomass.

(4) Renewable energies

・Create a system not dependent on mainland energy as much as possible by utilising sunlight and wind.

(Images: utilisation of renewable energies such as wind and sunlight)

Aim for a future 30 to 50% reduction in GHGs compared to BaU based on the combination of the above measures.

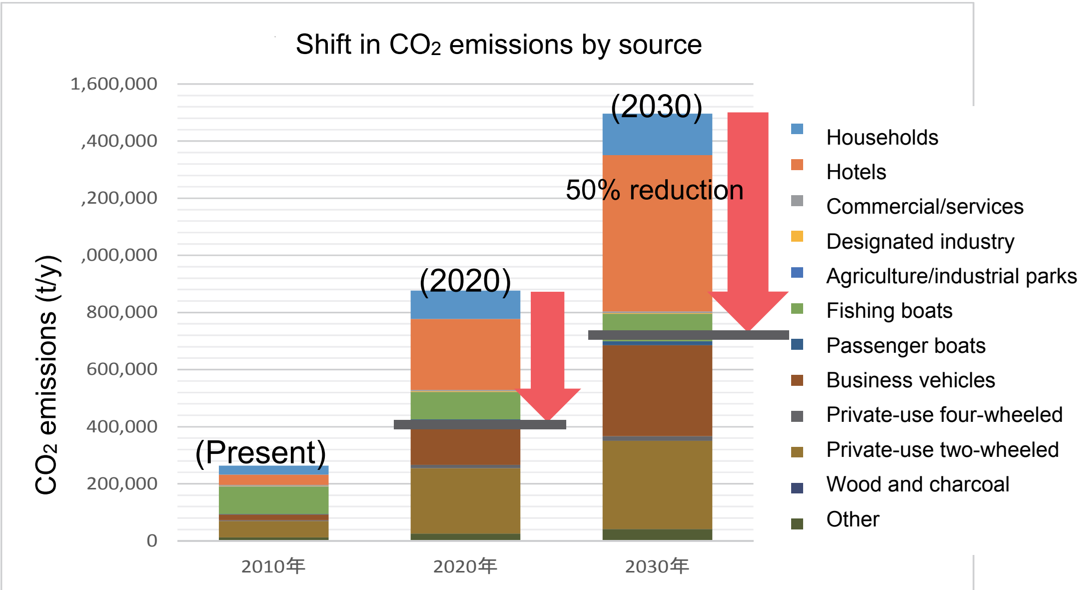


Figure 5.4.1 Concept for GHG emission reduction compared to BaU due to various

Chapter 6. MRV Methodology (draft) and Preparation of PDD (draft)

6.1 MRV Methodology (draft)

6.1.1 Water infrastructure

(1) Methodology title

"Installation of equipment in sewage treatment facility to utilise sewage sludge digester gas"

(2) Definition of terminology

Terminology	Definition
Sewage sludge digester gas	Digester gas with methane as its main component generated by anaerobic digestion (methane fermentation) of condensed sludge including organic matter generated in the sewage treatment process.

(3) Overview of methodology

1) Means of GHG reduction

First, the organic matter contained in sludge from the sewage treatment process is reduced to methane (anaerobic treatment) by a reactor maintained in a low-carbon state. The methane is then recovered and effectively utilised as energy. Emissions of methane gas from sludge are controlled.

2) Calculation method of baseline emissions

- The baseline emissions are the methane emissions that occur when sludge is disposed at an SWDS as is, without carrying out intermediate treatment such as digester gas power generation.
- Emissions due to electricity consumption in the baseline scenario are added to the baseline emissions.
- When power generation based on using energy from recovered methane is involved, emissions that would occur assuming that electricity was generated by standard methods in the said country, are added to the baseline emissions.

3) Basic theory on project emissions

- Project emissions are emissions of methane generated from sludge that was not reduced to methane in an intermediate treatment stage such as digester gas power generation, and was disposed at an SWDS as is.
- Emissions due to the electricity consumption of project activities are added to

project emissions.

4) MRV methodologies used as reference

CDM	Approved baseline and monitoring methodology AM0080 "Mitigation of greenhouse gases emissions with treatment of waste water in aerobic waste water treatment plants" (Version 01)
CDM	Methodological Tool "Emissions from solid waste disposal sites" (Version 06.0.1)
J-MRV	Guidelines for Measurement, Reporting and Verification of GHG Emission Reductions in Japan Bank for International Cooperation (JBIC) Global Action for Reconciling Economic Growth and Environmental Preservation (GREEN) operations

(4) Conditions for eligibility

This methodology can be applied to projects that meet all of the following conditions.

Condition 1: Equipment to utilise sewage sludge digester gas in a sewage treatment facility is installed.

Condition 2: Electricity generated based on using energy from recovered methane is substituted for electricity from grid electricity.

Condition 3: The sewage treatment facility is based on the investigation content of the "Preparatory Survey on Water Infrastructure Development Project on Phú Quốc Island, Kiên Giang Province, Vietnam (2013)"

(5) Emissions sources and types of GHGs

1) Baseline emissions

Emission source	GHG type
Emissions from sludge that is disposed at an SWDS without capture of landfill gas	CH_4
Emissions due to electricity consumption in the baseline scenario	CO_2
The emissions that would result assuming the volume of power generation displaced by project activities was generated by standard methods in the said country	CO_2

2) Project emissions

Emission source	GHG type
Emissions of methane generated from sludge that was not reduced to methane by an intermediate treatment stage such as digester gas power generation, and was disposed at an SWDS as is.	CH_4
Emissions due to the electricity consumption of project activities	CO_2

(6) Configuration of baseline emissions and calculations

Baseline emissions can be calculated following the formula below.

$$BE_y = BE_{CH4,SWDS,y} + BE_{EL,y}$$

Parameter	SI unit	Details
BE_y	tCO_2e/yr	Baseline emissions in year *y*
$BE_{CH4,SWDS,y}$	tCO_2e/yr	Baseline methane emissions occurring in year y generated from waste disposal at a SWDS during a time period ending in year *y* (where *y* is a period of 12 consecutive months)
$BE_{EL,y}$	tCO_2/yr	CO2 emissions associated with electricity generation that is displaced by the project activity and/or electricity consumption in the baseline scenario in year *y*

Here, $BE_{CH4,SWDS,y}$ can be calculated following the formula below.

$$BE_{CH4,SWDS,y} = \varphi_y \cdot (1 - fy) \cdot GWP_{CH4} \cdot (1 - OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum_{j} W_{BL,j,x} \cdot DOCj \cdot e^{-k_j \cdot (y-x)} \cdot (1 - e^{-k_j})$$

Parameter	SI unit	Details
x	-	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*)

Parameter	SI unit	Details
y	-	Year of the crediting period for which methane emissions are calculated (y is a consecutive period of 12 months)
φ_y	-	Model correction factor to account for model uncertainties for year y
f_y	-	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y
GWP_{CH4}	-	Global Warning Potential of methane
OX	-	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	-	Fraction of methane in the SWDS gas (volume fraction) Fraction of methane in the SWDS gas
$DOC_{f,y}$	-	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year y (weight fraction)
MCF_y	-	Methane correction factor for year y
DOC_j	-	Fraction of degradable organic carbon in the waste type j (weight fraction)
$W_{BL,j,x}$	t/yr	Amount of solid waste type j disposed or prevented from disposal in the SWDS in the baseline scenario in the year x
k_j	1/yr	Decay rate for the waste type j
j	-	Type of residual waste or types of waste in the MSW

Likewise, $BE_{EL,y}$ can be calculated following the formula below.

$$BE_{EL,y} = (EC_{BL,y} + EG_{PJ,y}) \cdot EF_{BL,EL,y}$$

Parameter	SI unit	Details
$EC_{BL,y}$	MWh	Annual quantity of electricity that would be consumed in the baseline scenario for the treatment of sludge

$EG_{PJ,y}$	MWh	Net quantity of electricity generated in year *y* with biogas from the new anaerobic biodigester
$EF_{BL,EL,y}$	tCO_2/MWh	Emission factor for electricity generated and/or consumed in the baseline scenario in year *y*
y	-	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)

(7) Computation of project emissions

Project emissions can be calculated following the formula below.

$$PE_y = PE_{CH4,SWDS,y} + PE_{EC,y}$$

Parameter	SI unit	Details
PE_y	tCO_2e/yr	Project emissions in year *y*
$PE_{CH4,SWDS,y}$	tCO_2e/yr	Methane emissions occurring in year *y* generated from waste disposal at a SWDS during a time period ending in year *y* (where *y* is a period of 12 consecutive months)
$PE_{EC,y}$	tCO_2/yr	Project emissions associated with electricity consumption in year *y* (where *y* is a period of 12 consecutive months)

Here, $PE_{CH4,SWDS,y}$ can be calculated following the formula below.

$$PE_{CH4,SWDS,y} = \varphi_y \cdot (1 - fy) \cdot GWP_{CH4} \cdot (1 - OX) \cdot \frac{16}{12} \cdot F \cdot DOC_{f,y} \cdot MCF_y \cdot \sum_{x=1}^{y} \sum_{j} W_{PJ,j,x} \cdot DOCj \cdot e^{-k_j \cdot (y-x)} \cdot (1 - e^{-k_j})$$

Parameter	SI unit	Details
x	-	Years in the time period in which waste is disposed at the SWDS, extending from the first year in the time period (*x* = 1) to year *y* (*x* = *y*)
y	-	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)

φ_y	-	Model correction factor to account for model uncertainties for year *y*
f_y	-	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year *y*
GWP_{CH4}	-	Global Warning Potential of methane
OX	-	Oxidation factor (reflecting the amount of methane from SWDS that is oxidized in the soil or other material covering the waste)
F	-	Fraction of methane in the SWDS gas (volume fraction)
$DOC_{f,y}$	-	Fraction of degradable organic carbon (DOC) that decomposes under the specific conditions occurring in the SWDS for year *y* (weight fraction)
MCF_y	-	Methane correction factor for year *y*
DOC_j	-	Fraction of degradable organic carbon in the waste type *j* (weight fraction)
$W_{PJ,j,x}$	t/yr	Amount of solid waste type *j* disposed or prevented from disposal in the SWDS in the project activity in the year *x*
k_j	1/yr	Decay rate for the waste type *j*
j	-	Type of residual waste or types of waste in the MSW

Likewise, $PE_{EC,y}$ can be calculated following the formula below.

$$PE_{EC,y} = EC_{PJ,y} \cdot EF_{PJ,EL,y}$$

Parameter	SI unit	Details
$EC_{PJ,y}$	MWh	Annual quantity of electricity that would be consumed in the project activity for the treatment of sludge
$EF_{PJ,EL,y}$	tCO_2/MWh	Emission factor for electricity generated and/or consumed in the project activity in year *y*
y	-	Year of the crediting period for which methane emissions are calculated (*y* is a consecutive period of 12 months)

(8) Linkages

As long as no marked impacts are found, linkages shall be not be taken into account.

(9) Computation of GHG emission reduction

GHG emission reduction can be calculated following the formula below.

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

Parameter	SI unit	Details
$ER_{y,estimated}$	tCO2e/yr	Estimated emission reduction in year *y*
BE_y	tCO2e/yr	Baseline emissions in year *y*
PE_y	tCO2e/yr	Project emissions in year *y*

(10) Data and parameters as fixed values

For (6) and (7) above, data and parameters that are fixed in advance, and their sources, as are follows.

Parameter	SI unit	Details
x	-	Specific year in the crediting period (1*y*-)
y	-	Crediting period
φ_y	-	Correction factor ➢ Default value (0.75: IPCC Guidelines)
f_y	-	Fraction of methane captured at the SWDS that prevents the emissions of methane to the atmosphere in year *y* ➢ Default value (0: diffusion of whole amount into the atmosphere)
GWP_{CH4}	-	Global warming potential of methane ➢ Default value (21: IPCC Guidelines)
OX	-	Oxidation factor (fraction of methane oxidized on the surface of the SWDS) ➢ Default value (0.1: IPCC Guidelines)
F	-	Fraction of methane in the SWDS gas ➢ Default value (0.5: IPCC Guidelines)

Parameter	SI unit	Details
$DOC_{f,y}$	-	Fraction of degradable organic carbon decomposed under specific conditions in the SWDS for year *y* ➢ Default value (0.5: IPCC Guidelines)
MCF_y	-	Methane correction factor for year *y* ➢ Default value (0.8: IPCC Guidelines)
DOC_j	-	Weight fraction of degradable organic carbon in waste *j* ➢ Default value (IPCC Guidelines) Sludge from households: 0.05 (based on wet sludge, estimate of default value 10% for dried matter content), sludge from industry: 0.09 (based on wet sludge, estimate of default value 35% for dried matter content)
$W_{BL,j,x}$	t/yr	Volume of waste *j* in the baseline scenario in year *x* ➢ Estimated value based on F/S, etc. (calculated value)
k_j	1/yr	Decay rate for waste *j* ➢ Default value (0.4: IPCC Guidelines)
$EC_{BL,y}$	MWh	Electricity consumption in the baseline scenario in year *y* ➢ Estimated value based on F/S, etc. (calculated value)
$EF_{BL,EL,y}$	tCO_2/MWh	Emission factor for grid electricity ➢ Default value (0.5408: Ministry of Natural Resources and Environment, Vietnam, December 2011)
$EF_{PJ,EL,y}$	tCO_2/MWh	Emission factor for grid electricity ➢ Default value (0.5408: Ministry of Natural Resources and Environment, Vietnam, December 2011)

(11) Data and parameters to be monitored

For (6) and (7) above, data and parameters that require monitoring for computation of GHG emission reduction, as are follows.

Parameter	SI unit	Details
$EG_{PJ,y}$	MWh	Electricity generated from captured methane in project activities in year *y* ➢ Measured value from electricity meter, record of electricity buying and selling
$W_{PJ,j,x}$	t/yr	Volume of waste *j* of project activities in year *x* ➢ Measured value from truck scale
$EC_{PJ,y}$	MWh	Electricity consumption of project activities in year *y* ➢ Measured value from electricity meter

(12) Monitoring plan and monitoring report

	エネルギーの種類	値	単位	ﾊﾟﾗﾒｰﾀｰ	出所
1. 排出削減量の算定結果					
排出削減量			tCO_2e/yr	$ER_{y,estimated}$	BE_y-PE_y
2. 選択されたﾃﾞﾌｫﾙﾄ値等					
補正係数		0.75	-	φ_y	IPCCｶﾞｲﾄﾞﾗｲﾝ
大気中にﾒﾀﾝを放散するのを防ぐため、埋立処分場で回収されたﾒﾀﾝの割合		0	-	f_y	IPCCｶﾞｲﾄﾞﾗｲﾝ
ﾒﾀﾝの地球温暖化係数		21	-	GWP_{CH4}	IPCCｶﾞｲﾄﾞﾗｲﾝ
酸化係数（埋立処分場の表層で酸化するﾒﾀﾝの割合）		0.1	-	OX	IPCCｶﾞｲﾄﾞﾗｲﾝ
ｶﾞｽ中のﾒﾀﾝｶﾞｽの割合		0.5	-	F	IPCCｶﾞｲﾄﾞﾗｲﾝ
埋立処分場において特定条件下で分解する分解性有機体炭素の割合		0.5	-	$DOC_{f,y}$	IPCCｶﾞｲﾄﾞﾗｲﾝ
ﾒﾀﾝ変換係数		0.8	-	MCF_y	IPCCｶﾞｲﾄﾞﾗｲﾝ
廃棄物中（下水汚泥中）の分解性有機体炭素の重量比		0.074	-	DOC_j	IPCCｶﾞｲﾄﾞﾗｲﾝ
廃棄物中（下水汚泥中）の腐敗係数		0.4	1/yr	k_j	IPCCｶﾞｲﾄﾞﾗｲﾝ
ﾍﾞｰｽﾗｲﾝｼﾅﾘｵにおけるｸﾞﾘｯﾄﾞ電力排出係数		0.5408	tCO_2/MWh	$EF_{BL,EL,y}$	ﾍﾞﾄﾅﾑ天然資源環境省(2011年12月)
ﾌﾟﾛｼﾞｪｸﾄ活動におけるｸﾞﾘｯﾄﾞ電力排出係数		0.5408	tCO_2/MWh	$EF_{PJ,EL,y}$	ﾍﾞﾄﾅﾑ天然資源環境省(2011年12月)
3. ﾍﾞｰｽﾗｲﾝ排出量の算定結果					
ﾍﾞｰｽﾗｲﾝ排出量			tCO_2e/yr	BE_y	$BE_{CH4,SWDS,y}$+$BE_{EL,y}$
埋立処分場へ廃棄された汚泥からの排出量			tCO_2e/yr	$BE_{CH4,SWDS,y}$	年平均値(操業開始後15年)を採用
ﾍﾞｰｽﾗｲﾝｼﾅﾘｵによる埋立処分場に廃棄される汚泥量			t/yr	$W_{BL,j,x}$	
ﾍﾞｰｽﾗｲﾝｼﾅﾘｵの電力消費/ﾌﾟﾛｼﾞｪｸﾄ活動により代替される発電により発生する排出量		0	tCO_2/yr	$BE_{EL,y}$	
ﾍﾞｰｽﾗｲﾝｼﾅﾘｵによる電力消費量	電力		MWh/yr	$EC_{BL,y}$	
ﾌﾟﾛｼﾞｪｸﾄ活動により代替される発電量	電力		MWh/yr	$EG_{PJ,y}$	
4. ﾌﾟﾛｼﾞｪｸﾄ排出量の算定結果					
ﾌﾟﾛｼﾞｪｸﾄ排出量			tCO_2e/yr	PE_y	$PE_{CH4,SWDS,y}$+$PE_{EC,y}$
埋立処分場へ廃棄された汚泥からの排出量			tCO_2e/yr	$PE_{CH4,SWDS,y}$	年平均値(操業開始後15年)を採用
ﾌﾟﾛｼﾞｪｸﾄ活動による埋立処分場に廃棄される汚泥量			t/yr	$W_{BL,j,x}$	
ﾌﾟﾛｼﾞｪｸﾄ活動の電力消費により発生する排出量			tCO_2/yr	$PE_{EC,y}$	
ﾌﾟﾛｼﾞｪｸﾄ活動による電力消費量	電力		MWh/yr	$EC_{PJ,y}$	

Chapter 7. Future Issues

This study examined proposals for the introduction of low carbon advanced Japanese technologies on Phu Quoc Island. Future issues are addressed in section 7.1 regarding the feasibility study on water and sewerage works in the water infrastructure sector, and in section 7.2 regarding the study on potential introduction of an incineration power generation facility in the waste sector. Furthermore, section 7.3 covers foundational research on technologies for transportation systems, harbour facilities and watercraft, production facilities and urban facilities for which needs on Phu Quoc Island were discovered in this study. Finally, section 7.4 covers low carbon guidelines.

7.1 Water and sewage works sector (FS)

Issues related to waterworks in the development plan for Phu Quoc Island include expansion of water supply areas based on new community development on the island and increase in water supply volume based on increase in the island's population serviced by water supply. However, there are few elements of carbon reduction in the new establishment or expansion of water treatment plants, nor in the new laying of water supply pipelines. Options include use of energy-saving type pumps for those installed at treatment plants and pump stations that consume a relatively large amount of energy, revision of the entire water supply plan, and optimisation of operation control. However, the absolute amount of carbon reduction that can be obtained by these options is not very large.

Meanwhile, the issue for sewerage works is the construction of sewerage facilities. Similar to waterworks, conventional construction of sewerage facilities does not contain many elements of carbon reduction. However, energy utilisation of digester gas generated in the sewage treatment process can be assessed as carbon reduction. Thus, the GHG emission reduction of this option was examined. As a result, a GHG reduction amount of 216 tons was found for the gas power generation technology using sewage sludge digester gas proposed in this study. Unfortunately, a comparison of the economic efficiency of introduction revealed the depreciation cost of construction of the digestion facility to be higher than the benefit of effective utilisation of digester gas (gas power generation). A result of an annual 25 million JPY was obtained, revealing the lack of feasibility of this proposal.

However, this proposal is also a co-benefit technology that if introduced for sewerage works would lead to reduced waste based on decreased wastewater treatment and sewage sludge volume. If an improved proposal were to be made on Phu Quoc, aiming to be an Eco Island, and if economic and technological feasibility were improved, it would contribute to the realisation of the Green Growth Strategy spearheaded by the national government and could be expected to lead to the improved image of this island as one of the country's tourism centres. Further, the "Manual on Prefectural Concept for Outfitting of Efficient

Sewage Treatment Facilities (draft)" of the Ministry of Land, Infrastructure, Transport and Tourism of Japan could provide a reference for a variety of sewage treatment plans including sewerage works plan. The advancement of dialogue within the Kobe City partnership is conceivable to contribute to the formulation of a plan suitable for Kien Giang Province.

7.2 Waste sector (study on potential for introduction)

Concerning issues involved in the study on potential introduction of an incineration power generation facility, elaboration on the following eight issues is put forth from the perspective of project feasibility related to the stage prior to discussion of low carbon effects.

(1) Waste treatment volume While the volume of waste is on an increasing trend, it is unclear whether this shift will continue as predicted. In order to bring about a certain level of feasibility to the project, a treatment volume of 500 tons/day is postulated. However, at present the proposal lacks profitability as not even 100 tons/day are collected, making the project unrealistic.

(2) Waste treatment tipping fee Similar to waste volume, a tipping fee of 25-30 dollars per ton must be aimed for to ensure a certain level of project feasibility and a stable enterprise.

(3) Waste collection The waste on Phu Quoc Island is collected by URENCO. The conclusion of a long-term (20-year) treatment consignment contract with DONRE is required for stable project operation following the alteration of collection routes.

(4) Analysis of waste quality Waste is surmised to contain a high ratio of raw waste and be low calorie. Allowances for co-incineration of high calorie waste and construction of drying facilities could potentially be required.

(5) Plant site Local surveys on the plant site, including geological surveys, water quality surveys and investigation of impacts on surrounding private households, will be required. Depending on the state of the land, separate responses would be required.

(6) Plant construction Henceforth confirmation of plant construction costs, including local construction costs, is required.

(7) Partners This study is premised on provision of 50% of construction costs by JCM related facility aid of the Ministry of the Environment of Japan. However, in addition to this, the existence of a Japanese enterprise or funding partner is advisable for implementation of the project. The existence of a powerful local partner is indispensable to the smooth operation of the project.

(8) Authorisation In order to realise the project, frequent contact must be made with Phu Quoc Investment Management & Development Authority to receive authorisation.

Aside from the above explanation of waste related issues, there are numerous existing technologies that could be employed for the waste on Phu Quoc Island, predicted to increase in the future, to be appropriately treated, including soft support based on the Kobe and Kien Giang partnership and not limited to advanced Japanese technologies. Kien Giang Province has shown a long-standing interest in the water infrastructure sector and waste treatment, and at present carries out human resource development related to improved water environment via JICA grassroots support. Further, the city of Kobe possesses many years of accumulated knowhow on the appropriate discharge, separation and treatment of waste. If necessary, cooperation is conceivable in the creation of guidelines for separate collection of waste on Phu Quoc Island. The results of an examination of the applicability of Japan's public cooperation schemes (ODA, JCM) are shown in Table 7.2.1 below.

Table 7.2.1 Results of feasibility studies on water and sewerage works and introductions the waste sector

Target	**Example of applicable technology**	**Project scale (ODA and JCM)**	**Initial cost (mil. JPY)**	**Potential for public cooperation**	**Issues**
Water-works	Establishment of facility	Water supply target areas	—	ODA/loans	Bid for ODA and research on promotion
Sewerage works	Establishment of facility	Sewage removal areas	-	ODA/loans	Bid for ODA and research on promotion
	Island-wide plan for optimisation of sewage treatment	Island-wide	20	ODA Grassroots	Waste water treatment and management in urban areas and for remote hotels is important.
	Digester gas power generation	Sewage treatment facility	530	JCM→×	(For the present, there is no prospect for implementation of a sewerage works project.)
Waste	Waste power generation	89t of waste	7,000	JCM→×	(Volume of waste in not large enough to obtain economic efficiency.)

7.3 Other sectors (Foundational research: transportation system, port/harbour facilities and watercraft, production facilities, urban facilities)

Technologies were discovered via this study that are considered to address needs on Phu Quoc Island for the transportation system, port/harbour facilities and watercraft, production facilities and urban facilities sectors. However, feasibility studies are yet to be carried out. Henceforth, detailed research utilising another scheme is required for portions that can be developed as JCM. In dialogue with the government of Kien Giang Province, the Province has expressed its interest. However, a response was received noting that future examination is required on financial responsibility outside of facility aid and recommendation of a counterpart company.

Based on examination of potential introduction of electric buses and motorbikes related to the transportation system, initial cost and operation cost were found to be high compared to those of diesel buses and gasoline motorbikes. The cause for this in both cases is the high price and short life of the batteries. These obstacles must be overcome if these vehicles are to be put into widespread use.

Meanwhile, the merits of the electric bus and electric motorbike lie not only in their contribution to CO_2 reduction. Because they have zero exhaust and are low-noise emitting, they contribute to improved air environment and lives of citizens. Above all, they are of great worth for introduction on Phu Quoc with its predicted drastic increases in island population and tourists. Further, environmentally-friendly vehicles could become an appealing activity for tourists, improving the image of the island and leading to development of the tourism industry.

For the port and harbour sector, a project on replacement of lighting facilities at Phu Quoc's largest harbour with LED lights, as well as a project on FRP conversion and energy-saving engines for wooden fishing boats that consume a great amount of light oil, were conceived. Results of examination on switching to LED for harbour lights revealed the CO_2 reduction to be small due to the small scale of the project targeting about 40 existing lights. For FRP conversion and energy efficient engines for wooden fishing boats, return on initial costs based on reduced fuel cost was found to be problematic due to a low fuel reduction effect in relation to high initial costs.

It is surmised that if harbour facilities are outfitted as planned and the volume of cargo handled increases according to predictions for the future, the application of Japanese technologies can be increased including not only lighting, but also optimisation of distribution and energy-saving loading facilities such as cranes. As for fishing boats, if future rising demand for seafood due to increased island population and tourists and an expanded market, were to lead to a rise in the income of persons engaged in fisheries, there is potential for increased need for FRP conversion and energy-saving engines.

For the production facility sector, an examination was carried out on introduction of Japanese energy-saving technology targeted at ice factories with heavy energy consumption on the island. If the actual level of potential energy saving is to be examined, a study on the cause of energy loss must be conducted, including measurement of the operating state of local facilities (e.g. compressor discharge temperature, COP). However, when compared with similar scale ice factories in Japan, it is estimated that an approximate 35% energy saving is possible with the upgrading of the cooling tower and machinery including the compressor, as well as improvements to surrounding facilities. There are 10 major ice factories on the island of Phu Quoc, making it possible to realise a certain scale of greenhouse gas reduction island-wide based on introduction of Japanese technologies. The demand for ice from hotels and restaurants is predicted to increase in the future. Above and beyond this, there are numerous ice factories on the Vietnam mainland, and the potential for energy saving in the ice-making and refrigeration industry is thought to be extremely high.

Foundational research on technology for urban facilities was carried out for lighting, air-conditioning and hot water supply at hotels and bungalows.

For lighting, conceivable options are replacement of downlights with LED bulbs and replacement of straight-tube fluorescent lights (T-8) with high efficiency T-5 (inverter-type) or LED. However, cheap LED are produced locally and in neighboring countries, making the overall price difference of Japanese product over double. Thus, diffusion of Japan-made products and technologies utilising the JCM scheme is considered problematic. However, from the perspective of LCA, there is ample scope for diffusion of Japanese manufactured product. Because Phu Quoc Island has designated tourism as a major industry, future increase in energy demand will greatly impact the island's energy supply in the urban facilities sector. While not a target for JCM subsidies, more soft forms of support, such as utilisation of BEMS, should be examined.

For air-conditioning equipment in hotel bungalows, at present room air-conditioners are mainstream, with the products of multiple Japanese manufacturers already widely used and relatively new inverter-equipped models of other country manufacturers adopted. An issue for the future is a detailed survey on performance comparison, such as COP, that could confirm the superior points of Japan-made product and the will of the advancing manufacturer on JCM application. Further, room air-conditioners are also mainstream for the air-conditioning facilities of large-scale multi-room buildings due to the resort style of hotels on the island. Thus, issues are the same as those for bungalows.

Subsequently, concerning water heating equipment in hotel bungalows, the combination of a vacuum type solar water heater that would utilise the plentiful solar heat of the area, with an electric water heater is considered ideal. In contrast, individual use of locally-made equipment is spreading. This issue is considered to be one on which cooperation should be carried out toward implementing green measures on the island. This includes confirmation of effect based on simulation of annual energy use, as well as continued information provision from Japan within the framework of local government partnerships.

For the large-scale multi-room buildings of hotels, heat pump water-heating equipment and the diesel cogeneration of Japan are conceivable alternatives to fuel oil burning boilers. For the heat pump type, the quantity of heat that can be obtained exceeds the energy input. Further, for cogeneration, if site-specific private power generation facilities are introduced, they can be used as cogeneration for water-heating and power generation. In this way, economic effects can be expected. If introduction of this equipment is to be made, quantitative assessment based on a detailed simulation that takes into account the electricity rate system in Vietnam based on time and days of use, as well as the scale and planned operation rate and annual climatic conditions of the hotel where the introduction will actually be made, is an issue.

At present, research and selection of a local enterprise suited to the JCM schedule to carry out an applicable project in the JCM scheme, is an issue within the People's Committee of Kien Giang Province. If a promising hotel enterprise were to emerge in the future, implementation of a detailed feasibility study on Japanese technology and products targeted at the hotel operation plan and design plan, would become an issue.

Further, procurement of financing would fundamentally be carried out by the hotel enterprise, but for large-scale expenditures for facility introduction, there is the potential to consider JBIC export financing. The results of an examination of the applicability of Japan's public cooperation schemes (ODA, JCM) for the targets of this foundational research are shown in Table 7.3.1 below.

Table 7.3.1 Results of examination on foundational research

Target	Example of applicable technology	Project scale (ODA and JCM)	Initial cost (mil. JPY)	Potential for public cooperation	Issues in public cooperation
Transportation	Electric bus	Use for airport transportation and hotels (Ex: total 2 vehicles)	120	JCM→FS	Enterprise that will introduce bus within 1 to 2 years
	Electric	Rental at	9.0	JCM→FS	Hotel, etc., that

	motorbike	hotels (Ex: 20 vehicles)			will introduce within 1 to 2 years
Ports/harbours and watercraft	Fishing boat improvements	Hull and engine replacement (Ex: 60 vessels per unit)	2,850	JCM× →ODA, etc.	(Presumed to have low business profitability)
Production facilities	Ice factory improvements	1 factory	30	JCM→FS	Enterprise that will upgrade facilities within 1 to 2 years
Urban facilities (hotel)	Solar water heater and auxiliary electric water heater	Hotel bungalows (Ex: 50 buildings)	3.25	Information provision on efficient utilisation of local product	(Local product is already common）
	Heat pump water heater	Hotel multi-room buildings (Ex: 200 rooms)	10.4	JCM→FS	Is there a hotel with groundbreaking planned within 1 to 2 years? Detailed analysis on efficiency and economic efficiency
	Cogeneration	Same as above (Ex: 200 rooms)	50	JCM→FS	Same as above
	High efficiency air-conditioner	Hotel (Ex: 200 rooms)	30 - 40	Requires additional survey for JCM, FS, etc.	Detailed study on capacity difference between Japan-made and foreign-made
	Energy plan audit	Hotel (Ex: 200 rooms)	20	—	(Not a target of JCM, ODA)
Renewable energies	Sunlight, wind	Variety of scales	By scale	JCM problematic →ODA, etc.	(Electricity rates are cheap. Foreign-made are dominating the market.)

7.4 Low carbon guidelines

Low carbon guidelines cover a broad range of issues, from urban planning methods to the energy efficiency of facilities in the private sector. For proposals such as these, many resources are available among materials released by agencies of the Japanese government or local authorities. From Kobe City as well, experience on systemisation shown in Kobe City's "Smart City Planning" could provide a reference for Phu Quoc and be utilised in the preparation of guidelines.

This study organised the various problems and issues expected to arise due to future increase in population and tourists, and with this report, is shared between the research group and Kien Giang Province. Of all the issues that arose, those on the economic side were major. Further, considering growth in population and numbers of tourists at the present time, a cost-benefit effect was not obtained, thus not leading to immediate project formation. Nevertheless, it is hoped that from the perspective of environmental preservation and prevention of pollution, this research will become a foothold for future measures as a soft form of support related to transportation problems predicted for the future as well as reduction of energy use.

SCHEDULE
The signing Ceremony of Cooperation Agreement
between Kien Giang province, Vietnam and Kobe city, Japan
(From 29 - 30/07/2014)

Time	Activities	Implementation Agencies
July 29th 2014		
10:55	Delegation's arrival.	Representatives of Foreign Affairs Department and People's Committee of Phu Quoc district.
14:00	Meeting Kobe city's representative to exchange the preparation works for Ceremony.	Foreign Affairs Department, Department of Resources and Environment.
July 30th 2014		
07:15	Welcoming.	Office Manager of Kien Giang Provincial People's Committee, Foreign Affairs Department.
07:30	Introducing the working program and host the Ceremony.	Office Manager of Kien Giang Provincial People's Committee
07:35	Introducing Kien Giang province's Delegation.	Office Manager of Kien Giang Provincial People's Committee
07:40	Introducing Kobe's Delegation	Kobe city's representative
07:45	Delivery speech made by Vice Chairman of Kien Giang Provincial People's Committee.	
07:55	Delivery speech made by Deputy Mayor of Kobe city's Hall.	
08:05	Assessment speech about the results of the cooperative process including water supply, sewerage and wastewater treatment.	Kien Giang Water Supply Company's representative
08:15	Speech by Kobe's partner.	
08:25	Signing Ceremony	
08:35	Taking photos and giving gift.	Foreign Affairs Department
08:45-9:00	Tea break	Foreign Affairs Department and People's Committee of Phu Quoc district
11:30	Vice Chairman of Kien Giang Provincial People's Committee give a lunch reception to Kobe city's Delegation.	Office Manager of PPC, Foreign Affairs Department
18:00	Deputy Mayor of Kobe city's Hall invites Kien Giang Delegation dinner.	Kobe City

LIST OF KIEN GIANG PROVINCE’S REPRESENTATIVES ATTENDING COOPERATION SIGNING CEREMONY WITH KOBE CITY

(Phu Quoc, July 30th 2014)

Kien Giang People's Committees	
Mr. Le Khac Ghi Ms. Do Thi Le Hao Mr. Nguyen Huu Suong Mr. Vo Van Tu Mr. Duong Thanh Nha Ms. Phan Thi Hoa Tran	Deputy Chairman Deputy chief of the secretariat Head of General Economic Division Deputy Head of General Division Deputy Head of Economic Division Officer of Culture and Social Division
Department of Natural Resources and Environment	
Ms. Vo Thi Van*4 Mr. Doan Huu Thang*3 Mr. Pham Minh Lien	Deputy Director Director of Environment Protection Department Officer of Environment Protection Department
Department of Foreign Affairs	
Ms. Nguyen Duy Linh Thao*2 Mr. Thai Thien Tri	Deputy Director Deputy Head of International Cooperation Division
Department of Science and Technology	
Mr. Phung Van Thanh Mr. Nguyen Thanh Hai	Deputy Director Head of Kien Giang Biosphere Reserve Division
Phu Quoc People's Committee	
Mr. Huynh Quang Hung	Deputy Chairman
Phu Quoc Investment and Development Management	
Mr. Nguyen Thanh Tung	Deputy Head
Kien Giang Water Supply and Sewerage One-member Limited Company	
Mr. Nguyen Duc Hien Mr. Nguyen Dinh Tam	Director Deputy Director of Project Management Board

*2,3,4 の人は、別途キエンザン省連絡先の担当者

CONFERENCE AGENDA

Reporting on Feasibility survey of Eco-island Project

(Attached by the submission numbered …/TTr-SNgV dated …./01/2015 by Department of Foreign Affair)

Time: 14:00 – 16:30, 4th February 2015

Venue: Kien Giang People's Committee Office

Time	Contents	In-charge parties
14:00	- Deliver opening speech (statements of purpose), representatives introduction by Kien Giang side (5min) - Representatives introduction by Kobe mission (5min)	Foreign Affair Department Kobe representative
14:10	Agenda briefing *(5 min)*	KGPC Office
14:15	Survey report by Kobe mission *(60 min)*: - Overview of the survey -. Presentation of the eco-island idea and the survey report about energy-saving conduct in the transportation sector, sea ports and urban - Presentation of the general survey on water infrastructure (water supply and sewerage works) - Presentation of survey on solid waste treatment	Kobe mission - Mihoko Yoshida – IGES Kansai Research Center - Kenta Fujio –Nikken Sekkei Civil Engineering Co., - Manabu Hori – Kobelco Eco-Solutions Co., - Ohiraki Kenji –Kobelco Eco-Solutions Co. ,
15:15	Break *(15 min)*	
15:30	Speech by Kien Giang mission *(30 min)*: - *Mission and effort of reducing the greenhouse emission in Phu Quoc island (10min)* - *Update on the progress of the water supply and sewerage project in Phu Quoc island* - Update on the solid waste management status in Phu Quoc island and the challenges *(10 min)*	Ministry of Natural Resources and Enviornment KIWACO Phu Quoc district People's Committee
16:00	Discussion *(20 min)*	
16:20	Closing *(10 min)*	

LIST OF PARTICIPANTS FROM KIEN GIANG DELEGATION
Workshop on Report on Eco- Island feasibility studies
(February 4th, 2015 in Office of Provincial People's Committee)

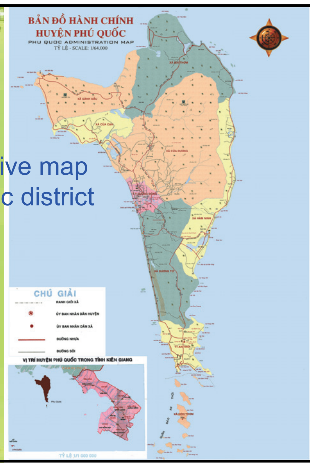
No	Full name	Position
1	HE.Mr. Mai Anh Nhin	Vice Chairman of Kien Giang provincial People's Committee
2	Mrs. Nguyen Duy Linh Thao	Deputy Director of Kien Giang Department of Foreign Affair
3	Mr. Huynh Quang Hung	Vice Chairman of People's Committee of Phu Quoc island
4	Mr. Tran Chi Vien	Deputy Director of Kien Giang Department of Natural Resources and Environment
5	Mr. Luong Quoc Binh	Deputy Director of Kien Giang Department of Industry and Trade
6	Mr. Duong Minh Tam	Deputy Director of Kien Giang Department of Science and Technology
7	Mr. Huynh Đang Khoa	Deputy Director of Board of Project Management, Kien Giang Department of Agriculture and Rural Development
8	Mr. Tran Van Nhan	Deputy Director of Kien Giang Water Supply One Member Company Ltd.
9	Mr. Đoan Huu Thang	Head of Environment Protection Division, Kien Giang Department of Natural Resources and Environment
10	Mr. Mai Minh Luan	Head of Urban Infrastructure of Kien Giang Department of Construction
11	Mr. Tang Chi Uyen	Head Office of Business Travel, Kien Giang Department of Culture, Sports and Tourism
12	Mr. Le Van Hieu	Deputy Head of Investment Office, Phu Quoc Management Board of Investment and Development
13	Mr. Duong Thanh Nha	Officer of Specializing economy of PPC

“Digital Dream Utopia”

THE REDUCTION IN GREENHOUSE GAS EMISSIONS IN PHU QUOC DISTRICT, KIEN GIANG

By MA. Thang Huu Doan
Director of Kien Giang Environmental Protection Agency

Administrative map of Phu Quoc district



A brief overview of Phu Quoc district

Phu Quoc has 10 commune-level administrative units, comprising Cua Can, Cua Duong, Ham Ninh, Duong To, Hon Thom, Bai Thom, Tho Chau, Ganh Dau, Duong Dong và An Thoi towns.

A brief overview of Phu Quoc, cont.

- In 2014, income of Trading - Tourism and Services sector is 16, 785 billion VND; Industry - Handicraft sector is 1,565 billion VND; Exploiting and feeding aquaculture is 803 billion VND.

This shows that Trading - Tourism and Services sector is the strength of Phu Quoc.

A brief overview of Phu Quoc, cont.

- The average GDP per capita in 2014 was 86.94 million VND/person/year (2,8 times higher than those in 2010 and increase of 20,47% compared to those in 2013).

-There are 144 accommodations with 3,900 rooms which can welcome 7352 visitors per day.

A brief overview of Phu Quoc, cont.

Urban solid waste (SW):

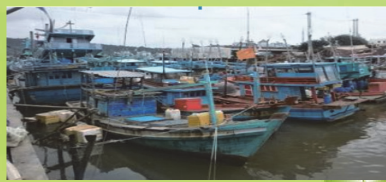
- generating 110 – 120 tonnes/day.
- collecting 75 – 80 tonnes/day.
- Treating: disposes of dumping sites which are not up to standards, causing environmental pollution.

MAJOR SOURCES OF GREENHOUSE GASES EMISSION

- Dumping sites of municipal solid waste

MAJOR SOURCES OF GHGs EMISSION, cont.

- Transportation activities; mining
- Seafood industry (fishing boat)



- The construction of large projects

MAJOR SOURCES OF GHGs EMISSION, cont.

- Air conditioning system, water heater hotel, motel, public works...
- Diesel generators
- Wastewater from restaurants, hotels is treated but has not met standard.
- Contaminated rivers and canals.

MAJOR SOURCES OF GHGs EMISSION, cont.

- Emissions of daily living

SOLUTIONS TO REDUCE GHGs

*** For existing facilities:**

- Increased investment in human resource and SW facilities, equipment to collect and handle the entire amount of waste generation in the district.

- Making plans for thoroughly dealing with environmental pollution caused by poor sanitary landfills.

SOLUTIONS TO REDUCE GHGs, cont.

*** For existing facilities (cont.):**

- Implementation of socialization policy, calling for priority investment in building 02 solid waste treatment areas associated with advanced and modern technology in Ham Ninh and Duong Cua commune, Phu Quoc.

- Accelerating the speed of infrastructure construction, especially roads Duong Dong - An Thoi; Cua - An Thoi.

SOLUTIONS TO REDUCE GHGs, cont.

* For existing facilities (cont.):

- Reviewing chain of production technology:

+ For the operated projects with the old technology, there is the chronological order and orientation to replace with the advanced and environmentally friendly technologies, and low emissions of greenhouse gases.

+ For out-of-date technology, causing environmental pollution. If it is unlikely to improve, the technology will be stopped.

SOLUTIONS TO REDUCE GHGs, cont.

* For existing facilities (cont.):

- Reviewing and developing a roadmap for using energy-saving air conditioning; vessels (particularly fishing boats) with the latest engine, lightweight body; the modern means of transportation, and low emissions of greenhouse gases.

- Increased supervision, inspection and strictly processing businesses discharging waste which is not up to standards.

SOLUTIONS TO REDUCE GHGs, cont.

* For new projects:

- prioritizing and encouraging investors to apply advanced and environmentally friendly technologies, and low emissions of greenhouse gases.

SOLUTIONS TO REDUCE GHGs, cont.

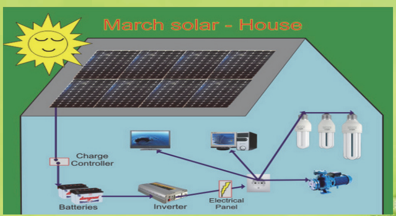
* For new projects (cont.):

Technology of new projects must be appraised. Projects with advanced and environmentally friendly technologies will be approved.

SOLUTIONS TO REDUCE GHGs, cont.

* For new projects (cont.):

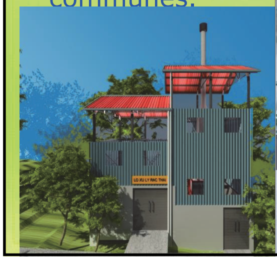
- Prioriting and encouraging researches and using biofuel, solar energy, wind energy.



SOLUTIONS TO REDUCE GHGs, cont.

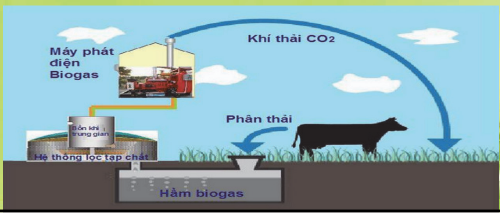
For new projects (cont.):

Accelerating the speed of implementation model of solid waste treatment by incinerators up to standards in island communes.



SOLUTIONS TO REDUCE GHGs, cont.

* Popularize technologies which treat and reuse products, residues in agricultural and aquaculture production to produce animal feed, to make raw materials for industry, biogas and organic fertilizer and to reduce GHGs emissions.



SOLUTIONS TO REDUCE GHGs, cont.

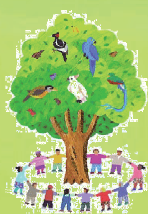
* promoting the transfer and application of advanced science and technology in production and animal husbandry, ensuring agriculture sustainable development (Global Gap model).

* Making plans to implement fire protection effectively, so there is no large-scale forest fires.

SOLUTIONS TO REDUCE GHGs, cont.

* Maintaining existing forest areas in Phu Quoc Island.
* Promoting the development of Phu Quoc forest in the period 2011 and vision to 2030 by Decision No. 633 of the Prime Minister.

Thank you for your attention



Delivery Speech by Kien Giang Water Supply One Member Company Ltd

Distinguish:

- Mr. Yusuke NAKAMURA - Japan International Cooperation (JICA);
- H.E. Mr. Mai Anh Nhin - Vice Chairman of Kien Giang provincial People's Committee;

Ladies and Gentlemen;

During last years, the comprehensive relationship between Viet Nam and Japan has been developing, especially in infrastructure investment. Project investment of Japan has been contributing significantly to socio-economy development of Vietnam in general and Kien Giang province in particular.

Within the framework of cooperative relation between Kien Giang province – Vietnam and Kobe city – Japan signed on July 8th, 2011 and extended on July 31st, 2014, Kien Giang provincial People's Committee assigned Kien Giang Water Supply One Member Company Ltd to consult and propose ideas in deploying external activities and implementing projects such as water supply, drainage and wastewater treatment project in Phu Quoc island strengthen relationship and cooperate international relations with Kobe City- Japan.

Approved by Kien Giang provincial People's Committee, Company worked with consulting unit of Kobelco Eco-Solution Company and contributed idea to the projects within cooperative framework with Kobe City implemented since 2011 to present. Up to June, 2013, final report of water supply, drainage and wastewater treatment project in Phu Quoc island was completed and submitted for approval. On April 1st, 2014, consulting unit completed the project basing on idea contribution of relevant departments and Kien Giang province officially approved project's feasibility report.

In the period of 2011-2014, Kien Giang Water supply One Member Company Ltd and Kobe City co-operated to implement feasibility report: water supply, drainage and wastewater treatment project in Phu Quoc in water and environmental sectors. Implementation situation and result of each cooperative project assessed as follow:

Project had implemented the first step of research and created the important premise to deploy next steps, that is the completion of feasibility report in which it determines total investment cost (approximately 6,800 billion Viet Nam Dong) and the unit is responsible for the investment of sub-projects under both components of water supply, drainage and wastewater treatment project; providing the project's feasibility. In particularly, water price is based on current regulation price and determine the object to charge for wastewater treatment; determine the duration progress to invest and build the project.

Following the cooperation of both sides, the project has been detailed and invested water supply component: Department of Agriculture and Rural Development and Kobelco Eco-Solutions Company have established relevant file for deploying: the water supply project in Phu Quoc island is a part of the water supply, drainage and wastewater treatment project in Phu Quoc island. So far, the project is in the process of negotiation, exchange and agreement on some problems such as the consumption of clean water output, investment capital of raw water reservoir, whole-sale price of clean water, commitment with investors, etc…

Furthermore, company is deploying the water supply project in Phu Quoc district which is part of the Vietnam water supply and urban wastewater, project loaned by World Bank with preferential interest (Treaty No.4948-VN). The project target is to raise the current capacity of clean water supply in Duong Dong from 5,000m^3/ day-night to 16,500m^3/day-night with total investment capital of 296.73 billion VND (approximately 14.35 million USD), in which World Bank loan is 220.19 billion, accounting for 74 % (about 10.65 million USD). The corresponding capital of Company is 76.54 billion VND (26%). The duration is from 2011 to 2016.

Project goal is to improve living condition, provide safe tap-water source to meet the water demand up to 2020 of Duong Dong town, An Thoi town, urban centers, Duong To commune, residential areas toward Cua Can, providing favorable conditions for Phu Quoc island to be one of tourism centers in region and international.

There are five packages of construction in this project. They are deployed and constructed the project's progress obtains 60%, the packages are estimated to complete in June, 2015.

Distinguish guests!

Besides the advantages, development and cooperation opportunities, there also have many challenges during the project implementation process:

- The project need huge capital to invest raw water reservoirs, this problem is required to discuss in detail in the coming time.
- Policy mechanism for the project as well as coordinating regulation between Private- Public sides will apply to implement them in the coming time.
- Their negotiating procedure is implemented in form of BOT with foreign investors (100% foreign capital from private company).
- Process, procedure to a project in form of PPP (Public- Private) still complicates.

Lady and Gentlemen!

I In the period of 2011-2014, with the concern and support from Kien Giang provincial People's Committee, Departments of Kien Giang province and Kobe City. The cooperative relation of water and environmental sectors of Company and Kobe City has significantly obtained achievement. Water supply project in Phu Quoc island, has been proposed, deployed and achieved some good results. To maintain the development of cooperative activities between Company and Kobe Company in the coming time, we would like to jointly coordinate, exchange and share experience in water and environmental sectors in region and over the world cooperated between Kobe City and Kien Giang province in the coming time.

Kien Giang province highly appreciates and kindly thanks Japan Government, Japanese and Japan International Cooperation Agency (JICA) for cooperating and granting ODA project and technical assistance project for Kien Giang province; Kien Giang province will manage and use Japan ODA loan efficiently for development target, also exploit efficiently the projects of water, improving environmental sanitation sponsored by JICA.

Wish successful workshop and wish distinguish guests healthy!

(3)

REPORT
Challenges and the situation of implementation progress of waste treatment on Phu Quoc island

1. The environmental status of Phu Quoc island

Phu Quoc is an island district covering an area of 589 square kilometres along with 36 big and small islands. The island has abundant natural resources, diverse ecosystem, potential for tourism development and a strategic position in trading with neighboring countries and coastal areas. Therefore, Phu Quoc is to make the most of the advantages and mobilize resources to become an island district with economy basing on orientation of low-carbon growth.

Tourism, agriculture and transportation activities are considered as one of the sources generating waste. Currently, however, waste from households and manufacturing activities untreated radically are the main cause of the generation of waste. Most of wastewater does not get the standard rules although it is not treated or pre-treated. In fact, the waste collection and treatment by burning, burying have made a serious impact on the environment of the island. As to Phu Quoc district, the issue of waste treatment is a major challenge in the global efforts to reduce greenhouse gas, to pursue low-carbon orientation.

Over the last year, the local authority continues to implement the campaign "For a green, clean, beautiful and safe Phu Quoc environment" in an effective way; the localities and departments have coordinated with many business units to organize the movement and activities in collecting waste, cleaning up the streets, neighborhoods for building a cleaner environment, especially in holidays and the World Environment Day. According to the statistics, in 2014, the total volume of garbage collection is 30,561.5 tons, an increase of 1,521 tons over the same period. In general, environmental sanitation have positive changes to ensure a green, clean, beautiful environment for tourists.

2. The situation of implementation progress of waste treatment

Pursuant to Decision No 137/QĐ-TTg dated on October 10th, 2008 by the Prime Minister on approving "the overall scheme on environmental protection on Phu Quoc island up to 2010 and orientation toward 2020" in which has approved in principle 16 priority projects for implementation. Up until now, most of waste disposal projects is not yet implemented such as the solid waste treatment plant with capacity of 200 tons/day, the project of wastewater treatment station focused on environmental standards in Duong Dong and An Thoi town. The waste from Duong Dong, An Thoi town, the concentrated residential areas and the island communes is mainly collected and processed by burning and landing opencast in two major areas where are overload for many years. Choosing the investors to implement the new projects of waste treatment under the plan are facing a lot of difficulties that is the reason why they not yet been implemented.

3. The current problems and difficulties

Difficulties in capital, technology to implement plans, construction, solid waste and wastewater treatment systems in urban centers, tourism and service area on Phu Quoc Island.

The problems in exploitation plan, sustainable use and protection of water resources, especially groundwater resources in the district.

The other challenges that Phu Quoc have to face at the present is urban flooding, declines in the quality of surface and groundwater; increase in the number of transportation as well as amount of municipal waste including domestic waste and wastewater from households.

The application of environmental protection technologies such as low-emission technology was concerned and directed by District Party Committee and People's Committee of Phu Quoc district. However, it is a big challenge to mobilize capital for new investment, operation, maintenance and management of environmental protection equipments because there are too many small and medium-sized businesses.

3. Suggestions and recommendations

The local authority calls for assistance to Kobe to establish an action plan to respond to climate change; efficient use of energy; sustainable management of water resource; urban plan, waste management; energy recovery from garbage; sludge treatment ... in which issue of garbage disposal and domestic wastewater is the first priority.

Thank for your kind attention./.