FY2016 Project for Ministry of the Environment Japan

FY2016
Feasibility Study of Joint Crediting Mechanism
Project by City to City Collaboration

（Phnom Penh City Climate Change Strategic Action Plan

（Kitakyushu City - Phnom Penh City Collaboration Project））

Report

March 2017

Nikken Sekkei Civil Engineering Ltd.

Kitakyushu Asian Center for Low Carbon Society

Contents

Chapter 1　Purpose of project

1.1　Purpose and Schedule of project

On July 17th, 2015, Japan submitted a draft promise to the Secretariat of the United Nations Framework Convention on Climate Change with a 26% reduction from 2013 levels (approx. 1,042 million t-CO2; 25.4% reduction from 2005 levels) by 2030 as a realizable reduction target consistent with the energy mix to be achieved through domestic emission reductions and securing absorption volume. As part of that draft promise, it was decided to appropriately count the emission reductions and absorption volumes obtained by Japan under the bilateral credit system (JCM) as reductions within our own country. Specifically, Japan's contributions to the reduction and absorption of greenhouse gas emissions realized through dissemination of greenhouse gas reduction technology, products, systems, services, infrastructure, etc. to developing countries and implementation of countermeasures in those countries will be quantitatively evaluated. In order to utilize such contributions toward achieving Japan's reduction targets, implementation of the project through the bilateral credit system (JCM) is necessary.

Cambodia, the country where this project will be implemented, is one of the countries that will be greatly affected by climate changes due to global warming, with reductions in rice production due to increases in the average summer temperature, disasters due to increased annual rainfall and rising sea levels, etc. The Cambodian government, with the cooperation of international organizations, etc. formulated the "Cambodia Climate Change Strategic Plan 2014-2023" in November 2013 as the first comprehensive national plan to cope with climate change issues, and each ministry has formulated action plans (2015 to 2018) based on this strategic plan. On the other hand, this plan does not go as far as concrete implementation of measures, and specific projects for GHG reductions are being sought.

The city of Kitakyushu has been conducting technical cooperation for waterworks with Phnom Penh since 1996, and as a result of such cooperation, water leakage and stealing have been greatly improved and in 2005 the water became drinkable, and the contributions of Kitakyushu have been called "the miracle of Phnom Penh". When Prime Minister Hun Sen visited Kitakyushu in July 2015, he proposed the conclusion of a sister-city agreement with Phnom Penh, and based on the relationship of trust that had been built up through technical cooperation in the waterworks field, a sister-city agreement between Kitakyushu and Phnom Penh was concluded on March 29, 2016.

Since the conclusion of the sister-city agreement proposed by Prime Minister Hun Sen is handled as a national project of Cambodia, Kitakyushu City is able to obtain full cooperation and support from the various ministries and agencies in the Cambodian government, including Phnom Penh as well as the Ministry of the Environment. In addition, for project formulation, this has also enabled improvement and strengthening of the implementation structure of this project through direct access to the governments of Phnom Penh and Cambodia, support for the activities of Japanese companies such as matching with local partners, etc.

Furthermore, conversion of the entire city to low carbon is being promoted through utilization of the Kitakyushu model which systematically arranges the technology and knowhow of Kitakyushu from overcoming pollution to becoming an environmental city.　By formulating the project from the upstream phase called plan formulation, JCM projects can be positioned in the plans of Phnom Penh.

In this project, under the strong city-to-city collaboration between Kitakyushu and Phnom Penh described

above, we supported the formulation of an action plan (Phnom Penh city Climate Change Strategic Action Plan) which took higher-level plans into consideration and would become the official guidelines of the Phnom Penh version targeting six fields that Kitakyushu City considered its strengths, such as environmental preservation, water supply and sewerage, etc. in order to promote low carbon city. Furthermore, we examined for formulating JCM proposals and incorporated them to the action plan. For the JCM project formulation examination, the aim was to formulate about 2 projects.

1.2 Schedule

The overall schedule of this work and the date of workshop in Phnom Penh city are as shown in Table 1.2-1 and Table 1.2-2.

Table 1.2-1 The overall schedule of this work (Plan・Result)

Items			Year 2016									Year 2017		
			Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jun	Feb	Mar
Support for formulating the action plan	0.Preparation of the Plan	Plan												
		Result												
	1.Understanding of Current Status	Plan												
		Result												
	2. Formulation of Strategy	Plan												
		Result												
	3.Specific measures	Plan												
		Result												
	4. Verification methods of the strategy measures	Plan												
		Result												
	5.Order and Fund Procurement Methods	Plan												
		Result												
	6.Plan Summary	Plan												
		Result												
JCM project formulation	1. Needs study	Plan												
		Result												
	2.Equipment introduction possibility	Plan												
		Result												
	3.Project implementation organization	Plan												
		Result												
	4.Monitoring methods	Plan												
		Result												
	5.Monitoring methods	Plan												
		Result												
On-site Seminar (4 Times)		Plan												
		Result												
Report (Draft, Final Draft, Final Report)		Plan												
		Result												

Table 1.2-2 Holding of Seminars in Phnom Penh City

Number	Date	Contents of Discussion(Draft)	Participants
1st	May 12, 2016	**＜Inception Conference＞** ・ How to proceed planning, Confirmation of requirements ・ Request of material and data	・ Related bureau of the capital ・ Related bureau of the central government ・ Other related enterprisers
2nd	September9, 2016	**＜Interim Report Meeting 1＞** ・Propose of the essential features of the action plan, Exchange of opinions ・ Propose of the Project by field	・ Same as above
3rd	December 15, 2016	**＜Interim Report Meeting 2＞** ・ Propose of the action plan (Draft), Exchange of Opinions ・ Explanation of the pilot project(Draft) by field, Exchange of opinions	・ Same as above ・ Enterpriser related to the pilot projects
4th	February 14, 2017	**＜Final Report Meeting＞** ・ Explanation of the final action plan based on the opinions given at the previous meeting. ・Discussion aimed at implementing JCM project after the next year, etc.	・ Same as above

Chapter 2　Supporting to develop the action plan for the climate change strategy in Phnom Penh Capital City

2.1　Needs and Positioning of the Action Plan

2.1.1　Needs of Phnom Penh City Climate Change Strategic Action Plan

Cambodia has been identified as a country which will be strongly affected by climate change due to global warming.With cooperation of international agencies, etc. , the Cambodian government launched the Cambodia Climate Change Strategic Plan 2014-2023, as the first comprehensive national plan to respond to climate change issues in November 2013(Phase 1). This was followed by Phase 2 (mid-term), where individual central governmental agencies established action plans (2015-2018). However, specific measures were not implemented and a specific project for the reduction of GHG is needed.

Kitakyushu City concluded sister city accord with Phnom Penh City on March 29, 2016, and plans to provide technical cooperation in fields which are strong points of Kitakyushu City, such as environmental conservation, water supply and sewerage systems. As one specific approach, support in the formulation of the Phnom Penh City version of the action plan (Phnom Penh City Climate Change Strategic Action Plan), based on plans with higher priority, is carried out.

2.1.2　Positioning of Phnom Penh City Climate Change Strategic Action Plan

Phnom Penh City climate change strategic action plan was formulated based on the Rectangular Strategy, CCCSP which are the superior plan (national plan), and related plans. The relationship between superior plans, various plans of the city and climate change strategy action plan is shown in the figure below.

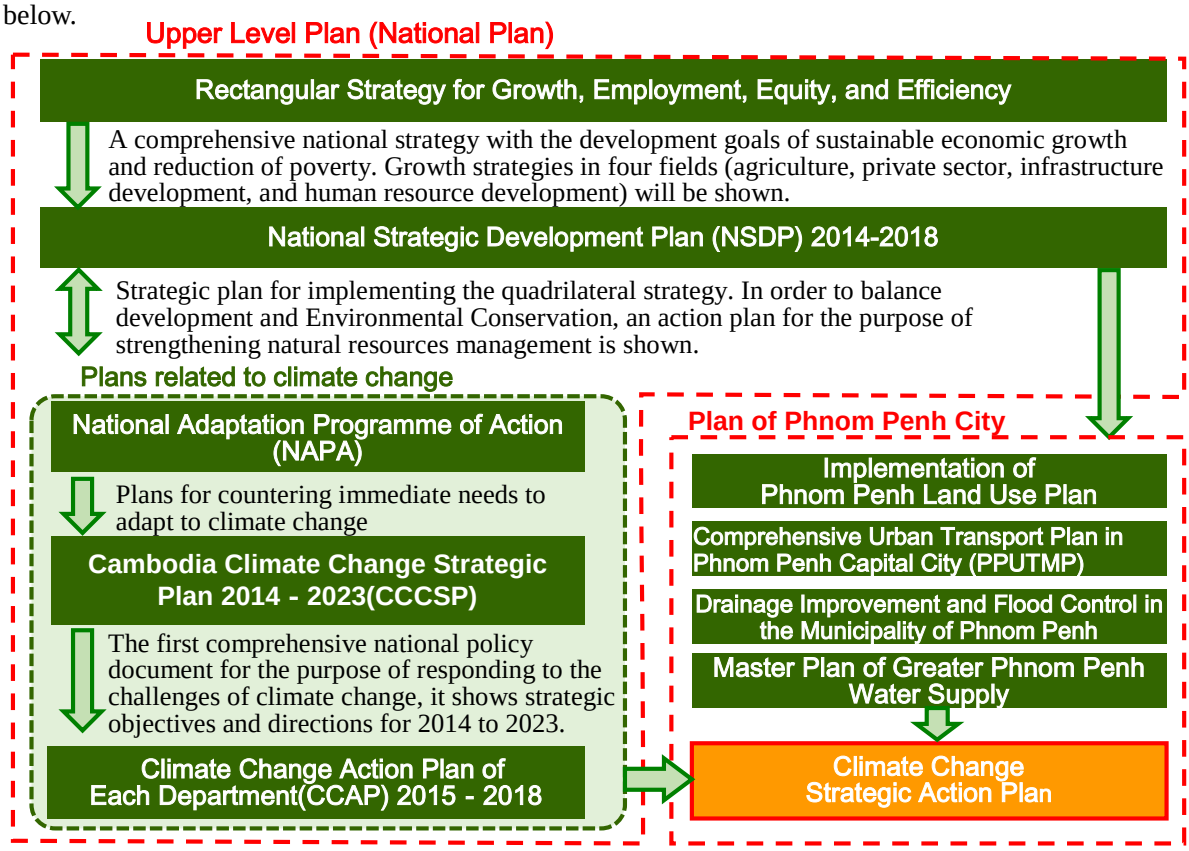


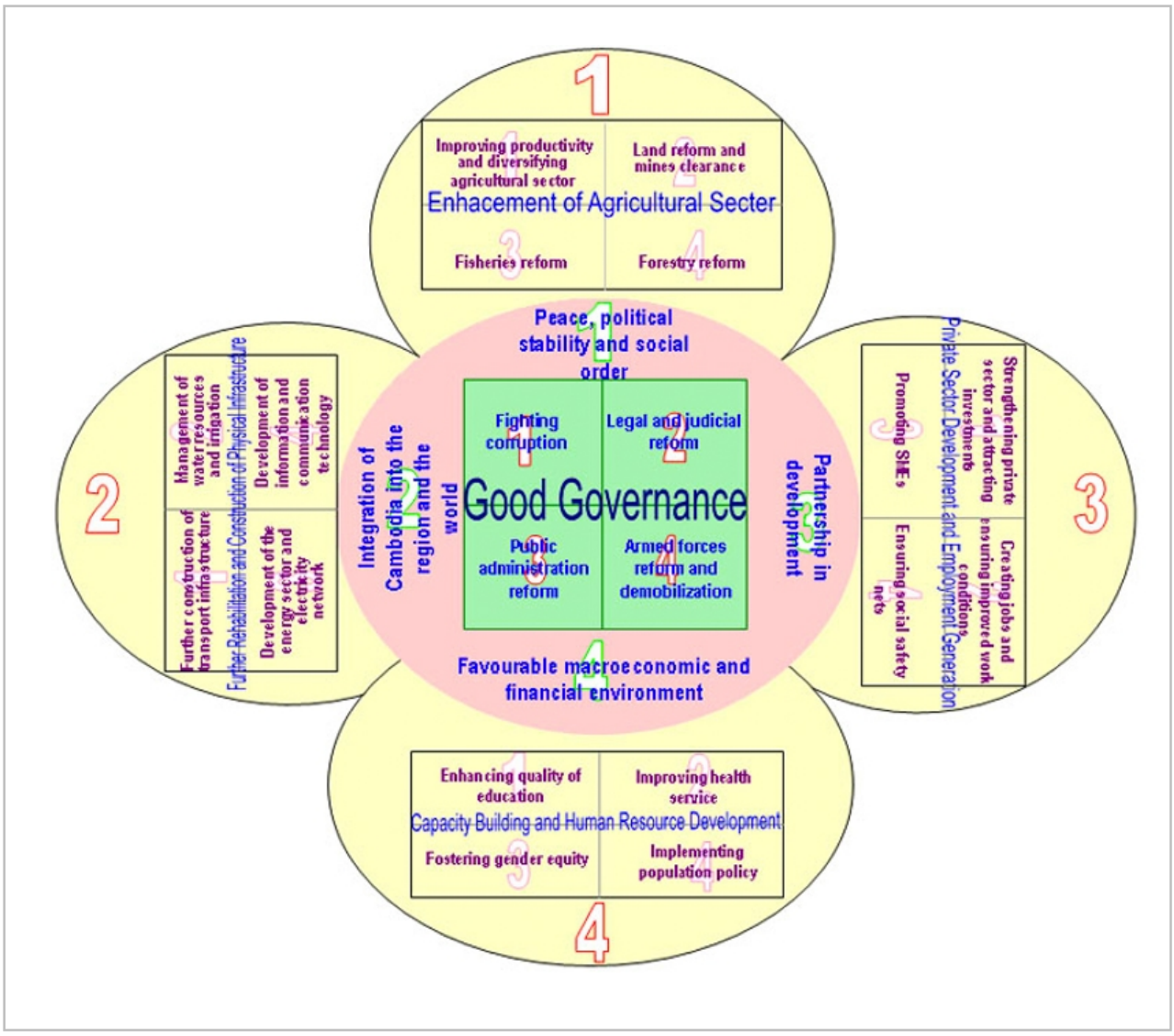
Fig. 2.1.2-1　Positioning of Phnom Penh City Climate Change Strategic Action Plan

2.1.3 Overview of related plans

(1) Rectangular Strategy

In Cambodia, the third coalition government was established in July 2004, Prime Minister Hun Sen said that as a future national development strategy of the new administration, a rectangular strategy for growth, employment, fairness and efficiency.

The rectangular strategy, which was announced as a comprehensive national development framework, was developed with the development goals of sustainable economic growth and poverty reduction taken into account with the Millennium Development Goals of the Cambodian version. Therefore, it is a strategy that puts governance as a top priority, and as shown in the figure below, four issues (Anti-corruption measures, Legal and judicial reform, Administrative reform and weapons collection/cancellation of mobilization) are listed. At the same time, in order to achieve the objectives, the government will develop the environment in four areas (Agriculture, Private sector, Infrastructure development, Human resource development and capacity development) for growth.



Source: http://www.cdc-crdb.gov.kh/cdc/8cg_meeting/national_strategic/rectangular.htm

Fig. 2.1.3-1 Royal Government of Cambodia Rectangular Strategy

(2) National Strategic Development Plan (NSDP)

The National Development Strategic Plan (Primary NDSP 2006-2010) that unified the National Poverty Reduction Strategy (NPRS) and the Second Socio-Economic Development Five-Year Plan (SEDP II) 2001-2005 as the 5-year plan after 2006 , Which was formulated in 2006. Today, tertiary NDSP 2014-2018 has been formulated in 2013 after secondary NSDP 2009-2013. NSDP is a strategy to embody the Rectangular Strategy, with the goal of reaching the index of Cambodia's Millennium Development Goals (CMDGs), with the largest target as poverty reduction.

Environmental conservation, green growth, and climate change countermeasures are mainly categorized in the context of agricultural sector development, and policy objectives are to further strengthen natural resource management to balance development and environmental protection.

(3)National Adaptation Programme of Action to Climate Change (NAPA)

NAPA is a strategy for identifying and responding to mid and long-term adaptation needs of each country. Least developed countries including Cambodia (LDCs, Least Developed Country) have formulated plans for imminent needs to adapt to climate change with the support of the GEF, which manages the Least Developed Countries Fund. The Cambodian NAPA mainly consists of 1) introduction / background, 2) framework of adaptation planning, 3) confirmation of major adaptation needs, 4) selection criteria for actions to be preferentially implemented, 5) Top priority action list

(4)Cambodia Climate Change Strategic Plan 2014-2023

CCCSP(Cambodia Climate Change Strategic Plan 2014-2023、 November, 2013) is designed to ensure strategic cohesion to address a wide range of climate change issues concerning adaptation, GHG mitigation, and low-carbon development. CCCSP is the first ever comprehensive national policy document responding to climate change issues launched in November 2013. Summary of CCCSP 2014-2023 is shown in Fig. 2.1.3-2 and Table 2.1.3-1.

Source: Brochure produced by National Climate Change Committee (NCCC)

Fig. 2.1.3-2 Cambodia Climate Change Strategic Plan 2014-2023

Table 2.1.3-1 Stage-specific action plan of Cambodia Climate Change Strategic Plan 2014-2023

Immediate term (2013 – 2014)	▪ Institutional and financial arrangements; ▪ Develop action plans (2014-2018) by concerned line ministries and agencies; ▪ Develop a Climate Change Financing Framework; ▪ Establish a national M&E framework; ▪ Develop a Climate Change Legal Framework.
Medium term (2014 – 2018)	▪ Establish a nationally accredited mechanism for the Adaptation Fund and Green Climate Fund; ▪ Research and knowledge management activities; ▪ Develop capacity; ▪ Mainstream climate change at various sectoral levels; ▪ Operationalize M&E and data management system; ▪ Increase the climate change finance for national and sub-national planning, budgeting and implementation modalities; ▪ Establish appropriate institution with sufficient capacity and full credibility for direct access to the Adaptation Fund and Green Climate Fund.
Long term (2019 – 2023)	▪ Scale-up successful pilots and carry on with the mainstreaming of climate change at national and sub-national levels; ▪ Increase the use of budget support for national programmes, including implementation of climate change response measures through sub-national administrations.

Source: Brochure produced by National Climate Change Committee (NCCC)

(4)Climate Change Action Plan of Each Department(CCAP) 2015－2018

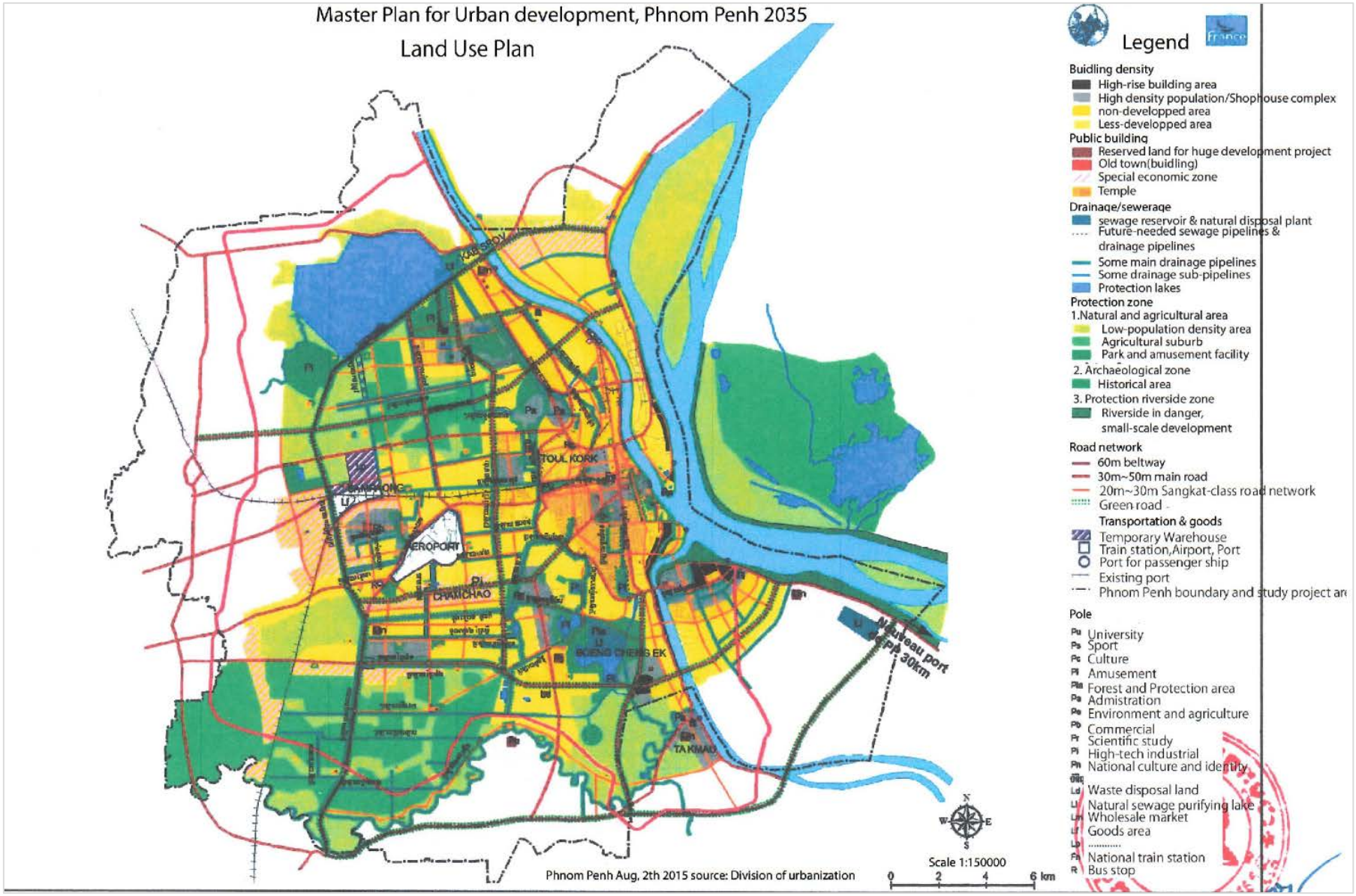
Based on the Cambodia Climate Change Strategic Plan 2014-2023, an action plan covering 2015 to 2018 is formulated for each department.

(5) The Implementation of Phnom Phnom Penh Land Use Basic Plan

Table 2.1.3-2 shows the outline of Phnom Penh land use basic plan, and Fig. 2.1.3-3 shows the land use plan.

Table 2.1.3-2 The outline of Phnom Penh land use basic plan (Target year：2035)

The Plan Name	The Implementation of Phnom Penh Land Use Basic Plan (Appendix of sub decree No.181 S.P)
Approval Authority and Date	Council Ministers Plenary Meeting on December23,2015
Target Year	2035
Planned Population	300 million (There are 6 million people in zones covering areas approximately 100km from Phnom Penh)
Development Strategy	Phnom Penh City will become a central city of social economic development in Southeast Asia by preserving her identity, environment and international standard. 1. Central development base in Southeast Asia(Urban development corresponding to the rapid population increase) 2. City of the international quality standard 3. Improvement of important infrastructure (national highway, harbor, railroad, the airport and dry port) 4. Development preparations of the great city level (building of a network in a public space, a road and a green tract of land) 5. Patrimony of Special zone and city view (Development policy of each zone, Construction of sewage purification plants, new landfills, and incineration facilities, etc.)
Action Plan	1.Dissemination of the development strategy 2.Crucial projects required urgent approval ・Regulation and planning regarding public facilities, main roads, railway and drainage in suburb area. ・Setting location for railway station and dry port ・International Railway project(Ho Chi Minh- Phnom Penh) ・Expanding of Phnom Penh International airport ・Concreting of Shore of Bassac River as development base ・Setting the area where skyscrapers are led or restricted. ・Construction of new landfills and improvement of the existing landfills. ・Setting ecological area ・Preservation and Development in the historical center area. 3.Urbanization regulation of each area4.Continued development activities and public investment



Source: Phnom Penh City Urban Management Division

Fig. 2.1.3-3 Master Plan for Urban development, Phnom Penh 2035 Land Use Plan

2.1.4 The Flow of Supporting to develop the Strategic Action Plan

This plan covers six fields on waste, energy, transportation, water and sewerage / rainwater drainage, environmental conservation and green production. The flow of support for formulation of this plan is as shown in Fig. 2.1.4-1 and Table 2.1.4-1.

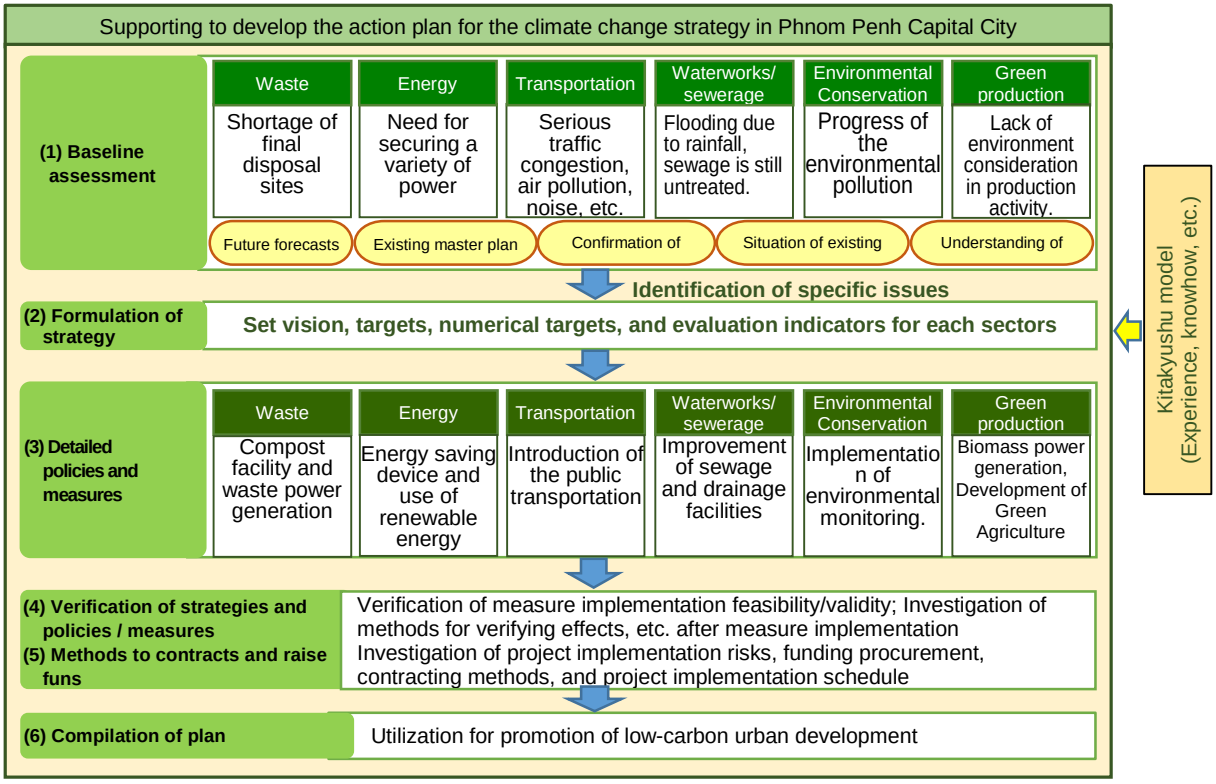


Fig. 2.1.4-1 The Flow of Supporting to develop the Strategic Action Plan

Table 2.1.4-1 Items of Consideration and Details

Items of Consideration	Details
1)Baseline Assessment	・Collect data and resources for each field related to GHG emissions, understand the actual conditions, and clarify any issues involved. ・Understanding items which should be considered, such as the plan with higher priority and legal regulations.
2)Formulation of Strategy	・Based on the climate change strategy plan of the country, establish the vision of sustainable development in Phnom Penh City, specific numerical goals included GHG reduction, and indications to evaluate goal achievement, etc.
3)Detailed Policies and measures	・To achieve the vision and goals described above, specific measures which should be worked on are determined, and their short, mid, and long term priorities should be considered. ・For the projects which should be carried out in a short term, a pilot project is considered, as well as applicable operations such as JCM, the implementation system, GHG emission reduction effect, environment improvement effect, approximate costs, an operations schedule, etc.
4)Verification of the strategy and measures Consideration of methods	・Consider the feasibility, risk, appropriateness of verification and approaches for continuous improvement of the plan.
5)Ordering / fund procurement Consideration of methods	・To promote specific measures, consider the ordering / fund procurement method focusing on short and mid term projects, as well as the overall schedule for the measures.
6)Organization of the plan	Organize documents of the plan in a visually, easy to understand way. (Japanese/English ver)

2.2 Baseline Assessment

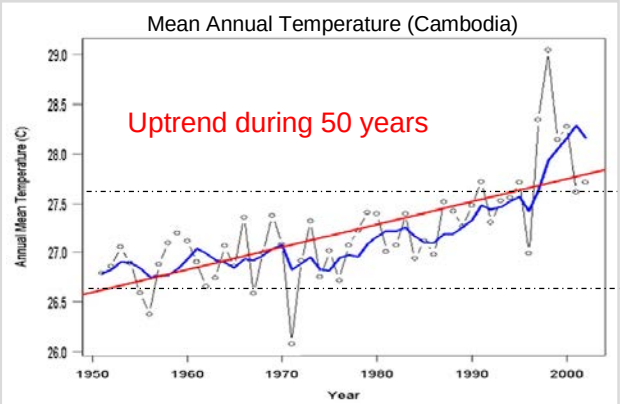
2.2.1 Natural Condition

(1) Temperature

In the climate change prediction of CCCSP (Cambodia Climate Change Strategic Plan 2014-2023), the temperature is expected to change as follows.

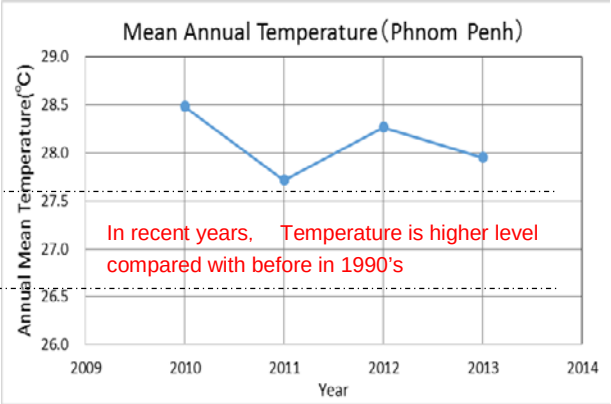
・Mean monthly temperature will increase between 0.013 and 0.036 degrees C per year by 2099.

・Rice grain yield will decline by 10% for each 1 degrees C increase in growing-season.



Source: Heng Chan Thoeun, Observed and projected changes in temperatureand rainfall in Cambodia, Weather and Climate Extremes 7 (2015) 61–71

Fig. 2.2.1-1 Mean Annual Temperature during 1951-2001 in Cambodia



Source: Japan Meteorological Agency, http://www.data.jma.go.jp/gmd/cpd/monitor/climatview/frame.php

Fig. 2.2.1-2 Mean Annual Temperature during 2010-2013 in Phnom Penh

(2) Rainfall

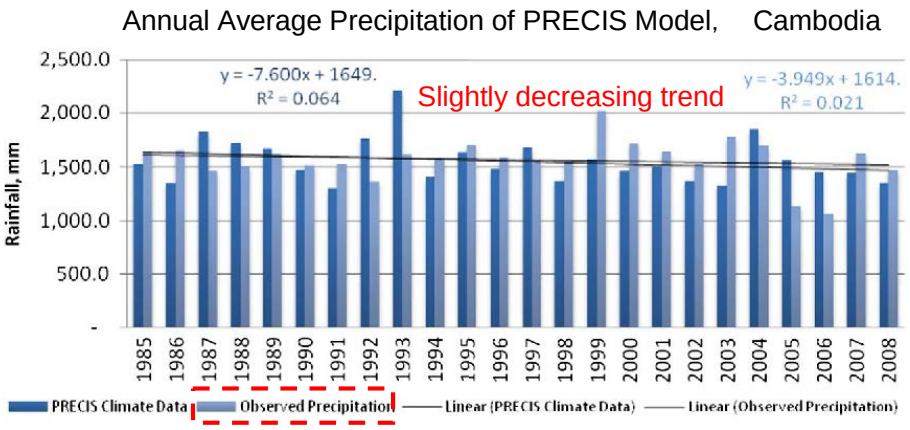
According to the climate change prediction of CCCSP, the rainfall is expected to change as follows.

・Mean annual rainfall indicates an increase

・Rainfall will get higher in the provinces at higher elevation during wet season, but it will get drier during the dry season.

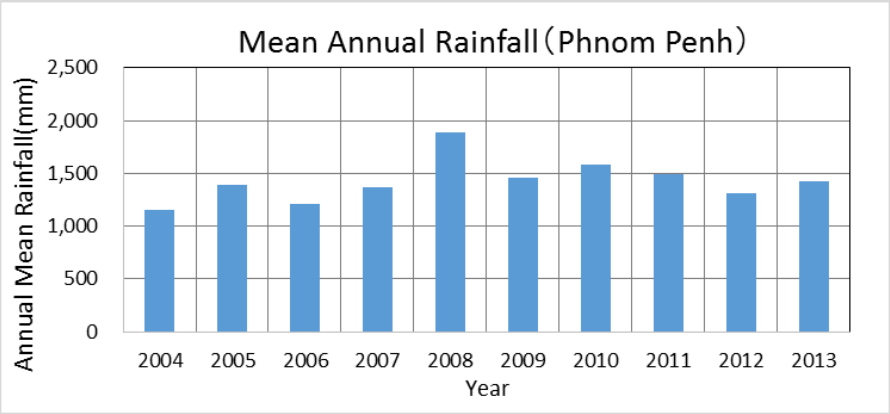
・The coastline is vulnerable to sea-level rises and the sever impacts of more frequent typhoon.

・Coastal zones would be affected by tropical cyclones while the central plains would experience seasonal flooding



Source: Heng Chan Thoeun, Observed and projected changes in temperature and rainfall in Cambodia, Weather and Climate Extremes 7 (2015) 61–71

Fig. 2.2.1-3 Annual Rainfall during 1985-2008 in Cambodia



Source: Japan Meteorological Agency, http://www.data.jma.go.jp/gmd/cpd/monitor/climatview/frame.php

Fig. 2.2.1-4 Mean Annual Rainfall during 2004-2013 in Phnom Penh

(3) Sea Level

According to the climate change prediction of CCCSP, the sea level is expected to change as follows.

・Sea levels in the region are projected to rise under various scenarios by 2090 relative to 1980-1999.

a. 0.18-0.43m under low emission scenario

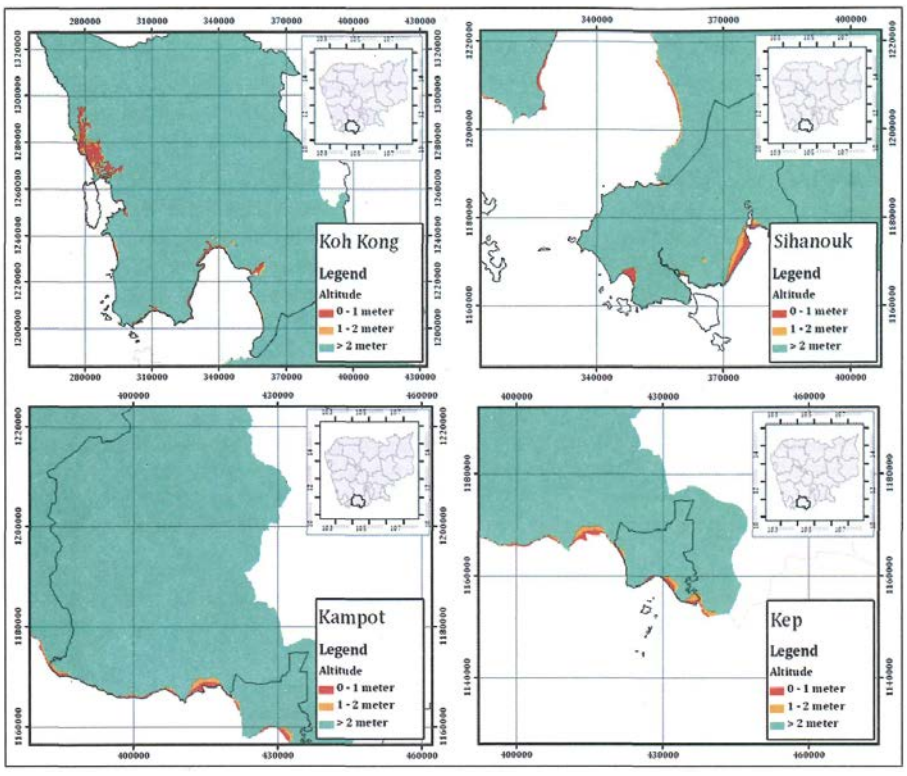
b. 0.21-0.52m under medium emission scenario

c. 0.23-0.56m under high emission scenario

(This rate would cause permanent inundation of about 25,000 ha of coastal Cambodia within 90 years.)

・The coastline is vulnerable to sea-level rises and the sever impacts of more frequent typhoon.

・Coastal zones would be affected by tropical cyclones while the central plains would experience seasonal flooding.



Source: Cambodia's Second National Communication

Fig. 2.2.1-5 Area of Coastal Zone being inundated due to Sea Level rise

(4) Water Level

The Mekong River and the Tonle Sap River rise in the rainy season from June to November due to the influence of Southeast Asian Monsoon climate.

Because of the short time period in which the data was collected, the trend of the water level is not seen.

Fig. 2.2.1-6 Positioning Map

Phnom Penh Port Zero gauge Phnom Penh Port = 0.07 m above MSL

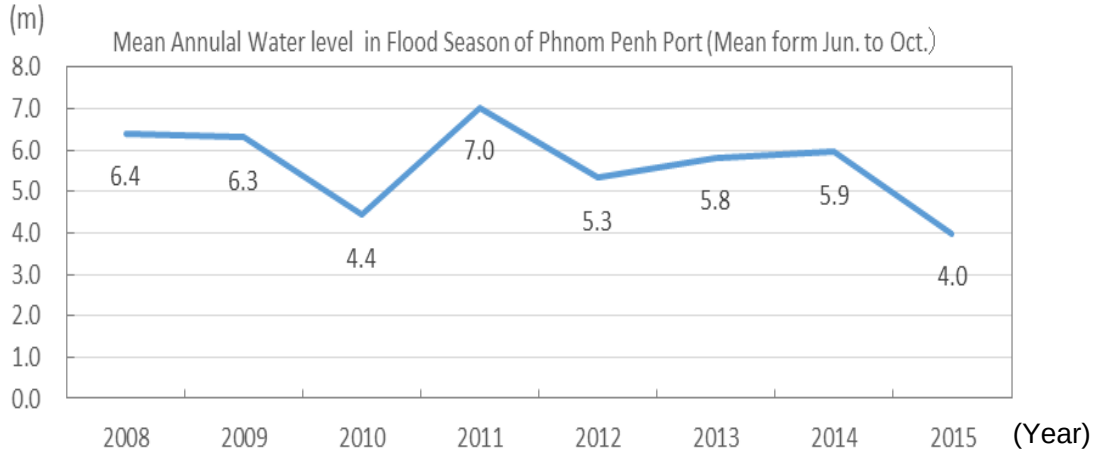
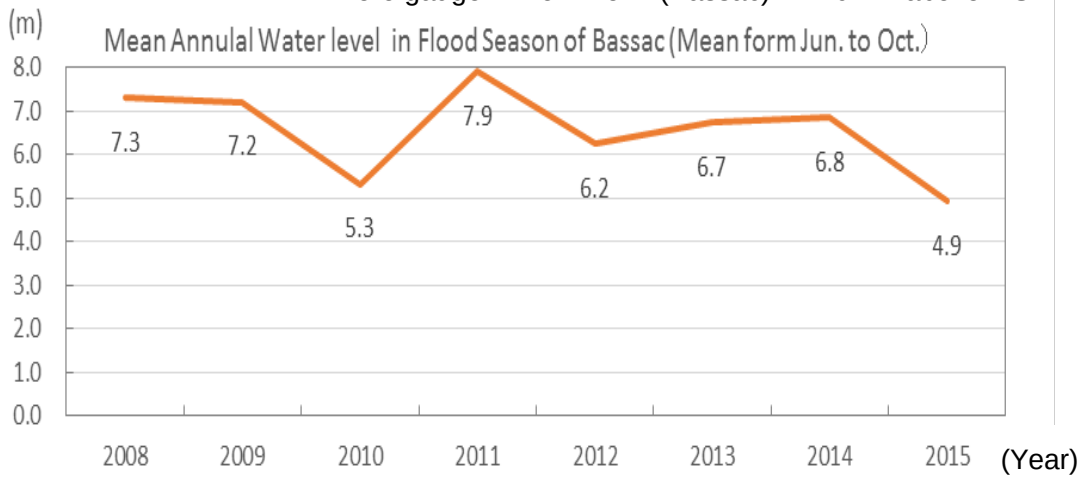


Fig. 2.2.1-7 Mean Annual Water Level in Flood Season of Phnom Penh Port

Phnom Penh (Bassac) Zero gauge Phnom Penh (Bassac) = -1.02 m above MSL



Source: Mekong River Commission, Graph of Water Levels and Reports, http://www.mrcmekong.org/

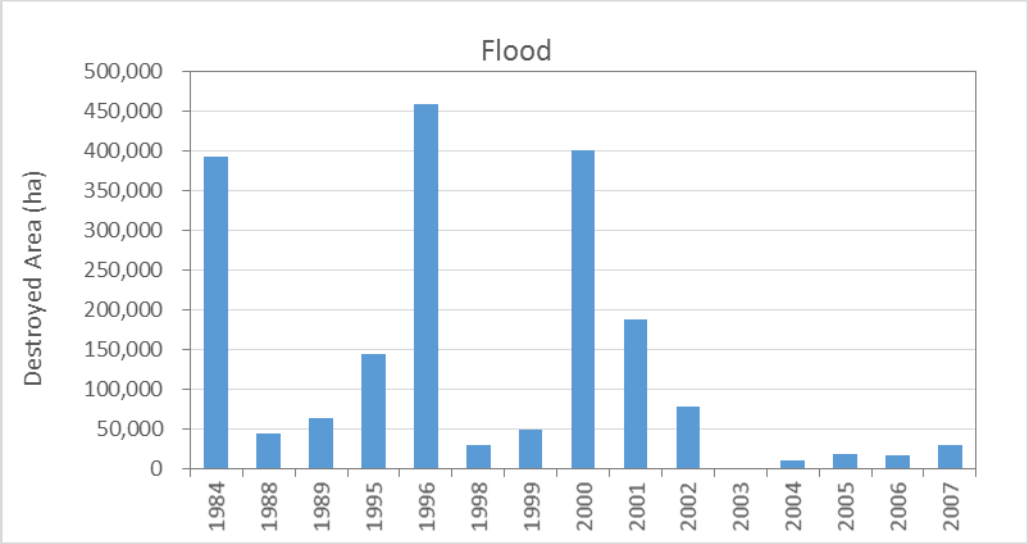
Fig. 2.2.1-8 Mean Annual Water Level in Flood Season of Bassac

(5) Flood・Drought

The influence of floods and droughts on agriculture is shown in the Cambodia's Second National Communication as follows.

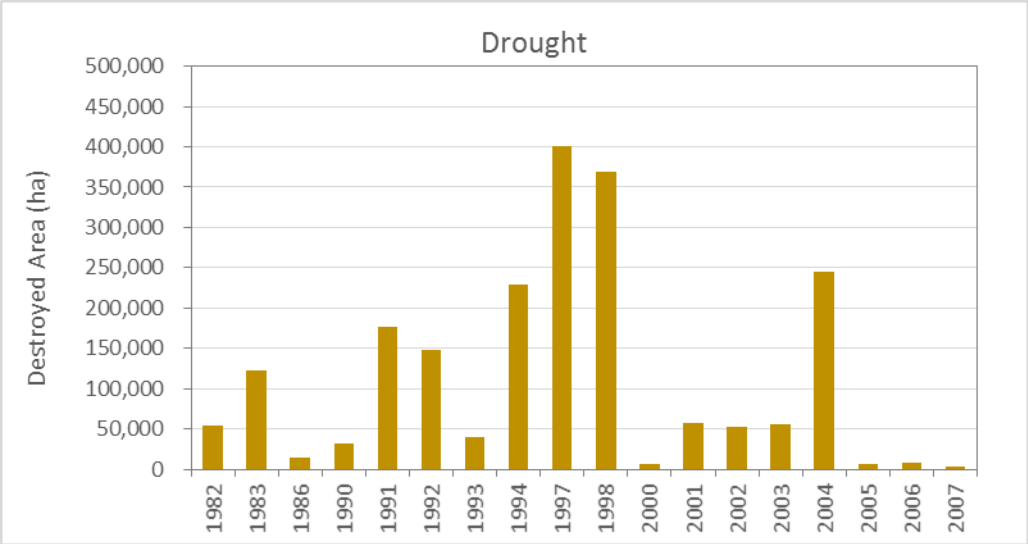
＜Impact of flood and drought on agriculture＞

- Based on data from the past 20 years, losses in production were mainly due to flooding (about 62%) and drought (about 36%).
- Floods have not always coincided with high rainfall in Cambodia. Most flooding occurs due to increased water levels in the Mekong River and Tonle Sap Lake between early July and early October.
- In the last 30 years, the most devastating floods were in 1984, 1996 and 2000. The 1984 and 2000 floods were due to increased water levels in the Mekong River, rather than heavy rainfall in Cambodia.
- Floods destroy infrastructure, including irrigation facilities, and can result in loss of life.



Source: Cambodia's Second National Communication

Fig. 2.2.1-9 Total Rice Cultivation are destroyed by flood in Cambodia



Source: Cambodia's Second National Communication

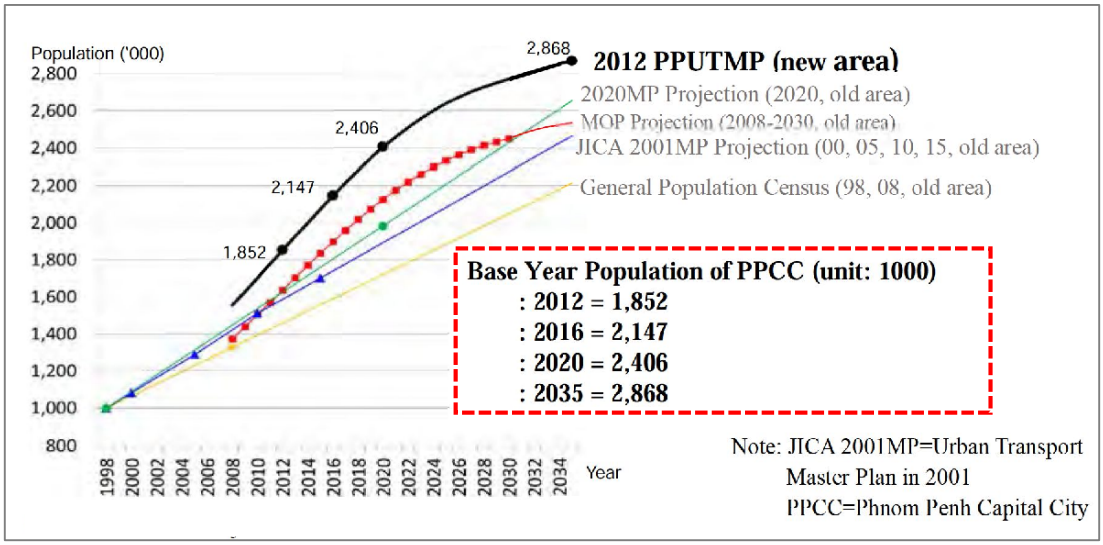
Fig. 2.2.1-10 Total Rice Cultivation are destroyed by drought in Cambodia

2.2.2 Socioeconomic Situation

(1) Population

【The future population of Comprehensive Urban Transport Plan in Phnom Penh Capital City (PPUTMP)】

- The future population of Phnom Penh for 2016, 2020 and 2035 are forecasted in this study based on the population forecasts by the Ministry of Planning (MOP) in January 2011. However, the population forecasted by the Ministry of Planning was only confined to the old city area.
- In this study, the 2008 population census is also used to correct this shortcoming for estimating the future population of the city inclusive of the new city areas. The population of Phnom Penh City at 2012 which is the base year in this study, is set at 1.85 million. The population for the medium-term target year of 2020 is forecasted at 2.41 million and for the final target year of 2035, 2.87 million.

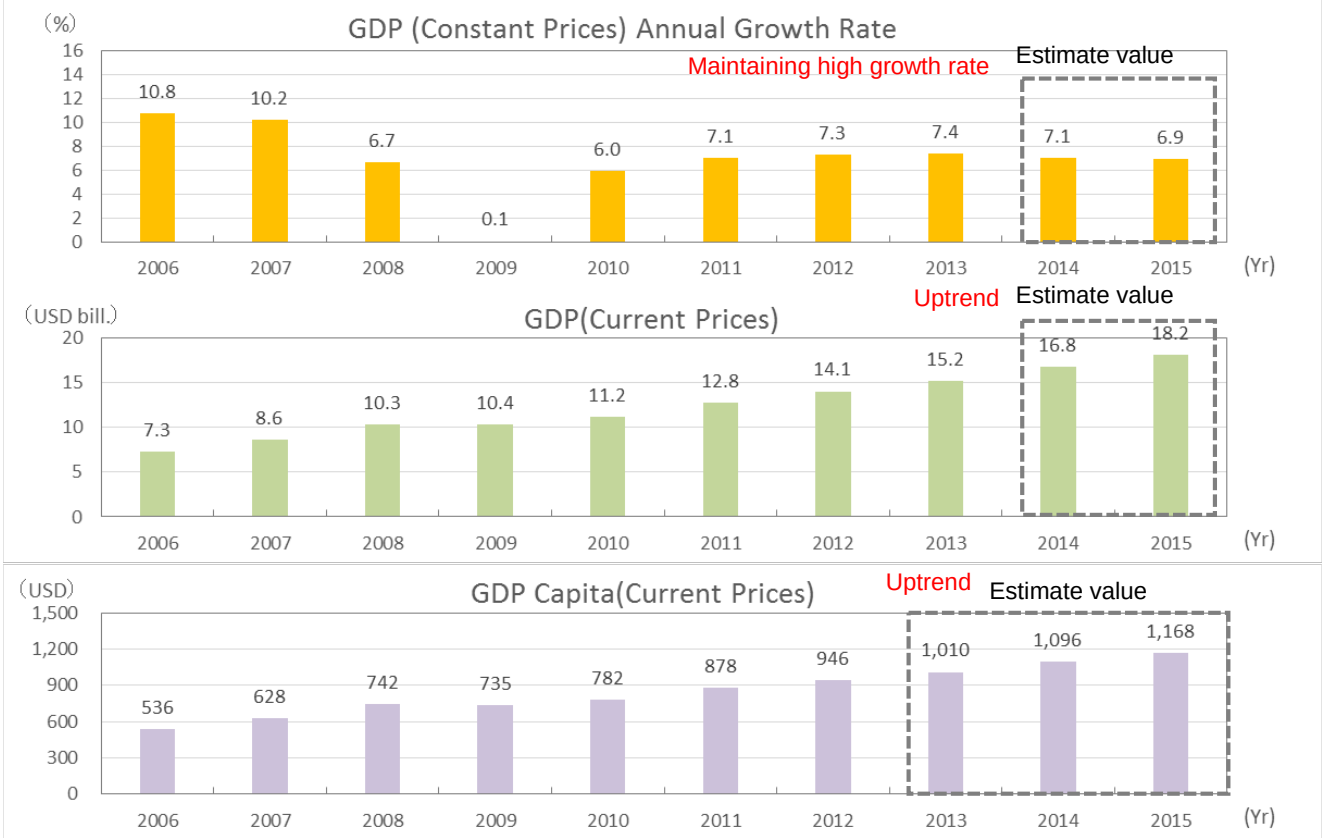


Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Fig. 2.2.2-1 Estimating future population of Phnom Penh

(2) GDP・Economic Growth

Cambodia's economic growth rate fell to 0.1% in 2009, the year after the bankruptcy of Lehman Brothers occurred, but since that time it has maintained around 7.0% due to the expansion of service industry and manufacturing industry, especially tourism sector.



Source：International Monetary Fund, World Economic Outlook Database, April 2016

Fig. 2.2.2-2 Changes in GDP and economic growth rate in Cambodia

2.2.3 Social infrastructure

A summary of issues relating to social infrastructure is shown below. For details, see Section 2.4 "Tasks by category and concrete measures".

(1) Transportation

- Road maintenance is insufficient because there are problems such as main road being interrupted on the way due to geographical constraints in existing urban areas and road density is low and most of the existing quasi-main roads are not paved in suburb. (Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014)
- In addition, public transportation consists of only 3 bus routes and railway service has been suspended for the entire line. Because of this, traffic congestion in the capital is severe.

(2) Waterworks/sewerage and rainwater drainage

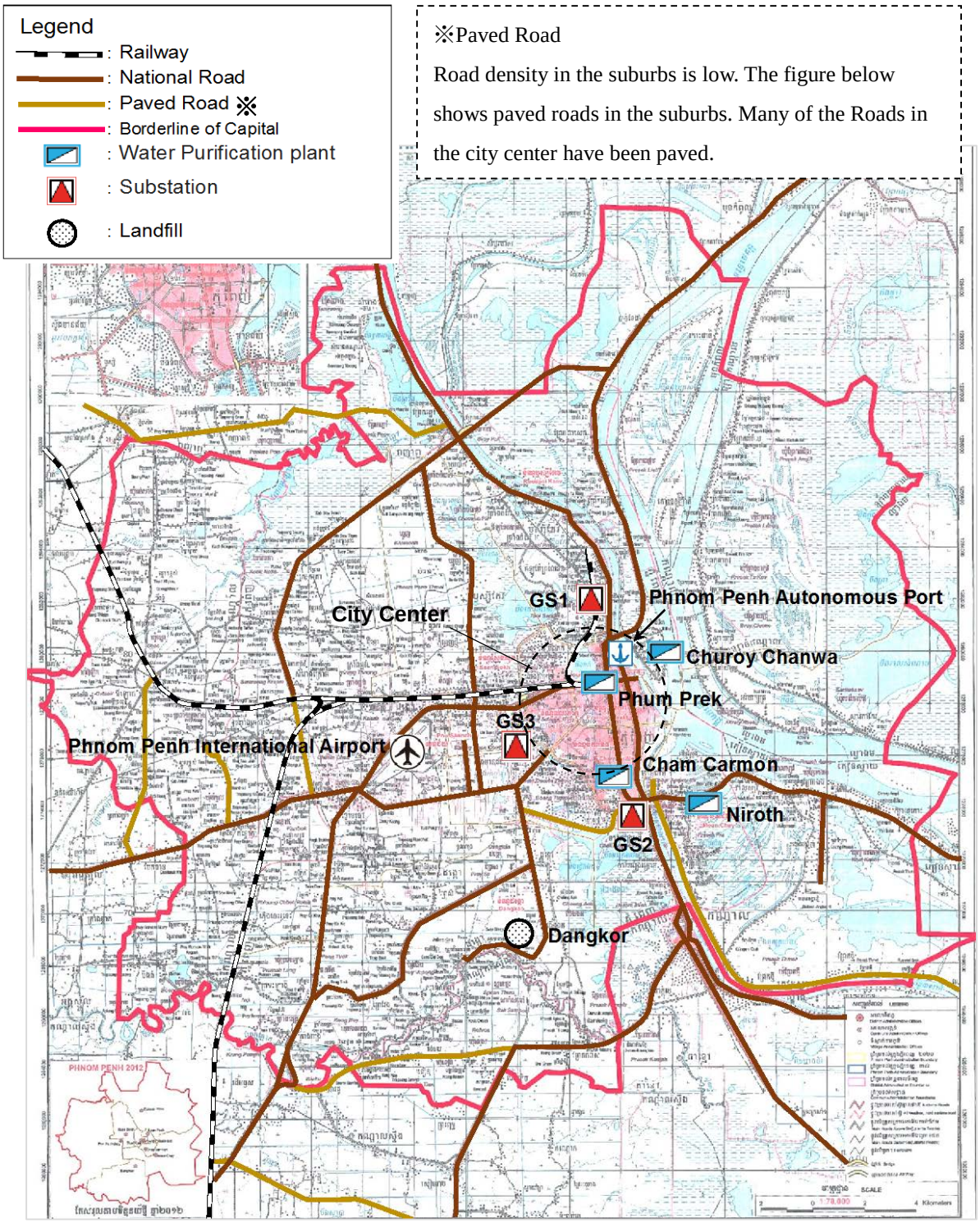
- There are four water purification plants and the population with water supply in the capital is about 85%.
- Daily life wastewater is released virtually untreated into waterways and ponds, so environmental pollution is progressing.
- Rainwater drainage was improved in areas that were improved under the support of JICA and others, but for other areas, it is necessary to proceed with maintenance according to the rainwater drainage master plan.

(3) Energy

・Power is supplied mainly from Vietnam or diesel generators in the capital, and supplied to the capital via three substations, and power supply is unstable with power outages, etc. In addition, electricity prices are high compared to neighboring countries.

(4) Waste

・In the capital, there is only one landfill. Due to rapid population growth and economic development, the remaining years of landfill are tight.

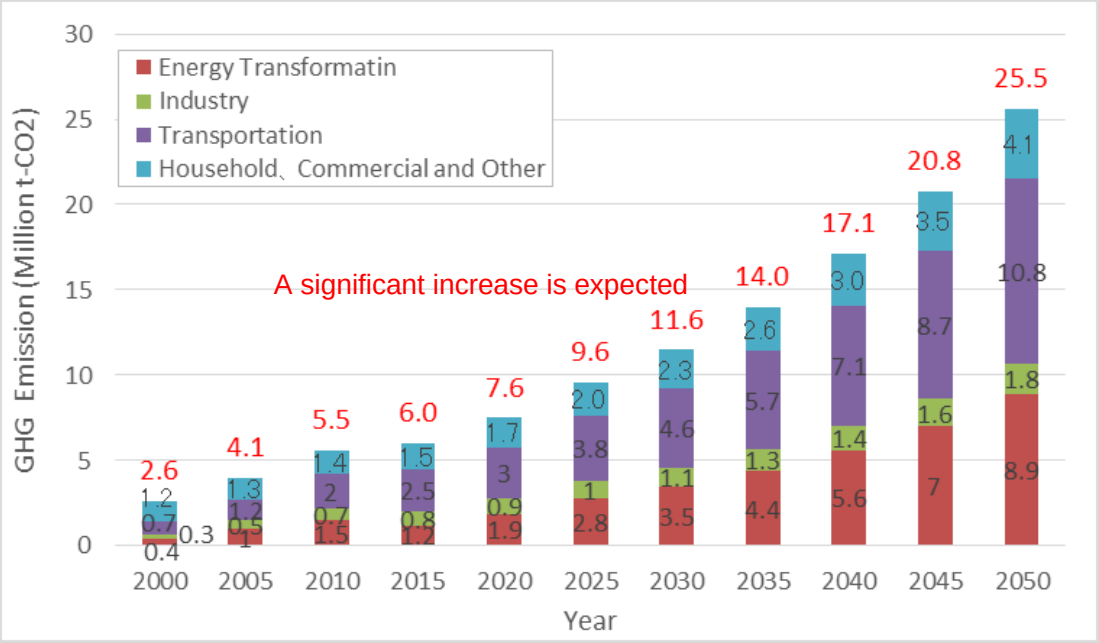


Source: The base map of the location map was bought at the bookstore in Phnom Penh

Fig.2.2.3-1 Location map of social infrastructure facilities in Phnom Penh

2.2.4 Greenhouse Gas (GHG)

Future prediction of greenhouse gas (GHG) emissions in Cambodia is indicated in the Cambodia's Second National Communication, and it is expected that GHG emissions will increase (ref. Fig. 2.2.4-1).



Source：the Ministry of the Environment, Japan, 2016. New Mechanisms Information Platform
http://www.mmechanisms.org/initiatives/cambodia_info.html

Fig. 2.2.4-1 Estimated GHG emission from Energy sources (excluding biomass) (2000-2050)

2.2.5 Current status and tasks

The current status and tasks are summarized from the viewpoint of general review, administrative, corporate and citizen as follows.

(1) General remarks

- The water supply adoption rate is about 85%, and development is progressing with it being possible to drink the water directly from the tap except for some areas. On the other hand, development of social infrastructure such as roads, sewerage, waste management, etc. is delayed, and environmental pollution and public health are progressively getting worse. In order to improve the life of citizens, social infrastructure development is urgently needed.
- Supplying power faces the challenges of power outages, voltage instability, etc. In addition, because electricity prices are high, the impact extends to the entrance of countries from abroad and economic activities of companies. The development of diverse power sources including renewable energy such as solar power, biomass power generation, etc. is necessary.
- As an effect of climate change, Cambodian coastal areas are susceptible to sea level rise and frequent typhoons. In addition, Phnom Penh city is also susceptible to the rise of the river water level due to the increase in rainfall because it is a low flat land where the Mekong River and Tonle Sap River flow. In Phnom Penh which is considered to emit the largest amount of greenhouse gas in Cambodia, it is desirable to reduce greenhouse gas emissions by proactively promoting the introduction of renewable energy and

energy saving.

- It is necessary to suppress the energy demands, water demands, and greenhouse gas emissions that are expected to accompany future rapid economic development and population increases.
- As can be seen from the example of Kita Kyushu which has experienced green growth, it is possible to carry out environmental improvements while undergoing economic expansion, and in order to overcome severe pollution, sustainable development with harmony between the economy and the environment is necessary.

(2) Administration

- Part of the organization of the central government is incorporated into the Phnom Penh administration structure, so the chain of command has become more complex and in one aspect speedy administration operations have become difficult.
- For solving problems in the capital area, in addition to a top-down approach, a bottom-up approach based on proposals from the level of the person in charge is also important, and nurturing of personnel who can offer specific solutions is necessary.

(3) Company

- Although it is currently in the development stage focusing on light industry, in the future, nurturing of local industries to increase the industrial level and attracting overseas companies for the introduction of technology and knowhow is required.
- In particular, when evolving from light industry to heavy industry, pollution prevention measures and clean production efforts are necessary so that air, water, soil, etc. do not become contaminated.

(4) Citizens

- With the problem of waste becoming serious, raising the environmental consciousness level of citizens, promotion of garbage sorting and recycling, and prevention of illegal dumping is necessary.
- Air pollution and increases in CO_2 are progressing because of to traffic congestion due to automobiles and gasoline motorcycles. A shift to public transportation use is required.

2.3 Formulation of Strategy

2.3.1 Vision of the Plan

The respective growths of environment, economy, society, and culture are important elements for achieving environment capital Phnom Penh, and while creating harmony and balance between the elements, it is also important that they have sustainability. In addition, development of human resources to support this group will be planned.

The capital city of Phnom Penh will realize sustainable development by handling climate change wisely and becoming a model for an Asian environmental capital city.

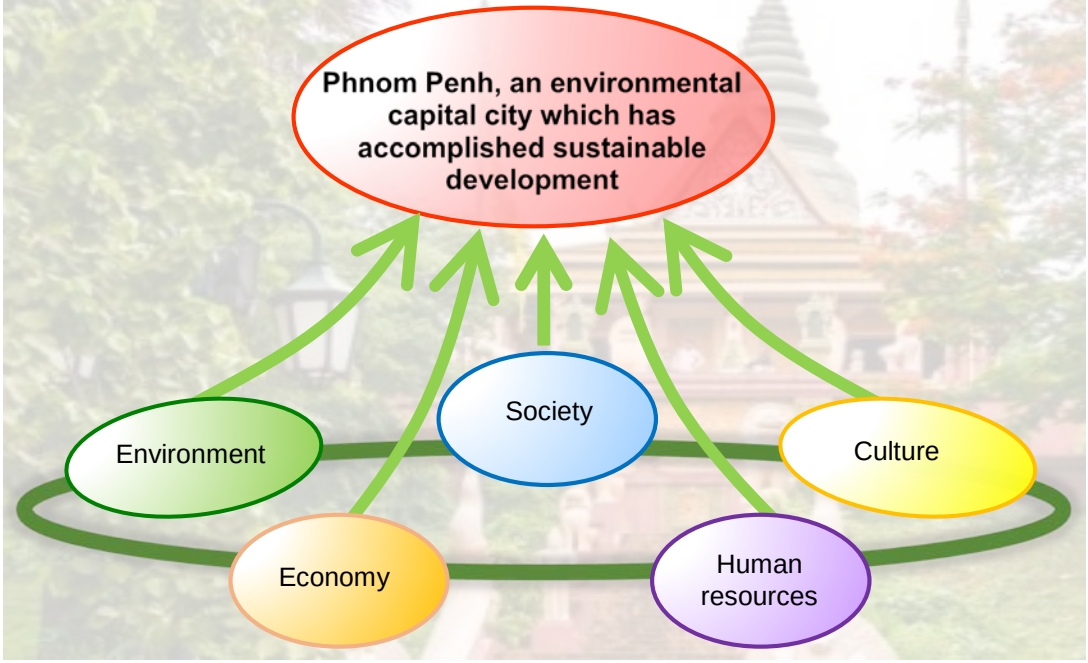


Fig. 2.3.1-1 Vision of the Plan (Conceptual diagram)

2.3.2 Basic policy

In order to realize the vision, the basic policies of six fields on waste, energy, transportation, water and sewerage / rainwater drainage, environmental preservation, green production are set as follows based on current status and tasks.

＜Waste field＞

Reliable waste collection/proper treatment and construction of a resource cycle society and economy

- Waste will be reliably collected and properly treated. In addition, a cyclic societal and economic system in which waste is reused as resources will be constructed, and development of recycling business is planned.
- The occurrence of environmental problems due to waste will be thoroughly prevented and suppressed. Lifestyles and industrial structures/production activities which generate small amounts of waste will be achieved, and GHG from waste will be reduced.

＜Energy field＞

Efficient use of energy and active utilization of renewable energy

- The currently unstable power supply will be corrected, efficient energy utilization and energy conservation will be actively promoted, and GHG which are forecast to increase in the future will be reduced.

▸ Renewable energy such as solar energy using the sunlight with which Phnom Penh is blessed, biomass, etc. will be actively promoted and a framework that can achieve both environmental and economic goals will be constructed.

＜Transportation field＞

High-convenience, low-carbon public transportation system

▸ In order to improve traffic congestion and air pollution which has become a major problem from societal, economic, and environmental aspects, a highly convenient public transportation system using low-pollution vehicles will be developed.

▸Together with the development of hardware such as roadways, signal systems, etc. the software side such as a vehicle inspection system, exhaust gas restrictions, etc. will be enhanced, and these will be reliably implemented to relieve traffic congestion.

＜Waterworks/sewerage and rainwater drainage＞

Expansion of drinkable waterworks area and thorough treatment of sewage and rainwater・

▸ Together with expanding the area where waterworks water can be drunk directly, sewage from households and offices will be properly treated to regenerate and create a good waterside environment free from water pollution.

▸ Flooding of areas which are still subject to frequent flooding will be eliminated so that citizens can live safely. In addition, in order to maintain functions as the capital, infrastructure development such as rainwater drainage facilities, etc. will be promoted so that the flood damage risks due to the increasing frequency of heavy rains because of climate change can be reduced.

＜Environmental conservation＞

Maintenance of an environment level suitable for an environmental capital city and coexistence with the natural environment

▸ Planning and comprehensive implementation of measures to reduce the negative impact of environmental problems (waste, sewerage, exhaust gas, noise, etc.) due to socioeconomic activities and maintain and improve the environmental level suitable for the environmental capital that Phnom Penh is aiming for.

▸ Expansion of measures to preserve the natural environments of the capital, such as forests, green spaces, and wetlands, ensure biodiversity for inherent coexistence with the natural environment, and foster a sense of values for the Cambodian culture which has been carefully handed down.

＜Green production＞

Construction of low-carbon, environmentally friendly industrial structures

▸ Actively promote environmentally friendly production activities such as introducing cleaner production (production processes that efficiently use raw materials and energy and reduce environmental loads) with the aim of becoming low-carbon.

▸ Planning the transition to environmentally friendly structures in agriculture and also in other industries.

▸Development human resources who will actively promote environmentally friendly societal and economic activities.

2.3.3 Numerical Goals

Numerical goals in the table below was set referring to the numerical goals of Cambodia's Second National Communications (MoE、Nov.2015) and various master plans and indicates of other cities.

Table 2.3.3-1 Numerical Goals

	Items \ Target Year			2017-2023	2035
Entire Country	GHG		Amount of emissions	7,149$GgCO_2$ (2025) (=BaU 9,601−2,452)	1,0313$GgCO_2$ (=BaU 14,043−3,730)
			Reduction Amount	2,452$GgCO_2$(2025) (26% reduction Compared to BaU)	3,730$GgCO_2$ (27% reduction Compared to BaU)
Phnom Penh City	GHG		Amount of emissions	3,053$GgCO_2$	4,403$GgCO_2$
			Reduction Amount	1,047$GgCO_2$	1,593$GgCO_2$
	Index value of the evaluation (indication)	Waste Collection Rate		City Solid Waste : 90% or more Industrial Waste : 85% or more	City Solid Waste : 100% Industrial Waste : 100%
		Waste Recycle Rate		City Solid Waste : 50% or more Industrial Waste : 85% or more	City Solid Waste : 95% or more Industrial Waste : 95% or more
		Reduction Amount of GHG by Utilizing Renewable Energy		100.8$GgCO_2$ (2025)	99.9$GgCO_2$
		Share of public transport		20% or more	30%
		Automobile Inspection Rate		50% or more	100%
		Achievement Rate of the Exhaust Standard (Cars, bikes, etc.)		50% or more	100%
		Achievement rate of the environmental quality standard for air		50% or more	100%
		Achievement rate of environmental quality standard for surface water		50% or more	100%
		Piped Water Supply Coverage Ratio		90% (Possibility rate of drinking a tap water directly : 80% or more)	100% (Possibility rate of drinking a tap water directly : 100%)
		Sewage Treatment Rate		Domestic Sewage:5% or more Industrial Sewage : 10% or more	Domestic Sewage : 50% or more Industrial Sewage : 100%
		Urban Green Area		10m /Person (Whole country : 60% of the National land)	20m /Person (Whole country : 60% of the National land)
		Implementation Rate of Green Agriculture		10% or more	70%

＜Basis for setting numerical goals＞

(1) GHG emissions amount and reduction amount for the entire country

For the numerical goals for the emissions amount and reduction amount for the entire country, it was decided to use the Total Baseline Emissions and Total Savings stated in Cambodia's Second National Communications (MoE, Nov. 2015) (ref. Table 2.3.3-2)。

GHG emissions amount (numerical goal)＝Total Baseline Emissions-Total Savings

GHG reduction amount (numerical goal)＝Total Savings

(2) Phnom Penh GHG emissions and reductions

GHG emissions are often explained in relation to GDP because GHG emissions contribute greatly to economic activity. Therefore, it was thought that GHG emissions of Phnom Penh city should be obtained by multiplying entire country GHG emissions amount by the ratio of Phnom Penh's GDP to GDP of whole country at first. However, since the GDP of Phnom Penh city had not yet been organized (as of 2016), as an index to replace GDP, income ratio which was survey results of the Cambodia statistical capacity improvement project supported by the Statistic Bureau, Ministry of Internal Affairs and Communications of Japan was used. Specifically, GHG emissions and reductions in Phnom Penh city were obtained from the following formula.

Phnom Penh GHG emissions amount and reduction amount

= Entire country GHG emissions amount and reduction amount × Income ratio (42.7%)[*1]

Here,

Income ratio (2013 to 2014) is determined by the following formula (ref. Fig. 2.3.3-1):

Income ratio (42.7%) = Total income for all Phnom Penh businesses (1,614 million USD)

/ Total income for businesses in entire country (3,776 million USD)

＜Reference＞

- Ratio of population of Phnom Penh/Entire country (2025 forecast) = 11.5%[*2]
- Ratio of number of businesses in Phnom Penh/Entire country (2014) = 14.9%[*1]

(ref. Fig.2.3.3-2)

- Ratio of number of employees in Phnom Penh/Entire country (2014) = 29.5%[*1]

(ref. Fig.2.3.3-3)

＊1 Results of 2014 Cambodia Inter-Censal Economic Survey, Ministry of Planning, Cambodia http://www.stat.go.jp/info/meetings/cambodia/c14f_tb1.htm

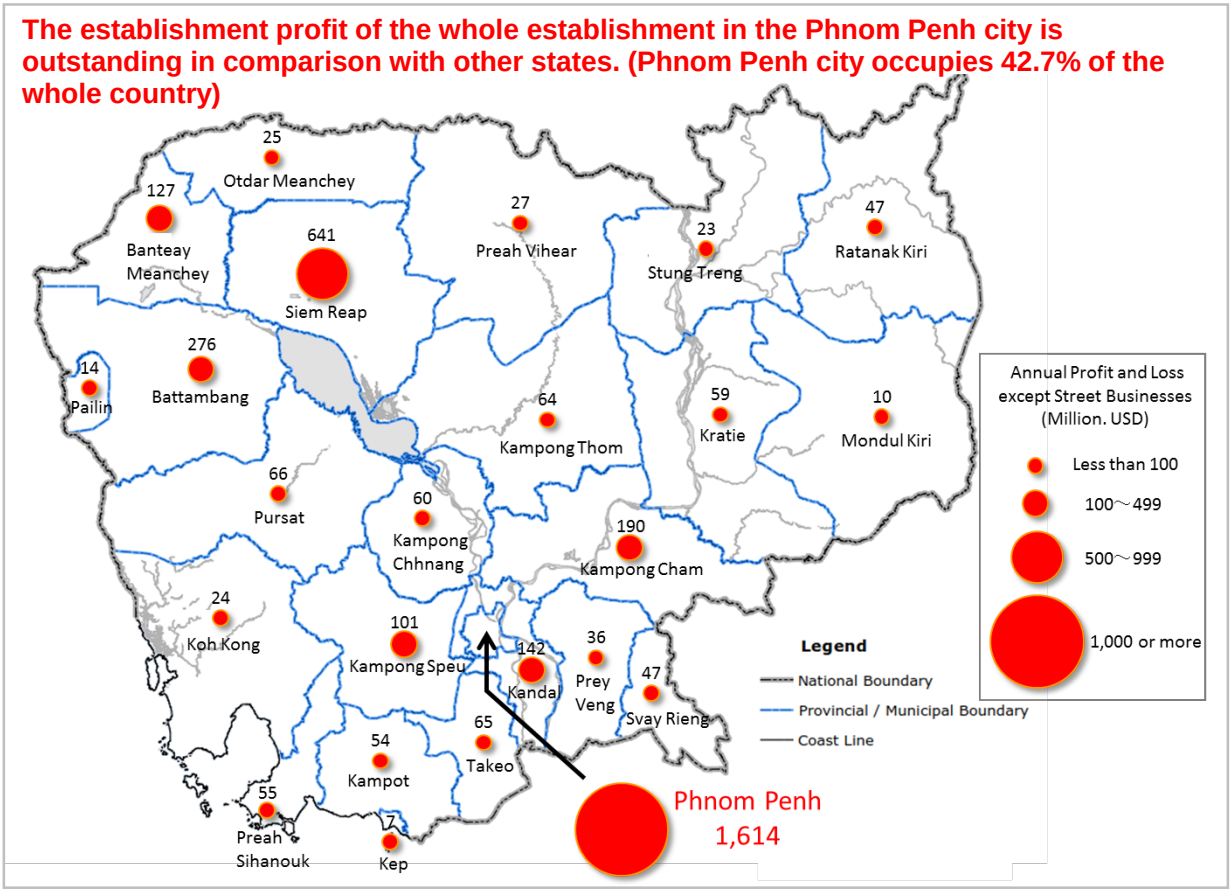
＊2 Overview of Urban Development in Phnom Penh Capital City, Urbanization Division, Phnom Penh Capital Hall

Table 2.3.3-2 Cambodia's Second National Communications(MoE、Nov.2015)
Maximum reduction of CO_2 compared to baseline emissions

[$GgCO_2$-eq]

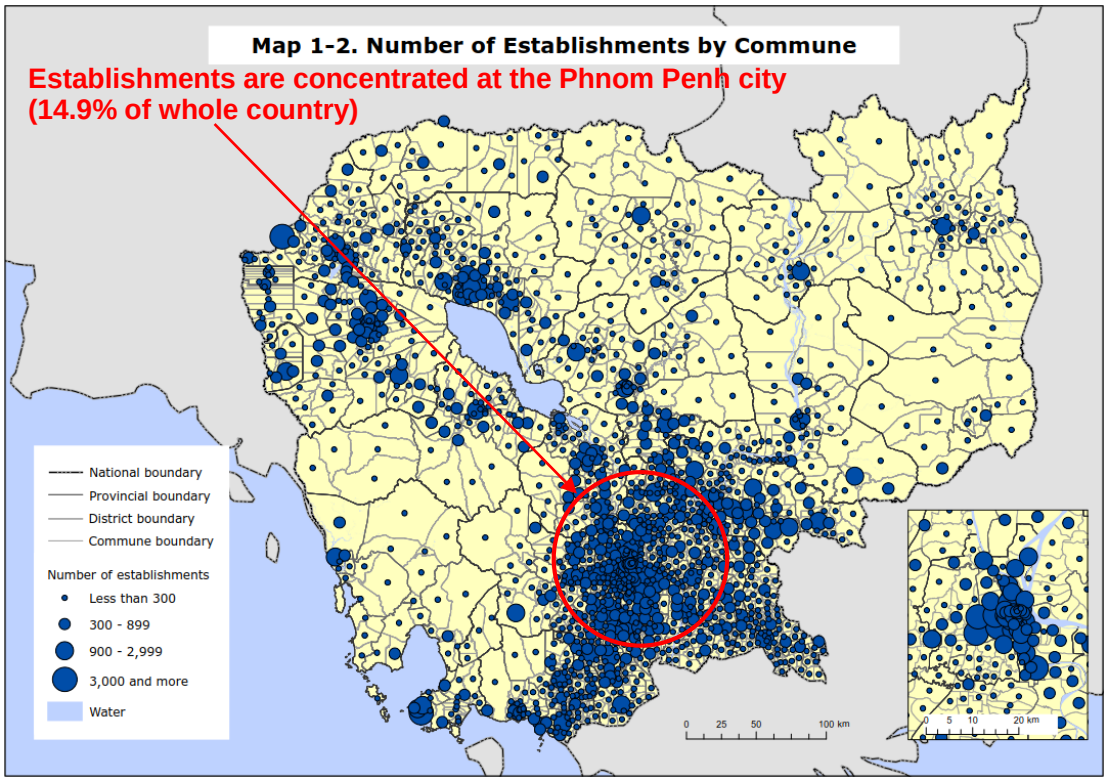
Year	2010	2015	2020	2025	2030	2035	2040	2045
Total Baseline Emissions	5,533	5,987	7,551	9,601	11,599	14,043	17,075	20,848
Energy Industries								
Grid Connection REEs	3	12	30	51	80	106	140	172
Grid Connection Auto Producers	18	152	269	268	309	354	430	492
Grid Connection Battery Charging Stations		5	12	16	16	14	12	10
Solar Power Plant	0	0	1	2	5	9	18	36
Solar Home Systems	0	6	16	22	22	19	16	12
Mini and Micro Hydro		2	3	4	4	4	4	4
Rice Husks for Electricity Generation	27	67	167	417	445	463	481	498
Energy efficiency end users	22	55	138	344	592	797	1,002	1,264
Energy efficient buildings	50	85	193	285	354	443	557	702
Sub Total Savings	**120**	**384**	**829**	**1,409**	**1,826**	**2,210**	**2,659**	**3,191**
% savings compared to Baseline	2%	6%	11%	15%	16%	16%	16%	15%
Manufacturing Industries								
Rice milling ,Garment, Rice Mills, Brick Works	326	373	429	497	580	681	803	953
Biofuel	13	32	79	147	147	147	147	147
Sub Total Savings	**339**	**405**	**508**	**644**	**727**	**828**	**950**	**1,100**
% savings compared to Baseline	6.1%	6.8%	7%	7%	6%	6%	6%	5%
Transport Sector								
Hybrid Cars			2	6	15	37	92	229
Motor Vehicle Inspection	62	154	192	238	297	369	461	574
Electric scooters and Bicycles	4	9	22	54	78	95	116	141
Sub Total Savings	**66**	**163**	**216**	**298**	**390**	**501**	**668**	**944**
% savings compared to Baseline	1.2%	2.7%	3%	3%	3%	4%	4%	5%
Other Sectors								
Efficient Cookstoves, Biodigesters, Water Filters	3	7	17	39	96	136	160	170
Solar Lanterns	0.6	6.2	31	56	50	44	44	44
Wind Water Pumping	0.0	0.4	3	5	9	11	14	16
Sub Total Savings	**4**	**14**	**51**	**100**	**155**	**191**	**218**	**230**
% savings compared to Baseline	0.1%	0.2%	0.7%	1.0%	1.3%	1.4%	1.3%	1.1%
Total Savings	**528**	**966**	**1,603**	**2,452**	**3,098**	**3,730**	**4,495**	**5,465**
% savings compared to Baseline	9.5%	16.1%	21%	26%	27%	27%	26%	26%

Source: Cambodia's Second National Communications(MoE、Nov.2015)



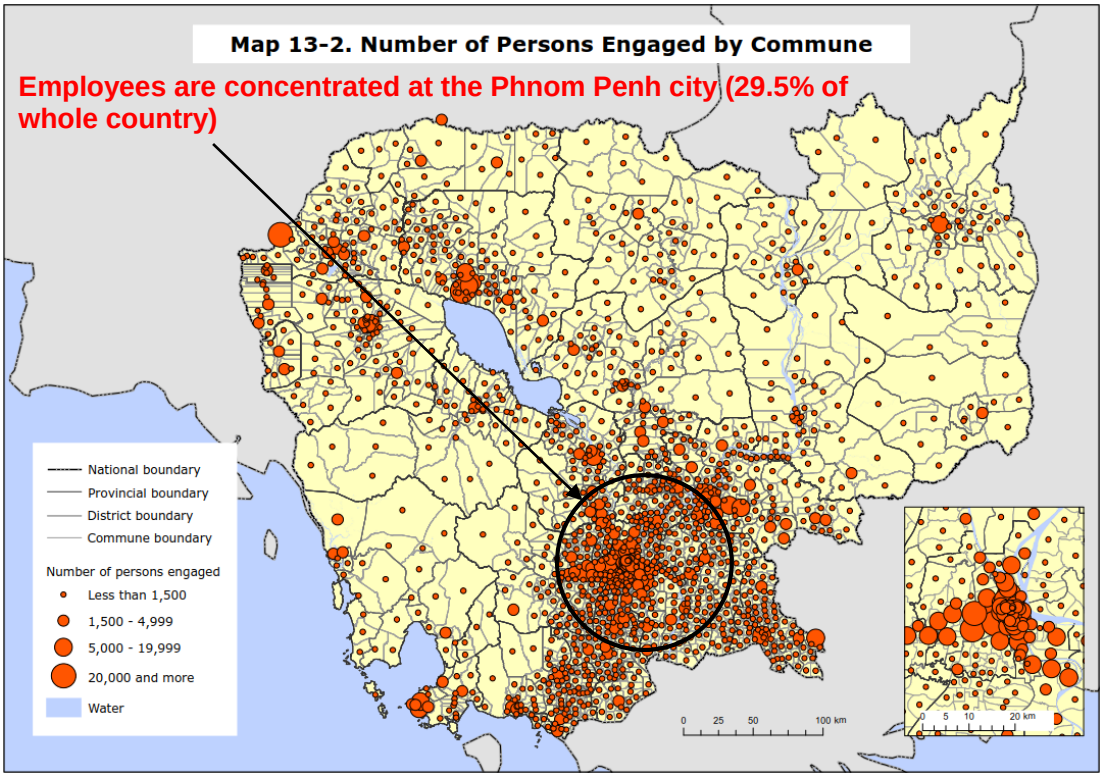
Source: http://www.stat.go.jp/info/meetings/cambodia/e11f0mp1.htm

Fig. 2.3.3-1 Annual Profit and Loss except Street Businesses by Provinces of Cambodia (2014)



Source: http://www.stat.go.jp/info/meetings/cambodia/e11f0mp1.htm

Fig. 2.3.3-2 Distribution of the number of the Cambodian Establishments (2011)



Source:http://www.stat.go.jp/info/meetings/cambodia/e11f0mp1.htm

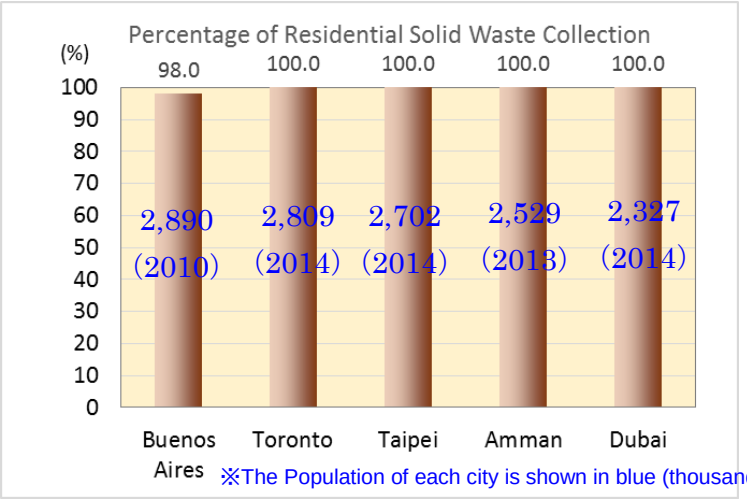
Fig. 2.3.3-3 Distribution of the number of the Cambodian Persons Engaged (2011)

(3) Waste collection ratio and waste recycling ratio

The collection ratio for household solid waste in cities of the same scale as the future population of Phnom Penh (2020: 2,406,000 people; 2035: 2,868,000) is essentially 100%.※

Phnom Penh will work to also achieve a municipal solid waste collection ratio of 100% by 2035, and for the waste recycling ratio as well, they will work toward a ratio of more than 95%.

（Source: World Council on City Data Open Data Portal , http://open.dataforcities.org/）



Source: World Council on City Data Open Data Portal , http://open.dataforcities.org/）

Fig. 2.3.3-4 Percentage of Residential Solid Waste Collection

(4) Renewable energy amount

Cambodia's Second National Communications (MoE, Nov.2015) states the GHG reduction amount due to renewable energy for the entire country. This entire country GHG reduction amount was multiplied by the Phnom Penh income ratio (42.7%) to obtain the numerical goal.

Table 2.3.3-3 GHG reduction amount (BaU ratio) due to use of renewable energy

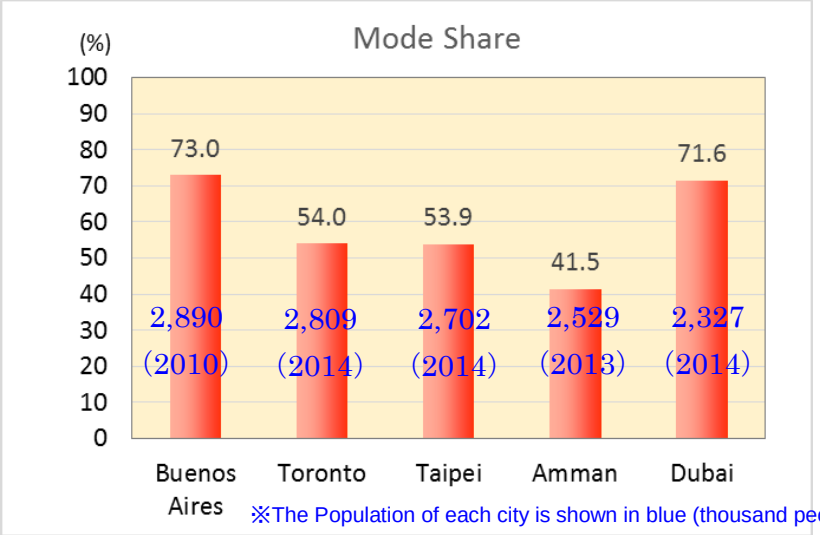
Item	Entire country CO_2 reduction amount ($GgCO_2$)		Phnom Penh CO_2 reduction amount ($GgCO_2$)	
	2025	2035	2025	2035
Solar Power Plant	2	9	0.9	3.8
Solar Home Systems	22	19	9.4	8.1
Mini and Micro Hydro	4	4	1.7	1.7
Biofuel	147	147	62.8	62.8
Solar Lanterns	56	44	23.9	18.8
Wind Water Pump	5	11	2.1	4.7
Total	236	234	**100.8**	99.9

(5)Share of Public transport

Based on the project for comprehensive urban transport plan in Phnom Penh Capital City (Dec. 2014), we set the target value for 2035 to 30%.

As a reference, the share of public transport in cities of the same scale as the future population of Phnom Penh (2020: 2,406,000 people; 2035: 2,868,000) is around 40 to 70%.

（Source: World Council on City Data Open Data Portal , http://open.dataforcities.org/）



Source: World Council on City Data Open Data Portal , http://open.dataforcities.org/）

Fig. 2.3.3-5 Percentage of Commuters traveling to work by a travel mode other than a personal vehicle

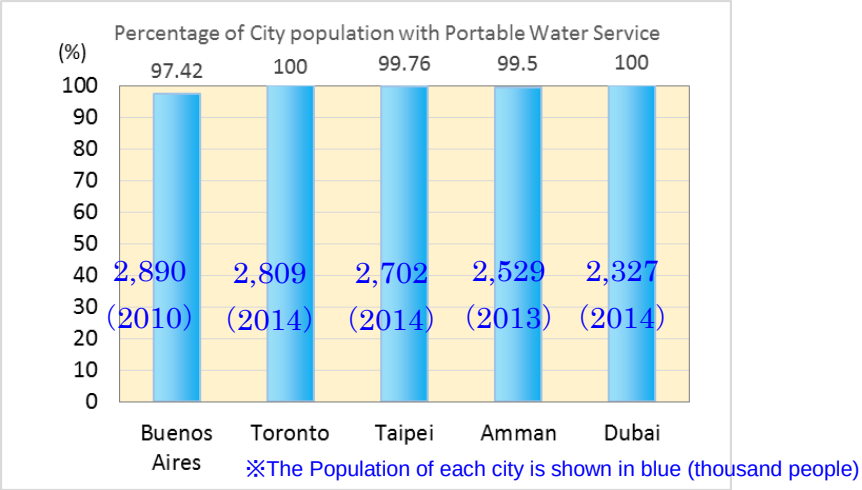
(6) Ratio of potable water direct from water supply taps

The major part of Phnom Penh is supplied with water by the Phnom Penh Water Supply Authority. In the area under the jurisdiction of the Phnom Penh Water Supply Authority, the waterworks water supply

penetration rate has reached approximately 85% (as of May 2016). Phnom Penh city should work to achieve 90% by 2023 and 100% by 2035.

For reference, it shows the water penetration rate of cities of the same size as the future population of Phnom Penh (2020: 2,406,000 people, 2035: 2,868,000 people). Every city is almost 100%.

（Source: World Council on City Data Open Data Portal , http://open.dataforcities.org/）



Source: World Council on City Data Open Data Portal , http://open.dataforcities.org/）

Fig. 2.3.3-6　Percentage of City Population with Potable water service

(7) Urban Green area

The urban green area per person of Phnom Penh is 1.1m^2, which is extremely small when compared to the world's major cities. In Japan's green policy outline, as the long-term goal, the area of the city park etc. per inhabitant is set to 20 m^2 (target year: early 21th century). The area of urban green areas in Phnom Penh, as well as Japan, is set to 20 m^2 / person as a long-term target until 2035.

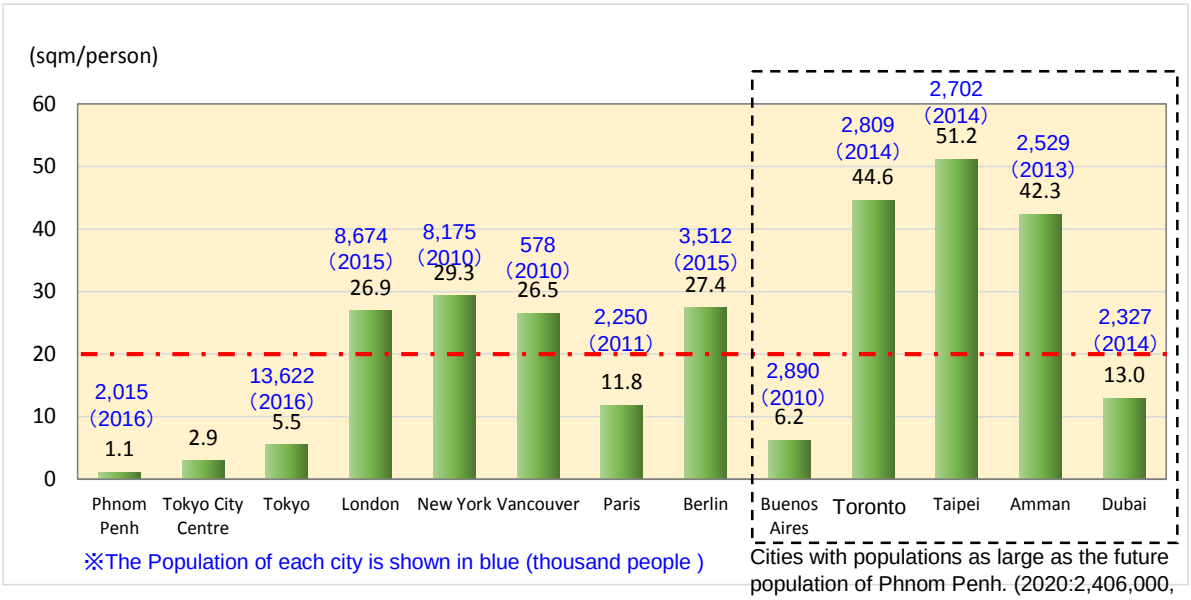


Fig. 2.3.3-7　Urban Green Area per Population

Source:
+Phnom Penh, Tokyo, London, New York, Vancouver, Paris, Berlin: PPUTMP Project Team based upon the data from MLIT, Japan
+Buenos Aires, Toronto, Taipei, Amman, Dubai: World Council on City Data Open Data Portal , http://open.dataforcities.org/

2.3.4 Promotion system

(1) Creation of a new organization for plan promotion

Since this plan spans diverse themes and since cooperation and coordination with relevant agencies of the central government is necessary, a new organization (new department) for climate change and promoting this plan will be established to centrally oversee the promotion of this plan and carry out the creation of organizations that can consistently implement the plan.

(2) Development of human resources with an eye on realizing an environmental capital

Steady implementation of this plan requires a large number of personnel who are familiar with environmental policies. In order to realize becoming an environmental capital which is the aim of this plan and to become a model for the environmental policies of other states as the capital of Cambodia, the development of environmental policy professionals will be promoted in a planned and organized manner. The responsibility for this shall be a cooperative effort between the new department described above and the personnel management department.

(3) Securing important financial resources for promotion of the plan

Regarding important financial resources for plan promotion, not only will requests be made to the central government, private sector know-how and funds will be actively utilized through methods such as PPP (Public Private Partnerships), etc. from the viewpoint of environmental business development. In addition, by gaining approval of this plan as the formal plan of the capital, it can be utilized as the basis for receiving support from various international organizations. For this issue, the Finance Department shall take main responsibility, and shall cooperate with the new department in striving to secure financial resources.

(4) Understanding trends in relevant state-of-the-art technologies and their applications

In order to improve and resolve the problems and issues faced by each sector, the new department shall gather information, application examples, etc. of relevant state-of-the-art technologies and work to understand their trends. Furthermore, it shall investigate applicable technologies and provide information to related organizations in a timely manner.

(5) Providing and sharing of information

In order to carry out this plan more effectively and efficiently, the content of this plan and its progress status shall be made available to businesses, citizens, NGOs, NPOs, etc. by utilizing various media such as TV, the internet, etc. with the aim of providing and sharing of information. The main responsibility for this issue shall rest with the Public Relations and International Affairs Department, which shall work in cooperation with the new department.

2.3.5 Roles of each principal

(1) Government

- The government shall promote the development of infrastructure such as waste management, sewerage, roads, etc. which form the backbone of urban development, shall implement specific measures in each sector based on this plan in a planned and consistent manner, with the aim of achieving sustainable development for the realization of an environmental capital.
- The government shall fully explain to businesses and citizens the importance of environmental consciousness, shall make known the content, effects, and progress status of the measures positioned for implementation under this plan, and shall encourage the active participation and cooperation of businesses, citizens, etc.
- Furthermore, the government shall support the environmental protection activities (for example, cleanup activities in the capital, etc.) and environmental learning of businesses and citizens through provision of places, opportunities, funds, etc.
- The environmental improvement effects of measures which are relevant for businesses and citizens shall be publicized to businesses and citizens using examples of actual initiative results to promote their understanding in an effort to create an environment for obtaining further cooperation.

(2) Businesses

- For businesses, it is necessary that they properly understand that their consumption of large amounts of energy and discharge of waste, exhaust gases, wastewater, etc. in their production activities leads to deterioration of the living environment of citizens and the natural environment.
- Therefore, businesses shall not just pursue economic benefits and efficiency in their production activities but shall also review their production processes in accordance with laws and regulations, and shall convert to production processes that minimize environmental loads as much as possible.
- The environmental consciousness of businesses shall in the end increase the value of products and the trust of society toward businesses, and lead to the sustainable development of businesses themselves.

(3) Citizens

- For citizens, it is first necessary that they fully understand that their own daily activities and behavior have effects on their own living environment and the natural environment, in other words, that each individual citizen is part of the cause.
- With this awareness, they shall practice activities which will lead to improvements in public health and living environment (Eco Life) as citizens of an environmental capital, with their responsibility to pass down a good environment to future generations.

・Furthermore, citizens shall bear their fair share of costs (processing costs, etc.) related to waste disposal, rainwater/household wastewater treatment, etc. performed by public facilities.

■Eco Life

1) Waste reduction, reuse, and recycling (Promotion of waste 3R)
2) Utilization of ecological products and energy-conserving appliances.
3) Practice of energy-conserving activities (saving power, etc.)
4) Utilization of public transportation facilities such as buses, etc.
5) Participation in environmental learning activities
6) Urban cleanup activities
7) Participation in volunteer activities such as environmental awareness, etc.
8) Improving manners, etc.

(4) Others (tourists, etc.)

・Recently, the number of domestic and international tourists and business visitors to Phnom Penh has been increasing, and economic activities are intensifying. On the other hand, the environmental loads from these activities have also been increasing, and it is necessary to reduce their effects as much as possible.
・In order to preserve the living environment, natural environment, and tourism resources of Phnom Penh, it is necessary to also ask visitors to bear some costs in the form of facilities fees or tourist taxes which will be used as financial resources devoted to infrastructure development, etc.

2.4 Tasks and Specific Measures by Field

2.4.1 Composition of specific measures

We propose the specific measures to be implemented to achieve the goals as follow.

Table 2.4.1-1 Composition of specific measures by Field (1/2)

Field	Specific measure
Waste	1.Creation of waste management master plan 2.Improvement of collection/transportation 3.Implementation of model project for household garbage sorting/reduction 4.Establishment of "Garbage bank" 5.Introduction of waste power generation as intermediate treatment 6.Proper treatment at final disposal site 7.Recycling of electrical and electronic waste (E-waste) 8.Recycling of industrial waste 9.Proper treatment of industrial wastes 10.Awareness-raising activities and human resource development for sorting and 3R
Energy	1.Energy conservation projects and projects to promote the introduction of renewable energy targeting offices and commercial facilities 2.Energy conservation projects and projects to promote the introduction of renewable energy targeting public facilities 3.Promotion of energy conservation and the introduction of renewable energy targeting factories 4.Promotion of energy conservation and introduction of renewable energy targeted residents in the city 5.Mega-solar power generation projects 6.Development of educational projects to expand energy conservation activities 7.Stable and high quality power supply 8.Promotion of the introduction of a fixed purchase price system for renewable energy
Transportation	1.Introduction of public transportation systems and development of transportation hubs 2.Effective use of existing public transportation, such as railways and water transportation 3.Road development 4.Introduction of traffic management facilities 5.Development of comfortable pedestrian space 6.Mobility management 7.Increasing efficiency of logistics 8.Measures against air pollution and vibration, or reducing CO2 emissions, etc. 9.Roadway plan integrating waterworks development plan and waste collection plan 10. Establishment of appropriate transportation-related city organizations
Waterworks/ sewerage/ rainwater drainage	1.Introduction of public transportation systems and development of transportation hubs 2.Effective use of existing public transportation, such as railways and water transportation 3.Road development 4.Introduction of traffic management facilities 5.Development of comfortable pedestrian space 6.Mobility management 7.Increasing efficiency of logistics 8.Measures against air pollution and vibration, or reducing CO2 emissions, etc. 9.Roadway plan integrating waterworks development plan and waste collection plan 10. Establishment of appropriate transportation-related city organizations

Table 2.4.1-1 Composition of specific measures by Field (2/2)

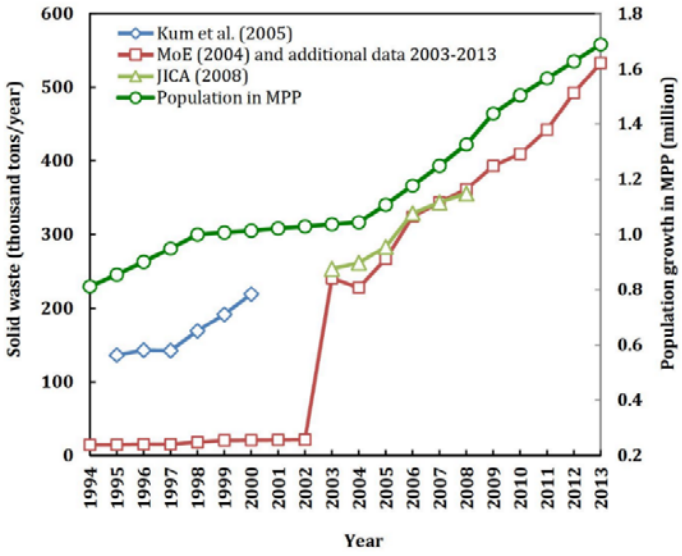
Field	Specific measure
Environmental conservation	1.Formulation and appropriate operation of environmental plans 2.Promotion of environmentally conscious city development 3.Development of air quality monitoring system 4.Setting of environmental standards related to noise and vibrations, 5.Expansion of vehicle exhaust gas regulations 6.Periodic performance of water quality monitoring 7.Proper management of industrial wastewater 8.Preservation of valuable ecosystems
Green production	1.Promotion of industry diversification and high added value 2.Promotion of green production 3.Nurturing of small- and medium-scale businesses 4.Sales of environmentally friendly products 5.Development of green agriculture 6.Effective utilization of biomass emitted from agriculture and raising of livestock 7.Popularization of green tourism

2.4.2 Tasks and Specific Measures in Waste Field

2.4.2.1 Waste/Current status and tasks

(1) Solid wastes (household + business wastes)

- Waste-related projects are being conducted by various donors including international development aid organizations from various countries, but the results have not been improved. It is important to understand that for waste management, the issue must be looked at as the entire system from sorting/reduction at household disposal level, collection/transportation, intermediate treatment, and final disposal, and partial approaches will not lead to radical solutions. Because of this, the creation of a master plan for waste disposal is urgently required.
- Priorities for waste management are firstly the suppression of waste generation, followed by reuse/recycling and utilization as an energy resource, with landfill disposal as a last resort, and it is necessary to aim for the creation of a recycling society through these efforts.
- In August 2015, the “Ordinance concerning solid waste management in urban area" was issued, in which solid waste was separated into the two types of general waste and hazardous waste, and it was clarified that solid waste was the responsibility of district administrative authorities which are the basic local government. For waste management, the ordinance stipulated sorting of waste, collection/transportation, and recycling, and in addition, also included monitoring of final disposal sites.



Source: ITC Report, 2015

Fig. 2.4.2.1-1 Trends of solid waste and population over time

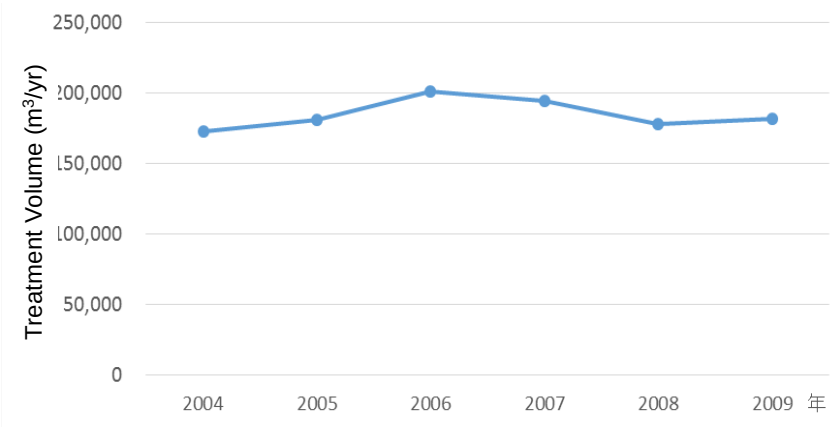
・In 2002, Phnom Penh and CINTRI concluded a 49-year concession agreement for collection/transportation. As a city, Phnom Penh recognizes that there are areas where collection is not performed or where the collection service is insufficient. On the other hand, CINTRI emphasizes that the contract between the company and the city covers only those districts with paved roads and that the waste collection coverage is approximately 80%, with the remaining 20% being districts which have been newly absorbed into the city and in which the roads are not paved, so that such districts are not subject to the collection agreement. In order to solve this problem, the document exchanged between Phnom Penh's 12 districts and CINTRI based on Ordinance 113 is not an agreement on collection/transportation, but the contents are related to garbage collection plans, road cleaning, and transportation methods, and only part of the authority is delegated to the districts.

・Based on the disposal amount at Dangkor Landfill, the only final disposal site in Phnom Penh, the amount of waste generated in the city in 2013 was 1,550 t per day, and it is estimated that by 2015 it will reach 2,000 t per day because of population increases and expansion of collection areas due to the transfer of some regions from Kandal State to the capital. The amount of generated waste has increased almost 2.5 times from the 800 t at the time the disposal site was established in 2009. This trend is expected to continue in the future, so reducing waste generation and reducing the amount brought to the disposal site is an urgent issue.

・Although sorting of waste is not done, for a fee Ejay (a valuable material recycling agent) will collect cans, bottles, PET bottles, etc. from the garbage put out on the side of the road in front of each house. However, when garbage brought to the disposal site was checked, not only is there vinyl materials and plastics in the mainly raw household garbage, but also fairly large amounts of cans, bottles, PET bottles, etc. mixed in.

(2) Hazardous waste (including industrial wastes)

・Under the "Ordinance concerning solid waste management in urban area", waste would be separated into general waste and hazardous waste, and hazardous waste other than medical waste would be accepted solely by Salom Trading Company with the approval of the Ministry of the Environment. The actual situation of industrial waste treatment and disposal is not grasped, and ensuring traceability using a manifest system, etc. is important.



Source: Document of MOE, 2010

Fig. 2.4.2.1-2　Trend of industrial waste treatment volume

・The industrial structure of Cambodia is at the stage focused mainly on light industry and there is little industrial waste requiring sophisticated treatment, but it is important to not just perform treatment and disposal but also to promote utilization of emitted industrial wastes through industrial waste resource recovery and conversion to resources, such as conversion to fuel for cement plants, etc.

・According to a survey by the United Nations University, the per-person generation of electrical and electronic waste (E-waste) in East Asia and Southeast Asia in 2015 was about 10 kg, but in Cambodia it was 1.10 kg and in Vietnam, 1.34 kg. The Cambodia government is expecting rapid increases in the future due to economic growth and in addition to starting work on formulating laws concerning E-waste, they are also taking measures to prohibit the importation of E-waste and the importation of used electrical and electronic equipment. However, treatment is performed mainly by the informal sector, and the current situation is far from proper treatment.

・In 2008, the "Ordinance concerning medical waste management" was issued, and although the system is that hospitals and clinics would separate medical waste from garbage and store it for a certain period of time, and it would then be collected by the Red Cross, problems such as hospitals and clinics disposing of medical waste together with general garbage have also been found. In addition, there is no system for separation and collection of mercury-containing fluorescent lamps from general garbage, and there is also a fear of contamination of the final disposal site.

(3) Educational activities for citizens

・Although the cooperation of citizens is indispensable for promoting suppression of waste generation, recycling and reuse as resources, sorting and 3R, etc. educational activities are insufficient for citizens.

Photo. 2.4.2.1-1 D'Angkor Landfill

Source: Document of MOE, 2010

Photo. 2.4.2.1-2 Final industrial waste disposal site in operation

2.4.2.2 Waste/Introduction of efforts in Kitakyushu

■How to reduce household waste in Kitakyushu

New recycling system was carried out

1. Carried out plastic container recycling


(1993)


(1997)


(2006)

45 liter	20 ¢
25 liter	12 ¢

2. Increased the price of designated garbage plastic bag.

45 liter	15 ¢

45 liter	50 ¢
30 liter	33 ¢
20 liter	22 ¢


(Until 2006)


(2006)

45 liter garbage plastic bag
Average Weight : 6 kg/one bag
Treating cost : 2.5US$/one bag
(Collection and Incineration)

■Waste reduction civil awareness appears

26% reduction


Before


After

■Development of Waste management Project in Surabaya

We achieved a reduction of over 30% in household waste.

We launched the waste management project in 2004 in Surabaya, Indonesia's second largest city with a population of three million. The project entailed proactive steps to encourage residents to compost the organic matter that comprises over half of Surabaya's total waste. As a result of the project, more than 20,000 households now have composting baskets and more households are separating their rubbish into different types, leading to a reduction of over 30% in annual volume of household waste.

City in 2001
Streets overrun by garbage

Surabaya's streets today
Increased greenery in parks and along roads using compost

■Social and Environmental Impact Caused by the Promotion of Composting Practices

A cockroach infested in raw garbage.

Kitchen waste hung on a wall until a collection day.

Hygienic composting of kitchen waste at each household.

Composting the kitchen waste hygienically at each household.

A street before implementation of the project.

Streets lined with trees and plants as a result of using compost.

Streets became green using compost.

Income generation from the sale of compost, as well as plants and vegetables grown using compost. Job creation at composting centres.

Employment at composting centres.

Growing and selling herbs and plants using compost.

Growing and selling vegetables using compost.

Purchasing compost produced at households.

Selling compost products.

■Taking on the Challenge of a Resource Recycling SocietyKitakyushu Eco-Town Project

Japan's Largest Eco-Town(Recycling Park)

【Automobile recycling】

1997: Certified 1998: Operations start
Number of business facilities:24
Number of research institutes: 10

【R&D on recycling technologies for photovoltaic power generation systems】

【Recovery and treatment of rare metals 】

- **Investment: Approx. JPY 71.4 billion**
- **Employees: Approx. 955**
- **Visitors: Approx. 1.52 million (1998 to Nov 2016)**

【Recycling of fluorescent tubes】

■Recycling of Electrical and Electronic Waste (Nippon Magnetic Dressing Co., Ltd.)

Nippon Magnetic Dressing has developed technologies for the concentrated recovery of rare and precious metals (secondary treatment) from household waste electronic circuit boards, mobile phones, and small electronic devices, and started plant operations in Kitakyushu Eco-Town in May 2012. As part of this project, Nippon Magnetic Dressing imports waste electronic circuit boards from overseas with the aim to treat this waste together with electronic waste in Japan.

India

In order to prevent the improper recovery of rare metals that may have adverse impacts on health and the environment, waste electronic circuit boards, such as computers, started to be imported to Japan which possesses proper advanced recovery technologies

Viet Nam

Expansion of recycling of electrical and electronic equipment waste, such as mobile phones and computers that generate large amounts of waste due to the rapid introduction of new products.

Philippines

Installation of collection boxes in communities and large-scale commercial facilities in Cebu and Manila for small electrical/electronic household waste, such as cell phones, and implementation of collection projects with the participation of the public.

Import of electrical and electronic waste from India and Viet Nam are the first cases in the world under the Basel Convention.

Business Scheme

2.4.2.3 Waste/Specific Measures

Based on the issues in the waste field, specific measures in this field were set up as shown in the table below. The Implementing entity, timing of implementation and evaluation index of each specific measure were also set.

Table 2.4.2.3-1 Waste/Specific Measures (1/3)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
1.Creation of waste management master plan	A waste management master plan will be created in order to construct a waste management system consisting of sorting/reduction at household disposal level, collection/transportation, intermediate treatment, and final disposal and promote proper treatment of wastes from a comprehensive perspective.	PPWMD	Medium to long term	
2.Improvement of collection/transportation	In order to perform management appropriately for collection of waste suppliers and transportation suppliers, delegation of authority is promoted to the ward, area without collecting and transporting waste is dissolved. The service to the metropolitan citizens is improved by these actions.	PPWMD	short-term	Waste Collection Rate
3.Implementation of model project for household garbage sorting/reduction	In order to promote sorting/reduction at the household disposal level, proper sorting of household garbage and popularization of raw garbage composting will be performed in a model district.	Same as above	short-term	Waste Recycle Rate Amount of GHG reduction
	A regional composting center will be established as a composting center for raw garbage generated by markets and pruned branches, leaves etc. from trees along city streets. In addition, it will also be a base for incentivized collection of compost generated by households.		short-term	
	The model district will be gradually expanded and sorting/reduction will be promoted throughout Phnom Penh, and work will be performed on creation of the above waste management master plan concept.		mid-long term	

※Establishment of mechanism for employing waste pickers who make a living collecting valuable materials at composting centers or garbage banks. Such a system may lead to supporting the economic independence and preventing health hazards of waste pickers.

PPWMD : Phnom Penh Waste Management Division

Table 2.4.2.3-1 Waste/Specific Measures (2/3)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
4.Establishment of "Garbage bank"	In order to promote community-level separation and recovery of valuable materials such as PET bottles, cans, bottles, metals, plastics, etc. generated from households and other sources, a "Garbage bank" will be established.	PPWMD Private Company	short-term	Waste Recycle Rate
5. Introduction of waste power generation as intermediate treatment	For handling the increasing quantities of municipal garbage, there are limits to using landfill disposal alone, and in order to promote volume reduction through intermediate treatment, waste power generation projects will be introduced. There are methods for generating power using steam generated through waste incineration in a stoker furnace or utilizing methane gas generated by separating out raw garbage only, so investigations will be conducted for introduction of the most suitable facilities taking into consideration regional characteristics.	PPWMD Private Company	mid-long term	Disposal amount of Waste Amount of GHG reduction
6. Proper treatment at final disposal site	At the current Dangkor final disposal site, constant monitoring and proper treatment is performed to prevent environmental contamination from leached water, etc. Furthermore, in constructing the next disposal site, it will be changed to a sanitary landfill with the aim of reducing environmental impact.	PPWMD	mid-long term	Disposal amount of Waste Amount of GHG reduction
7.Recycling of electrical and electronic waste (E-waste)	The country is urged to prepare laws regarding electrical and electronic waste (E-waste) to shift from informal sector handling to proper treatment and recycling of E-waste will be performed by businesses approved by the country	PPWMD	mid-long term	Waste Recycle Rate Recycle Rate
8.Recycling of industrial waste	Together with utilizing industrial waste by converting it to fuel for cement plants, production of roadbed material from construction waste or fuel from sludge will also be performed to facilitate industrial cycles.	PPWMD Private Company	mid-long term	Waste Recycle Rate Recycle Rate
9..Proper treatment of industrial wastes	In order to properly treat hazardous waste such as mercury-containing fluorescent lamps, businesses that can perform proper treatment of hazardous wastes will be nurtured.	MOE PPWMD	mid-long term	Disposal amount of Waste Amount of GHG reduction

PPWMD : Phnom Penh Waste Management Division, MOE: Ministry of the Environment

Table 2.4.2.3-1　Waste/Specific Measures (3/3)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
10. Awareness-raising activities and human resource development for sorting and 3R	・Practicing of environmental education at elementary schools, etc. and training of teachers for that purpose. ・To promote educational activities for sorting and 3R, practicing of environmental education at elementary schools, etc. and training of teachers for that purpose will be performed. In addition, environmental education at the regional community level will be carried out in collaboration with private businesses, NGOs, NPOs, etc.	PPWMD NGO NPO	short-term	The Number of Training and trainees

PPWMD : Phnom Penh Waste Management Division,　MOE: Ministry of the Environment

Encouragement of composting the kitchen waste in Surabaya, Indonesia

Kogasaki Incineration power plant(Kitakyushu City)

Source：http://www.kitaq-ecotown.com/

Eco Center of Kitakyushu city
（Base of enlightenment activity）

2.4.2.4 Pilot Project in waste field 1 (Municipal waste reduction and recycling (Step 1))

This project is intended to promote waste recycling and reduction in a model district under governmental guidance with the cooperation of residents and resident organizations. Thereafter, the model district will be gradually expanded throughout the city.

(1) In the model district, composting of household waste will be popularized through suitable sorting of municipal waste.

(2) Distribution of household-generated compost shall also be an objective, and compost centers targeting markets, etc. which produce regular quantities of raw garbage will be constructed.

(3) In local communities, garbage banks will be constructed to promote the sorting and collection of valuable substances such as plastic, cans, bottles, metals, etc. generated by households, etc.

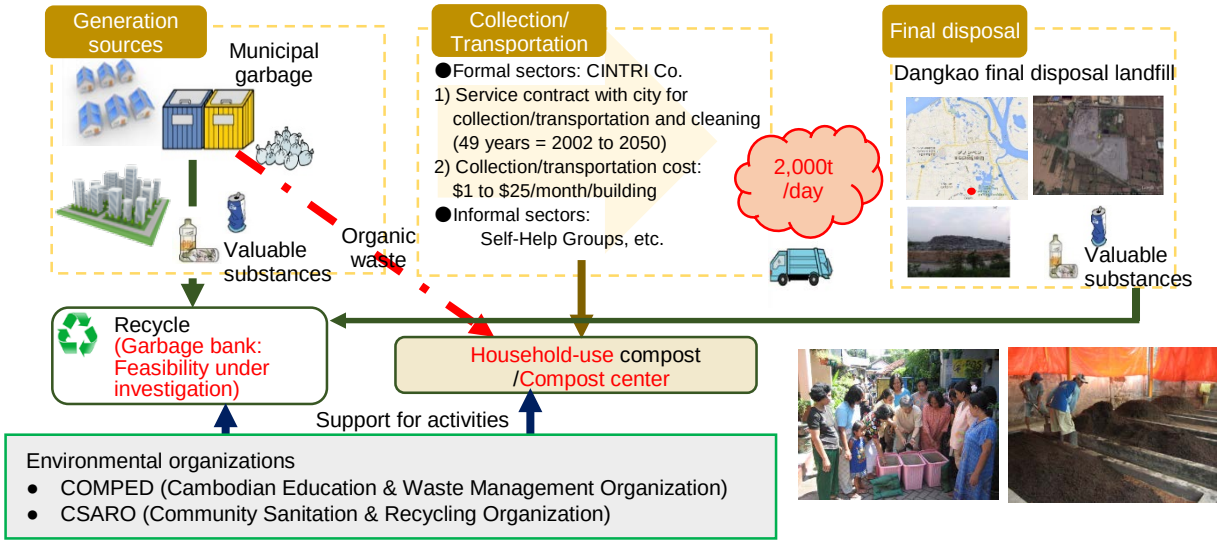


Fig. 2.4.2.4-1 Overview of Pilot Project in waste field (1)

2.4.2.5 Pilot Project in waste field 2 (Introduction of waste power generation for municipal waste (Step 2))

- The amount of generated waste has increased to nearly 2.5 times the 800t amount at the time that the disposal landfill opened in 2009, and since this trend is expected to continue in the future, reducing the amount of generated waste together with reducing the amount of waste transported to the disposal landfill has become an urgent issue.
- Because of this, focus has also been placed on a waste power generation project (with introduction of a 500t incinerator as the first step) for intermediate waste processing to promote optimization of waste management with an integrated approach.

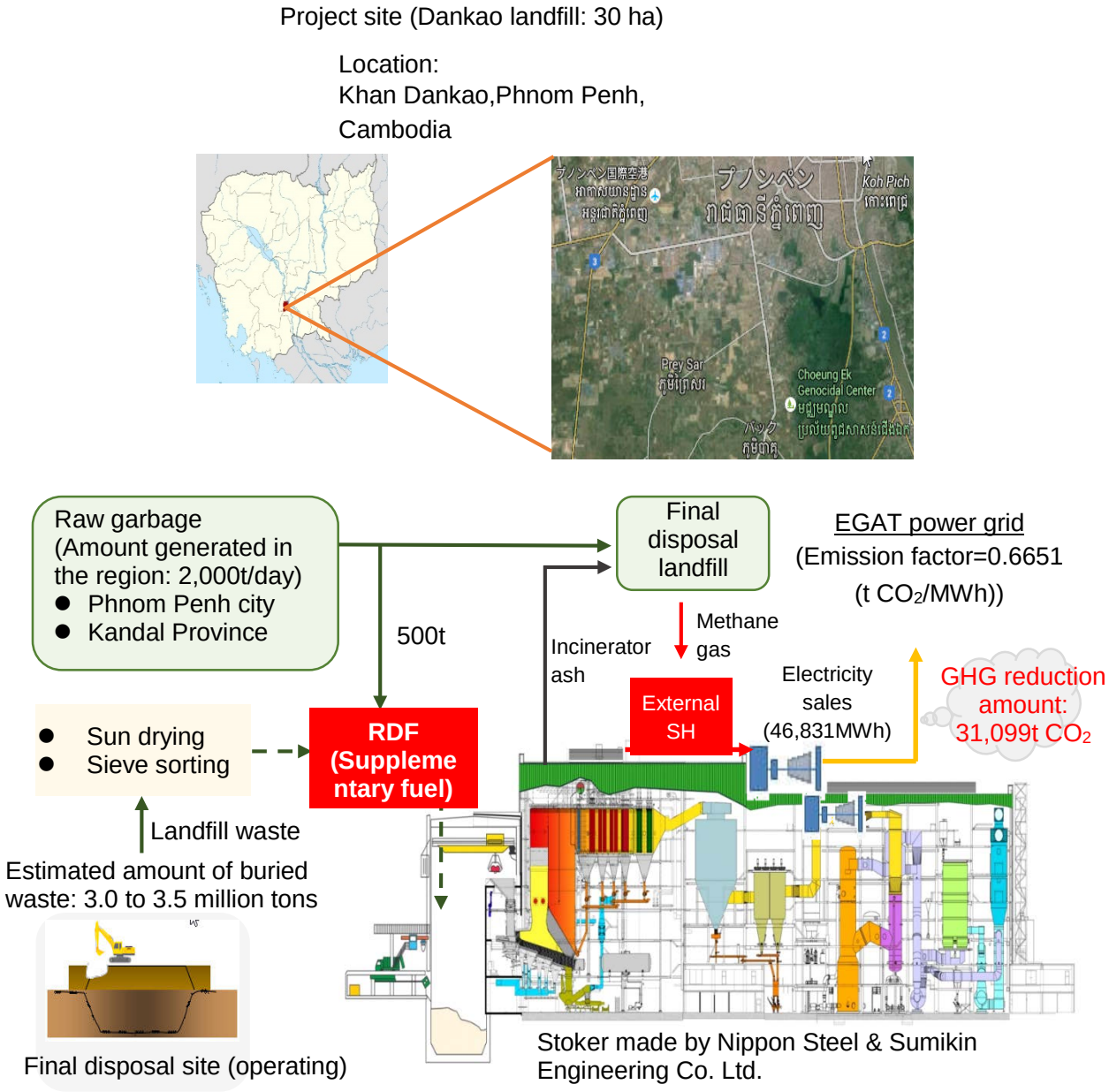


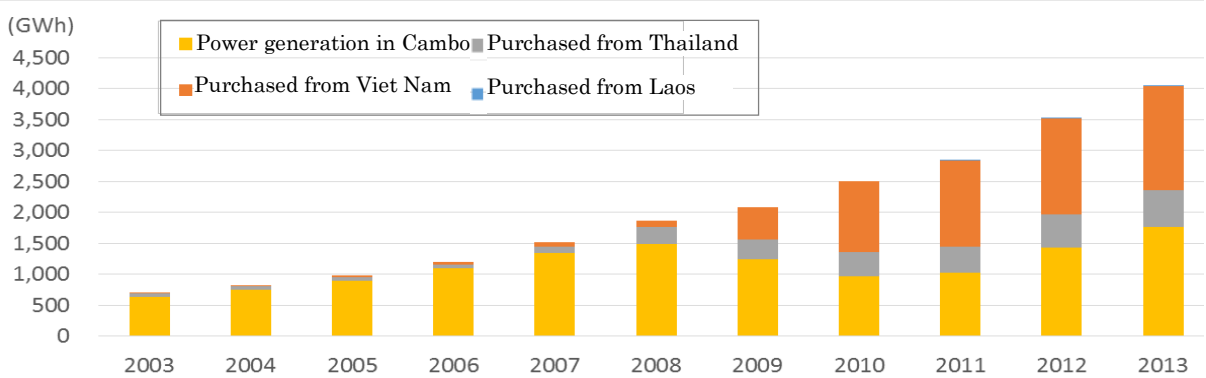
Fig. 2.4.2.5-1 Overview of Pilot Project in waste field (2)

2.4.3 Tasks and Specific Measures in Energy Field

2.4.3.1 Energy/Current status and tasks

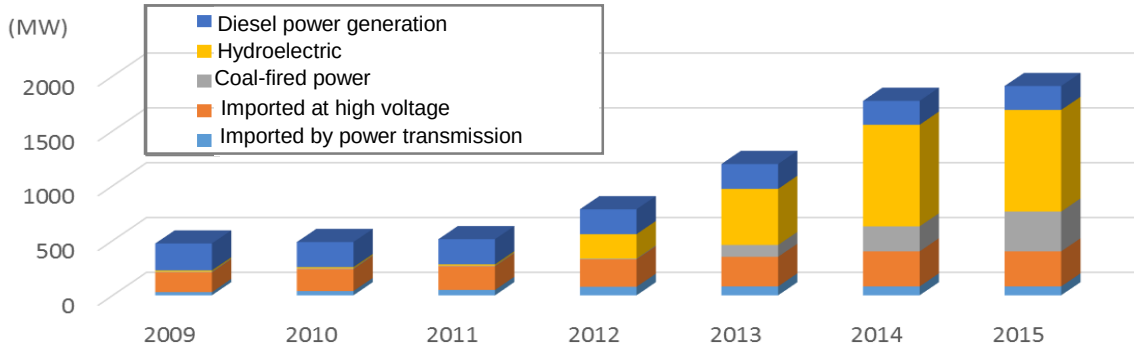
(1) Power Supply Status

- Cambodia imports electric power from Vietnam, Laos, and Thailand, and 60% of all electric power is imported. In addition, 90% of the domestically generated power relies on independent power generation companies (IPP).
- Two electric power systems, the Phnom Penh system and the Northwest system, exist, but these two systems are not connected to each other. Moreover, the electric supply line to cover the entire country area has not been maintained, and the reliability of power supply and rate of electrification in rural areas are low.
- Increasing the ratio of hydroelectric power generation, by utilizing the abundant water resources, to more than 50% by 2020 is planned, and construction of three hydroelectric power plants and three thermal power plants are scheduled. However, if the power configuration becomes centered on hydroelectric power generation, the amount of power supplied in the summer will decrease, and there is concern that blackouts may more easily occur.



Source: JICA, Preparatory survey for Phnom Penh city transmission and distribution system expansion project phase2 in the Kingdom of Cambodia, December 2014

Fig. 2.4.3.1-1 Trend of power supply volumes in the Kingdom of Cambodia



Source: JICA, Preparatory survey for Phnom Penh city transmission and distribution system expansion project phase2 in the Kingdom of Cambodia, December 2014

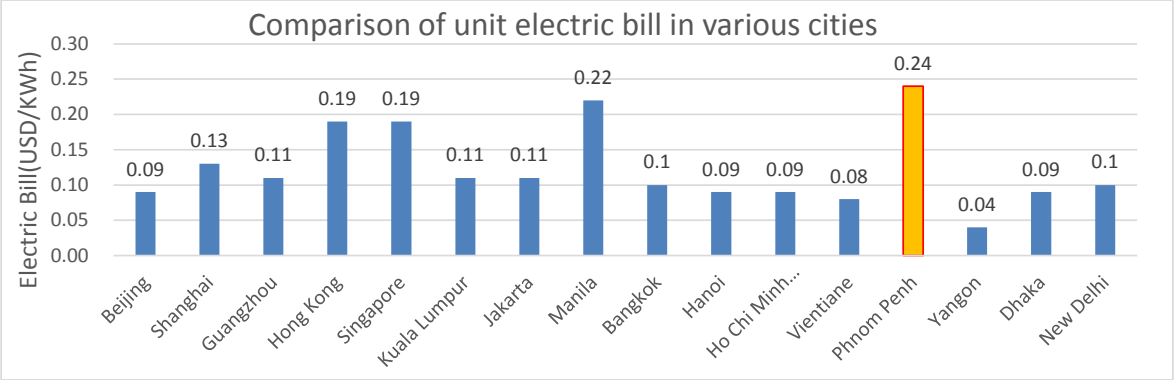
Fig. 2.4.3.1-2 Volume of power that can be generated under EDC jurisdiction

(2) Occurrence of power outages

- Although the frequency of power outages in the city has decreased, in some regions power outages still occur frequently.
- Although the frequency of the power outages in Phnom Penh Special Economic Zone (PPSEZ) has decreased to about once per month for about 10 minutes, problems are occurring in some factories. Tenant companies are strongly demanding the complete elimination of power outages.
- In regions outside the PPSEZ where Japanese companies are operating, power outages occur frequently.

(3) High electric bill

- Many businesses expanding into the Phnom Penh metropolitan area consider the high electric bill and poor quality of electricity as issues.
- There is a high dependency on diesel power generation, which is small scale and high fuel cost, in Cambodia, and is relatively more expensive than in Vietnam, Laos, or Thailand. The average electricity bill for a general household by the Cambodia Electricity Company (Electricite Du Cambodge, EDC), is 17.7 US Cent/kWh in Phnom Penh, 21.4 US Cent/kW at local stations, and 51.6 US Cent/kWh from a regional electric company (REE) (December 2010).



Notice：Basic monthly charges are not included. Source：JETRO, 25th Comparison of investment-related costs in the Asia-Oceania major cities and regions

Fig. 2.4.3.1-3 Comparison of unit electric bill in various cities

(4) Voltage instability

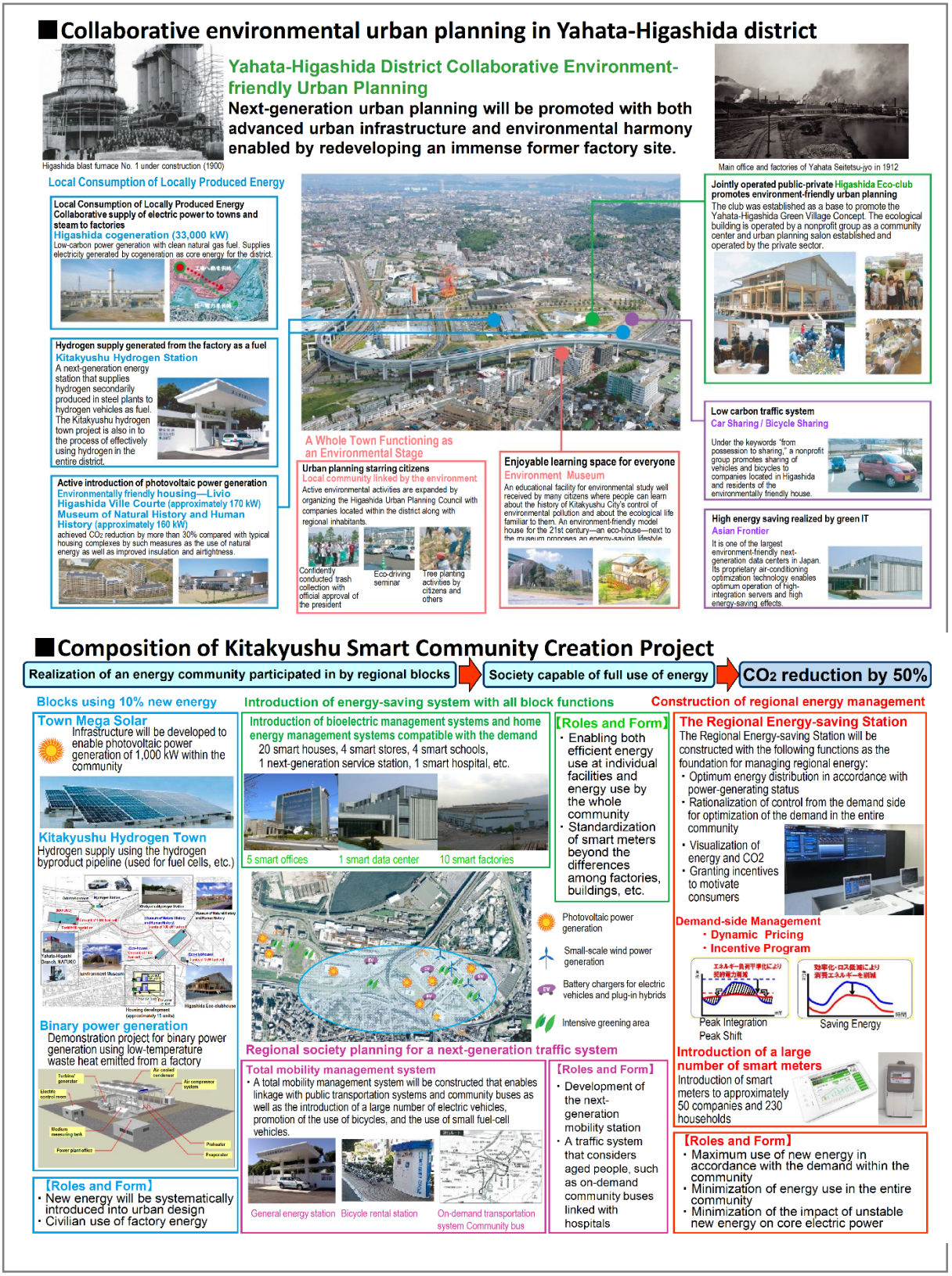
- Problems with factory equipment are occurring due to the effects of power outages and voltage instability caused by insufficient supply capacity.
- A stable and high quality power supply system is needed to attract factories. But currently, adjustment to a higher frequency would mean a higher dependency on Vietnam, which has larger system capacity.

(5) Utilization of renewable energy

- In areas with insufficient power supply, approaches in rural electrification using small hydro stations will progress, but mega solar generation utilizing the generous sunny conditions and biomass generation from chaff generated from active agriculture, would also be very effective.
- Within the inadequate power supply, energy savings by buildings and factories would be effective in the

city of Phnom Penh, where population, offices, and commercial facilities are concentrated. First however, determining current conditions by energy conservation diagnosis, etc. is required.

2.4.3.2 Energy/Introduction of efforts in Kitakyushu

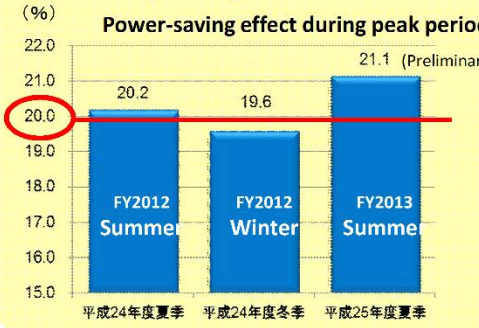


■Introduction of Energy Saving System in the Whole Region

Intensive introduction of system for two-way communication and control with the center, and corresponding HEMS and BEMS

■Demonstration results until now

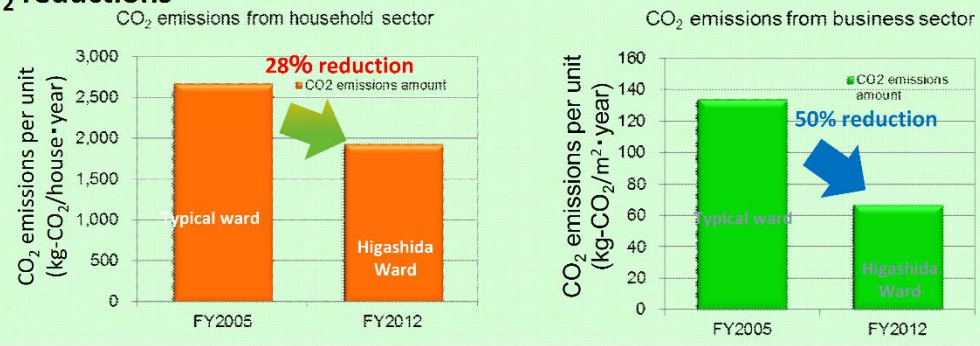
Dynamic pricing



Dynamic pricing was applied from the summer of FY 2012, and a peak-period reduction effect of roughly 20% was confirmed.

Highly evaluated by Stanford University, etc. as high-accuracy academically valuable data

CO_2 reductions

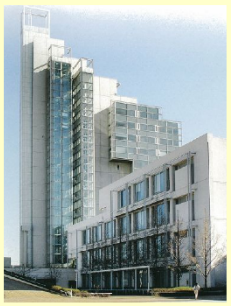


■ESCO (Energy Service Companies)

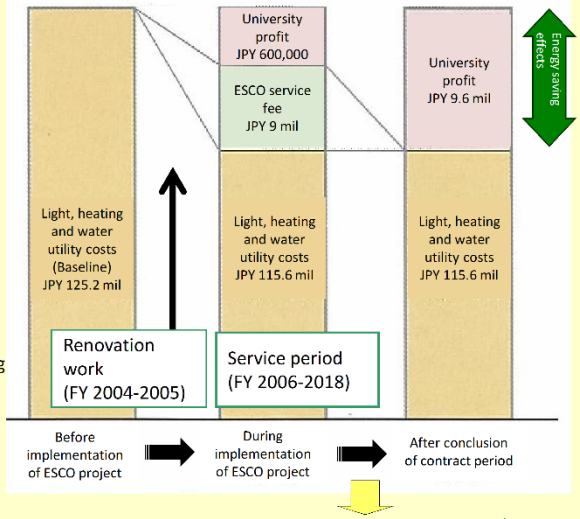
ESCO companies comprehensively offer all points necessary to improve energy savings, including technology, equipment, human resources, and funding.

ESCO companies guarantee energy-saving effects (cost reductions, etc.)

ESCO projects at The University of Kitakyushu



〔Project details〕
・Increase efficiency of transformers
・Develop inverters for lighting
・ Reduce number of fluorescent lamps with the use of reflection plates
・Attach solar radiation adjustment film to window surface, other



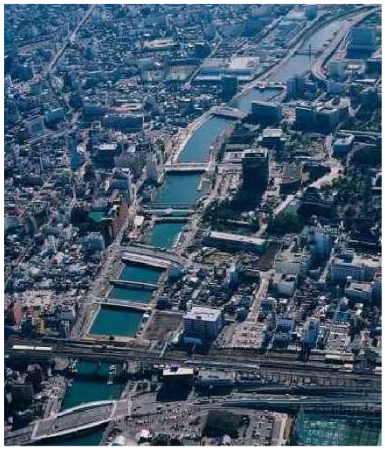
Examples of ESCO projects by businesses in Kitakyushu

Steel Memorial Yawata Hospital

〔Project details〕
High-efficiency boiler
Kerosene-fired flue and smoke boiler ⇒ Updated to small, natural gas-fired, high efficiency once-through boiler

Expectation of reductions of 138 k ℓ annually in crude oil equivalent (CO2: about 360 tons) 13 years after the end of construction in comparison with earlier equipment updates. ESCO companies guarantee about a JPY 9 million/year reduction in expenses for heat and water annually.

■Murasakigawa My Town, My River Project



[10 bridges on Murasakigawa River]

[Suhama Plaza]

[Flood (1953)]

[Murasakigawa Bashaku District Redevelopment]

[Riverbank (Around 1965)]

■ Projects

(1) Flood prevention: Expansion of river, dredging of river floor

(2) Bridges: 10 bridges with natural themes (Themes: Ocean, Fire, Trees, Stones, Water Birds, Sun, etc.)
((1) Widening of river leads to insufficient bridge length, (2) Relief of traffic congestion, (3) deteriorated Bridges)

(3) Creating river banks where people can gather:
Water Environment Museum, Waterfall, Suhama Plaza, Riverfront Promenade, etc.

(4) Creating areas where people can gather: Castle Road, Kokura Castle Garden, Matsumoto Seicho Museum, Comprehensive Health and Welfare Center, Kokura Kita Ward City Office, Redevelopment of Murasakigawa Bashaku District, Redevelopment of Muromachi 1-chome District, etc.

■ Period FY 1990 - 2005

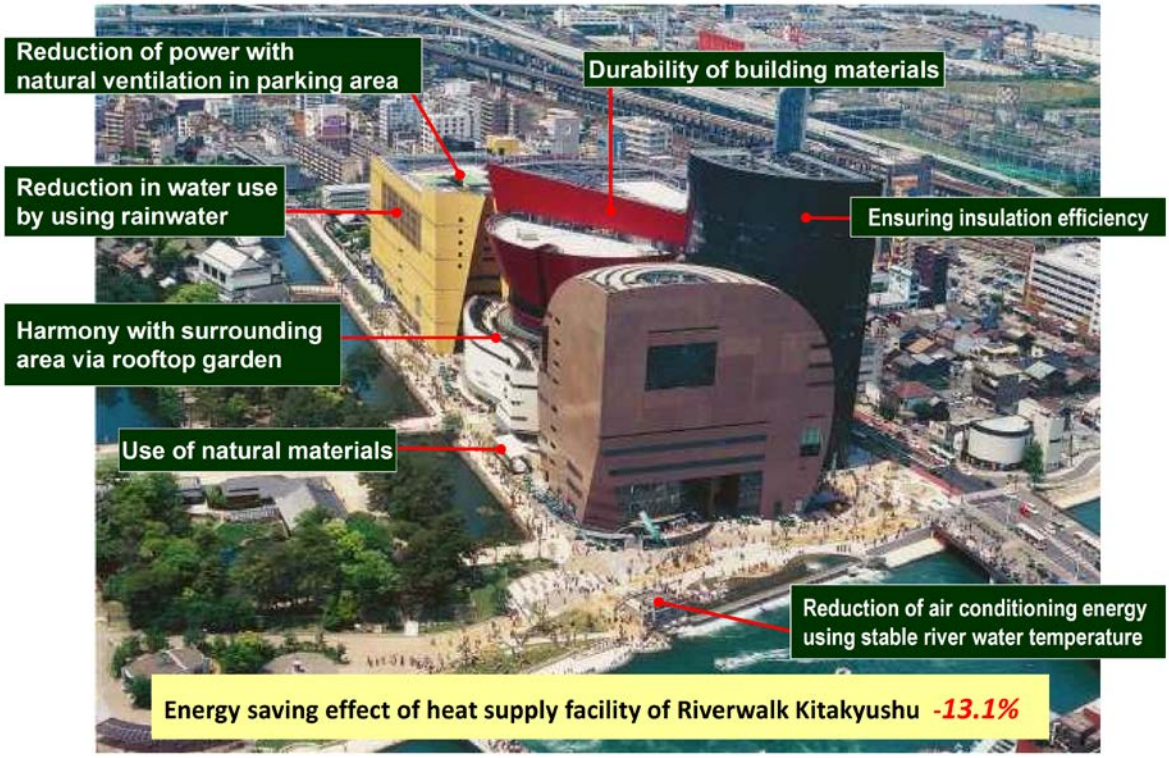
■Heat Island Measures for Downtown Kokura

View of Murasakigawa area

Riverwalk Kitakyushu

Item	Major Heat Island Measures
Promote use of unused energy	Heat pumps using river water* (Riverwalk) Regional cooling and heating (Asano Heating & Cooling Energy Center)
Promote greening on buildings	Rooftop gardens (Riverwalk, etc.)
Promote greening in public space	Katsuyama Park improvement project
Promote measures for water use	Carry out a “water sprinkling campaign” using reclaimed sewage water
Promote creation of water and greenery network	*My Town, My River* Project Project to create avenues lined with flowers and greenery
Promote the use of an Urban Planning System	Use of porous asphalt pavement in Downtown Kokura

■Environmental Symbiosis Urban Redevelopment (Riverwalk Kitakyushu)



2.4.3.3 Energy/Specific Measures

Based on the issues in the energy field, specific measures in this field were set up as shown in the table below. The Implementing entity, timing of implementation and evaluation index of each specific measure were also set.

Table 2.4.3.3-1 Energy/Specific Measures(1/2)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
1. Energy conservation projects and projects to promote the introduction of renewable energy targeting offices and commercial facilities	・Increase energy utilization efficiency through implementation of energy conservation diagnosis targeting offices and commercial facilities and continue to introduce energy-saving equipment such as high-efficiency air conditioning systems. In addition, the introduction of renewable energy such as solar power generation, etc.	Private Company	short-term	Amount of Energy reduction and GHG reduction
2. Energy conservation projects and projects to promote the introduction of renewable energy targeting public facilities	・Carrying out energy conservation diagnosis targeting public facilities such as water treatment plants, schools, etc. Increase the efficiency of energy utilization, including the introduction of energy-saving equipment such as high-efficiency air conditioning systems. In addition, the introduction of renewable energy such as solar power generation, etc.	PPWSA	short-term	Amount of Energy reduction and GHG reduction
3. Promotion of energy conservation and the introduction of renewable energy targeting factories	・To increase efficiency of energy utilization targeting factories, promote introduction of various energy conservation facilities, including exhaust heat recovery and creation of cement business. ・Promote the introduction of renewable energies such as solar power generation utilizing factory roofs. ・Make progress in low carbonization, such as switching from diesel fuel which has higher environmental load to biomass fuel in private power generation facilities.	Private Company	short-term	Amount of Energy reduction and GHG reduction

PPWSA : Phnom Penh Water Supply Authority, EDC: Electricite du Cambodge

Photovoltaic system（The roof of bicycle parking lot of AEON mall)

Photovoltaic system（Phnom Penh capital water supply authority)

Waste heat recovery power generation in cement factory

High efficient chilling machine

Source: http://www.enecho.meti.go.jp/about/whitepaper/2016html/1-1-4.html

Table 2.4.3.3-1 Energy/Specific Measures(2/2)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
4. Promotion of energy conservation and introduction of renewable energy targeted residents in the city	・Make progress in energy conservation and introduction of renewable energy, such as the use of energy efficient household appliances and lighting, expanding the use of solar water heaters, etc..	Residents	Short term	Amount of Energy reduction and GHG reduction
5. Mega-solar power generation projects	・For a stable power supply in the city and surrounding area, promote mega-solar generation projects which utilize the advantageous sunlight conditions, in the suburbs of Phnom Penh city and its neighboring districts which have a lower population density.	Private Company	mid-long term	Amount of Energy reduction and GHG reduction
6. Development of educational projects to expand energy conservation activities	・Advertise energy conservation activities which can be done implemented close by, such as in the household or office, by setting an appropriate temperature for the air conditioner, introduction of energy saving lighting, and water conservation, by targeting residents and businesses.	Residents, Private Companies	Short term	Amount of Energy reduction and GHG reduction
7. Stable and high quality power supply	・In addition to strengthening the maintenance of power transmission lines such as the construction of new substations, the links between system lines, and introduction of a system stabilizer, work to develop new power sources and to create the best combined composition of power sources.	Ministry of Industry Mines and Energy, EDC	Mid-term	Decreased frequency and length of time of power blackouts.
8. Promotion of the introduction of a fixed purchase price system for renewable energy	Introduction of fixed-price purchasing system for the purpose of power supply diversification and popularization of renewable energy such as solar power generation, biomass power generation, etc.	Ministry of Industry Mines and Energy EDC	mid-long term	Establishment of the system

PPWSA : Phnom Penh Water Supply Authority, EDC: Electricite du Cambodge

2.4.3.4 Pilot project in energy field 1 (Introduction of promotion of shift to low-carbon society through energy-saving measures, etc. targeting large hospitals)

(1) Project overview (assumed)～Assumed project (Khmer Soviet Friendship Hospital)～

・With the Khmer-Soviet Friendship Hospital, which would be counted among facilities with large energy consumptions, as the assumed target, the feasibility of a JCM subsidized project is being investigated.

・Installation of solar panels on the hospital roof space (approx. 1,800m^2) is assumed.

Photo. 2.4.3.4-1　Left: Appearance of the hospital, Right: Roof space of the hospital

(2) Expected effects (assumed)

Based on rough estimation, the following effects are expected:

・Yearly Power Generation: approximately 250,000 kWh/year

・Yearly Electricity Cost Reduction: approximately 47,500 USD

・Yearly CO_2 Emission Reduction: approximately 160 tCO_2/year

*Note that these figure are based on rough estimation. Detail design with PV panel manufacturer and EPC company are needed for actual project.

(3) Funding procurement methods (assumed)

・Based on rough estimation, initial cost is approximately 300,000 USD.

・It is assumed that around 30% of the initial cost is subsidized by JCM equipment subsidy project.

・As results of hearing with hospital, financing by themselves may be difficult.

・As one of the solution of initial cost, we started discussion with local bank using ESCO or lease scheme.

・After power generation is started, monthly lease fee which is commensurate with cost reduction by power generation will be paid by hospital to the bank

2.4.3.5 Pilot project in energy field 2 (Introduction of promotion of shift to low-carbon society through energy-saving measures, etc. targeting large hospitals)

(1) Project overview (assumed)～Assumed project (Sunrise Japan Hospital)～

- Joint venture hospital by JGC, Innovation Network Corporation of Japan (INCJ), Kitahara Hospital Group.
- The hospital is one of the Growth strategy of the Japanese government's "hospital export." It was opened on 20th September 2016.
- Installation of solar panels on the hospital roof space and parking space are assumed.

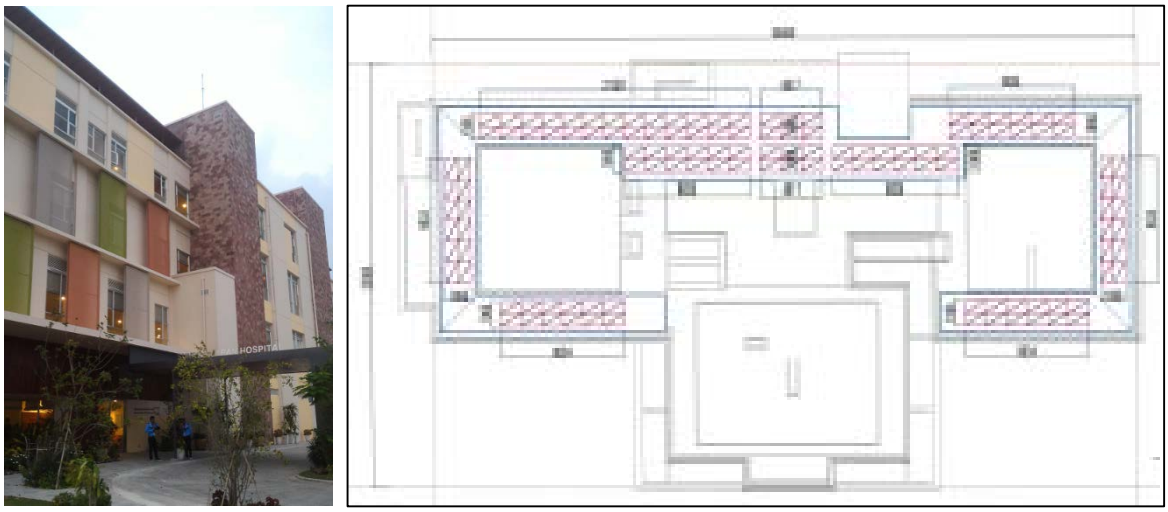


Photo. 2.4.3.5-1 Left: Appearance of the hospital, Right: Roof space and parking space of the hospital

(2) Expected effects (assumed)

Based on rough estimation, the following effects are expected:

- Scale of PV panels: approximately 80kW
- Yearly Power Generation: approximately 110,000 kWh/year
- Yearly Electricity Cost Reduction: approximately 20,000 USD
- Yearly CO2 Emission Reduction: approximately 70 tCO2/year

*Note that these figure are based on rough estimation.

Detail design with PV panel manufacturer and EPC company are needed for actual project.

(3) Funding procurement methods (assumed)

- Based on rough estimation, initial cost is approximately 200,000 USD.
- It is assumed that around 30% of the initial cost is subsidized by JCM equipment subsidy project.
- Financing by themselves at this stage is difficult, since they are opened recently.
- As one of the solution of initial cost, we started discussion with local bank using ESCO or lease scheme.
- After power generation is started, monthly lease fee which is commensurate with cost reduction by power generation will be paid by hospital to the bank

2.4.3.6 Pilot project in energy field 3 (Introduction of solar large power generation and high efficiency chiller for large shopping mall)

(1) Project Outline ～AEON mall Cambodia No.2～

・Introduction of solar power generation and high efficiency chiller for AEON mall No.2 PPC(Tentative name, It will open in the summer of 2018) which AEON Cambodia is planning to construct.

・Reduction of CO_2 emissions which is produced from the combustion of the fossil fuel when the grid electricity is generated by introducing renewable energy (solar power generation) and energy saving device (high efficiency chiller).

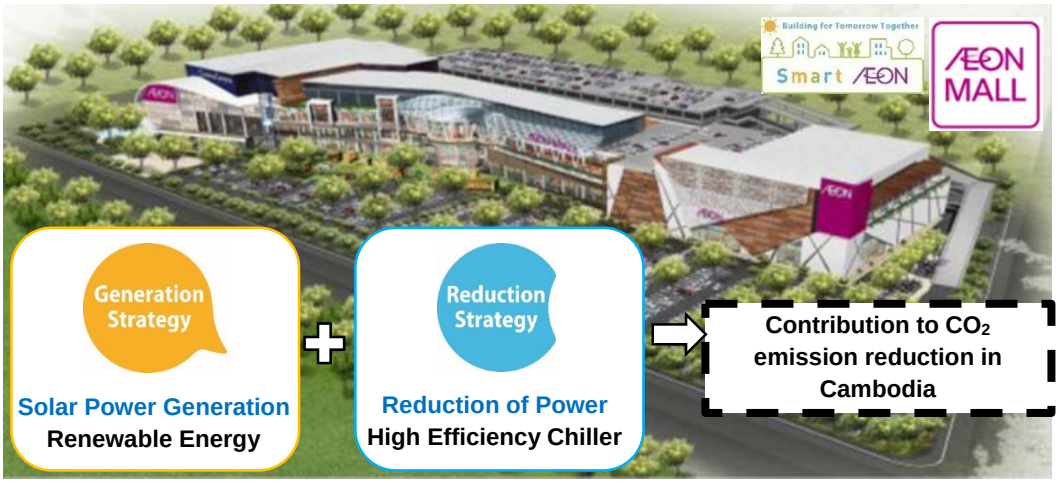


Fig. 2.4.3.6-1 Overview of Pilot project in energy field (1)

(2) Expected Effects

Solar Power： CO_2 Reduction：948.7[tCO_2/year]

High Efficiency Chiller： CO_2 Reduction ：615.6 [tCO_2/year]

(3) Method for Raising Funds

Application of JCM scheme：Solar Power System ;Subsidy rate 40%,

High Efficiency Chiller System; Subsidy rate 50%

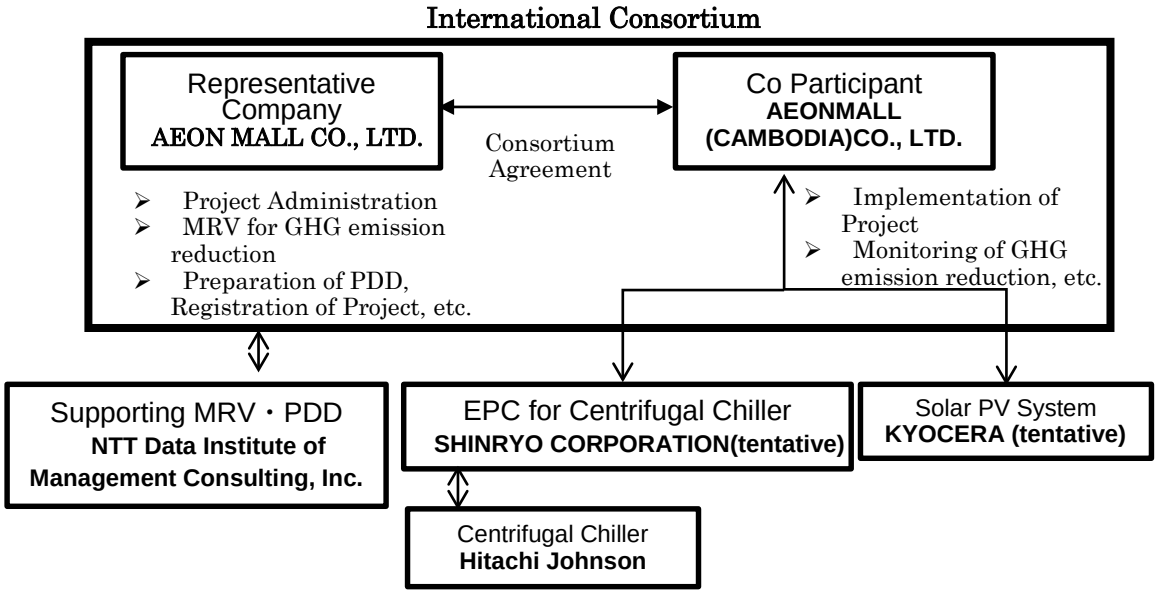


Fig. 2.4.3.6-2 Business Structure

2.4.3.7 Pilot project in energy field 4 (Introduction of waste heat recovery power generation system for cement plant)

(1) Project overview (assumed)～Assumed project (CHIP MONG INSEE CEMENT)～

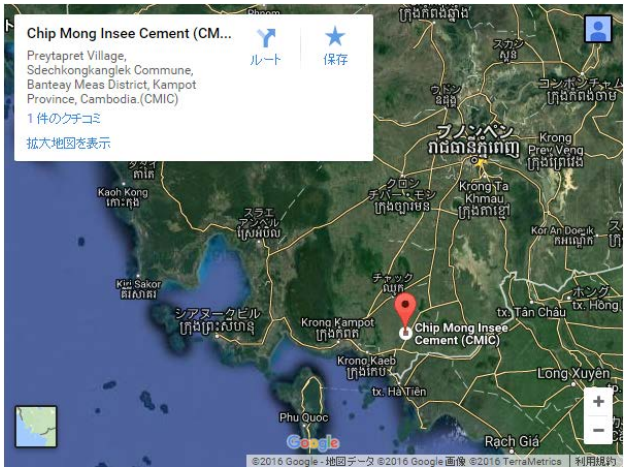
・We conduct feasibility study of a JCM subsidized project for cement plant which have high potential for the CO_2 reduction by using waste heat recovery power generation system.

・CHIP MONG INSEE CEMENT is a joint venture company of Chip Mong Group (CMG): 60% and Siam City Cement Company (SCCC): 40%.

・The plant will start production in mid Q4/2017.

・Around mid 2018, tendering exercise for suppliers of waste heat recovery (WHR) system will be stated.

・Commissioning of WHR system is expected in Q1 to Q2 of 2020.



Google Map: Cement Plant in Kampot (125km from Phnom Penh)

Fig. 2.4.3.7-1 Location map of CHIP MONG INSEE CEMENT

(2) Expected effects (assumed)

・Power generation of around 8MW of electrical power is expected.

・Yearly CO_2 Emission Reduction of around 30,000 tCO_2/year is expected.

(3) Funding procurement methods (assumed)

・Initial cost of equipment would be financed by the cement company.

・It is assumed that 50% of the initial cost, as maximum, is subsidized by JCM equipment subsidy project.

2.4.3.8 Pilot project in energy field 5 (Introduction of solar large power generation for cement plant)

(1) Project overview (assumed)～Assumed project (CHIP MONG INSEE CEMENT)～

・Company profile are shown in previous slide.

・Installation of solar panels on roof of a few buildings are assumed.

・We are also studying less-weight panels on rounded-shape roof and floating-type panels on pond.

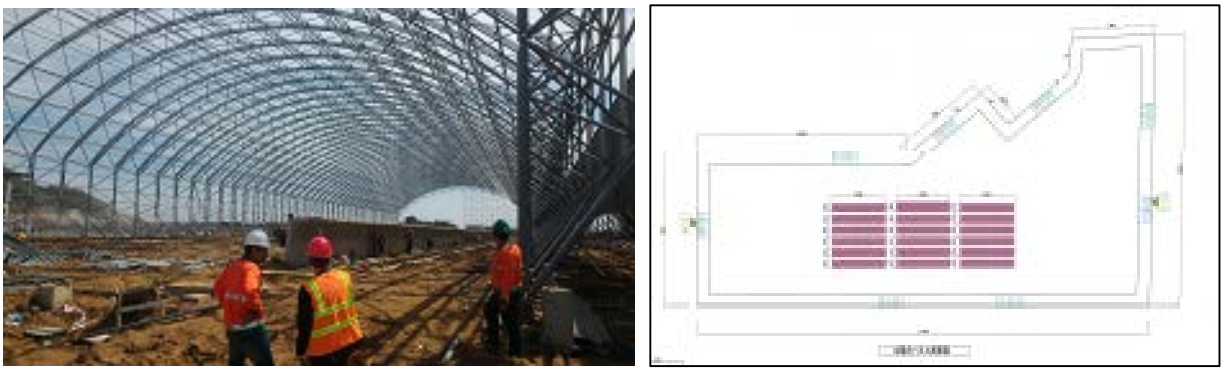


Fig. 2.4.3.8-1 Installation space of solar panels (Rounded-shape roof)

(2) Expected effects (assumed)

Based on rough estimation, the following effects are expected:

・Scale of PV panels: approximately 5.5MW

・Yearly Power Generation: approximately 7,500,000 kWh/year

・Yearly Electricity Cost Reduction: approximately 937,500 USD

・Yearly CO2 Emission Reduction: approximately 4,800 tCO2/year

*Note that these figure are based on rough estimation.

Detail design with PV panel manufacturer and EPC company are needed for actual project.

(3) Funding procurement methods (assumed)

・Based on rough estimation, initial cost is approximately 14,000,000 USD.

・It is assumed that 30% of the initial cost, as maximum, is subsidized by JCM equipment subsidy project.

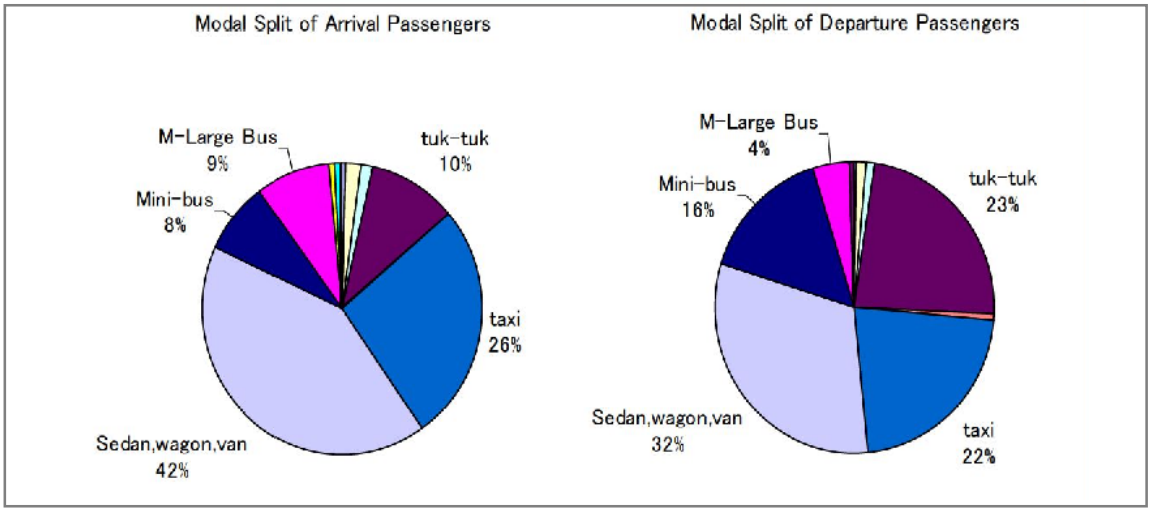
・As alternative option, ESCO or lease scheme are also considered.

2.4.4 Tasks and Specific Measures in Transportation Field

2.4.4.1 Transportation/Current status and tasks

(1) Public Transportation

- PPCH and DPWT(Department of Public Works and Transport) have taken over the management of city buses with 3 routes currently being operated. However, private passenger cars, motorcycles or Remorque are still main players as travel modes due to the limited bus route network and bus fleet. Hence the mobility of citizens is still low.(Especially, mobility-impaired people like ladies and the senior citizens)
- There are several ferry transport services in Mekong River on the east side in the city. However, access to the passenger jetties is chiefly by motorcycles, which is rather inefficient. An efficient, reliable and comfortable mode of transfer is very necessary. For this reason, public transport system should provide direct linkages to these ferry jetties.
- Currently, access to Phnom Penh International Airport is via the relatively low capacity travel modes of passenger cars, taxis and para-transits. In view of the future rapid growth of passengers, it is very necessary to begin preparing a public transport system that can provide efficient access to the airport with large travel capacity.

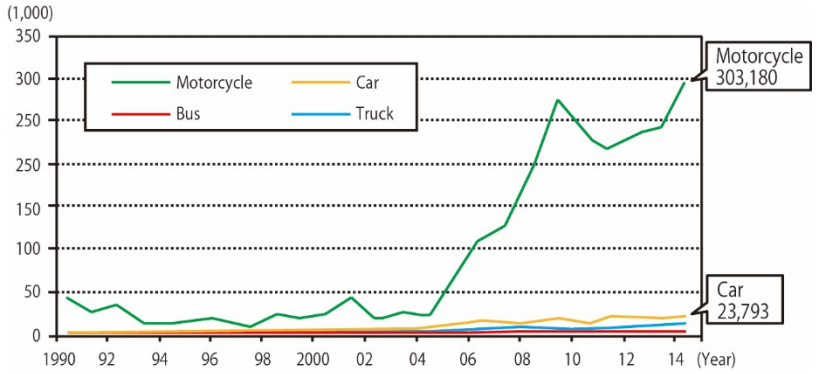


Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Fig. 2.4.4.1-1 Share of Phnom Penh International Airport Access Modes

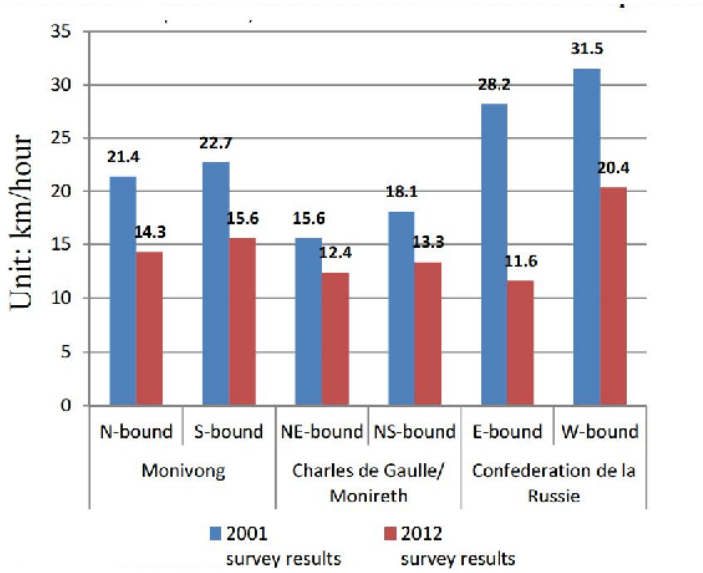
(2) Road Development

- Traffic conditions on roads in the city center deteriorate very rapidly such that, roads face serious space constraint while traffic demand increases exponentially.
- The continuity of several primary and secondary roads in the city is disrupted due mainly to geographical reasons such as presence of rivers and built-up areas.
- Road density in the suburban areas is low (City center: 12.2 km/sq. km and suburban area: 1.6 km/sq. km).Most of the existing secondary roads in these areas are not paved, making travels on such roads very difficult during the rainy season. Furthermore, widths of these roads are too narrow for the safe passage of two opposing vehicles.



Source: JETRO, Cambodia Basic knowledge of economy
Department of Public Works and Transport

Fig. 2.4.4.1-2 Vehicle registration number in Cambodia



Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

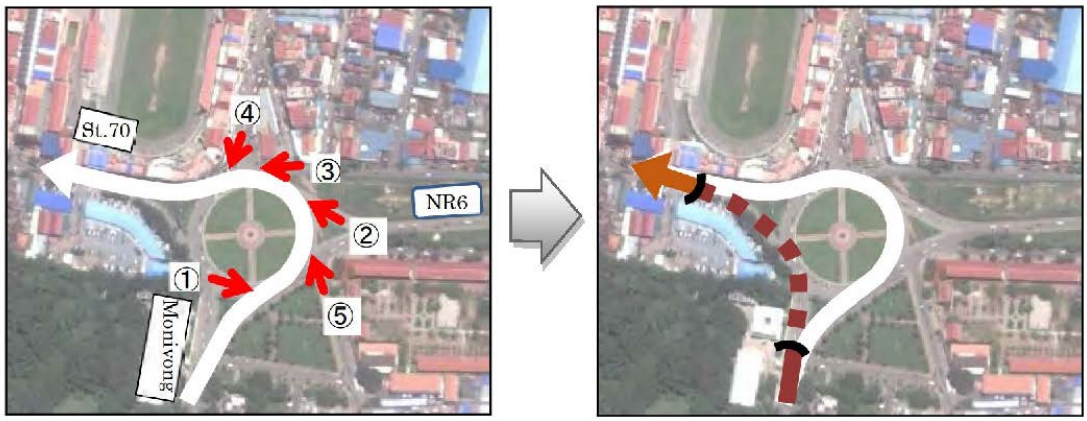
Fig. 2.4.4.1-3 Change in Travel Speed between 2001&2012

Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Photo. 2.4.4.1-1 Current Traffic Conditions in the City Center

(3) Traffic Management

- While problems at many major intersections have been improved through the "Phnom Penh Urban Transportation Improvement Project", etc., there are still intersections （Chamkar Morn、Neang Kong Heang、Chrouy Changvar）where problems continue to exist.
- All signals in the city are isolated signals operating independently without coordination with neighboring signals. This type of signal operation becomes inefficient.
- There are a lot of drivers who don't obey traffic rules.
- In the Central Business District (CBD), there is currently a shortage of 12,000 parking spaces for motorcycles and another 6,000 spaces for cars.
- Pedestrian Walking Environment is very poor because sidewalks are often taken over by illegally parked vehicles or cafes as their outdoor terraces, or for the display of merchandise by shops or as planter areas by residents.(Pedestrians are thus forced to risk their lives walking on the roadways.)
- In the city of Phnom Penh, many accidents are found to have been caused by human error or unsafe behavior such as drunk driving and speeding.



Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Fig. 2.4.4.1-4 Proposed Improvement Measure at Chrouy Changvar Roundabout (Underground Passageway)

.

Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Photo. 2.4.4.1-2 Sidewalk Parking

(4) Freight Transport

- The road surface along the trucking routes is badly damaged because of poor maintenance and management. As a result, trucks travel at low speed and safety level is not satisfactory.
- Freight transport facilities are located in the heavily built-up areas of the city. Freight trucks have to mix with the general urban traffic. As a result, its service and safety level are adversely affected.

・There are still some roads with narrow widths among the freight transport routes. Large and heavy trucks are thus forced to travel at very low speed.
・There is also no sufficient space for loading and unloading of freights by the trucks. Trucks are forced to do so by the roadsides, causing severe interference to the traffic flows and creating hazardous situations for other road users.

Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Photo. 2.4.4.1-3　Badly Damaged Trucking Route (Veng Sreng Road)

(5) Environmental and Social Considerations etc.

・The rapid urbanization of suburban areas has caused a rapid decline of green areas. Meanwhile, in the city center, nature parks and green lungs are also decreasing, while emission of greenhouse gases such as the exhaust gases from vehicles is on the increase.
・Traffic volumes in the city are increasing year after year causing a serious deterioration of the air quality and elevated levels of vibration in the urban areas. There are still many factories located within the urban areas, and exhaust and other particulates emitted by vehicles coming in and out of these factories are also a major concern.
・There are areas in the suburbs still without water supply simply because there are no roads leading to these areas. Since development of water distributing pipe is closely related, it is necessary to coordinate with road development plans adequately.
・In suburban area that fee of collection waste cannot be collected, waste is not collected sufficiently and illegal dumping to the sidewalk and drainage is found. Therefore, countermeasures against illegal dumping should be considered with road environment improvements integrally.

Photo. 2.4.4.1.-4　Increasing in traffic volume(left) ・Illegal dumping(center) ・ Road and sewer maintenance (right)

2.4.4.2 Transportation/Introduction of efforts in Kitakyushu

■Low-carbonization in the transportation sector

Promoting the use of public transportation

Super "No Car" campaigns

Short drives Car sharing
Eco-cycling

Public transportation is convenient and can reduce CO_2 emissions.

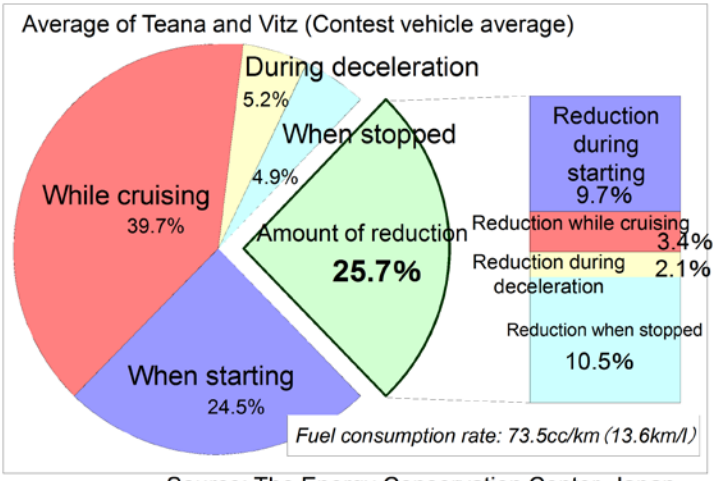
Eco-Drive

Economical and safe driving that anyone can do.

Gentle acceleration:
Saves ~9,860 yen (Reduces CO_2 94 kg)
Driving with little acceleration/deceleration:
Saves ~3,460 yen (Reduces CO_2 68 kg)
Stop accelerating early:
Saves ~2,130 yen (Reduces CO_2 42 kg)
Idling stop
Saves ~2,040 yen (Reduces CO_2 40 kg)

Electric vehicle

■Effects of Ecodriving



Source: The Energy Conservation Center, Japan

Improved fuel economy
- Reduced costs (economic benefit)
- Reduced CO_2 (environmental effects)

Reduced traffic accidents

10 rules for ecodriving

1. Stop idling.
2. Drive at economical speed.
3. Keep tires at proper pressure.
4. Do not load unnecessary items.
5. Stop unnecessary revving.
6. Stop sudden starts, sudden acceleration, and sudden braking, and maintain appropriate distance between vehicles.
7. For manual transmissions, shift up as soon as possible.
8. Do not cause traffic jams by parking illegally.
9. Use air conditioning moderately.
10. For car owners, try to share the ride. Also, use public transportation as much as possible when available.

■Introduction of Urban Monorail: Japan's first urban monorail

Successful case of public transit-oriented development (TOD) leading to urban development along railways ～OECD Report～

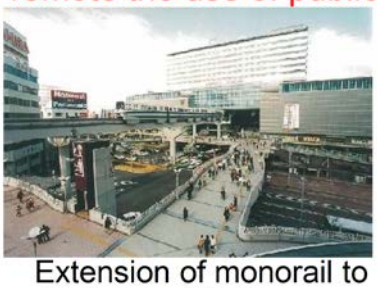
- Reduced traveling time: Traveling time from Tokuriki, Shii area in Kokura Minami district to Kokura city centre has been reduced by approximately 30 minutes.
- Car traffic reduction/Traffic congestion moderation: After monorail has been introduced, car traffic in national highway of 322 has been reduced by 14,920 cars per day.
- Promotion of development along railway line: Promotion of site location for residential and commercial complex along monorail line/ Population growth/ Growth of employment population and merchandise sales etc.

Reduction in vehicular traffic in the city limits due to the convenience of public transportation
Reduction of automobile exhaust gas

Transit Oriented Development or TOD is defined as a mixed-use residential or commercial area designed to maximize access to public transport, and often incorporates features to encourage transit ridership. A well planned TOD would turn a rail or bus station from a transport hub into an activity hub so that people could easily access the development by means of convenient public transport, in particular, railways or metros, for longer distance and by walking/cycling, if walkways and cycle network are provided.

■Promotion of public transport usage and development along railway line

Promote the use of public transportation systems



Extension of monorail to JR Kokura Station

Kikugaoka Station Park and Ride

Season-ticket holders of the Kitakyushu monorail , can receive discount service of parking charges, when they use the park-n-ride facilities.

Improve roads with the construction of urban monorail

2.4.4.3 Transportation/Specific Measures

Specific measures are in accordance with Comprehensive Urban Transport Plan in Phnom Penh Capital City (PPUTMP). The Implementing entity, timing of implementation and evaluation index of each specific measure were also set.

Table 2.4.4.3-1 Transportation/Specific Measures (1/4)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
1. Introduction of public transportation systems and development of transportation hubs (ref. Photo. 2.4.4.3-1)	1) Development of bus transportation • Position bus transportation as a short-term basic public transit system for Phnom Penh and enhance the route network.	DPWT PPUD	short-term	Number and Ratio of Public Transportation utilization
	2) Development of railway systems • For the long term, develop a loop public transportation system and reorganize bus routes as feeder lines to the loop system.		mid-long term	
	3) Development of transportation hubs • Create good urban areas through urban development centered on public transportation nodes, such as transit-oriented development, etc. • Develop car and bicycle parking lots at public transportation nodes to enable smooth transfers between public transportation facilities and cars, paratransit, bicycles, etc.		mid-long term	
2. Effective use of existing public transportation, such as railways and water transportation	1) Development of railway lines connecting Central Station and PPSEZ station; Development of area in front of Central Station ・Establish a new station will be established in the PPSEZ which is expected to have a worker population of 20,000 people in the future, and promote reuse of the commuter railroad between the central station and the PPSEZ station.	DPWT PPUD	mid-long term	Number and Ratio of Public Transportation utilization
	2) Formation of a regional transportation network utilizing water transportation ・Promote the development of low-cost, environmentally friendly water transportation as a transportation network between Phnom Penh and its surrounding areas divided by the Mekong River and Tonle Sap River.			

DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division

Table 2.4.4.3-1 Transportation/Specific Measures (2/4)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
3. Road development (ref. Fig. 2.4.4.3-1 & 2.4.4.3-2)	Promotion of the formation of a city framework and road improvements with the aim of smooth cooperation between cities in the Mekong region. 1) Development of inter-city roads: Improvement and widening of national highways (NR1 to NR6) 2) Development of roads in cities: Widening of main roads in city centers; Development of ring roads (RR-Ⅲ, RR-Ⅳ); Development of radial roads 3 Effective utilization of roadway space in the city center (construction of flyovers, etc.) 4) Road development in suburban areas	DPWT	short-term	Road improvement ratio
4. Introduction of traffic management facilities	1) Development of a traffic control system: Optimal control of traffic signals at intersections in the metropolitan area from the traffic control center to promote alleviation of traffic congestion. 2) Changing narrow streets to one-way streets (to ensure smooth passage) ・Promote a change to one-way traffic in order to alleviate traffic congestion on narrow streets and reduce traffic accidents.	DPWT JICA	short-term (2015～)	Travel Speed in main Road
5. Development of comfortable pedestrian space	・Promote the development of parking lots and restrictions on illegal parking to create spaces where pedestrians can walk in peace.	DDWT PPUD	short-term	Illegal parking number in sidewalk
6. Mobility management	・In addition to hard measures, implement soft measures such as thorough driver education at time of license renewal, traffic manner PR, etc. to make the citizens themselves give more consideration to traffic congestion and environmental/health problems and promote a shift from the current overdependence on automobiles to the wise use of public transportation, bicycles, etc.	Police	short-term	The number of times carried out driver education

DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division

Table 2.4.4.3-1 Transportation/Specific Measures (3/4)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
7. Increasing efficiency of logistics	1) Appropriate location of logistics facilities ・In order to alleviate traffic congestion and improve logistics efficiency, inter-regional logistics facilities shall be located at key junctions for suburban transportation and urban logistics facility will be consolidated on the city outer edge. ・On roads with sufficient road shoulder for parking, space for cargo trucks shall be secured using road surface markings, traffic cones, etc. 2) Increase efficiency of logistics networks ・In order to improve the efficiency of logistics networks, cargo transportation trucks shall be separated from private daily traffic, and in addition, development of roads that will become logistics routes (two lanes or more) will be promoted.	DPWT PPUD	mid-long term	Transportation and delivery time Logistics cost
8. Measures against air pollution and vibration, or reducing CO_2 emissions, etc.	・Thorough compliance with vehicle inspection system	DPWT	short-term	Rate Automobile inspection
	・Promotion of vehicle CO_2 emission absorption by developing urban parks and green spaces and planting roadside trees.	DPWT PPUD	mid-long term	Green area
	・Environmental monitoring shall be implemented in order to grasp the pollution situation and status of compliance with environmental standards and to utilize such data as criteria for judging traffic volume and speed regulations, etc. ・Become involved with the popularization of low-pollution vehicles and encourage eco-driving in order to deal with air pollution and noise from vehicles.	MOE	short-term	The Number of Point and implementation frequency of monitoring
9. Roadway plan integrating waterworks development plan and waste collection plan	・Sufficiently coordinate waterworks development plans, waste collection plans, and road development plans to promote the spread of waterworks and waste collection.	DPWT PPWSA PPWMD	short-term	Penetration rate of water supply and Waste Collection Rate in suburban area

DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division
PPWSA: Phnom Penh Water Supply Authority, PPWMD: Phnom Penh Waste Management Division,
MOE: Ministry of the Environment

Table 2.4.4.3-1　Transportation/Specific Measures (4/4)

Classification	Description	Implementing entity	Timing of implementation	Evaluation index
10. Establishment of appropriate transportation-related city organizations	Since it is difficult for all of the traffic problems of Phnom Penh to be handled by the single institution of the DPWT, the PPUTA (Phnom Penh Urban Transport Authority) will be established as a new institution at the city level <Function and responsibilities of PPUTA> ・Monitoring of development action plans defined in the master plan ・Coordinating with the various agencies regarding traffic ・Supervising maintenance projects related to urban traffic ・Designing of traffic mode policies ・Realization of traffic-related development plans, etc.	Phnom Penh Capital	short-term	—

DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division
PPWSA: Phnom Penh Water Supply Authority, PPWMD: Phnom Penh Waste Management Division,
MOE: Ministry of the Environment

Kitakyushu City Bus

Source: Kitakyushu City
http://www.city.kitakyushu.lg.jp/koutsuu/08200089.html

Kitakyushu City Monorail

Source: Kitakyushu Urban Monorail Co., Ltd
http://www2.kitakyushu-monorail.co.jp/news/detail.php?id=198

Kitakyushu City Passenger Ship

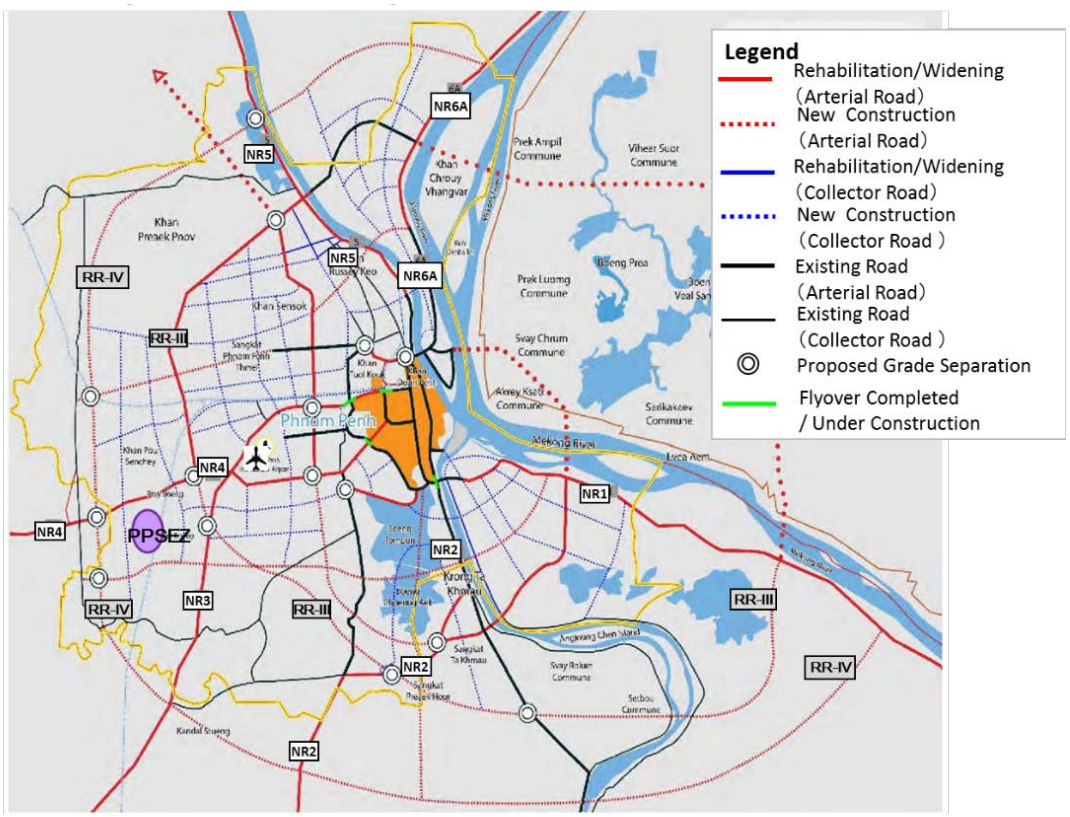
Source: Kitakyushu City
http://www.city.kitakyushu.lg.jp/sankei/file_0046.html

National Road (Japan)

Flyover (Phnom Penh)

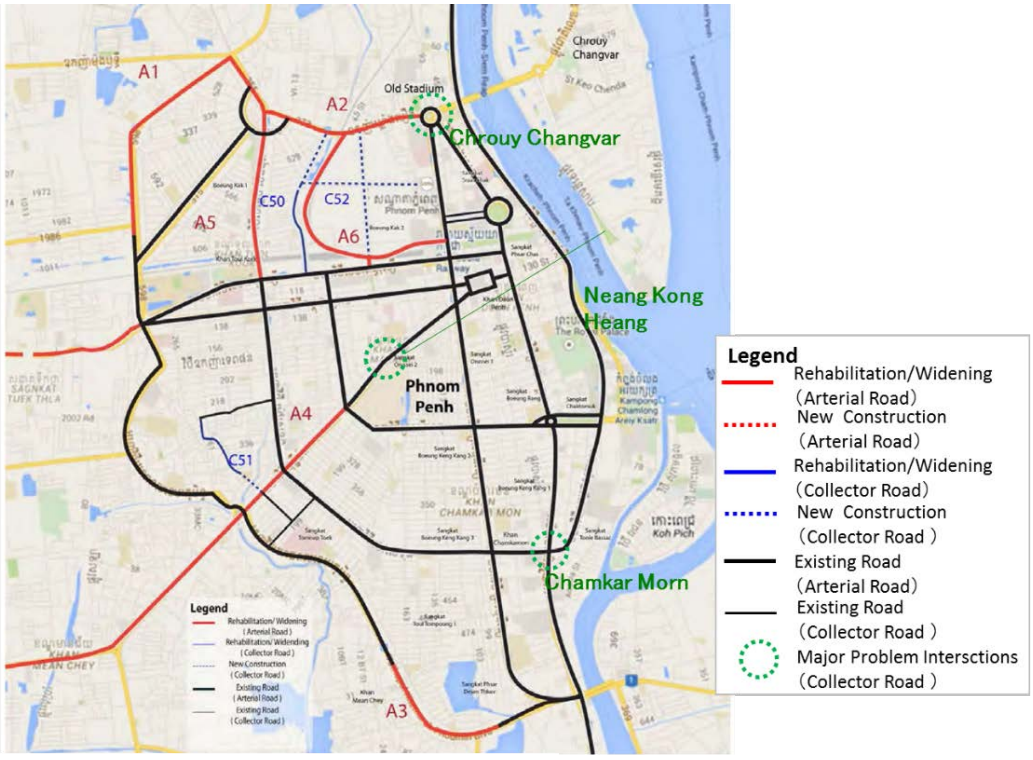
Source: The Phnom Penh Post
http://www.phnompenhpost.com/real-estate/flyovers-subway-drawing-board-phnom-penh

Photo. 2.4.4.3-1　Introduction of public transportation systems and development of transportation hubs



Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Fig. 2.4.4.3-1 Comprehensive Urban Transport Plan in Phnom Penh (Inter-Regional Road& Ring Road)



Source: JICA, The project for comprehensive urban transport plan in Phnom Penh Capital City, December 2014

Fig. 2.4.4.3-2 Comprehensive Urban Transport Plan in Phnom Penh (Road Network Development in Phnom Penh (Central Area))

2.4.4.4 Pilot project in transportation field (Introduction of Electric tricycle)

As a pilot project in the transportation field, we conducted an examination on the introduction of electric tricycle using the JCM scheme. Details are given in Chapter 3.

2.4.5 Tasks and Specific Measures in Water Works & Sewerage Field

2.4.5.1 Waterworks/Current status and tasks

(1) Waterworks water supply penetration rate; Non-revenue water rate

- The major part of Phnom Penh is supplied with water by the Phnom Penh Water Supply Authority. In the area under the jurisdiction of the Phnom Penh Water Supply Authority, the waterworks water supply penetration rate has reached approximately 85% (as of May 2016).
- The waterworks water supply quality meets the WHO standards and it is possible to drink water directly from the tap, and the non-revenue water rate and fee collection rate are 5.94% and 99.9% respectively, which are outstanding numerical achievements compared to cities of other ASEAN countries.

(2) Current status of private water supply sector in the suburbs

- In the suburbs of Phnom Penh such as farming villages, etc., water is supplied by the private water supply sector.
- In the private water supply sector, since measuring equipment has not yet been installed, water leakage, faulty water output, and wasteful power expenses occur. For proper operation and maintenance management, the development of the necessary measuring equipment is required.

(3) Increased demand volumes

- The Phnom Penh Water Supply Authority owns four water purification plants, with a total waterworks water treatment capacity of 430,000 m3/day (as of September 2013). It has been forecast that the demand volume in 2025 will increase to approximately 710,000 m3/day. Securing water sources to meet the increased demand and preserving water quality is required.

(4) Introduction of energy-saving waterworks water supply equipment and renewable energy

- It is desirable to promote the introduction of energy-saving waterworks water supply equipment and renewable energy such as solar power generation, etc. in order to reduce GHG.

Photo. 2.4.5.1-1 Solar Power Generation (Phnom Penh Water Supply Authority)

2.4.5.2 Sewerage/rainwater drainage field /Current status and tasks

(1) Household sewerage・Medical wastewater

- Even though Phnom Penh is the capital city, sewerage treatment plants have not been developed. Currently, the "Phnom Penh Metropolitan Sewage Water Management and Wastewater Improvement Master Plan" is being formulated in the ongoing JICA technical cooperation project, and it is expected that the development of sewerage treatment plants will progress in the future based on this master plan.
- Currently, sewerage is discharged through city sewerage systems to treatment facilities (supported by

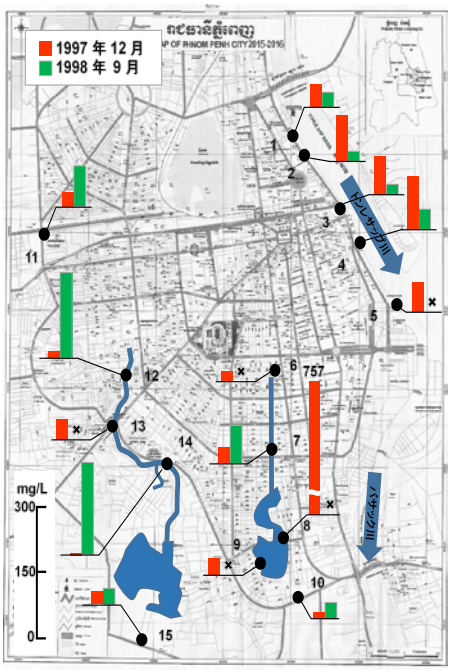
the European Community) etc. that use marsh/stabilization pond methods, but with population growth and urbanization, the amount of sewerage is increasing and the water quality environment is deteriorating drastically. Because of this, it is necessary to promote urgent development of sewerage and wastewater treatment plants, improvement of public hygiene, and environmental conservation.

・For almost all hospitals, the discharged wastewater has medical liquid wastes mixed in and is discharged untreated into local waterways, etc. which is extremely problematic in terms of public hygiene.

（Source：TAKEUCHI et al. , Journal of Water and Environment Technology, Vol.3, No.1, 2005）

Photo. 2.4.5.2-1 Condition of sewerage discharge into stabilization ponds (Tumpun)

Photo. 2.4.5.2-2 Illegal disposal of sewerage



Source：TAKEUCHI et al. , Journal of Water and Environment Technology, Vol.3, No.1, 2005

Fig .2.4.5.2-1 SS in the sewage discharged from the Phnom Penh City

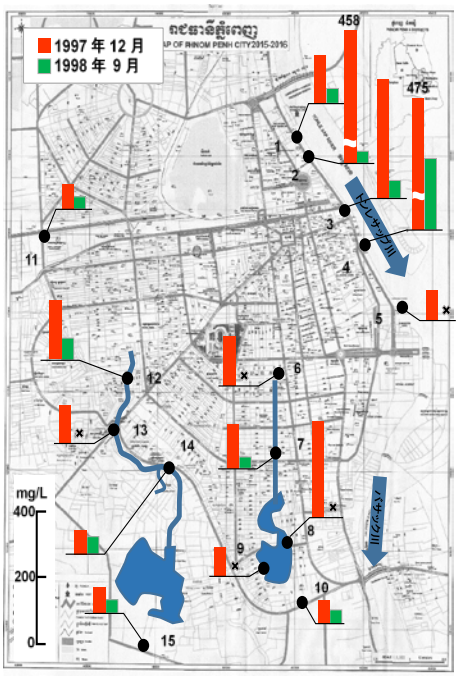
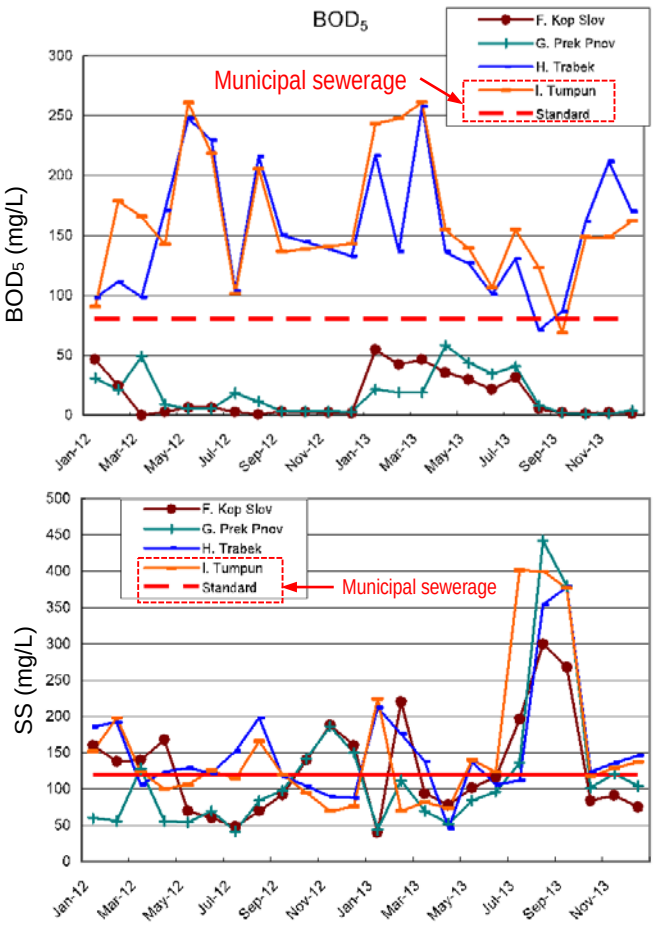


Fig.2.4.5.2-2 CODcr in the sewage discharged from the Phnom Penh City



Source: JICA, Phnom Penh sewerage/drainage improvement project, June 2016

Fig. 2.4.5.2-3 Water quality status (BOD, SS) of municipal sewers

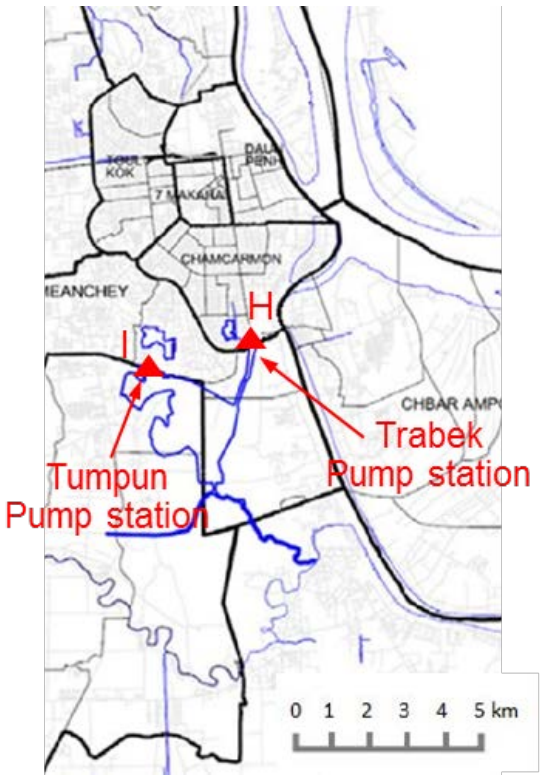


Fig. 2.4.5.2-4 Map showing locations of test points for municipal sewer water quality

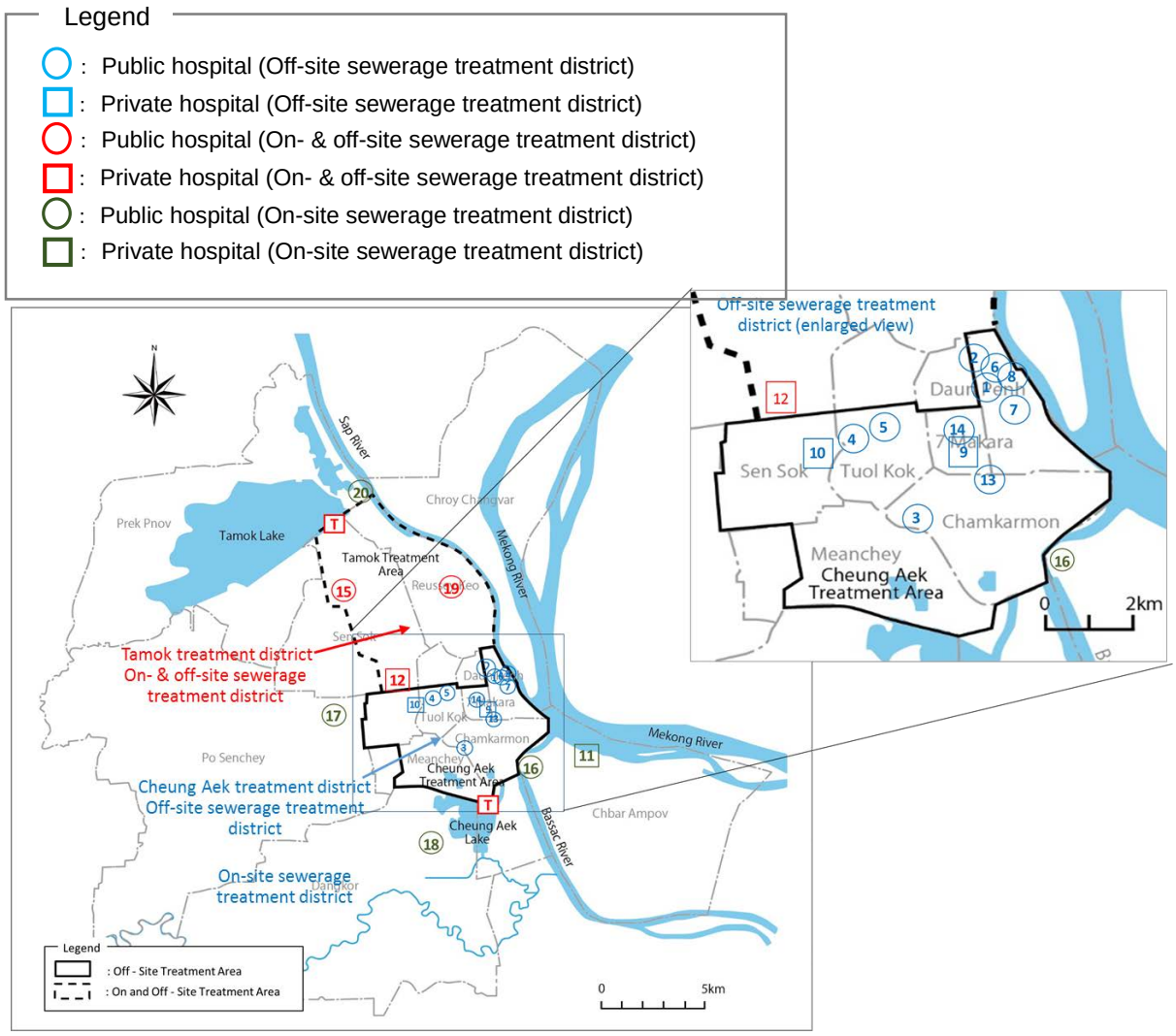
Table 2.4.5.2-1　List of major hospitals in Phnom Penh

No.	Name	Beds	Manage
①	Kantha Bopha Children Hospital	1,032	Under MOH
②	Calmet Hospital	530	Under MOH
③	Cambodian-Soviet Friendship Hospital	465	Under MOH
④	Preah Kossamak Hospital	250	Under MOH
⑤	National Pediatric Hospical	150	Under MOH
⑥	National Maternal and Child Health Center	145	Under MOH
⑦	Ang Duong Hospital	80	Under MOH
⑧	Preah Ket Mealea Hospital	1,000	Under MOH
9	Aurora Poly Clinic	18	Private
10	Royal Phnom Penh Hospital	580	Private
11	Cho Ray Phnom Penh Hospital	500	Private
12	Sen Sok International University Hospital	250	Private
⑬	National Center for Tuberculosis and Leprosy (CENAT)	400	Under MOH
⑭	Phnom Penh Referral Hospital	142	Under MHD
⑮	Cambodia-Chines Friendship Sen Sok Referral Hospital	60	Under MHD
⑯	Meanchey Referral Hospital	42	Under MHD
⑰	Porchentong Referral Hospital	35	Under MHD
⑱	Chamkar Doung Health Centre	25	Under MHD
⑲	Samdach Ov Referral Hospital	19	Under MHD
⑳	Praek Pnov Referral Hospital	13	Under MHD

Legend

- ○ : Public hospital (Off-site sewerage treatment district)
- □ : Private hospital (Off-site sewerage treatment district)
- ○ : Public hospital (On- & off-site sewerage treatment district)
- □ : Private hospital (On- & off-site sewerage treatment district)
- ○ : Public hospital (On-site sewerage treatment district)
- □ : Private hospital (On-site sewerage treatment district)

Source:　Written in materials from Phnom Penh branch of Ministry of Health



Source: JICA、The Study on Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area, June 2016

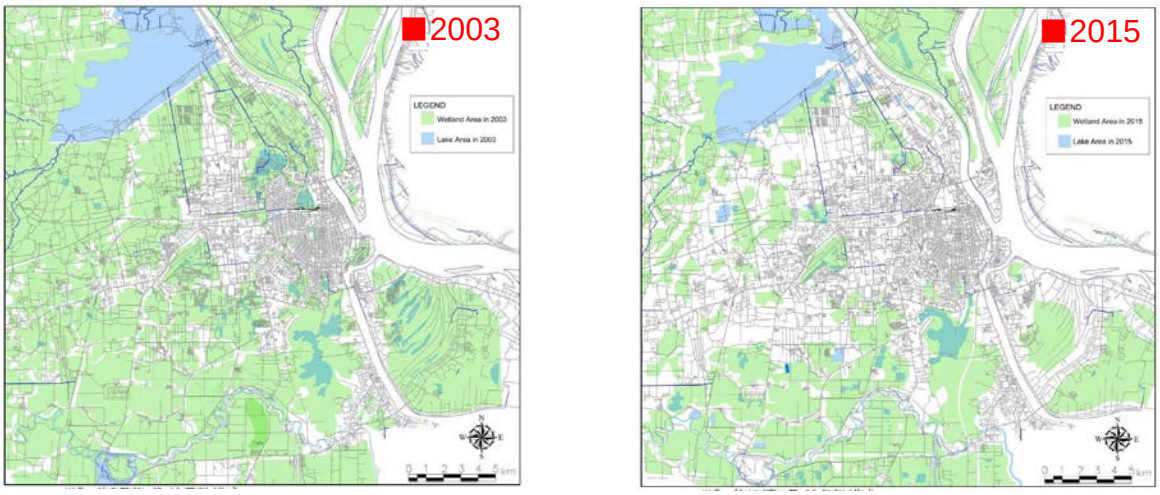
Fig. 2.4.5.2-5 Relationship between hospital locations and treatment districts of sewerage treatment master plan

Photo 2.4.5.2-3 Sewerage tank at Cambodian-Soviet Friendship Hospital (with progressive deterioration)

Photo 2.4.5.2-4 Sewerage pump building of same hospital. Discharge performed by temporary pump due to equipment failure.

(2) Rainwater drainage

- Phnom Penh city has the characteristics that rainwater is likely to collected and difficult to drain because it is in low-lying area.
- The obstruction of drainage is getting worse and the function of the drainage is dropping because of the civil war and the aging cleaning equipment.
- Furthermore, as a result of an increase in surface runoff due to the increased impermeable area, reduced marsh and lake area accompanying urbanization, various parts of the capital have been flooded even with daily rainfall of about 20 mm that occurs about 20 times during the rainy season.
- Under the aid of JICA, " a Master Plan for drainage improvement and flood control in Phnom Penh Capital City and suburbs " (JICA master plan) has been formulated in 1999 with 2010 as the target year. In the JICA Master Plan, it has been proposed to improve the revetment along the Sap River, reinforce the Tompun circle levee, improve Tompun basin drainage (see Fig.2.4.5.2-8).



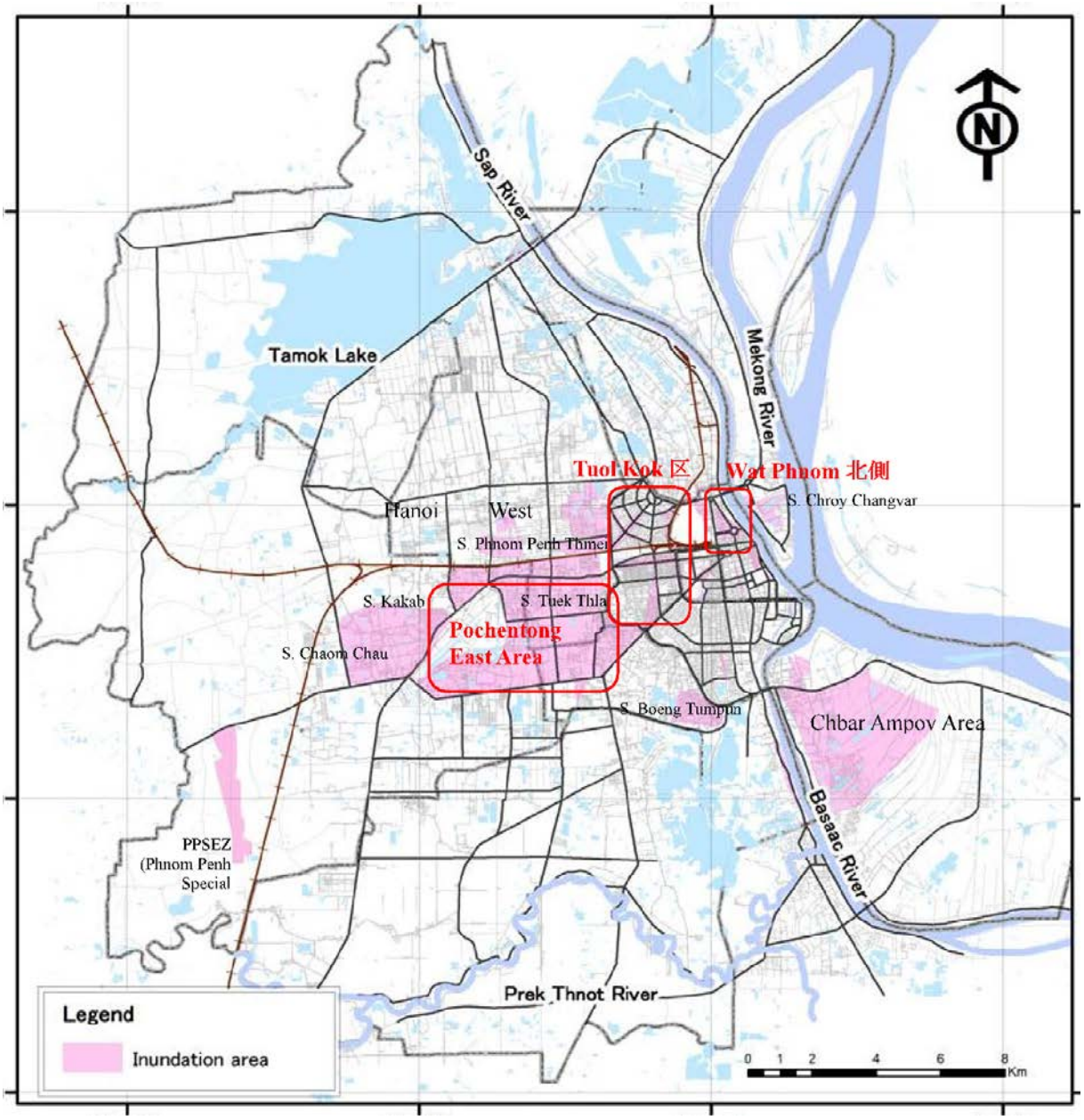
Source: JICA、The Study on Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area, June 2016

Fig. 2.4.5.2-6 Comparison of marsh and lake areas in Phnom Penh

Photo 2.4.5.2-5 Flooding of Charles de Gaulle Boulevard (April 2010)

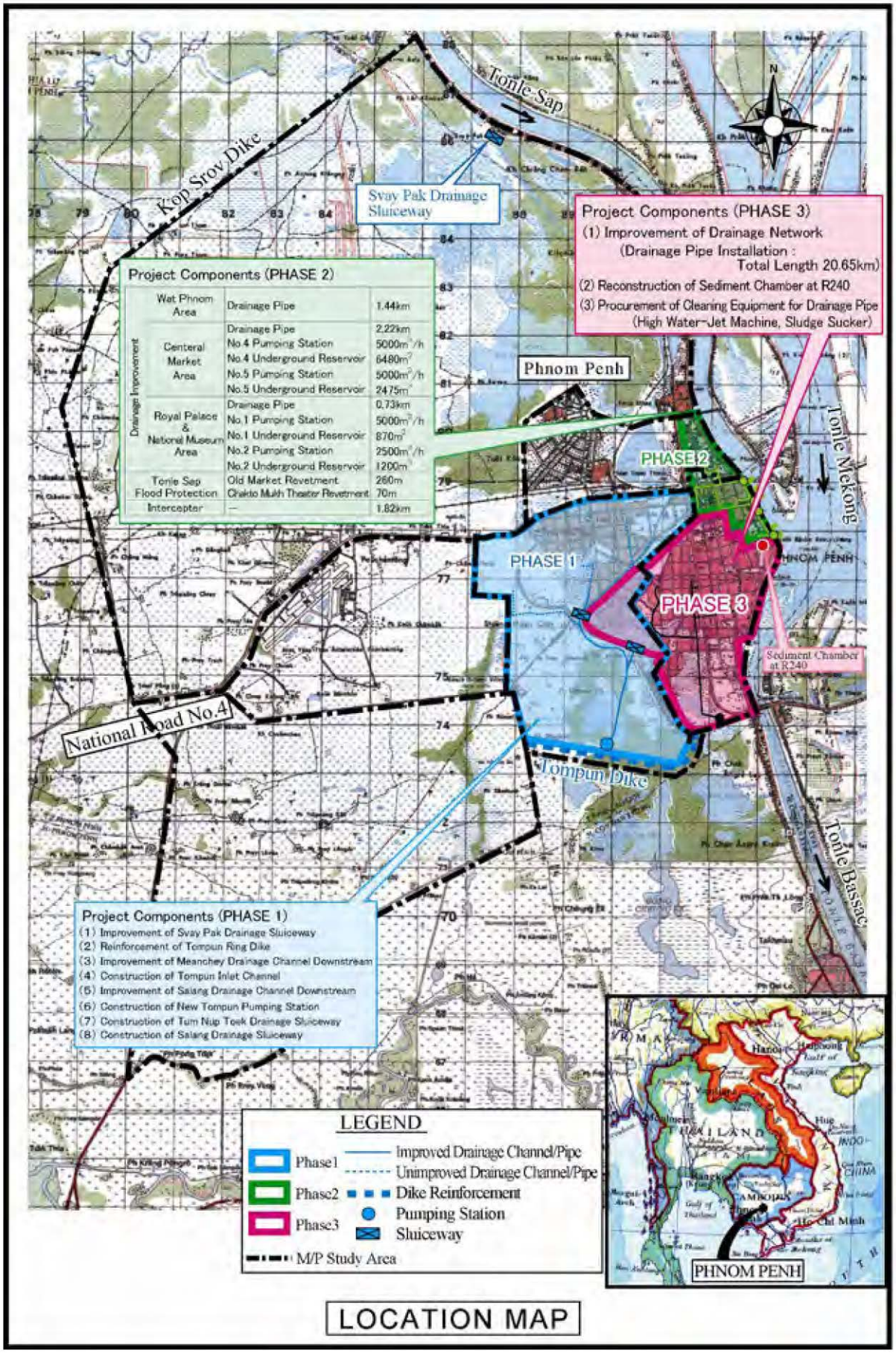
Photo 2.4.5.2-6 Flooding of intersection of Street 63 and Street 352 (Sept. 2009)

Source: JICA, Preparatory survey report on the project for flood protection and drainage improvement in the Phnom Penh Capital City (phase III) in the Kingdom of Cambodia. March 2011



Source: JICA、The Study on Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area，June 2016

Fig. 2.4.5.2-7　Inland inundation map of Phnom Penh



Source: JICA, Preparatory survey report on the project for flood protection and drainage improvement in the Phnom Penh Capital City (phase III) in the Kingdom of Cambodia. March 2011

Fig. 2.4.5.2-8 Phnom Penh Flood Prevention/Drainage Improvement Plan: Project locations for Phases I to III

2.4.5.3 Waterworks/sewerage and rainwater drainage/Introduction of efforts in Kitakyushu

■ Onga River water source water-treatment know-how (U-BCF)

Upward Biological Contact Filtration patented in Japan by Kitakyushu
（Upward Biological Contact Filtration : U-BCF）

Dam at mouth of Onga River

Honjo Water-Treatment Plant

【Kitakyushu waterworks water sources】
Waterworks source water intake is at the most downstream point of the river which is affected by household wastewater.

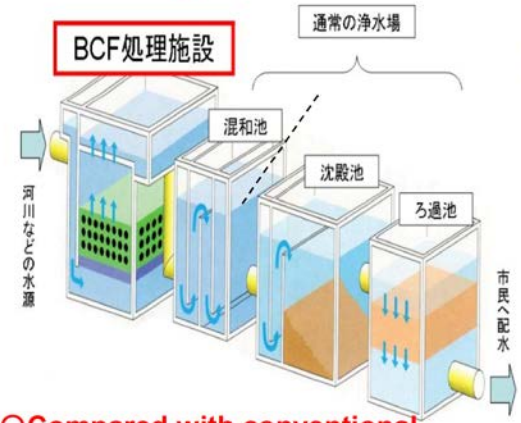
Original development of a new water-treatment technology (U-BCF) over 11 years as a measure for Onga River as a water source
Patent Number 3831055 (Application: 1997; Registration: 2006)

【Upgrading of main water-treatment plants to U-BCF】
Honjo Water-Treatment Plant (2000 & 2010): 106,500m³/day
Anoo Water-Treatment Plant (2003): 171,000m³/day

【Features】
Running cost = ¥3.6/m³
Compactness (economical construction cost)

■Introduction of U-BCF to main water-treatment plants

Introduction of U-BCF from small-scale water-treatment plant in Hai Phong to main water-treatment plants (utilizing grant aid)



○Compared with conventional advanced treatment:
・Construction costs: 1/2
・Running costs: 1/20

Main water-treatment plant
(An Duong water-treatment plant)

Expansion within Vietnam and throughout various countries in Southeast Asia

■Overview of Kitakyushu sewerage system

【History】

- ・Feb. 1963 Establishment of Kitakyushu ⇒ **Start of full-scale development**
- ・July 1963 Start of Kogasaki Treatment Cente
- ・March 1977 Sewerage coverage ratio reaches
- ・Jan. 1982 Total length of installed culverts re
- ・March 2005 Total length of installed culverts reaches 4,000 km.
- ・**March 2006** Sewerage coverage ratio reaches 99.8% (general sewerage development)

More than 600 billion yen invested in construction costs over approx. 40 years.

【Main sewerage facilities】

- ・**treatment centers: 5 locations**

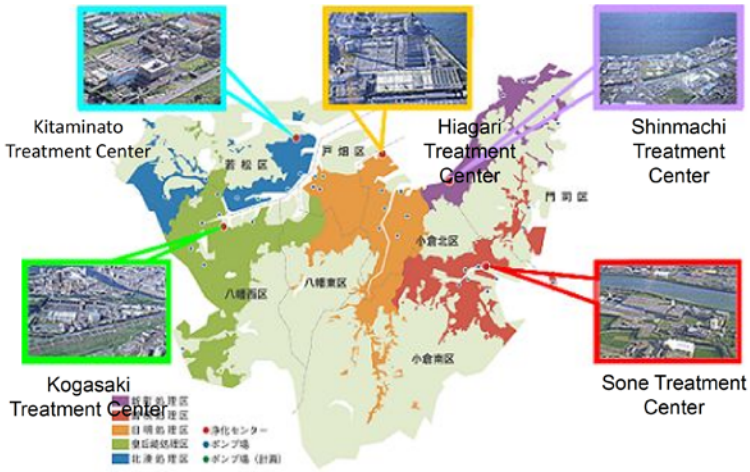
(Treatment capacity: 621,000 m³/day)

- ・Pump stations: 36 locations
- ・Culverts: 4,361 km
  - Sewerage: 3,197 km
  - Rainwater drainage: 321 km
  - Mixed flow: 843 km

【Treatment district area】

- ・16,191 ha

(Including mixed flow district area of 3,422 ha)

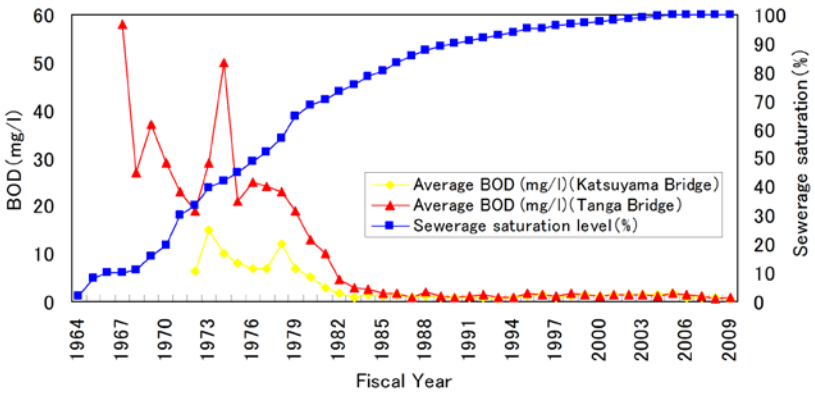


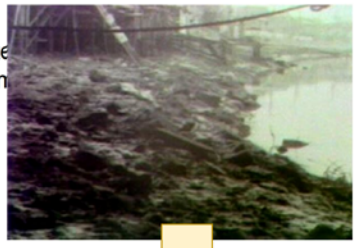
■ Results of sewerage system development

◆The government and citizens worked together as one over approx. 40 years to promote sewerage system development

- Government: Development of sewage treatment plants and sewerage syste
- Citizens: Thorough clean water conversion (connection to sewerage systen

As sewerage coverage spread, the water quality of Murasaki River improved dramatically.





Ayu, fish who live in clear streams, returned.

2.4.5.4 Waterworks/Sewerage and rainwater drainage/Specific measures

Based on the issues in the waterworks/sewerage and rainwater drainage field, specific measures in this field were set up as shown in the table below. The Implementing entity, timing of implementation and evaluation index of each specific measure were also set.

Table 2.4.5.4-1 Waterworks/Specific measures

Project classification	Project description	Project implementing entity	Implementation timing	Evaluation indexes
1. Introduction of measuring equipment in the private waterworks sector (suburbs)	・Introduce measuring instruments in the private water supply sector that is responsible for supplying water in the suburbs with the aim of achieving proper management operation through preventing water leakage, eliminate flooding failures, reduce power consumption, etc.	PWS	Short-term	Amount of energy consumption reduction GHG reduction amount
2. Securing water sources and water quality preservation	・Since demand is forecast to increase significantly in accordance with future population increases, work on securing water sources together iwth preserving the water quality of water sources	PPWSA, PWS MoE	Medium-long term	Quantity and quality of water source water
3. Introduction of energy-saving waterworks equipment and renewable energy	Reduce power consumption and promote GHG reduction through the use of energy-saving waterworks equipment such as pumps, etc. and the introduction of renewable energy such as solar power generation, etc.	PPWSA, PWS	Short-term	Amount of energy consumption reduction Amount of GHG reduction

Phnom Penh Water Supply Authority：PPWSA, Private waterworks sector：PWS
Ministry of the Environment：MoE

Photo 2.4.5.4-1 Example of high-efficiency inverter-control motor

http://www.e-mechatronics.com/download/datas/catalog/ka-p920-1/ka-p920-1d_7_0.pdf

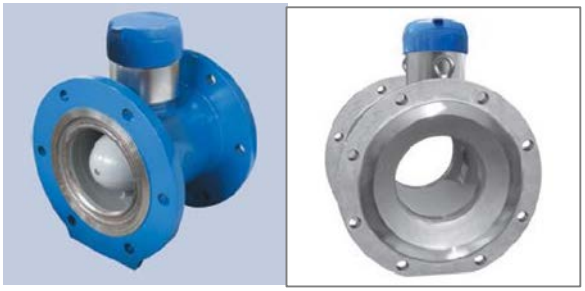


Photo 2.4.5.4-2 Examples of electromagnetic flow meters with excellent accuracy

http://www.aichitokei.co.jp/products/02_water/05_elemag_sy/

Photo 2.4.5.4-3 Solar power system (existing Phnom Penh Water Supply Authority equipment)

Table 2.4.5.4-2 Sewerage and rainwater drainage/Specific measures

Project classification	Project description	Project implementing entity	Implementation timing	Evaluation indexes
4. Area expansion of sewers and development of sewerage treatment plants	・Based on the Phnom Penh sewage countermeasures and drainage improvement master plan currently being formulated, shift away from marsh/stabilization pond methods for treating household wastewater and promote the development of suitable sewers for populated areas. ・In the development of sewers, coordinate and collaborate with road plans and public transportation plans in order to alleviate traffic congestion.	DPWT PPUD	Medium-long term	Sewerage system coverage ratio
5. Strengthening of administrative guidance and clarification and proper application of penalty regulations	・Based on the Phnom Penh sewage countermeasures and drainage improvement master plan currently being formulated, develop and improve rainwater drainage facilities together with sewerage projects in order to prevent flood damage caused by concentrated torrential rains, etc. ・Promote appropriate maintenance and management so that the functions of existing rainwater and drainage ditches are not impaired such as being clogged due to the illegal dumping of garbage, etc.	DPWT PPUD PPWMD	Short-term	Number of effluent inspections Effluent quality River water quality
6. Introduction of distributed wastewater treatment systems	・Introduce septic tanks as a distributed sewerage treatment system not only for household wastewater but also for hospitals which generate medical liquid waste or in rural areas such as villages, etc. where the population density is low and the spread of sewerage systems is delayed.	DPWT PPUD	Medium-long term	Dissemination ratio of septic tanks
7.Improve management capabilities for sewerage and drainage facilities	・While making full use of the capabilities of existing facilities, create maintenance/management manuals for sewerage/drainage facilities and flood hazard maps, conduct citizen enlightenment activities, etc. in order to improve facility maintenance/management and raise citizen awareness that contributes to the reduction of flood damage.	DPWT	Short-term	Number of times that flooding damage occurs

DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division

PPWMD: Phnom Penh Waste Management Division, Ministry of the Environment：MoE

Source：Kitakyushu city, http://www.city.kitakyushu.lg.jp/suidou/s01500007.html

Photo 2.4.5.4-4 Example of energy-saving improvements at final treatment plant

Photo 2.4.5.4-5 Example of improvements of industrial park wastewater treatment facilities（PPSEZ)

2.4.5.5 Pilot project in water/sewerage and rainwater drainage field 1 (sewerage/wastewater facilities management capacity development project)

JICA grassroots technical cooperation project, Cambodian capital Phnom Penh metropolitan area sewerage/wastewater facilities management capacity development project

(1) Current situation of Phnom Penh metropolitan area

◇Water environmental problems and flooding problems have manifested due to rapid urbanization.

⇒While maximizing existing facility capacity, facility maintenance and management to contribute to flood damage mitigation and educational activities to raise public awareness are necessary.

Source: JICA, Preparatory survey report on the project for flood protection and drainage improvement in the Phnom Penh Capital City (phase III) in the Kingdom of Cambodia. March 2011

Photo 2.4.5.5-1 Inundation situation

2) Project overview

◇Objective : To raise citizen awareness and suitable, efficient maintenance and management of sewerage and drainage facilities for the "sustainable development of sewers" and "flood damage mitigation" of the Phnom Penh metropolitan area.

◇Period: 2016 to 2019 (planned)

◇Activities: Public awareness activities/environmental studies, local technical guidance, acceptance of trainees, holding of seminars

＜Output＞

- Raise public awareness through awareness activities, flood hazard map creation, etc.
- Creation of maintenance/management manuals, etc. and operation of sewerage/drainage facilities

＜Implementation scheme＞

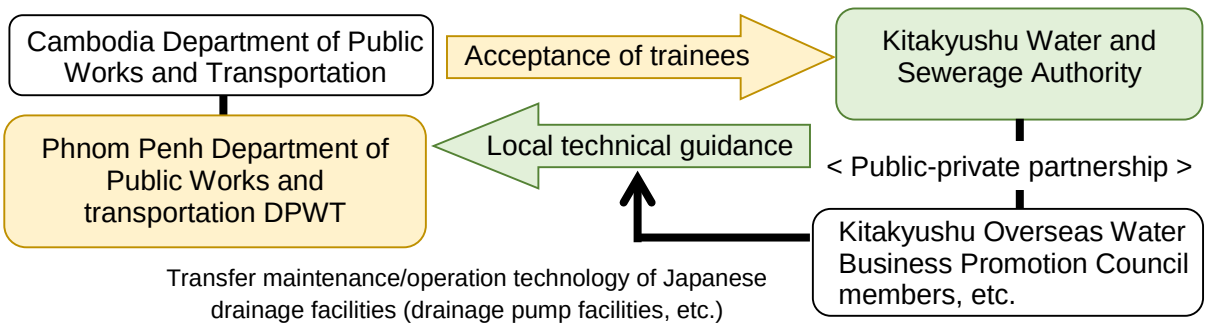
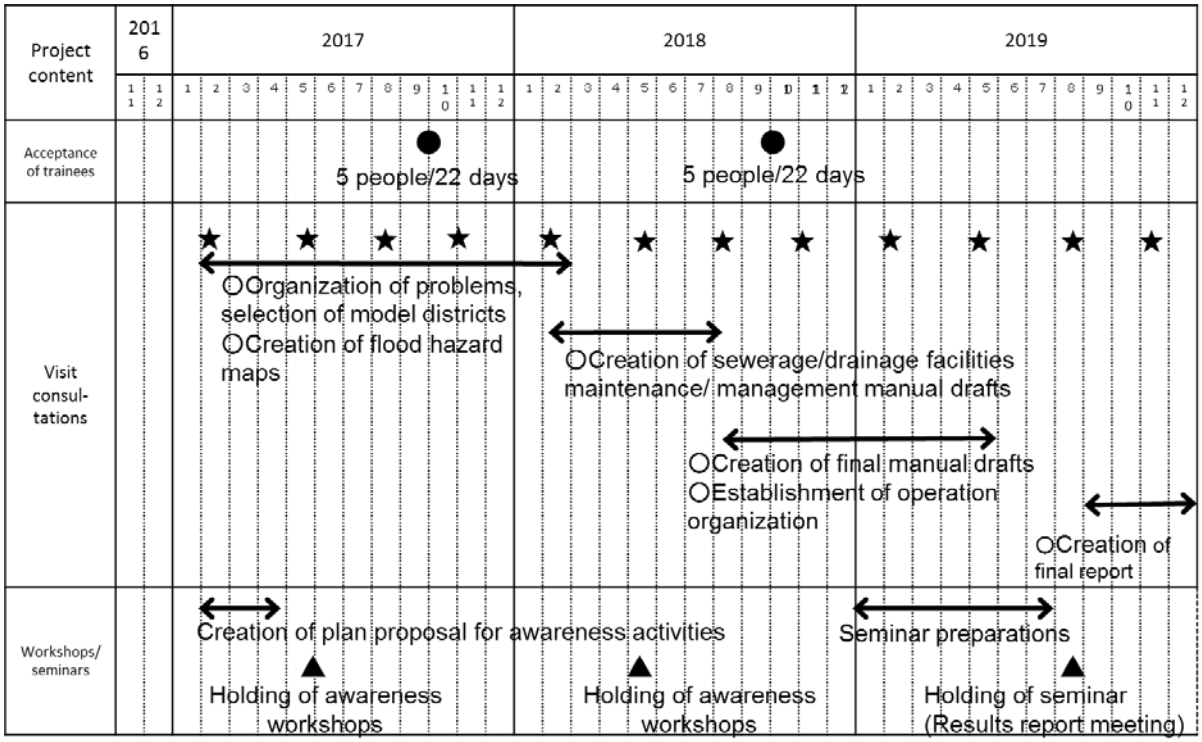


Fig. 2.4.5.5-1 Project Implementation scheme

(3) Project schedule (1/2017 to 12/2019)

Table 2.4.5.5-1 Project schedule (1/2017 to 12/2019)



Source: JICA, Project for Capacity Building of the Operation and Maintenance of Sewerage and Drainage System in Phnom Penh Capital City

2.4.5.6 Pilot project in water/sewerage and rainwater drainage field 2 (Introduction of energy-saving system suitable for private waterworks sector)

(1) Project overview

Many companies in the Cambodia private waterworks sector (approx. 150 companies) have problems with steadily supplying safe water. According to the FS survey conducted by Uni-Elex Co., Ltd., by introducing inverter pump systems to the Cambodia private waterworks sector, a high electricity consumption reduction effect can be expected.

The same company conducted demonstration tests in 2016 (at Prey Kub Water Supply Co.), and plans to promote the spread of inverter equipment, etc. to the private waterworks sector based on the results of that test.

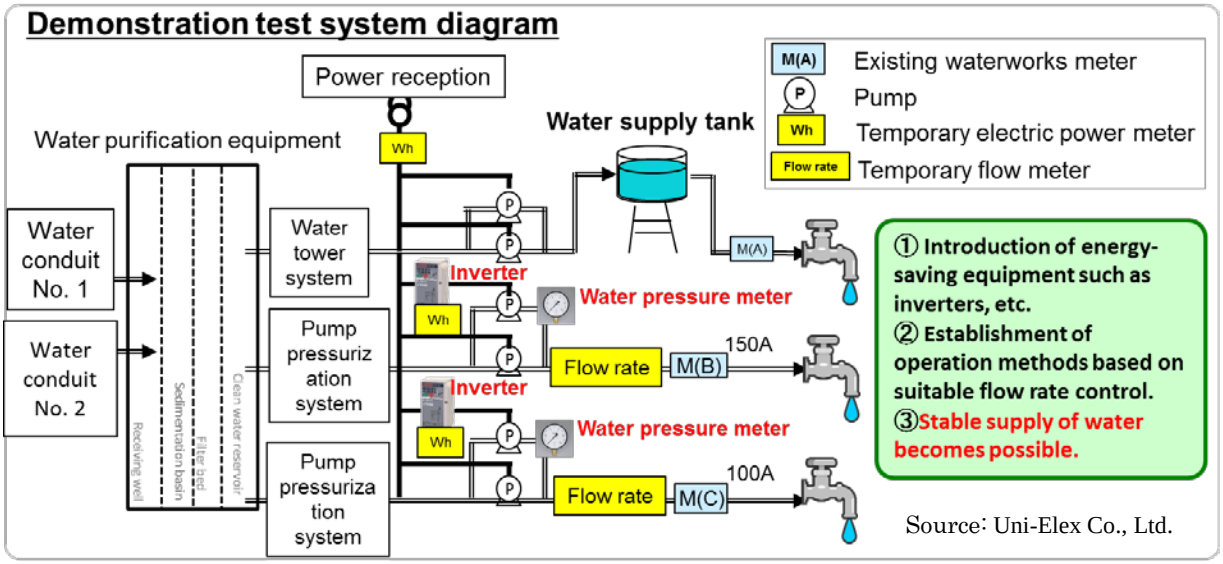


Fig. 2.4.5.6-1 Demonstration test system diagram

(2) Project implementation structure

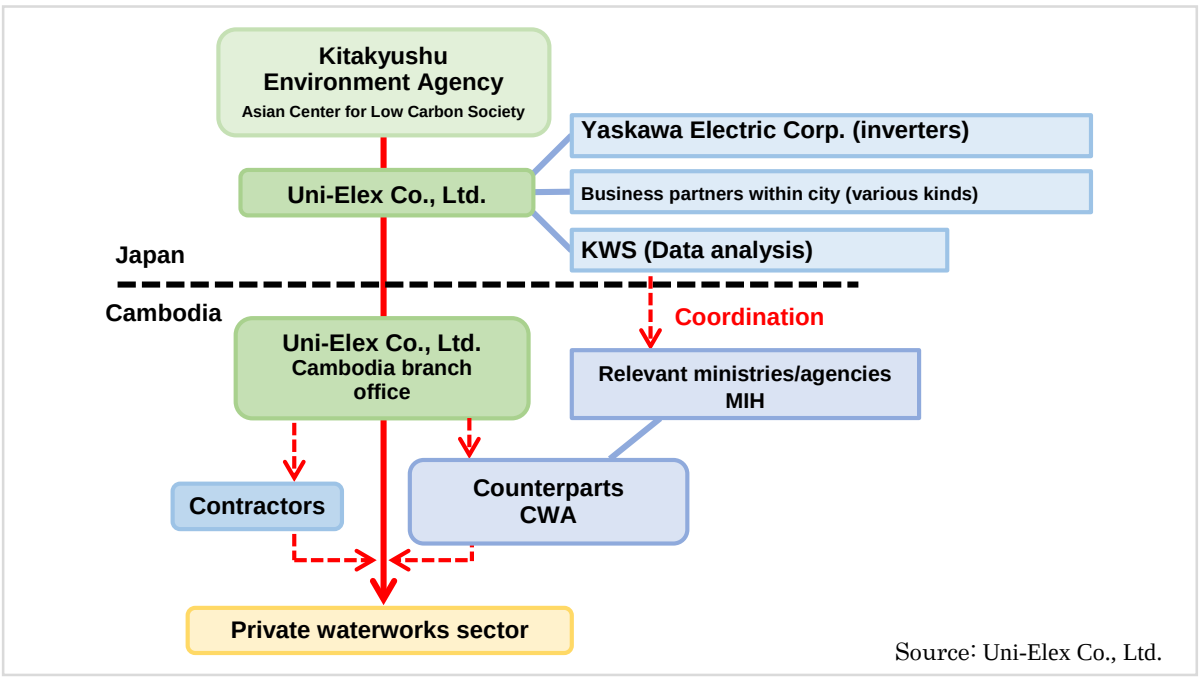


Fig. 2.4.5.6-2 Project implementation structure

2.4.5.7 Pilot project in water/sewerage and rainwater drainage field 3 （Hospital wastewater treatment project）

(1) Project overview

・In view of the fact that hospital wastewater is being discharged without even undergoing sterilization, with the exclusion of hospitals located in the Cheung Aek treatment district which will undergo off-site sewage treatment (construction of sewage treatment plants) under JICA's sewage master plan, septic tanks packaging together various kinds of treatment equipment will be introduced to the other hospitals and proper treatment of hospital wastewater will be performed.

・In the Tamok treatment district, wastewater treatment combining on- and off-site treatment was investigated under the current plan, but since the conclusion presumes on-site treatment, hospitals located in this area will also be subject to the above plan. There are 7 hospitals in the district, with a total bed count of approximately 940 beds.

Table 2.4.5.7-1　Subject hospitals and bed counts

No.	Name	Beds	Manager
11	Cho Ray Phnom Penh Hospital	500	Private
12	Sen Sok International University Hospital	250	Private
⑮	Cambodia-Chinese Friendship Sen Sok Referral Hospital	60	MHD
⑯	Meanchey Referral Hospital	42	MHD
⑰	Porchentong Referral Hospital	35	MHD
⑱	Chamkar Doung Health Centre	25	MHD
⑲	Samdach Ov Referral Hospital	19	MHD
⑳	Praek Pnov Referral Hospital	13	MHD
	Total	936	

Source ： http://www.vir.com.vn/cho-ray-hospitals-offspring-opens-in-phnom-penh.html

Photo 2.4.5.7-1　Cho Ray Phnom Penh Hospital

Source：http://www.hospitaldirectoryasia.com/HospitalPage.aspx?id=16080

Photo 2.4.5.7-2　Sen Sok International University Hospital

Source：http://hipcambodia.blogspot.jp/2011_06_01_archive.html

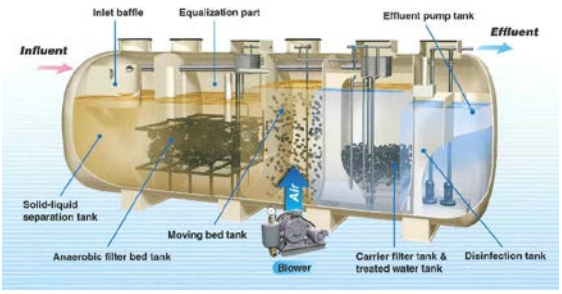
Photo 2.4.5.7-3　Porchentong Referral Hospital

Source : http://www.cambodiayp.com/company/46604/Samdech_Ov_Referral_Hospital

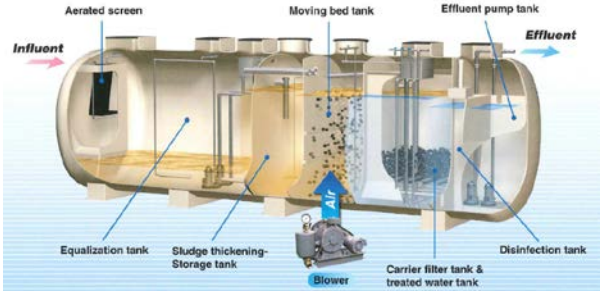
Photo 2.4.5.7-4　Samdach Ov Referral Hospital

■Cross-section perspective

◇Q=10～30m^3/day (For small- to medium-scale use)

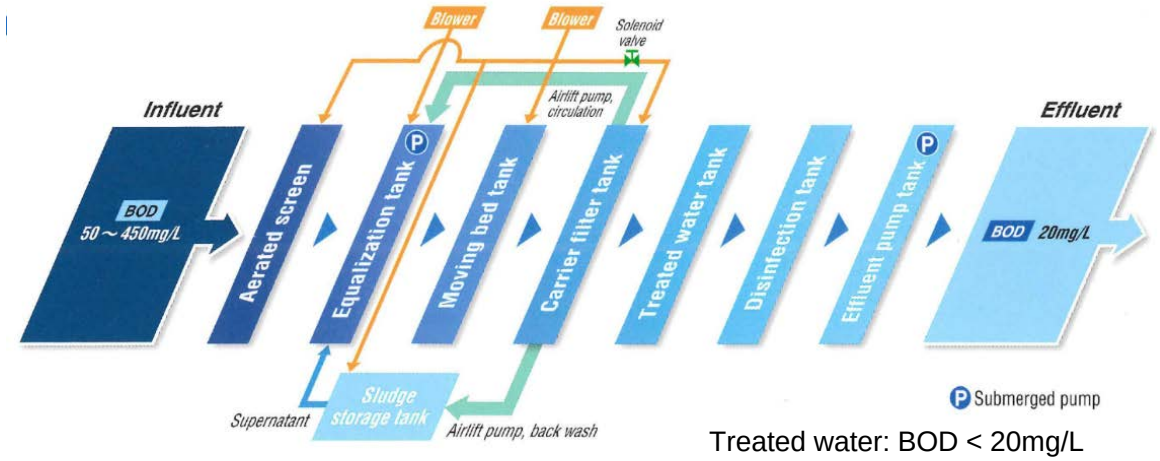


◇Q=20m^3/day～ (For large-scale use)



Source: KUBOTA JOHKASOU SYSTEM CO.,LTD

■Example of flow sheet (when using model for large-scale use)



Treated water: BOD < 20mg/L

・Hospital wastewater example

・Q=50m^3/day

・Factory wastewater example

・Q=80m^3/day

Source: KUBOTA JOHKASOU SYSTEM CO.,LTD

・The estimated treatment water volume and septic tank scale are shown in the table below.
・Since the septic tank is a package system, installation is simple.
・For large-scale septic tanks, sludge removal will be performed once per week. For medium-scale tanks, the frequency would be once every two weeks.
・Tank maintenance inspection needs to be performed once every two weeks, and it is necessary to cultivate personnel who will be capable of properly performing such maintenance and inspection in order to ensure stable septic tank operation.
・Facilities expense(total)=approx. 3.8M USD
・Maintenance cost(total)=approx. 0.4M USD*

*Estimate based on conditions in Japan

Table 2.4.5.7-2　Approximate septic tank scale for each hospital

No	Hospital name	Type	Treatment water volume (m^3/day)	Necessary electrical capacity (kW)	Annual power consumption (kWh/y)
11	Cho Ray Phnom Penh Hospital	Large	500	22	106,800
12	Sen Sok International University Hospital	Large	250	14	54,540
⑮	Cambodia-Chinese Friendship Sen Sok Referral Hospital	Medium	60	4.5	20,660
⑯	Meanchey Referral Hospital	Medium	42	3.8	20,440
⑰	Porchentong Referral Hospital	Medium	35	2.5	12,260
⑱	Chamkar Doung Health Centre	Medium	25	2.0	12,150
⑲	Samdach Ov Referral Hospital	Medium	19	1.6	12,100
⑳	Praek Pnov Referral Hospital	Medium	13	1.6	8,920

(2) Project scheme (proposal)

・Since the urgency of this problem is high, it is important to apply a scheme that can be implemented as a project in a short period of time.
・Although the project scheme is not yet determined, grant aid from the Foreign Ministry of Japan and support from ADB, etc. is being considered.
・Together with installation of the septic tank, cultivation of personnel capable of proper facility operation is essential.

(3) Project implementation organization (proposal)

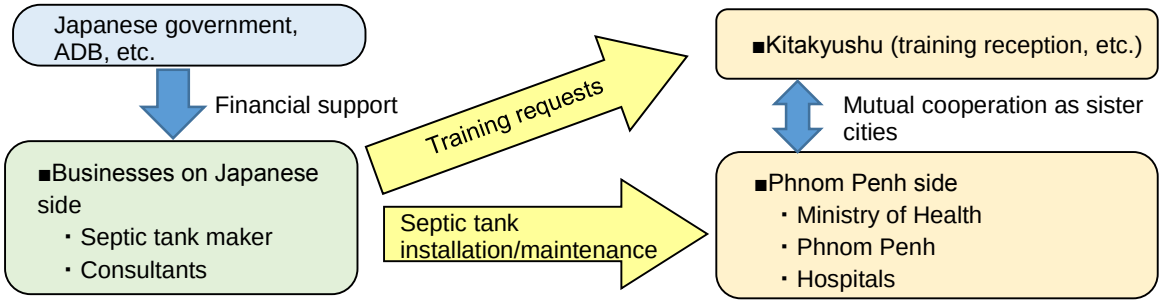


Fig. 2.4.5.7-1　Project implementation organization (proposal)

2.4.6 Tasks and Specific Measures in Environmental Conservation Field

2.4.6.1 Environmental Conservation/Current status and tasks

(1) Formulation and operation of environmental management plan

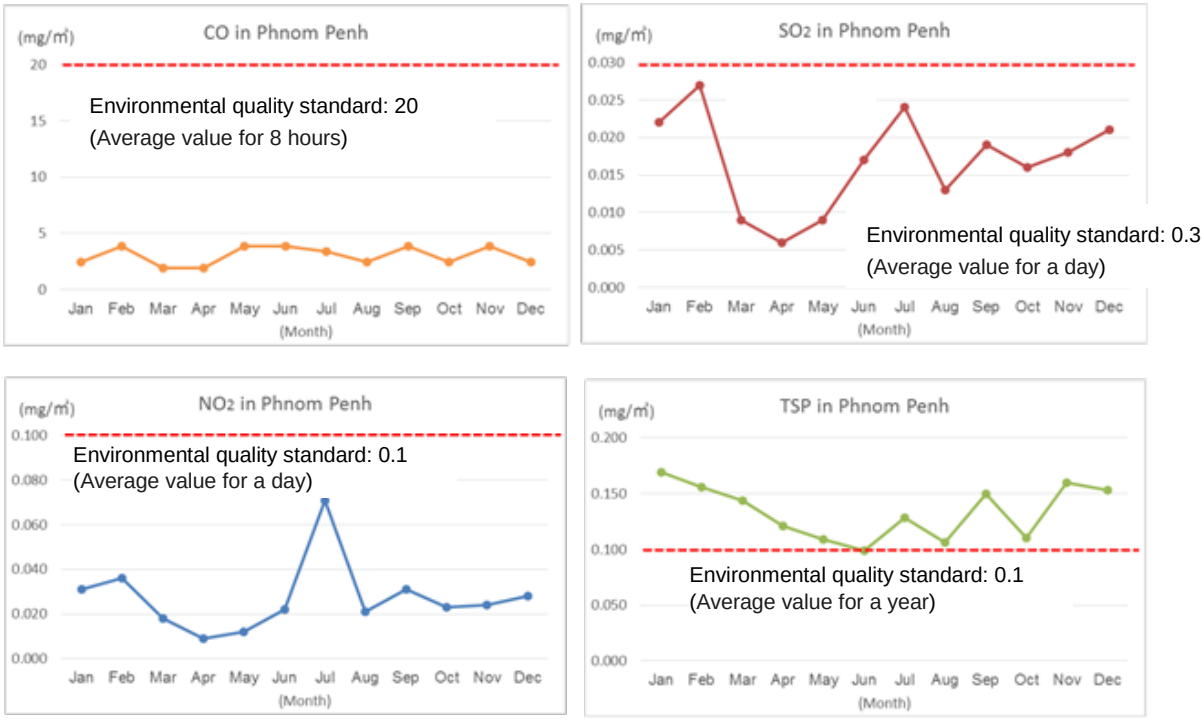
- In order to effectively promote environmental conservation, it is important to formulate an environmental management plan which will be the master plan for environmental conservation and to implement well-planned environmental conservation measures together with cultivating the human resources necessary for doing so.

(2) Preventing chaotic urban development

- In Phnom Penh, the skyscraper construction rush continues, but in order to create an environmentally conscious city, it is important to set land use zoning, etc. to promote systematic urban development.
- Because urbanization has proceeded rapidly even though urban infrastructure such as roads, sewers, etc. remain undeveloped, serious traffic congestion and water pollution is occurring.

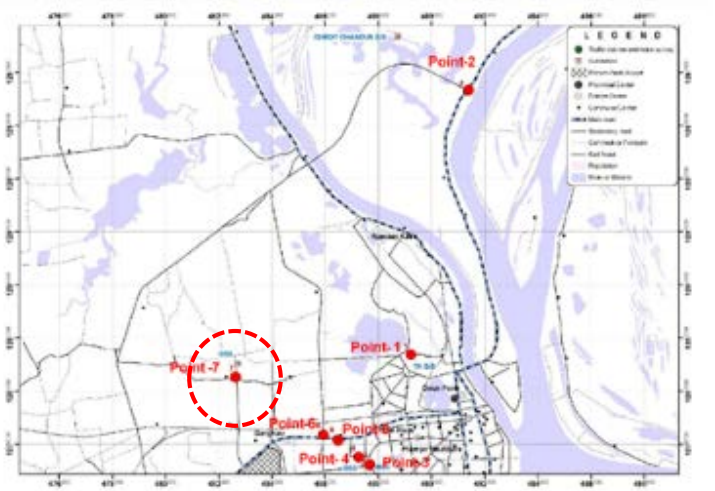
(3) Air pollution

- With the spread and increase of automobile and motorcycles, air pollution is progressing since appropriate inspections are not being carried out. At the current time, air pollution from factories is not progressing.
- Although environmental standard values were met in previous surveys, there is only one air pollution monitoring site, so the actual situation is not sufficiently grasped.
- Dust and volatile organic compounds (VOC) are being generated by the numerous building construction sites accompanying chaotic development, and air pollution due to such materials is a concern.



Source: MoE General Diretorate of Environmental Conservation

Fig. 2.4.6.1-1 Results of air quality monitoring at the intersection near the Olympic Stadium (2014)

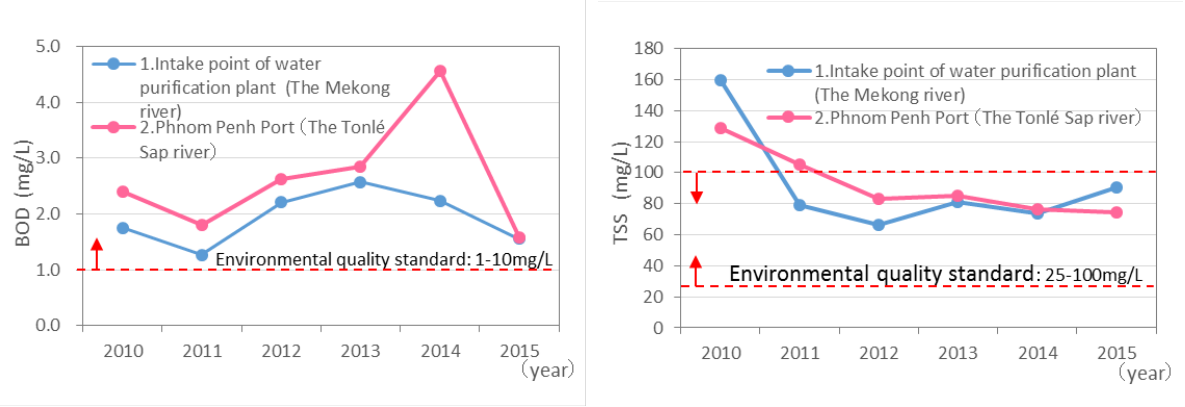


Source: JICA, Preparatory survey for Phnom Penh city transmission and distribution system expansion project phase2 in the Kingdom of Cambodia, December 2014

Fig. 2.4.6.1-2 Map of locations of noise and vibration monitoring points in Phnom Penh metropolitan area

(4) Water pollution

- The Mekong River, an international river with its source in the Tibetan Plateau, merges with the Tonle Sap River south of Phnom Penh and flows into Vietnam. In Cambodia, freshwater fish fisheries are flourishing, but recently the contamination of the Mekong River has also advanced, and its effect on fisheries is a concern. Although this is an international issue, measures in Cambodia such as proper treatment of household wastewater are also being requested.
- Many factories outside of PPSEZ do not have wastewater treatment facilities installed on site, and it is necessary to apply administrative guidance for water standards compliance and violation penalties.
- The situation of pollution in the urban canal is as shown in Figure 2.4.6.1-4, Photo 2.4.6.1-1, and the influence on the health of the surrounding residents is concerned. The pollution of urban waterways is serious, and the influence of surrounding residents on health is concerned (see Photo 2.4.6.1-1, Fig. 2.4.6.1-4).

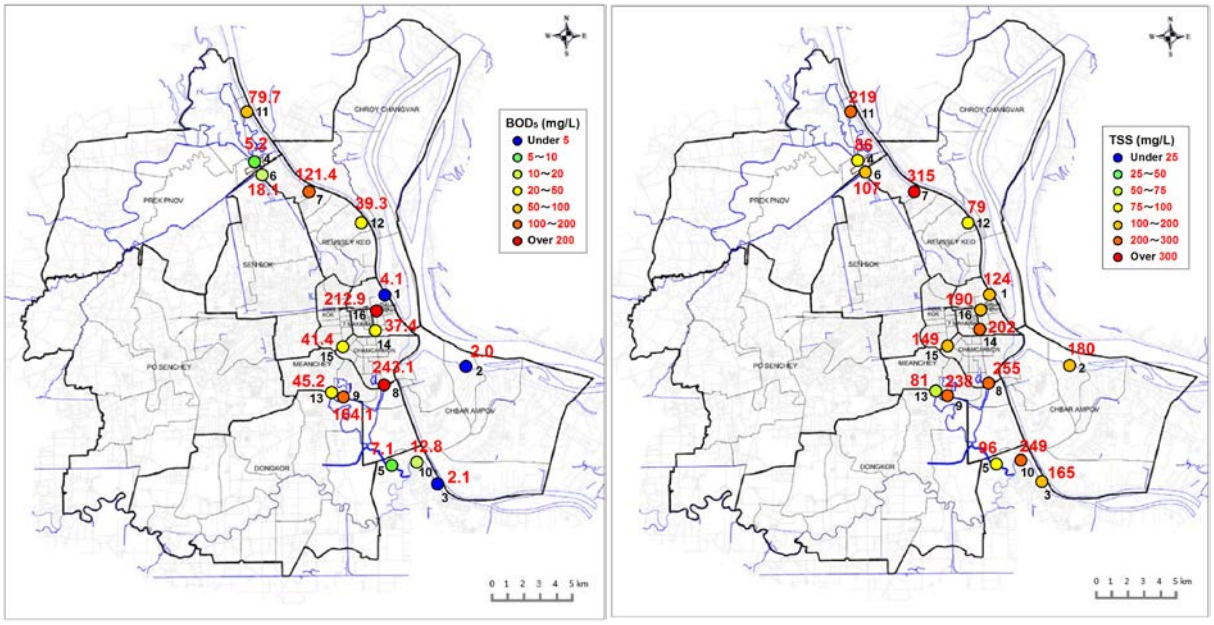


Source: MoE General Diretorate of Environmental Conservation

Fig. 2.4.6.1-3 Example of water quality survey results at Rivers in Phnom Penh City area

◇Example of water quality survey results of main bodies of water and drainage water in Phnom Penh(Average values for total of 6 times of measurement between Nov.2015 and Jan. 2016)

No.	Category	Monitoring Point	Analysis items	Remarks
1	River	Sap River (Phnom Penh Port)	pH,DO,BOD_5,COD_{Cr},COD_{Mn},TSS,T-N,T-P,Total Coliform	Sampling of surface water from river bank.
2		Mekong River (Kien Svay)		
3		Bassac River (Thakhmao)		
4	Lake/ swamp	Tamok Lake (Discharge Point)		Sampling of surface water at the point where lake water flows into the river.
5		Cheung Aek Lake (Discharge Point)		
6	Small Channel	Kop Slov Pumping Station	pH,DO,BOD_5,COD_{Cr},TSS, T-N,T-P,Total Coliform	Sampling of surface water at the center of the waterway for small waterways. Factories and commercial facilities were selected jointly with DOE/PPCC.
7		Svay Pak Sluiceway		
8		Trabek Pumping Staion		
9		Tumpun Pumping Station		
10	Small Channel	Prek Thnot River (Thakhmao Bridge)	pH,DO,BOD_5,COD_{Cr},TSS, T-N,T-P,Total Coliform	Treatment facility
11	Factory	Men Sarun (Noodle Factory)		Septic tank
12		SKD (Liquor)		Digesting tank + Lagoon Activated sludge process + Chemical treatment
13		SL (Garment and Washing)		
14	Commercial Facilities	Phnom Penh Tower (Office Building)		Activated sludge process
15		Intercontinental Hotel		Septic tank + Aeration equipment
16		Central Market		Septic tank



Source: JICA, Phnom Penh sewerage/drainage improvement project, June 2016

Fig. 2.4.6.1-4 Example of water quality survey results of main bodies of water and drainage water in Phnom Penh

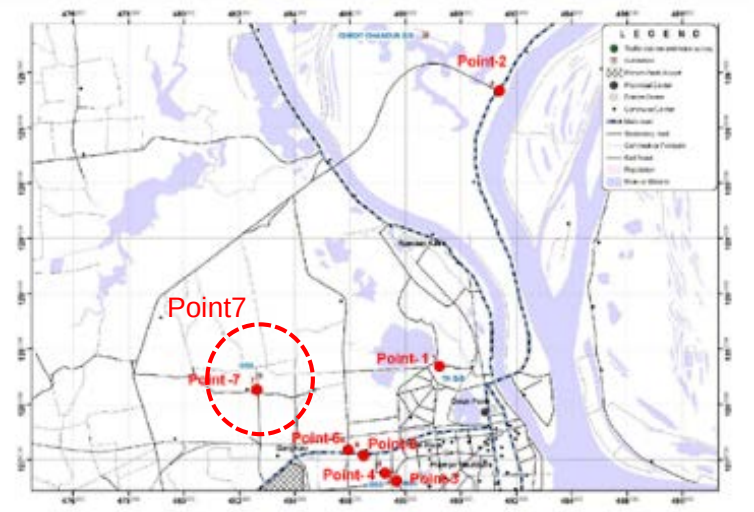
Photo 2.4.6.1-1　Pollution situation of Waterway in urban area

(5) Soil contamination

- The waste disposal site is open dumping and soil contamination caused by leachate water is a problem, so that contamination of groundwater and rivers is also a concern. Because of this, it is necessary to operate a sanitary landfill.

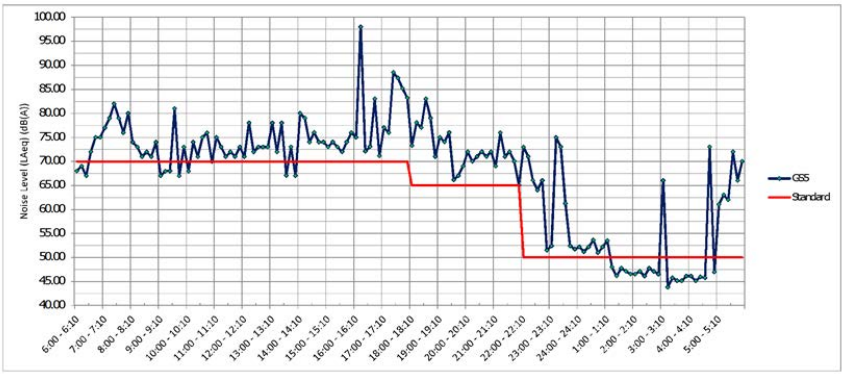
(6) Noise/vibration

- Although environmental standards for noise have been set, periodic monitoring is not being performed.
- At locations where traffic volume outside the city is larger than in the downtown area, environmental standards for noise are not being met.
- No environmental standards for vibration have been set, and the current situation is unclear.



Source: JICA, Preparatory survey for Phnom Penh city transmission and distribution system expansion project phase2 in the Kingdom of Cambodia, December 2014

Fig. 2.4.6.1-5 Map of locations of noise and vibration monitoring points in Phnom Penh metropolitan area



Source: JICA, Preparatory survey for Phnom Penh city transmission and distribution system expansion project phase2 in the Kingdom of Cambodia, December 2014

Fig. 2.4.6.1-5 Changes in equivalent noise level over time at Point 7

(7) Ecosystem

- There are important wetlands which are the habitat of valuable birds such as Philippines pelican, Oriental darter, etc., so conservation is required.
- Freshwater dolphins inhabiting the Mekong River from Cambodia to Laos are on the verge of extinction.
- Although the ecosystem has not been systematically investigated and the situation remains unclear, in September 2015 instructions were given for each ward in the capital region to clarify areas that should be protected from an ecological or cultural viewpoint.

Table 2.4.6.1-1 Important Wetland in Phnom Penh City

Wetlands identified	Location	Province/ Municipality	Elevation AV (m) (max)	Area (ha)
Prasant Tuyo Lake	About 57km East of Kampong Cham town	Phnom Penh	7	72,000
Boeung Veal Samnap	About 10m NE Phnom Penh	Phnom Penh	9	10,850
Boeung Prang	11m NE Phnom Penh	Phnom Penh	6	12,600

Data source : Statistical Yearbook of Cambodia 2011

Photo 2.4.6.1-2 Situation draining the sewage into the stabilization pond

Photo 2.4.6.1-3 Pollution situation of Wetland

2.4.6.2 Environmental conservation /Introduction of efforts in Kitakyushu

■Dokai Bay Cleanup

Dredging of Dokai Bay

Dredged sediment:
Sediment with total mercury concentration of 30 mg / L or more: 350,000 m³

Total project cost: 1.8 billion yen
Burden ratio:
- **Operator: 71%**
- **Public: 29% (Country: 1/2; Prefecture: 1/4; City: 1/4)**

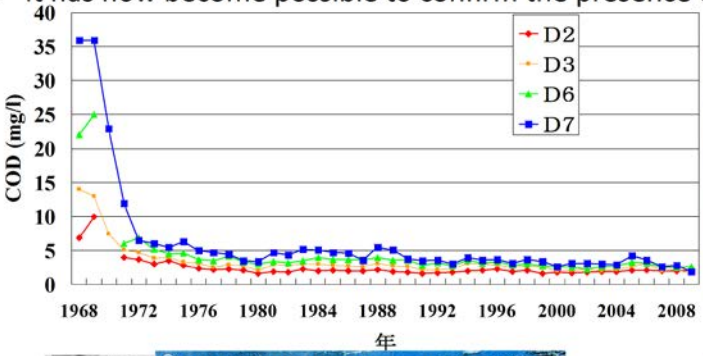
Environment monitoring
(Ocean region, rivers)

Monitoring of various items such as COD, BOD, etc. is being performed.

Ocean regions: pH, COD, total nitrogen, total phosphorus, dissolved oxygen, amount of suspended matter, transparency, number of coliform bacteria groups, etc.
Rivers: pH, BOD, electrical conductivity, dissolved oxygen, amount of suspended matter, transparency, number of E. coli groups, etc.

■Change over time of Dokai Bay water quality (COD)

- The water quality of Dokai Bay is improving as a result of various countermeasures.
- It has now become possible to confirm the presence of many types of marine products.



Dokai Bay had been heavily polluted by wastewater from steel and chemical plants, etc. Because it had reached the condition where no living thing could survive, it was nicknamed the "Sea of Death".

■Air pollution countermeasures

On-site inspection based on the Air Pollution Control Law

Installation status of soot-generating facilities (as of March 31, 2010)

Large-scale facilities※1	Medium-scale facilities※2	Small-scale facilities※3	Total
120	221	1230	1571

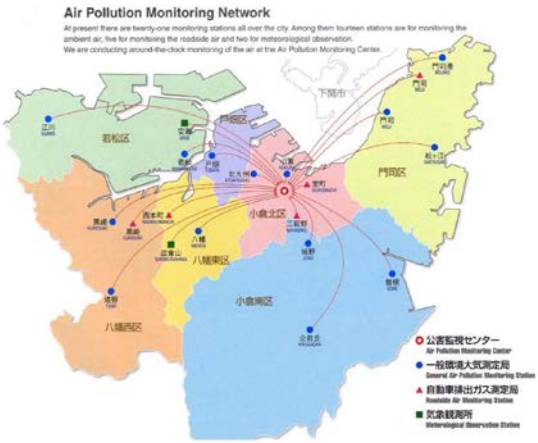
※1 Large-scale facilities: Exhaust gas volume ≥ 40,000 m^3_N/h
※2 Medium-scale facilities: 10,000 m^3_N/h ≤ Exhaust gas volume < 40,000 m^3_N/h
※3 Small-scale facilities: Exhaust gas volume < 10,000 m^3_N/h

On-site inspection plans are formulated every fiscal year

【 Selection criteria 】
(1)Large-/medium-scale facilities: All facilities (Approx. 90% of total city exhaust gas volume
(2)Small-scale facilities: Factories/businesses who did not respond to survey on fuel usage amount

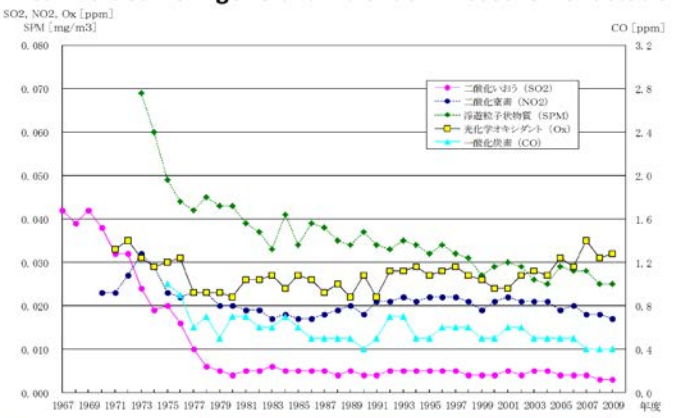
Companies develop pollution control equipment and energy-saving production processes.

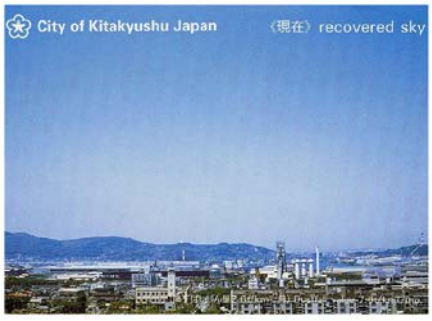
Network for constant air pollution monitoring/measurement



■Trend of air pollution situation

(annual mean values from general ambient air measurement stations)





2.4.6.3 Environmental conservation/Specific measures

Based on the issues in the environmental conservation field, specific measures in this field were set up as shown in the table below. The Implementing entity, timing of implementation and evaluation index of each specific measure were also set.

Table 2.4.6.3-1 Environmental conservation/Specific measures (1/2)

Project classification	Project description	Project implementing entity	Implementation timing	Evaluation index
1.Formulation and appropriate operation of environmental plans	· In order to comprehensively and systematically promote environmental conservation, formulate a "Phnom Penh City Metropolitan Environmental Management Plan" and operate it properly to effectively solve the environmental problems of Phnom Penh City. ・Regarding formulation of the plan and its proper operation, cultivation of human resources will also be carried out with the aim of promoting sustainable environmental conservation measures.	MoE	Medium-long term	Plan formulation Number of persons for human resource cultivation
2. Promotion of environmentally conscious city development	・Promote planned urban development, such as regionally restricting land use by area through a land-application regional system, etc. in order to create an environmentally conscious city.	PPUD	Medium-long term	Area regulation system for land use
3.Development of air quality monitoring system	・An air quality monitoring system will be developed and a constant monitoring system will be constructed in order to accurately grasp the current state of air pollution and implement appropriate air pollution countermeasures. ・As countermeasures against air pollutant sources, on-site inspections of plants and business sites that have facilities that generate smoke or common dust, and the management conditions and voluntary measurement results of such facilities will be confirmed.	MoE	Short-term	Development of monitoring system Environmental standard achievement ratio GHG reduction amount
4. Setting of environmental standards related to noise and vibrations,	・In order to effectively promote noise and vibration countermeasures, environmental standards for each land use type will be set and a monitoring system will be developed.	MoE	Medium-long term	Environmental standard achievement ratio

Ministry of the Environment：MoE
DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division
PPED:Phnom Penh environment-related departments

Table 2.4.6.3-1 Environmental conservation/Specific measures (2/2)

Project classification	Project description	Project implementing entity	Implementation timing	Evaluation index
5. Expansion of vehicle exhaust gas regulations	・In order to prevent emissions of harmful exhaust gas, etc. due to defective vehicle maintenance, the required inspection items related to vehicle inspections and the standards for vehicle inspection site certification will be reviewed in order to ensure reliable performance. ・In order to reduce air pollution due to vehicle exhaust gas, exhaust gas regulation values will be reviewed and regulation conformance and violation penalties will be strengthened.	DPWT PPUD	Medium-long term	Automobile inspection reception ratio Exhaust gas achievement ratio
6. Periodic performance of water quality monitoring	・In order to preserve water environments, water quality monitoring will be periodically performed in order to understand the actual pollution situation at public water areas within the capital region.	MoE PPED	Short-term	Environmental standard achievement ratio
7. Proper management of industrial wastewater	・In order to ensure proper treatment of industrial wastewater discharged from factories and workplaces, on-site inspections will be performed periodically so that factories and businesses will strive to comply with wastewater environmental standards, and factories / businesses that do not follow the guidance and continue to violate the standards will be penalized.	MoE	Short-term	Number of wastewater inspections Wastewater quality
8. Preservation of valuable ecosystems	・In order to protect the biodiversity of wetlands and the Mekong River in Phnom Penh, fundamental surveys will be conducted to clarify the actual situation and efforts will be made to preserve existing ecosystems..	MoE	Medium-long term	Wetland area Green land area

Ministry of the Environment：MoE

DPWT: Department of Public Works and Transport, PPUD: Phnom Penh Urbanization Division

PPED:Phnom Penh environment-related departments

Source: Horiba, Ltd.

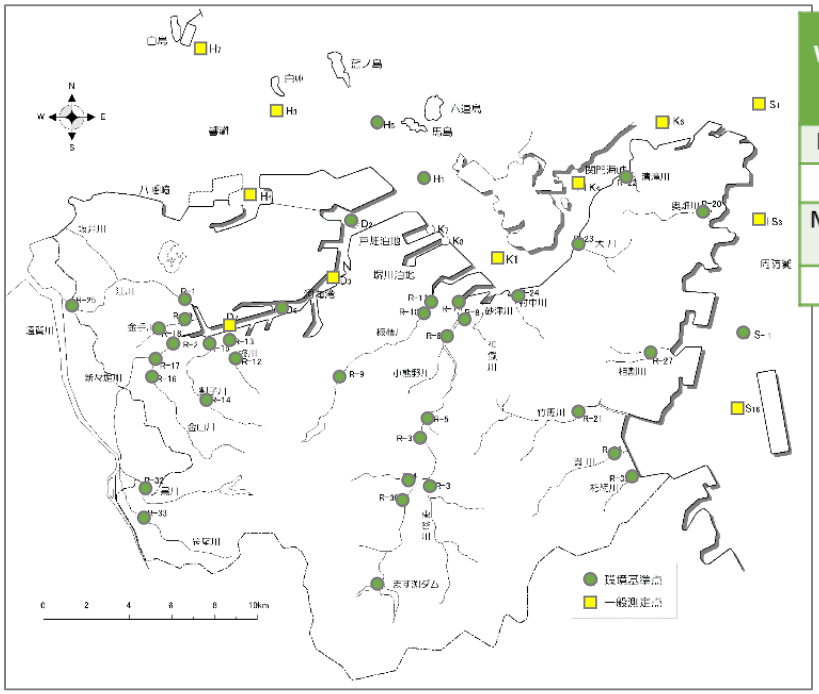
Example of air quality observation vehicle (mobile station)

Source:http://svmeas.rion.co.jp/download/catalog/VM-55#VM-55

Example of vibration measurement equipment (stationary station)

Source:https://www.do-blog.jp/riseup/article/29/

Example of measurement of exhaust gas during automobile inspection



Water area	Environ-mental reference points	General land points
Rivers	27	5
Lakes	1	0
Marine areas	7	11
Total	35	16

Example of water quality monitoring situation of Kitakyushu (2014)

Source:https://www.aeon.info/ef/sp/greening_activities/other_countries/phnom_penh_cambodia/

Tree-planting activity by volunteers at Phnom Tamao Wildlife Rescue Center (Aeon Environmental Foundation)

2.4.6.4 Pilot project in environmental conservation field 1 (Project for development of air quality and noise monitoring system)

(1) Project outline

- In order to understand the air quality and noise conditions in Phnom Penh, automatic monitoring equipment for air and noise will be introduced (around 3 units in fixed locations and 1 mobile unit). In addition, the monitoring data will be shared with the Cambodia Institute of Technology (CIT)'s monitoring station. The research on air pollution and the training of experts will also be supported.
- In conjunction with this, in order to develop a specialist for environmental monitoring, training will be performed at Kita Kyushu City.
- For the funding of this project, the use of ODA grant aid will be investigated.

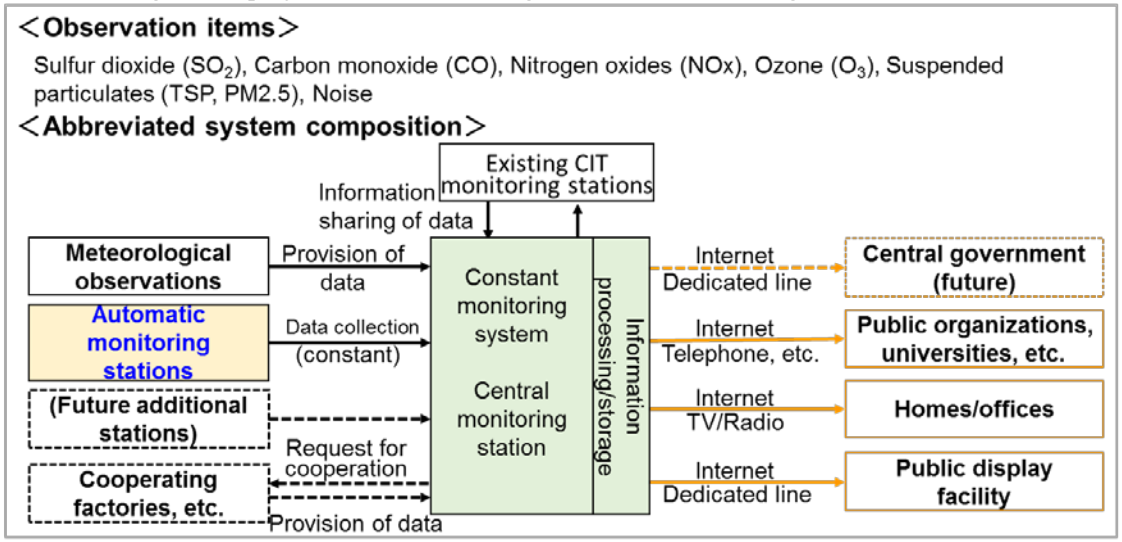
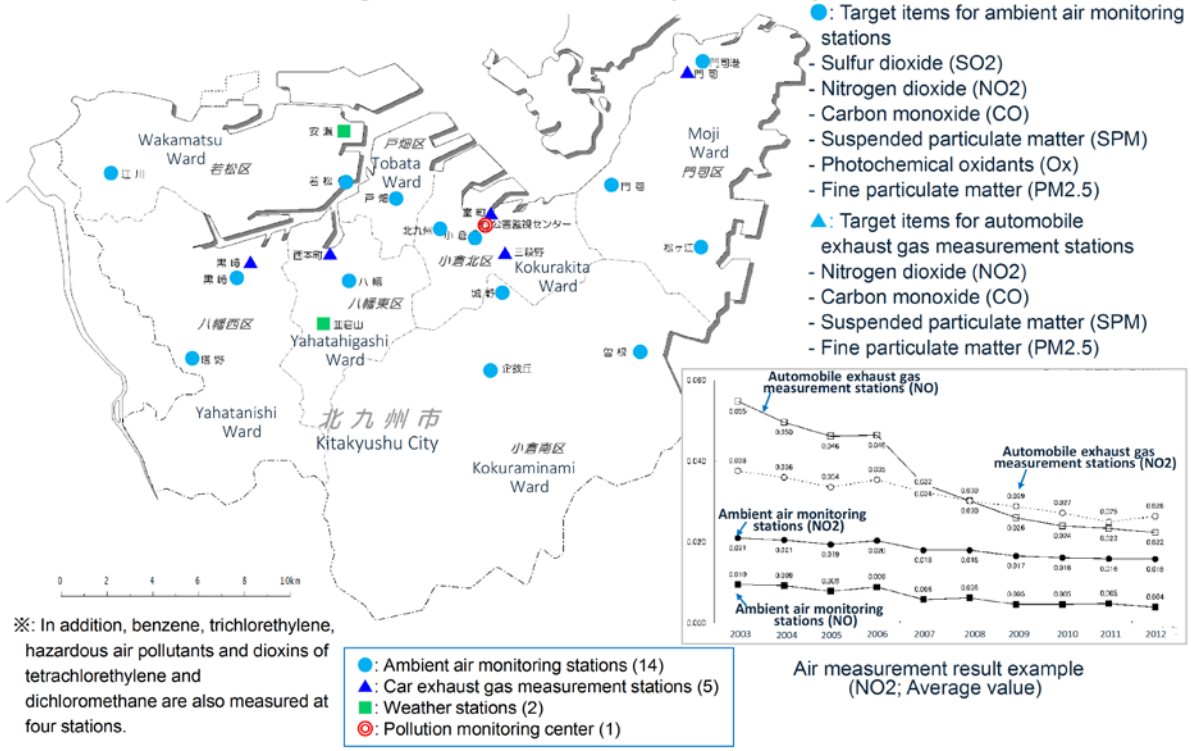


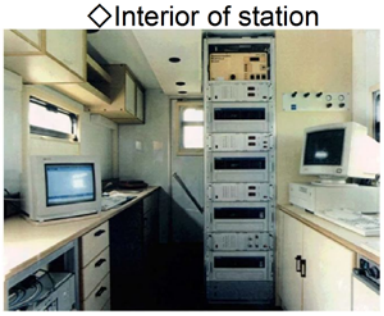
Fig. 2.4.6.4-1 Project outline

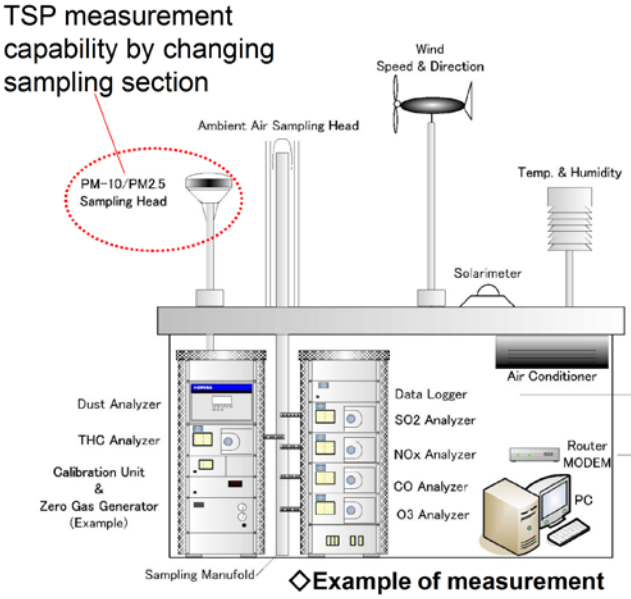
Reference: Air monitoring conditions in Kita Kyushu City



◆Example of equipment composition for fixed station

◇Interior of station





◇Example of measurement equipment composition

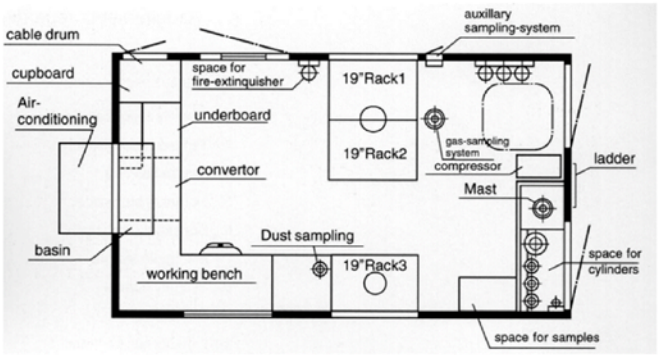
◇Exterior of fixed monitoring station

Source: Horiba Ltd.

◆Outline of mobile station

- The mobile station consists of a 2t-class truck equipped with monitoring equipment which can perform air monitoring at any desired location.
- Since it is assumed that from the cost aspect it would be difficult to install fixed-location stations at all areas within the city, a mobile station will be introduced and efforts will be made to understand the actual conditions of air pollution and noise in the city.

◇Example of mobile station



◇Example of composition of mobile station measuring equipment

Source: Horiba Ltd.

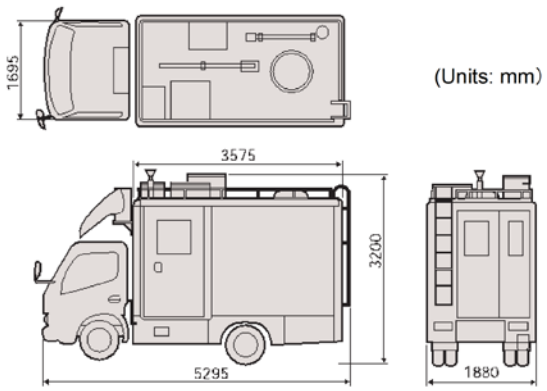
◆Outline of mobile station

◇Example of mobile station

◇Target items: Same as fixed stations
(measurement of desired items possible)

◇Example of vehicle specifications

- Vehicle class: 2t class
- Overall length: 5 to 5.5m
- Overall width: 1.8 to 2.0m
- Overall height: 2.8 to 3.2m
- Engine size: Approx. 2,700cc (Gasoline vehicle)
- Overall weight: Approx. 5 tons



◇External dimensions of mobile station

Source: Horiba Ltd.

(2) Results, etc.

1) Facility development

- Understanding of actual conditions of air pollution and noise (status of achievement of environmental standards), accumulation of measurement data
- Confirmation of effects when countermeasures have been implemented
- Provision of information to citizens, etc. in case of emergencies
- Possibility to perform monitoring at any desired location using the mobile station Etc.

2) Human resource development

- Acquisition of technique regarding maintenance of equipment and the way to take advantage of the monitoring data. Supporting the research on air pollution and noise and training of experts in association with Cambodia Institute of Technology (CIT)

(3) Implementation system, etc.

ODA grant aid (agreement between Japanese government and Cambodian government)

◇Cambodia: Ministry of the Environment (MOE), CIT
- Installation of automatic monitoring measurement equipment
- Establishment of central monitoring office
- Information network, Installation of public announcement lighted signboards
- Operation of facilities
- Planning countermeasures
- Establishment of the system of training experts in association with CIT

◇Japan side
(Kita Kyushu City, consultant, manufacturers)
- Investigation of monitoring methods
- System design, provision of equipment

(Kita Kyushu City, manufacturers)
- Acquisition of technique regarding maintenance of equipment and the way to take advantage of the monitoring data. Training of experts.

Fig. 2.4.6.4-2 Implementation system, etc.

(4) Funding procurement

・Investigation of utilization of ODA grant aid

・Taking advantage of the JICA Partnership Program for the human resource development

・Total project cost: Approx. 1.6 million USD (excluding the cost of human resource development)

+ Fixed station (3 stations) and central monitoring station: Approx. 1.2 million USD

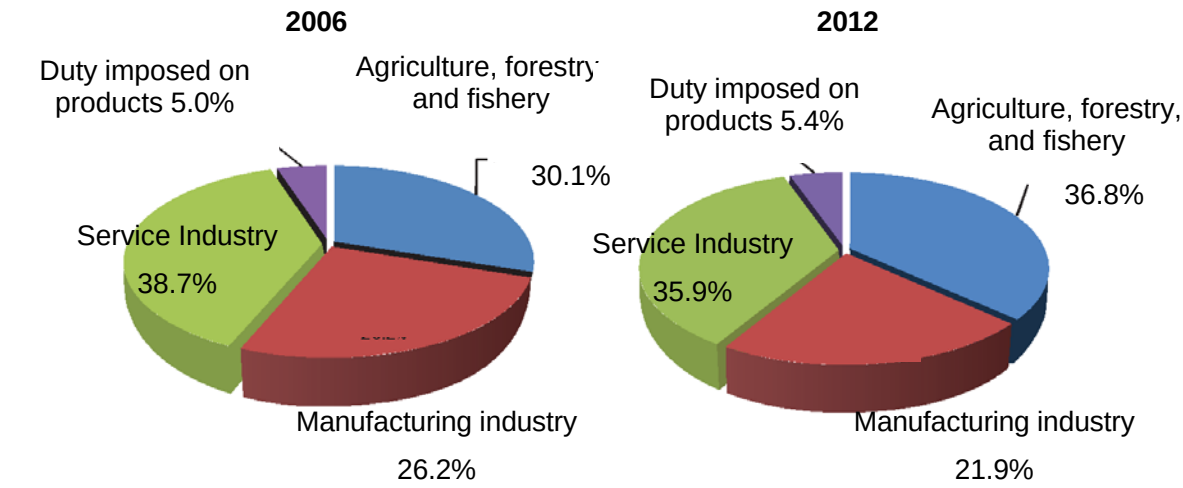
+ Mobile station (1 station): Approx. 0.4 million USD

2.4.7 Tasks and Specific Measures in Green Production Field

2.4.7.1 Green Production/Current status and tasks

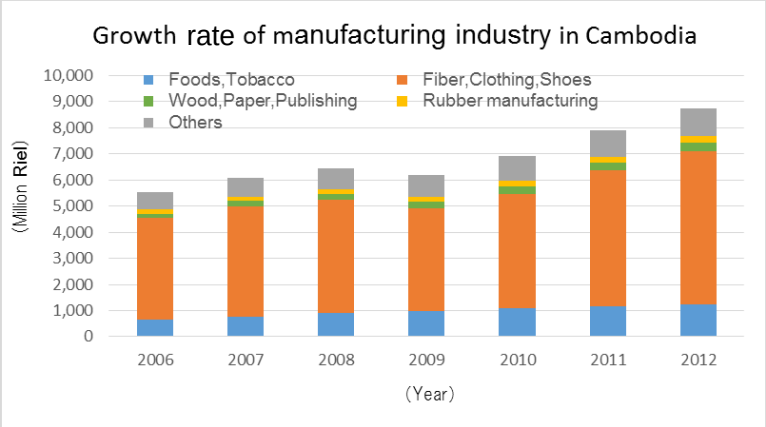
(1)Industrial field

- In Cambodia, secondary industry (manufacturing industry) occupies 27.1% of the GDP and 24.3% of employment, which is not a large ratio compared to other ASEAN countries, and this industry accounts for more than 60% of production value through sewn products and shoes. Because of this, the nurturing of industrial personnel with the aim of changing the industrial structure by diversifying industries, adding value, and promoting trade has become an important issue.
- The "Cambodia Industry Development Policy (2015 - 2025)" was announced in August 2015, with the main vision being the transformation and evolution of Cambodia's industries from labor-intensive to technology-driven. As specific approaches for achieving this goal, development in the manufacturing sector and agricultural product processing sector would be promoted. For this purpose, the policy aims to promote integration into international and regional production chains, development of industrial areas, increasing efficiency of special economic zone operating procedures, development of new industrial parks and industrial clusters, etc. Furthermore, it specifies the following as priority industries: 1) New industries that produce creative, highly competitive products with high added value, 2) small- and medium-sized enterprises, 3) agricultural product processing industry, 4) supporting industries related to the supply chain, 5) industries that contribute to international production lines, etc.



Source：Council for the Development of Cambodia, CIB & CSEZB、
http://www.cambodiainvestment.gov.kh/ja

Fig.4.7.1-1 Changes in GDP composition by industry



Source：Council for the Development of Cambodia, CIB & CSEZB、
http://www.cambodiainvestment.gov.kh/ja

Fig.2.4.7.1-2　Growth rate of manufacturing industry in Cambodia

Source：Euro News.com

Photo 2.4.7.1-1
Example of dormitory

Source:http://www.sankeibiz.jp/macro/news/141126/mcb1411260500007-n1.htm

Photo 2.4.7.1-2
Example of transporting laborers

Source: http://www.fukuoka-cambodia.jp/ohtsubo_blog/2010/01/post_4.php

Photo 2.4.7.1-3
Example of working conditions (Garment factory)

(2) Agricultural field

- Rice production is the main agricultural products of Cambodia, and it has been increasing steadily. But yield is low compared to neighboring countries.
- In Cambodia‘s farmland, productivity is low, and as a result the amount of chemical fertilizer usage has increased significantly in recent years. On the other hand, it is a dilemma that with the increased use of fertilizer, the fertility of the soil is conversely decreasing. Problems such as health damage due to misuse, overuse, etc. of agricultural chemicals and problems with food safety, etc. are occurring.
- For farmers, chemical fertilizers and agricultural chemicals are extremely expensive, and occupy a considerable portion of production costs. From the economic aspect as well, it is desirable to spread organic agriculture technology that can achieve reduced chemical fertilizer usage.
- Agriculture is also prosperous in the suburbs and outskirts of the Phnom Penh capital, and it is necessary to increase the added value of agricultural products by cultivating organic vegetables and fruits. In addition, not only agricultural production but also strategies to increase added value through processing of such agricultural products are required.

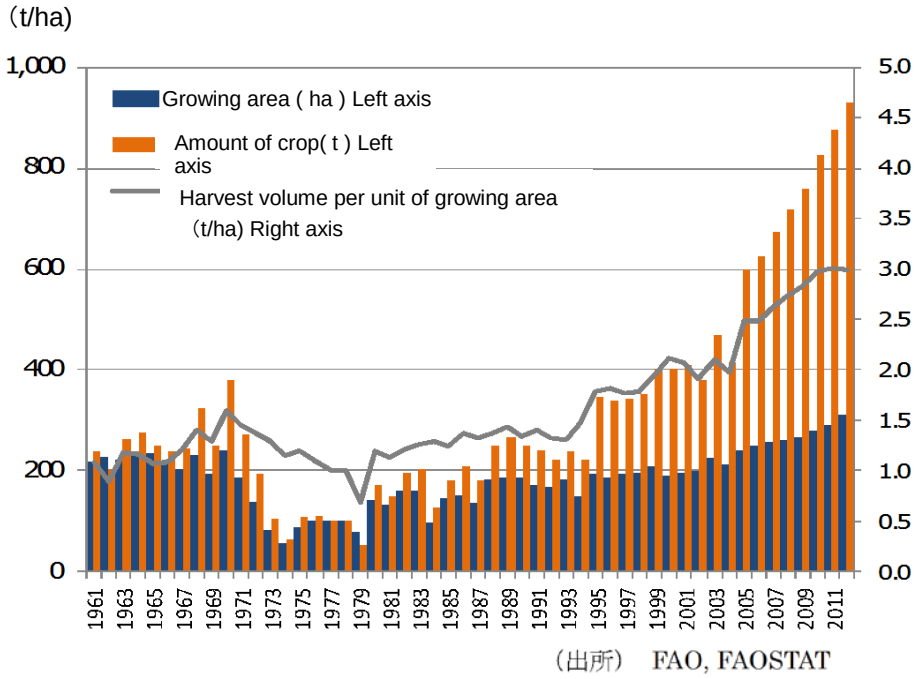


Fig.2.4.7.1-3 Rice production amount, etc. in Cambodia

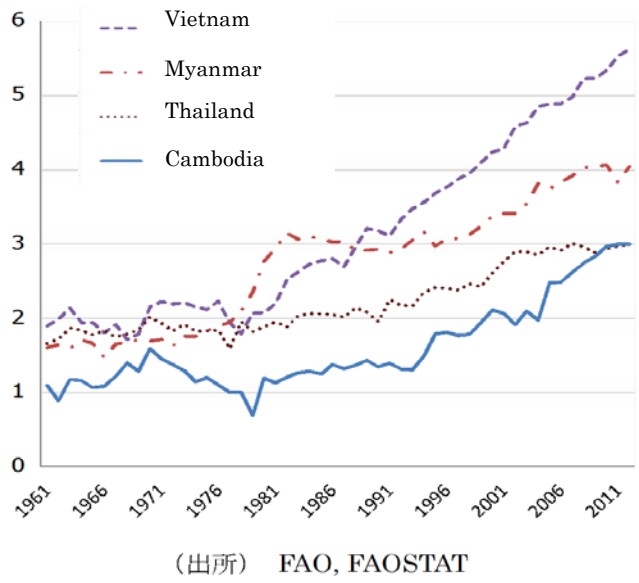
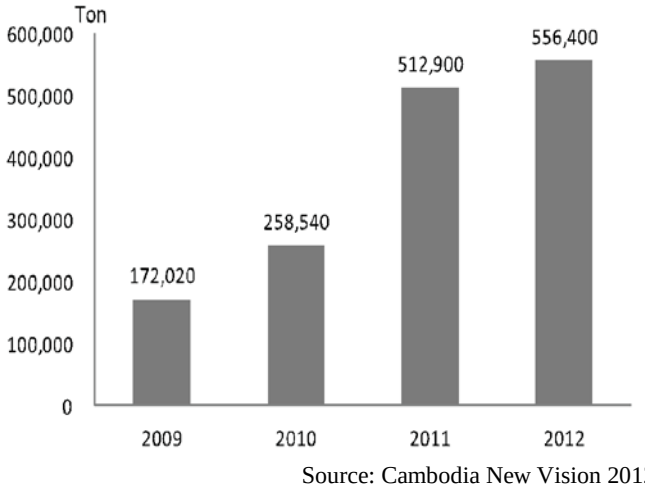
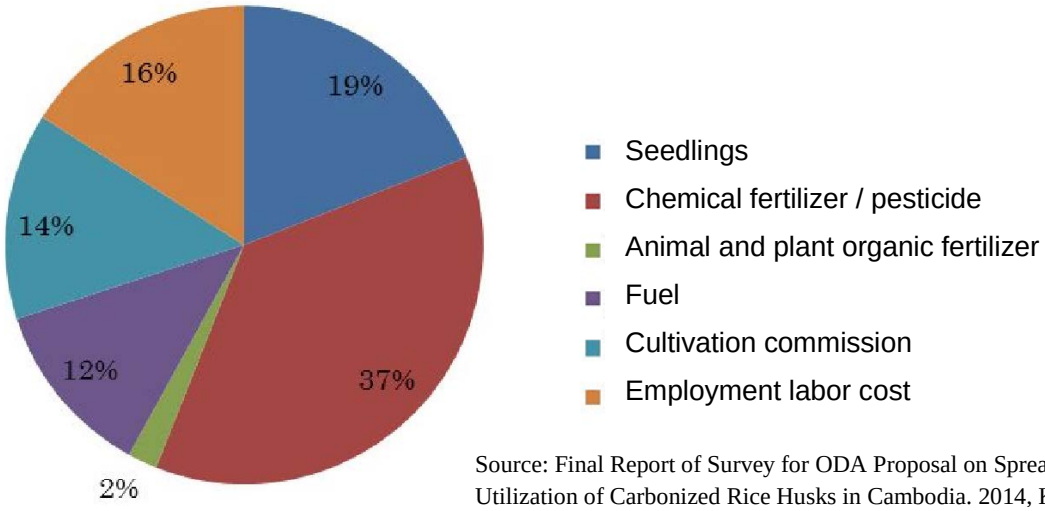


Fig.2.4.7.1-4 Comparison of rice yield with those of neighboring countries



Source: Cambodia New Vision 2012

Fig.2.4.7.1-5 Imported amounts of chemical fertilizer (nationwide)



Source: Final Report of Survey for ODA Proposal on Spreading Utilization of Carbonized Rice Husks in Cambodia. 2014, Kansai

Fig.2.4.7.1-6 Breakdown of production costs for farmers

(3) Tourism field

- The tourism industry comprises 20% of Cambodia's GDP. In 2014, 4.5 million foreign tourists visited Cambodia, making tourism one of the main industries. The main destination is Siem Reap with the ruins of Angkor Wat, but many foreign tourists are also seen in the Phnom Penh capital, which has an environment where tourists can enjoy not only Cambodian cuisine but also all kinds of dishes from various countries, and there is great potential for the tourism industry to become a main industry of Phnom Penh as well.
- From now on, it is also necessary to fully utilize suburban areas and investigate popularization of green tourism, etc. which focuses on the environment and food education.

Source: JICA, Evaluation study report at the time of completion of plan for Cambodia agricultural materials (chemical fertilizers and pesticides) quality control capability improvement; 2012

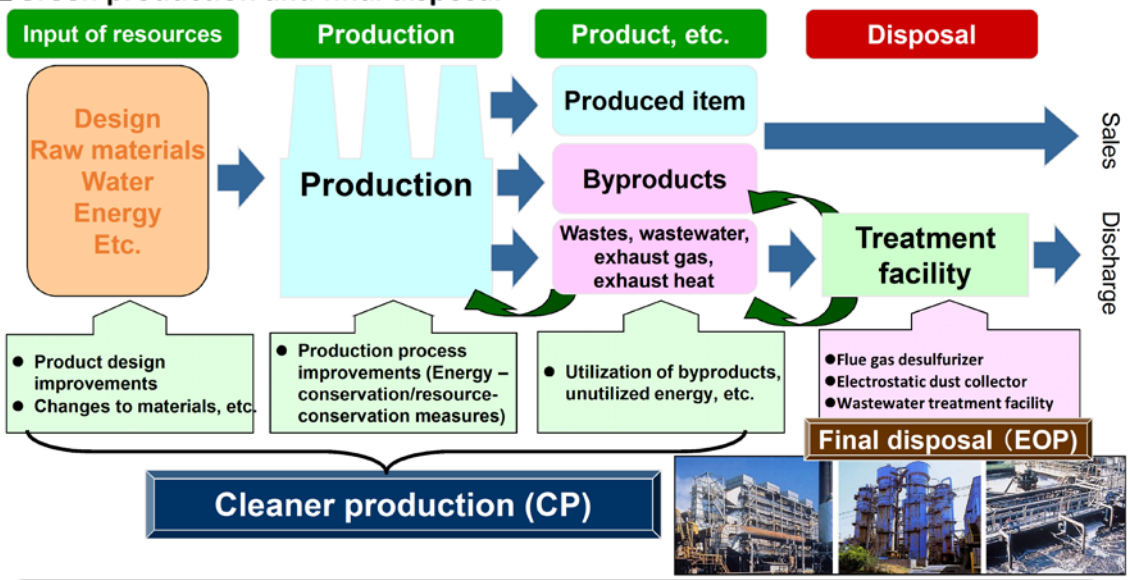
Picture2.4.7.1-4 Scene of conducting interview with pesticide retailer

Source: JICA, Agricultural Mechanization to Increase Yield and Farmer's Independence Support in the Kingdom of Cambodia Project Preparation Survey (BOP Business Cooperation Promotion) Report, 2015

Picture 2.4.7.1-5 Training scene at Royal Agricultural University

2.4.7.2 Green Production/Introduction of efforts in Kitakyushu

■Green production and final disposal

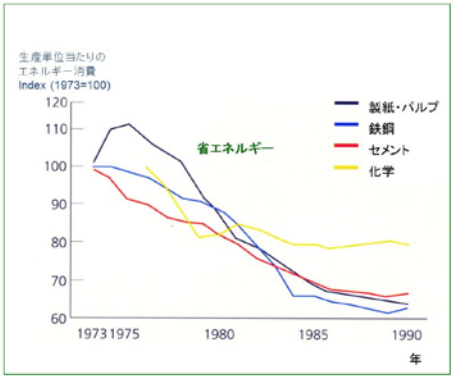


What is noteworthy in the process of overcoming pollution is that many companies have shifted from so-called end-of-pipe pollution prevention measures as final treatment facilities to cleaner production by reviewing the production process. As a result, production efficiency is improved by using raw materials and fuel without waste and at the same time pollutants are reduced. Although final treatment facilities require additional expenses, cleaner production is a win-win approach that achieves both reductions in corporate cost (improved profitability) and reduction of pollutants and waste.

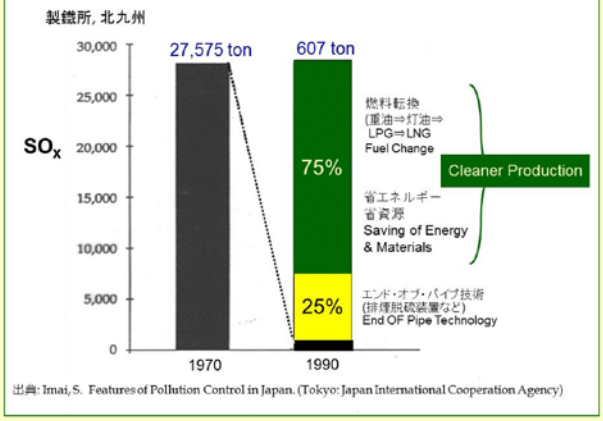
■Development of cleaner production (CP)

【Cleaner production concept】

- Low-pollution-type production technology that provides both economic benefits and environmental conservation
- Comprehensive evaluation and improvements
  - Raw material usage
  - Production processes
  - Maintenance management
  - Personnel training (workplace activities)



Various industrial fields have achieved energy savings of nearly half in about 20 years since the early 1970s.



In the case of iron and steel industry in Kitakyushu, SOX emissions were reduced from 27,575 t to 607 t in the period from 1970 to 1990. 75% of this reduction was the effect of cleaner production, and the remaining 25% was due to final disposal measures.

■Kitakyushu Eco Premium Industry Creation Project

■ Outline

Of the products and services offered by the industrial and technology field, products (Eco Products) and services (Eco Services) that lead to a reduction in the environmental load will be selected as "Eco Premium," and through their expansion and diffusion, will help to promote environmental consideration activities for all city industries.

* Eco Premium:
Products, technology and industrial activities with the added value of a lowered environmental load

Past Achievements (FY 2004 - 2016)

■ Selection: Eco Products – 163 (Field: Domestic, machinery and plants, engineering and construction, etc.)
Eco Services – 40 (Field: Targeting consumers and business entities)

■ PR Method: Introduction at Eco Town Center, Display at Eco Techno Exhibition and Eco Products Exhibition, Creation of pamphlets and booklets

■Kitakyushu Eco Premium[Services・Products]

1	Repair and maintenance service for household appliances from all makers
2	Rental apartment with photovoltaic power generation, the first in Japan (Received the FY 2005 New Energy Award from METI)
3	Refill service for printer ink
4	Community-based food waste recycle system
5	Thermal analysis service of heater appliances that leads to energy conservation

6	Hybrid city lamps generated by wind and solar energy
7	Automatic water-saving taps with self power generation function
8	Luminescence tube for ceramic metal halide lamps that are long-life and have very effective energy conservation features
9	Energy conserving high ceiling HID light system that enables a significant reduction in electricity use for lighting

2.4.7.3 Green Production/Specific measures

Based on the issues in the green production field, specific measures in this field were set up as shown in the table below. The Implementing entity, timing of implementation and evaluation index of each specific measure were also set.

Table 2.4.7.3-1 Green Production/Specific measures (1/2)

Project classification	Project description	Project implementing entity	Implementation timing	Evaluation index
1. Promotion of industry diversification and high added value	• For industry diversification and high added value, not only the sewn products industry but also various other diverse manufacturing industries such as automotive products, electronics, precision machinery, etc. will be cultivated by attracting foreign investment in order to change the industrial structure. • In order to attract superior overseas enterprises, the investment environment of special economic zones and industrial parks will be improved. • In order to handle changes in the industrial structure, vocational training schools, etc. will be established and operated in order to train diverse industrial personnel.	Private enterprises	Short-term	Manufacturing industry employment ratio
2. Promotion of green production	• When introducing production equipment for shifting from light industry to process assembly industries, from the initial stages introduction of energy-saving, resource-saving equipment, etc. will be undertaken as efforts toward green production and environmentally friendly production activities will be promoted. • Environmentally friendly renewable energy will be used as much as possible, such as using factory roofs for solar power generation, etc.	Business operators	Short-term	Amount of energy consumption reduction GHG reduction amount
3. Nurturing of small- and medium-scale businesses	• Promote Phnom Penh's autonomous industrial development by improving the technical capabilities and production management capabilities of small- and medium-sized enterprises and nurturing supporting industries. • Establish mechanisms for supporting entrepreneurs such as venture companies.	Business operators	Medium-long term	Amount of energy consumption reduction GHG reduction amount

Source:http://car-el.ksrp.or.jp/training/index.html

Photo 2.4.7.3-1 Scene of automotive technology training (Kitakyushu)

Source: NEDO,http://www.nedo.go.jp/hyoukabu/articles/201302chugai/index.html

Photo 2.4.7.3.-2 Biomass power generation

Source: http://ivyivy.org/act/cambodia/

Photo 2.4.7.3.-3 Scene of organic vegetable cultivation in Cambodia

Table 2.4.7.3-1 Green Production/Specific measures (2/2)

Project classification	Project description	Project implementing entity	Implementation timing	Evaluation index
4. Sales of environmentally friendly products	• In order to avoid the generation of useless garbage in cooking, shopping, and other activities in daily life, the use of excessive packaging, store-provided shopping bags, etc. will be reduced as much as possible. • Prohibition of excessive packaging at large stores and retail stores • Actively utilize recyclable containers such as glass containers and bottles • Collection of food plastic containers at stores • Prohibition of plastic bags and promotion of bringing own bag (shopping cart)	Business operators Citizens	Short-term	Amount of energy consumption reduction GHG reduction amount
5. Development of green agriculture	• Use organic fertilizers such as compost to reduce chemical fertilizers and promote the growing of rice with drastic reductions in the amount of agricultural chemicals used and it will be made a brand. • Promote sixth-order industrialization through the participation of processing (secondary industry) and distribution/sales (tertiary industry) in addition to the production of agricultural products (primary industry).	Agriculture workers Ministry of Agriculture and Fisheries NPO	Short-term	Amount of energy consumption reduction GHG reduction amount
6. Effective utilization of biomass emitted from agriculture and raising of livestock	• Promote power generation projects utilizing the husks of rice, Cambodia's largest agricultural product. • To promote resource recycling in agricultural areas, biomass power generation utilizing livestock manure and raw garbage will be promoted together with organic farming using the liquid fertilizer that is generated.	Agriculture workers Ministry of Agriculture and Fisheries Private businesses	Short-term	Amount of energy consumption reduction GHG reduction amount
7. Popularization of green tourism	・To promote the tourism industry, one of Cambodia's major industries, the popularization of green tourism focused on the environment and food education will be promoted.	Farmers Ministry of Agriculture and Fisheries Private businesses	Short-term	Number of projects Number of participants

2.4.7.4 Pilot project in green production field 1 (Introduction of power generation facilities utilizing agricultural biomass)

As a pilot project in the transportation field, we conducted an examination on the introduction of the agricultural biomass power generation facility utilizing the JCM scheme. Details are given in Chapter 3.

2.4.7.5 Pilot project in green production field 2 (Development of green agriculture)

(1) Project overview

- In this project, model districts are set up in agricultural areas in the suburbs of Phnom Penh and organic vegetables are cultivated utilizing compost (organic fertilizer) produced in the waste field pilot project.
- In addition, soil improvement will be performed using carbonized rice husk charcoal in order to increase the income of farmers and provide safe, worry-free vegetables.

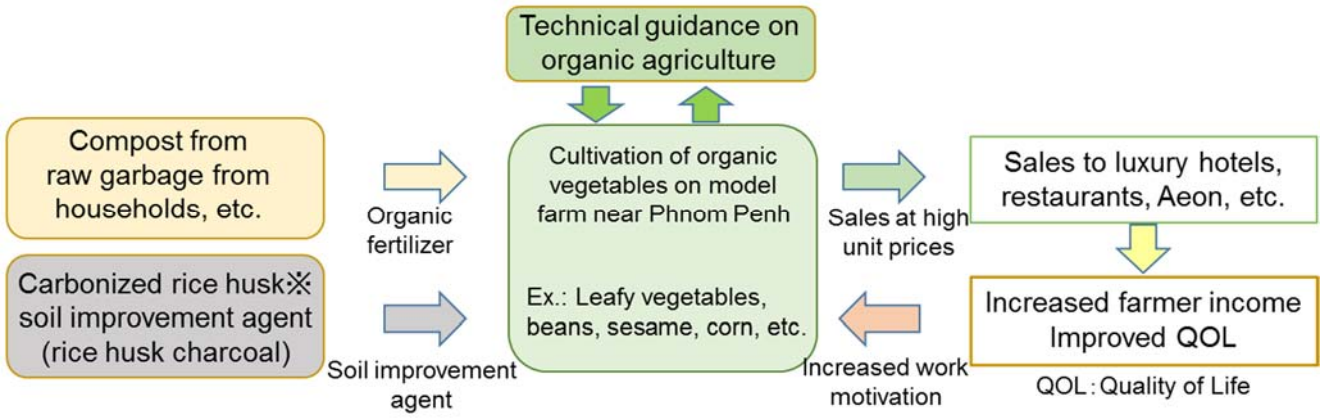


Fig.2.4.7.5-1 Overall outline of green agricultural project (proposal)

Photo 2.4.7.5-1 Compost from raw garbage (organic fertilizer)

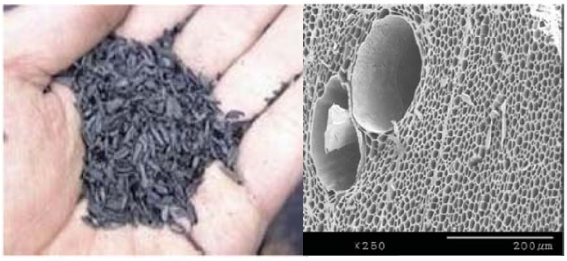


Photo 2.4.7.5-2 Microscope photograph (right) ※
(High porosity provides excellent water retention, water permeability, breathability, and fattening)

Photo 2.4.7.5-3 Scene of agricultural crop cultivation tests using rice husk charcoal※
(Left: Corn; Right: Soybeans. In both cases, plants on left are with rice husk charcoal use)

Source: Kansai Corp., et al, Survey for ODA Proposal on Spreading Utilization of Carbonized Rice Husks in Cambodia. 2014

(2)Project results

- Utilization of compost derived from raw garbage realized final disposal garbage amount reduction and resource recycling.
- Through realization of organic agriculture including soil improvement by rice husk charcoal in model districts, yield increased and it became possible to aim at reduced use of chemical fertilizers and agricultural chemicals to improve the working environment of farmers.
- It became possible to provide safe, tasty fresh crops to consumers (luxury hotels, restaurants, Aeon Malls, etc.)
- By selling agricultural products at high unit prices, farmer income was increased and QOL was improved, and work motivation was increased.
- It is planned to expand and develop the achievements of the model district to other districts to spread green agriculture.

(3)Project scheme (proposal) and implementation organization (proposal)

- For the business scheme, a JICA technical cooperation project or grassroots project is assumed.
- The project period is around 2 to 3 years, with the aim of starting in 2017 if possible.
- The assumed project implementation (proposal) is as shown in the diagram below.

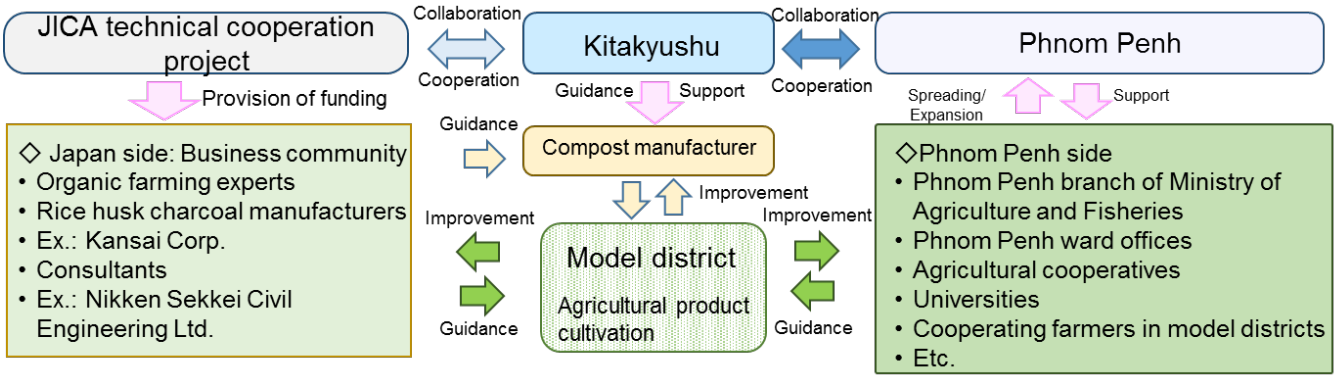


Fig.2.4.7.5-2 Project implementation organization (proposal)

2.5 Verification methods of the Strategy Measures

2.5.1 PDCA Cycle

- To achieve the goals on schedule, constant monitoring of implementation of the measures is needed. It is also important to resolve any issues that may arise.
- As method of verification, introduction of PDCA cycle is recommended. This PDCA cycle is a method to provide continuous improvement by repeatedly carrying out the four-phases of activity, namely Plan → Do → Check → Action.

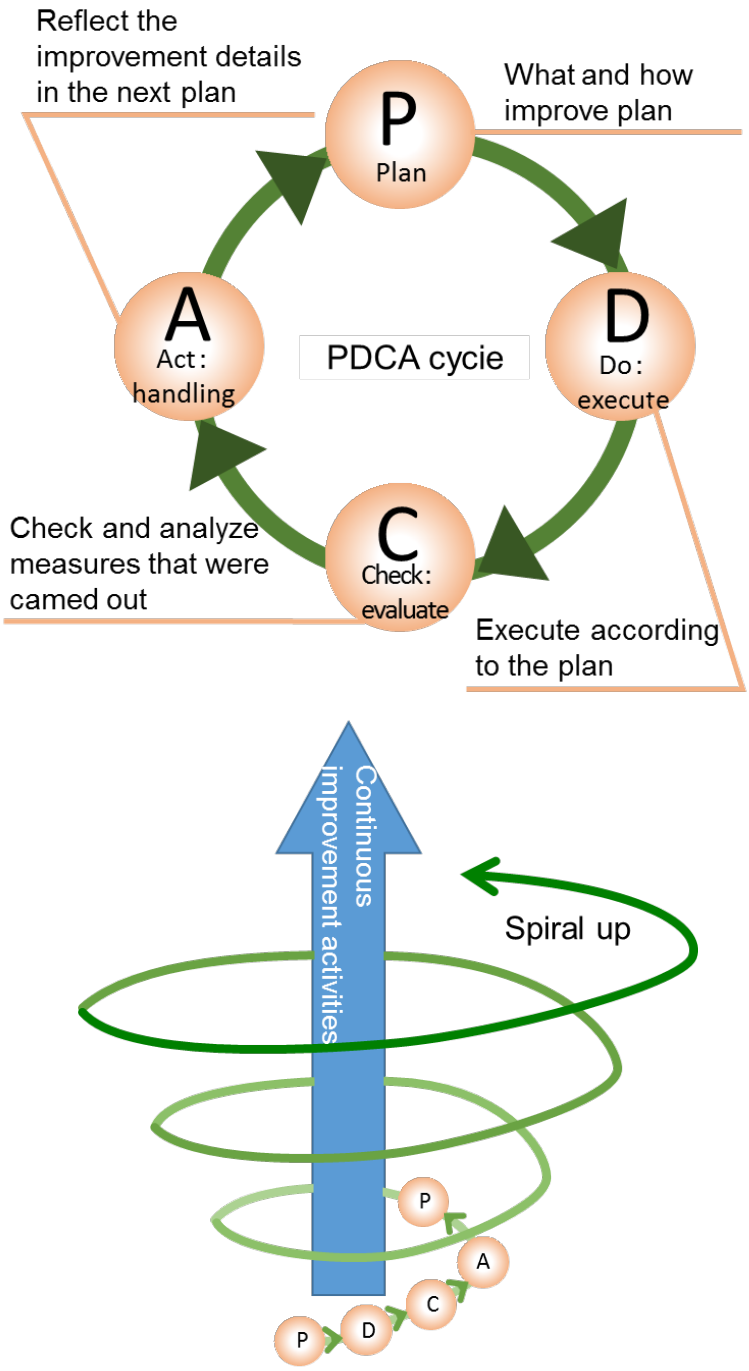


Fig. 2.5.1-1 Conceptual diagram of “PDCA Cycle” (upper) and “Spiral up” (lower)

Table 2.5.1-1 Implementation Item and Points to Consider by Item

Item	Implementation Item	Points to Consider
Plan （Plan）	◇Specific planning of the project ex) Waste separation and recycle in urban areas ◇Setting the evaluation indicators and monitoring method which can confirm progress ex)・Rate of waste recycle rate ・Operation rate of facility operation ・Reduction amount of GHG ・Obligation to report regarding the amount of waste generated recycled to business operators (every month)	・Predict current risks, details from previous cases, and future prospect, etc. and reflect these in the plan. ・The purpose of the plan is to determine problems, and establish improvement methods.
Do （Execute）	・Implementation of the project ・Monitoring and recording of evaluation indicators	・Evaluation indicators must be recorded
Check (Evaluation)	・Confirmation of the project achievement ・Extraction of the project problem ex) The achievement status of the project is not satisfied with the goal → Identification of the cause → Consideration of improvement measures.	・Objective analysis of the problem by the evaluation indicators, etc., is needed.
Action (Handling)	・Specification of improvement measures ・Identification of points which can confirm the effectiveness of the improvement measures. ・Reflection in the next planning	・Objective analysis and accurate reflection in the next plan are important.

2.6 Order and Fund Procurement Methods

2.6.1 Ordering/Financing Method

(1) Ways of utilizing private financing and know-how

The administration, etc. can utilize private funds and know-how to reduce the burden of initial costs, and PPP/PFI or ESCO businesses, etc. are available as ways to improve infrastructure facilities and save energy in existing facilities.

(2) Ways to use administrative policies to encourage voluntary efforts by private companies

It is extremely important for the government to instruct companies periodically to comply with environmental standards. At the same time, it is also desirable to introduce economic means such as environmental surcharges, etc. to provide economic motivation for companies to reduce emissions of pollutants.

It is also important to introduce a tourism tax along with environmental surcharges in order to secure resources to provide subsidies and low-interest loans to companies which introduce pollution prevention facilities.

Furthermore, it is possible to encourage voluntary efforts by companies through utilizing an environmental labeling system or existing certification systems (ISO 14001, etc.) and introducing a mechanism in which governmental and public agencies procure products and services from companies which are engaging in environmentally friendly activities.

2.6.2 PPP・PFI

(1)Overview

・The scheme in which public agencies and private organizations cooperate to provide public services is called PPP (Public ・ Private ・ Partnership), and PFI (Private Finance Initiative) is a typical PPP method.

・PFI is a way of thinking in which public services are provided through private initiatives utilizing private funds and know-how for the design, construction, maintenance and operation of public construction projects, etc., for the purpose of providing efficient and effective public services.

(2)Results

・It is expected to provide high-quality public services while reducing costs.

・New public-private partnerships are formed based on the appropriate division of roles between public and private sectors.

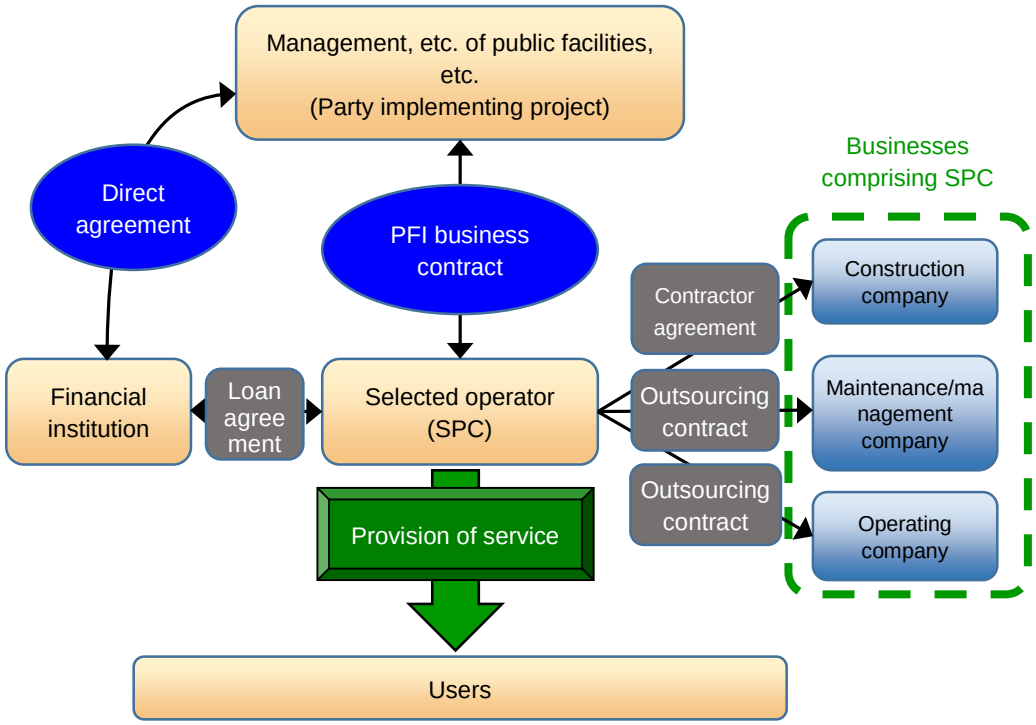
・Invigoration of the economy is expected through the creation of opportunities for private businesses.

Fig. 2.6.2-1 Case 1: Kitakyushu City: Renovation and maintenance of deteriorated Shiei Junior High School (pool, gymnasium, dojo)

Fig. 2.6.2-2 Case 2: Kitakyushu City: Maintenance and management of library and halls; Maintenance of open spaces and green areas

Source：http://www8.cao.go.jp/pfi/141010_100_ikkatsu.pdf

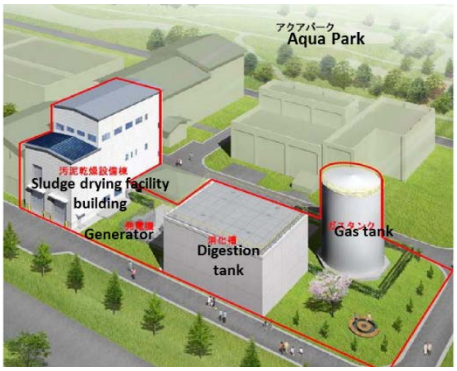
(3)Typical PFI scheme



Source：Cabinet Office, Government Of Japan, Outline of PFI, http://www5.cao.go.jp/keizai2/keizai-syakai/re-infra-invest/shiryou/4kai/sankou3_2.pdf

Fig. 2.6.2-3 Flow Diagram of Typical PFI scheme

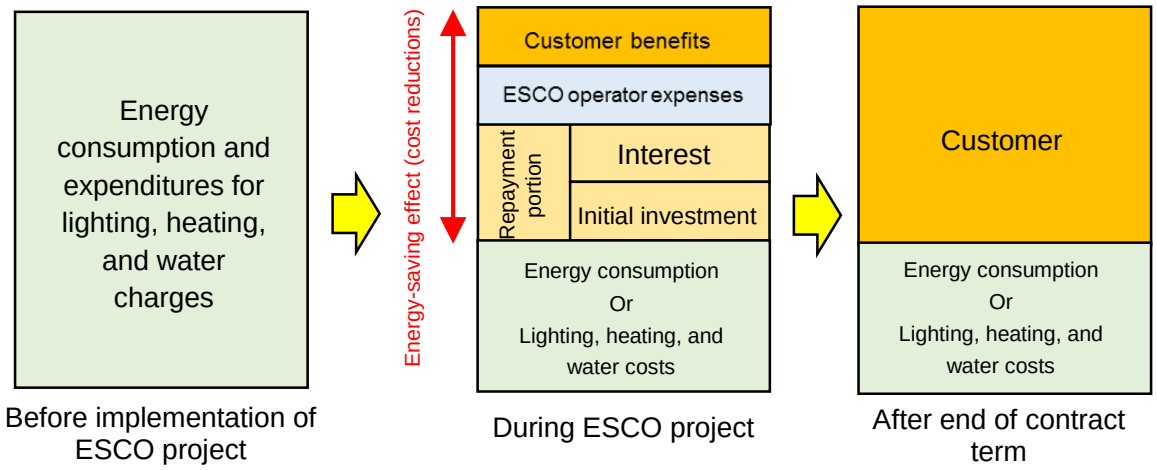
Table 2.6.2-1 Business for maintenance and operation of municipal sewerage biomass energy utilization facility in Kurobe

Order issuer	Kurobe (Toyama Prefecture)	Facility appearance
Facility outline	Facility scale: 2,050m^2 Biomass energy utilization facility (mixing tank, digestion tank, generator equipment, boiler, etc.), footbath	
Business description	Development, maintenance, and management of facilities to generate biogas from sewage sludge, etc. and coffee grounds for use by sludge drying facilities and on-site power utilization.	
Business period	17 years (maintenance and management period: 15 years)	
VFM	Approx. 4.1%(when selected as a designated project)	
Contract amount	Approx. 3.6 billion yen	
Implementation policy announcement	January 31, 2008	
Characteristics	・Methane generation facility utilizing sewage sludge, etc. and local biomass (coffee grounds). ・Utilizes approx. 1 million m3 of biogas produced annually as energy for sludge drying fuel and electricity generation. ・Dry materials derived from sewage sludge is registered and sold as fertilizer. In addition, efforts are being made to utilize it as fuel for power plants, etc. ・The generated power is used as power for the facilities and supplies 50 to 80% of the total power used. ・As a contribution to the community, a footbath that utilizes biogas was installed as a facilities amenity. ・Concentrated sludge volume of sewage sludge, etc.: 25,810 m3/year ・Amount of local biomass accepted: 2,800 m3/year	

Source: Kurobe city, http://www.city.kurobe.toyama.jp/event-topics/svTopiDtl.aspx?prev-1&servno=1124

2.6.3 ESCO project

- In an ESCO project, the basic concept is to cover all costs (construction costs, interest fees, expenses of ESCO project operators) through reductions in lighting, heating, and water charges achieved through energy-saving renovations. Because of this, the emphasis is placed on project profitability so that customers (local governments, factory owners, etc.) do not suffer losses due to the implementation of the ESCO project and there are no new financial expenditures required of customers. In addition, after the end of the contract term, all of the reductions in lighting, heating, and water charges benefit the customers.
- When utilizing funding procurement by ESCO project operators, from the initial year of the project, there will be no cost burdens that exceed conventional lighting, heating, and water costs, and at the same time it can promote energy conservation and achieve reductions in greenhouse gas emissions.



Source:https://www.env.go.jp/council/35hairyo-keiyaku/y352-01/ref06-2.pdf

Fig. 2.6.3-1 Costs and Customer benefits in ESCO project

2.6.4 Environmental surcharges

(1)Overview

- Environmental surcharges impose financial burdens on companies according to the amount and quality of environmental pollutant emissions, and are intended to give companies economic motivation toward reducing emissions.
- For factory wastewater, environmental surcharges will be higher as the discharge amount increases or the quality of discharged water worsens.
- The collected surcharges will be used as subsidies or low-interest loans for the introduction of pollution-prevention facilities.

(2)Examples

Table 2.6.4-1　Examples of Taxes and Surcharges

Country	Taxes / Surcharges
Japan	Sewerage fees and forest/water source replenishment taxes (both by local governments)
China	Emission surcharges, automobile fuel taxes
Korea	Overall water quality excess charges, overall air emissions excess charges, traffic environmental taxes
Vietnam	Environmental taxes

Table 2.6.4-2 Vietnam - Taxable items and tax amounts in environmental tax laws (Examples)

Taxable item	Tax amount (VND/unit)
1. Fossil fuels (L)	
1.1 Automobile-use gasoline (L)	1,000－6,000
1.2 Aviation fuel (L)	1,000－6,000
1.3 Light oil (L)	500－2,000
1.4 Kerosene (L)	300－2,000
1.5 Fuel oil for cooking (L)	300－2,000
1.6 Lubricating oils (L)	300－2,000
1.7 Coal (kg)	6－30
1.8 Natural gas, coal gas (m^3)	35－100
2. HCFC solutions (kg)	1,000－3,000
3. Plastics (kg)	500－2,000
4. Agricultural chemicals (kg)	500－5,000
5. Bleach detergents (kg)	400－2,000
6. Inorganic acid solutes (L)	600－3,000
7. Industrial paints (kg)	500－2,000

Source：Akihisa Mori, Environmental policy of East Asia

2.6.5 Sight-seeing Tax

The preservation of natural environment is an important element for sightseeing in Phnom Penh city. We'd like to propose that Sight-seeing tax is introduced and used for the environment conservation business in the whole Capital.

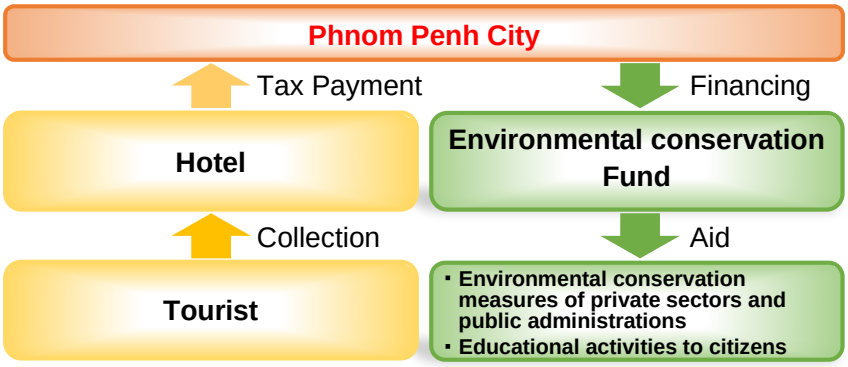


Fig. 2.6.5-1　Introduction and utilization of Sight-seeing Tax

【Example】

Source：http://tportal.toubiz.de
Dresden (Germany)・Sight-seeing tax
1.8USD (per person per stay)

Source：http://www.capritourism.com/
Capri(Italia)・Entrance tax
2.1USD (per person per stay)

2.6.6 Introduction of environmental labeling system and utilization of existing certification systems

(1) Environmental labeling system

- Environmental labels are labels given to products or services with low environmental impact, and are expected to raise environmental consciousness while helping consumers to choose products with low environmental impact.
- Although there are many types of environmental labels, the ones whose acquisition have the largest impact on a company's business are those defined in ISO 14024. This type of label has a system in which a third-party organization conducts an examination and determines whether or not to give certification based on whether or not the criteria for specific environmental labels are satisfied.
- Environmental labels not only provide company appeal but can also beneficially promote trading, funding procurement, and recruitment.
- The introduction of environmental labels is progressing in Europe, America, and Asian countries, and systems are being introduced in Indonesia and the Philippines with the support of JICA.

Blue Angel (Germany)　　Nordic Swan (Northern Europe)　　Eco mark (Japan)

Source：Ministry of Economy, Trade and Industry, Japan
http://www.meti.go.jp/policy/recycle/main/data/research/h18fy/180605-3_jema-mri/180605-3_3.pdf

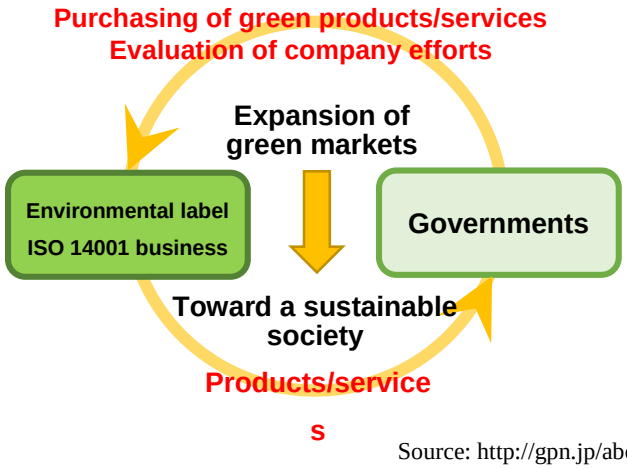
Fig. 2.6.6-1　Examples of environmental labels

(2)Existing public certification systems

- Public certification systems for environmentally friendly activities include environmental management certifications such as ISO 14001, EMAS (EU Eco-Management and Audit Scheme), etc.
- Both are international standards that check the voluntary efforts of businesses toward environmental management from objective standpoints.

(3)Preferential policies for companies which have acquired environmental labels and public certification

- Governments preferentially procure products and services from businesses who have acquired environmental labels and public certification (Green Public Procurement (GPP). In addition, they introduce companies inside and outside of the country, and support increased profitability of companies.
- Green public procurement is being performed in Asia in Japan, Indonesia, Thailand, the Philippines, Vietnam, Malaysia, China, Korea, etc.



Source: http://gpn.jp/about/index.html

Fig. 2.6.6-2 Preferential policies for companies which have acquired environmental labels and public certification

Chapter 3　Study for making JCM proposal

3.1　Needs study

Based on the results of grasping the current situation in the climate change strategic action plan, a study of needs for projects that will contribute to reductions in energy-derived CO_2 emissions in the fields of transportation, waterworks/sewerage, rainwater drainage, environmental conservation, and green production was performed. For this study, the waste field and energy field were excluded.

Since the results of the needs study were as shown in Table 3.1-1, from the next section JCM proposal studies were conducted for two proposals: Introduction of electric tricycles and introduction of biomass power generation facilities.

Table 3.1-1 Results of needs study of various fields; Necessity of JCM applicability study

Field	Needs	Necessity of JCM applicability study for this work	
Transportation	◆**Introduction of public transportation systems** ・Suppress traffic congestion and air pollution through the introduction of public transportation systems	×	・Since there is a plan for expanding route buses from the current 2 routes to 10 routes (in 2020) with JICA support, no study of JCM applicability was performed.
	◆**Introduction of electric tricycles** ・Replace gasoline-powered vehicles such as Remorques*, which have become a cause of air pollution, with low-pollution vehicles. ※A vehicle peculiar to Cambodia consisting of a motorcycle towing a cabin for passengers.	○	・The results of a hearing in which it was concluded that even after the introduction of public transportation systems, Remorque will continue to be an important supplementary means of transportation, were received from the government. ・Since performance improvements and lower costs for electric tricycles have progressed, a study about business characteristics utilizing JCM will be conducted.
Waterworks/ sewerage; Rainwater drainage	◆**Energy reductions through increased efficiency of water purification plant equipment** ・Since the two water purification plants of the Water Supply Authority were constructed in the 1990's and the substation equipment, motors, and pump equipment have aged, so that there is a need to increase efficiency through the introduction of energy-saving equipment.	×	・A JCM/FS study was conducted in 2014[*1], and it was evaluated that there was business profitability. ・Because of this, no study of JCM applicability for this work was performed.
Environmental conservation	There are no needs for projects that contribute to CO_2 reductions.	—	—
Green production	◆**Introduction of biomass power generation equipment** ・At rice processing plants in regions where voltage is unstable and power outages are frequent, large amounts of fossil fuels are consumed by diesel generators (home generators), so there is a need for the introduction of biomass power generation utilizing rice husks.	○	・According to past JCM studies[*2] related to the introduction of biomass power generation, there is a high cost effectiveness for CO_2 reduction. ・Through the utilization of rice husks as a substitute for fossil fuels, CO_2 reductions can be expected. A study about business characteristics utilizing JCM will be conducted.

※1 FY2004 Feasibility study related to construction of Joint Crediting Mechanism Projects (Energy Saving at Phnom Penh Water Supply Authority (Cambodia) by Improving Efficiency of Water Treatment Plants (METAWATER Co., Ltd.))

※2 FY2014 Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia -Feasibility Study (Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar (Mitsubishi Research Institute, Inc.))

3.2 Study of equipment introduction possibility

Based on the results of the needs study, a study of the CO2 reduction effect, cost effectiveness of JCM equipment subsidies, business profitability, and funding procurement methods for each project was conducted.

3.2.1 Introduction of electric tricycles

(1) Project overview

In Phnom Penh, gasoline-powered Remorques (vehicles peculiar to Cambodia consisting of a motorcycle towing a cabin for passengers) serve as a means of transportation for both general citizens and tourists, and have become a cause of air pollution (with 10 to 20 thousand vehicles operating in the city). Also, according to hearings of the Remorque association, each drier drives around 50 to 75 km per day, and the monthly income of 300 USD with a monthly running cost of 150 USD creating a severe living environment (Table 3.2.1-1).

In this project, the gasoline-powered Remorque will be replaced with electric tricycles, with the aim of suppressing air pollution and reducing CO_2. Table 3.2.1-2 shows the specifications, etc. for the electric tricycles, which will have a price of approximately 2,200 USD and will be capable of running about 100km per charge.

For the scale of this project, the number of electric tricycles to be purchased will be 100 units. In such case, the initial cost will become approximately 220,000 USD (Table 3.2.1-3).

In addition, in this project, the installation of solar charging stands at 5 locations in the city as the power sources for electric tricycles will also be studied, and in this case the initial cost will be approximately 1.32 million USD (Table 3.2.1-3). For the solar charging stands, 70kW solar power generation equipment will be installed at gasoline stands or commercial facilities, and it is assumed that each installation location can charge around 20 batteries for electric vehicles. An outline of the solar charging stand system is shown in Figure 3.2.1-1, and since the batteries can be removed from the electric tricycles, when the battery charge has become low, the electric vehicle can be driven to a charging stand and the batteries can be exchanged with fully charged batteries.

Table 3.2.1-1 Remorque association hearing results

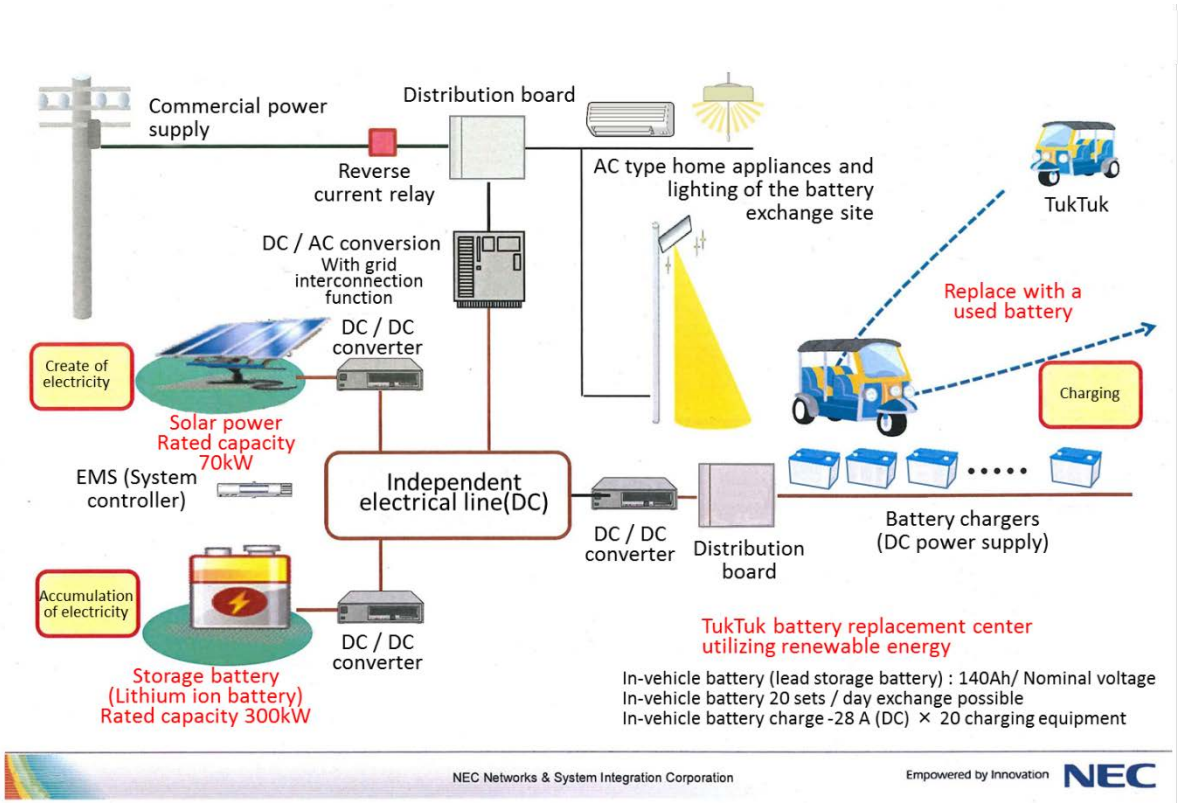
Item	Details
Purchase price	1,000 to 2,000 USD (Basket: 600 to 800 USD, Bike: 300 to 1,000USD)
Travel distance	50km to 75km/day (There are also drivers who travel 100km)
Driver revenue and expenses	Around 1,800 USD/year (Expenses including gasoline and maintenance are around 150 USD/month; Profit is 150 USD/month)
Other	Development of charging stations is important. Showing the performance (including travel distance) and safety of electric tricycles is important.

Table 3.2.1-2 Electric tricycle cost and specifications (Terra Motors Y6)

Item	Details
Selling price	2,200 USD (Vehicle: 1,200 USD; Batteries (5 pcs.): 1000 USD)
Batteries	Equipped with 5 lead-acid batteries (Voltage: 60V; Capacity: 140Ah) ∗ To be replaced around once every 1.5 years
Travel distance	Capability to travel around 100 km on a single charge (Charging time: 8 to 12 hours)
Maintenance cost	About 1,000 USD/year (Maintenance: 240 USD/year + Electrical charges 200 USD/year + Replace of battery 1,000/2 years ※Charging: 3times in 4 days; Mileage: 40 km/day × 300 days)
Specifications	Overall length: 2,950 mm; Overall width: 1,090 mm; Overall height: 1,800 mm; Vehicle weight: 278 kg; Maximum travel distance: 100 km; Rated output: 1 kW Maximum speed: 40km/h; Practical climbing capability: 10°

Table 3.2.1-3 Business scale and initial cost

Items	Unit price	Quantity	Initial cost
Electric tricycles	About 2,200 USD	100 vehicle	About 220,000 USD
Interchangeable batteries	About 1,000 USD	100 vehicles	About 100,000 USD
Solar charging stands (70kW):	About 200,000 USD	5 locations	About 1,000,000 USD
Total	—	—	About 1,320,000 USD



Source: NEC Networks & System Integration Corporation

Fig.3.2.1-1 Outline of solar charging stands (Number of electric tricycles charged: 20 vehicles/day)

(2) CO_2 reduction effect

In this section, the amount of CO2 emission reductions will be determined for the cases of a) when solar charging stands are not introduced (charging from power grid power) and b) when solar charging stands are introduced.

1) Reference emission amount

The reference emission amounts for a) when solar charging stands are not introduced (charging from power grid power) and b) when solar charging stands are introduced were set as the same. The reference emission amounts in the first year of the project were calculated using the following equation based on past methodology (AMS-Ⅲ.C) and past study reports. In addition, the parameter settings are shown in Table 3.2.1-4.

$$RE_y = \sum_i((DD_y/SFC_{RE}) \times IR^y \times NCV_{gasoline} \times EF_{gasoline} \times N_y)$$

$$= 11{,}999/31.6 \times 0.99^1 \times 32.8 \times 69{,}300 \times 10^{-9} \times 100$$

$$= 85.4\ tCO_2/year$$

where:

RE_y : Reference emissions in a year (tCO_2)

DD_y : Average project vehicle driving distance (km) for the project introduced in year y

SFC_{RE} : Reference vehicle fuel consumption (Km/L)

IR^y : Reference vehicle fuel consumption improvement factor (-) for year y

$NCV_{gasoline}$: Net caloric volume from gasoline (MJ/L)

$EF_{gasoline}$: Gasoline CO_2 emission factor (tCO_2/MJ)

N_y : Number of project vehicles (units) for the project introduced in year Y

Table 3.2.1-4 Reference emission amount: Parameter setting values

Parameter	Value	Basis/source for setting
DD_y	11,999(km)※ (Corresponding to 40km/day×300 days)	・CDM AMS-Ⅲ.C ・Report of 2014 JCM large-scale project creation feasibility study project "Study for support of creation of environmental cultural city in Cambodia Angkor ruins region utilizing JCM"; March 2015 (Overseas Environmental Cooperation Center) ※Although it was said at hearings of the Phnom Penh Remorque association that the average driving distance 50 to 75 km/day, the figures in the above report were used from a conservative viewpoint.
SFC_{RE}	31.6(Km/L)	
IR^y	0.99	
$NCV_{gasoline}$	32.8 (MJ/L)	
$EF_{gasoline}$	69,300×10^{-9} (tCO_2/MJ)	
N_y	100 (units)	・Number of vehicles to be introduced in the project

2) Project emission amount

a) When solar charging stands are not introduced (charging from power grid power)

The project emission amounts were calculated using the following equation based on past methodology (AMS-Ⅲ.C) and past study reports. In addition, the parameter settings are shown in Table 3.2.1-5.

$$PE_y = \sum_i ((DD_y / SEC_{PJ,y}) \times EF_{grid} / (100\% - TDL_y) \times N_y)$$

$$= 11{,}999/11.9 \times 0.6257 \times 10^{-3} / (100\% - 12.3\%) \times 100$$

$$= 71.9 \text{ tCO}_2\text{/year}$$

where:

PE_y : Project emission amount (tCO_2)

DD_y : Average project vehicle driving distance (km) for the project introduced in year y

$SEC_{PJ,y}$: Project vehicle electricity consumption (Km/kWh)

EF_{grid} : Grid power CO_2 emission factor ($kgCO_2$/kWh)

TDL_y : Transmission power loss ratio (%)

N_y : Number of project vehicles (units) for the project introduced in year Y

Table 3.2.1-5 Project emission amount: Parameter setting values

Parameter	Value	Basis/source for setting
DD_y	11,999(km) (Corresponding to 40km/day×300 days)	Value from parameter setting values for reference emission amount
$SEC_{PJ,y}$	11.9(Km/L)	Electricity consumption of electric vehicles being introduced
EF_{grid}	0.6257($kgCO_2$/kWh)	From Cambodia Electrical Power Department (2011) (Operating machines)
TDL_y	12.3(%)	From Cambodia Electrical Power Department (2013)
N_y	100 (units)	Number of vehicles to be introduced in the project

b) When solar charging stands are introduced

Since charging of the electric tricycles would be performed at solar charging stands, the project emission amount would be zero.

3) Emission reduction amounts

The emissions amount reduction was calculated as the difference between the reference emission amount and the project emission amount. The annual emission amount reductions in the first year of the project and the emission amount reduction during the project period for a) when solar charging stands are not introduced (charging from power grid power) and b) when solar charging stands are introduced are described below.

For the project period, since the 5 years specified for "vehicles for shipping business use or passenger services" stated in the "Ministry directive on service life, etc. for depreciating amortization assets" can be considered as appropriate for the legal service life of the electric tricycles, the project period was set as 5 years. The same value of 5 years was used for when solar charging stands are introduced. The basis for this is that although the 17 years for "Other retail use business equipment (mainly those made of metal)" in the above ministry directive would be applicable to the solar charging stands, since this project is centered on the electric tricycles, it can be thought necessary to set the project period to the same value as the shorter value of the legal service life of the electric tricycles.

a) When solar charging stands are not introduced (charging from power grid power)

【Annual emission reduction amounts in the first year of the project】

$$ER_y = RE_y - PE_y$$

$$= 85.4\ (tCO_2) - 71.9\ (tCO_2)$$

$$= 13.5\ (tCO_2)$$

where:

ER_y : (Emission reductions in a year) (tCO_2)

RE_y : (Reference emissions in a year) (tCO_2)

PE_y : (Project emissions due to fossil fuel in a year) (tCO_2)

【Emission reduction amounts during the project period】

The emission reduction amounts during the project period (legal service life) are shown in Table 3.2.1-6, with a total of 59.0 tCO_2. Although the project emission amounts are constant, the reference emission amounts decrease each year due to the "reference vehicle fuel consumption improvement factor", so that the emission reduction amounts also become smaller.

Table 3.2.1-6 Emission reduction amounts during the project period

Year	1	2	3	4	5	Total
Reference emission amounts (tCO2)	85.4	84.5	83.7	82.9	82.0	418.5
Project emission amounts (tCO2)	71.9	71.9	71.9	71.9	71.9	359.5
Emission reduction amounts (tCO2)	13.5	12.6	11.8	11.0	10.1	59.0

b) When solar charging stands are introduced

【Annual emission reduction amounts in the first year of the project】

$$ER_y = RE_y - PE_y$$

$$= 85.4\ (tCO_2) - 0$$

$$= 85.4\ (tCO_2)$$

【Emission reduction amounts during the project period】

The emission reduction amounts during the project period (legal service life) are shown in Table 3.2.1-7, with a total of 418.5 tCO_2. Although the project emission amounts are constant, the reference emission amounts decrease each year due to the "reference vehicle fuel consumption improvement factor", so that the emission reduction amounts also become smaller.

Table 3.2.1-7 Emission reduction amounts during the project period

Year	1	2	3	4	5	Total
Reference emission amounts (tCO2)	85.4	84.5	83.7	82.9	82.0	418.5
Project emission amounts (tCO2)	0	0	0	0	0	0.0
Emission reduction amounts (tCO2)	85.4	84.5	83.7	82.9	82.0	418.5

(3) Cost effectiveness of JCM equipment subsidies

If a JCM equipment subsidy ratio of 30% is assumed, the JCM subsidy for this project would be as shown in Table 3.2.1-8. The JCM equipment subsidy cost effectiveness for the cases of a) when solar charging stands are not introduced (charging from power grid power) and b) when solar charging stands are introduced is around 1,000 USD/CO_2 (around ¥100,000/CO_2) as shown, which is an extremely low result.

Table 3.2.1-8 JCM equipment subsidies

Item	Initial cost	Subsidy ratio	JCM equipment subsidy
Electric tricycles (100 vehicle)	Approx. 220,000USD	30%	Approx. 66,000USD
Interchangeable battery (100 vehicles)	Approx. 100,000USD	30%	Approx. 30,000USD
Solar charging stands (5 locations)	Approx. 1,000,000USD	30%	Approx. 300,000USD
Total	Approx. 1,820,000USD	—	Approx. 396,000USD

a) When solar charging stands are not introduced (charging from power grid power)

JCM equipment subsidy cost effectiveness

＝JCM equipment subsidy amounts / Emission reduction amounts

＝Approx. 66,000USD／59.0tCO_2

＝Approx. 1,119USD/tCO_2 (Approx. ¥111,900/ tCO_2)

b) When solar charging stands are introduced

JCM equipment subsidy cost effectiveness

＝JCM equipment subsidy amounts / Emission reduction amounts

＝Approx. 396,000USD／418.5tCO_2

＝Approx. 946USD/tCO_2 (Approx. ¥94,600/ tCO_2)

(4) Consideration for securing profitability

Studies for securing profitability in the case of a) when solar charging stands are not introduced (charging from power grid power) and b) when solar charging stands are introduced was performed (Table 3.2.1-9 and Table 3.2.1-10).

The results show that if a JCM equipment subsidy ratio of 30% is assumed, in the case of a) when solar charging stands are not introduced, if there is a fare income of 12 USD/day (2 USD fare × 6 times), the initial cost can be recovered in around 3 years, for an IRR of about 34%.

In addition, even in the case of b) when solar charging stands are introduced, if there is a fare income of 24 USD/day (4 USD fare × 6 times) the initial cost can be recovered in around 3 years, for an IRR of about 32%.

Therefore, it can be thought that sufficient profitability can be expected in both cases as long as the above fare income is secured.

(5) Project funding procurement methods

It is assumed that funding procurement would be through JCM subsidies and funding from representative businesses and co-participants.

Table 3.2.1-9 Study of project profitability (when solar charging stands are not introduced)

Year	0	1	2	3	4	5
1. Income(USD)	0	360,000	360,000	360,000	360,000	360,000
Fare income(30,000USD/month×12months=360,000USD)		360,000	360,000	360,000	360,000	360,000
※ 2USD/time×6 times×25days×100vehicles=30,000USD						
2. Expenses(USD)	154,000	243,660	343,660	243,660	343,660	243,660
Electric tricycle(Tariff is included) ＊JCM Subsidy (30%)	154,000					
Battery replacement cost			100,000		100,000	
Fuel cost (electricity charge)		19,660	19,660	19,660	19,660	19,660
Maintenance cost		24,000	24,000	24,000	24,000	24,000
Other operating expenses (Personnel expenses etc.)		200,000	200,000	200,000	200,000	200,000
3. Profit before depreciation(USD)	−154,000	116,340	16,340	116,340	16,340	116,340
4. Depreciation(USD)	0	30,800	30,800	30,800	30,800	30,800
Japanese statutory durable years of electric tricycle		30,800	30,800	30,800	30,800	30,800
5. Profit after depreciation(USD)	−154,000	85,540	−14,460	85,540	−14,460	85,540
6. Tax(USD)	0	17,108	−2,892	17,108	−2,892	17,108
Corporation Tax(20%)		17,108	−2,892	17,108	−2,892	17,108
7. Profit of the current term(USD)	−154,000	68,432	−11,568	68,432	−11,568	68,432
8. Cash flow(USD) ※	−154,000	99,232	19,232	99,232	19,232	99,232
	−154,000	−54,768	−35,536	63,696	82,928	182,160

IRR・Recovery period of initial investment	
IRR(5years)	34.4%
Recovery period of initial investment	3 years

Cash flow will be positive in 3 years (Recovery of initial investment will end in 3 years)

Table 3.2.1-10 Study of project profitability (when solar charging stands are introduced)

Year	0	1	2	3	4	5
1. Income(USD)	0	720,000	720,000	720,000	720,000	720,000
Fare income(60,000USD/month×12months=720,000USD)		720,000	720,000	720,000	720,000	720,000
※ 4USD/time×6 times×25days×100vehicles=60,000USD						
2. Expenses(USD)	924,000	244,000	244,000	244,000	444,000	244,000
Electric tricycle(Tariff is included) ＊JCM Subsidy (30%)	154,000					
Battery(Tariff is included) ＊JCM Subsidy (30%)	70,000					
Solar charging stands(Tariff is included) ＊JCM Subsidy (30%)	700,000					
Battery replacement cost					200,000	
Fuel cost (electricity charge)		0	0	0	0	0
Maintenance cost		24,000	24,000	24,000	24,000	24,000
Other operating expenses (Personnel expenses etc.)		220,000	220,000	220,000	220,000	220,000
3. Profit before depreciation(USD)	−924,000	476,000	476,000	476,000	276,000	476,000
4. Depreciation(USD)	0	184,800	184,800	184,800	184,800	184,800
Japanese statutory durable years of electric tricycle		184,800	184,800	184,800	184,800	184,800
5. Profit after depreciation(USD)	−924,000	291,200	291,200	291,200	91,200	291,200
6. Tax(USD)	0	58,240	58,240	58,240	18,240	58,240
Corporation Tax(20%)		58,240	58,240	58,240	18,240	58,240
7. Profit of the current term(USD)	−924,000	232,960	232,960	232,960	72,960	232,960
8. Cash flow(USD) ※	−924,000	417,760	417,760	417,760	257,760	417,760
	−924,000	−506,240	−88,480	329,280	587,040	1,004,800

IRR・Recovery period of initial investment	
IRR(5years)	32.2%
Recovery period of initial investment	3 years

Cash flow will be positive in 3 years (Recovery of initial investment will end in 3vears)

3.2.2 Introduction of biomass power generation

(1)Project overview

Introduce biomass power generation utilizing rice husks at rice processing plants, and reduce CO_2 by reducing the consumption of fuel (light oil) by the existing diesel-powered generators.

For the rice processing plant, a large-scale plant which processes around 800 t/day of processed rice and generates around 200 t/day of rice husks is assumed. The results of a hearing about the same factory are as shown in Table 3.2.2-1.

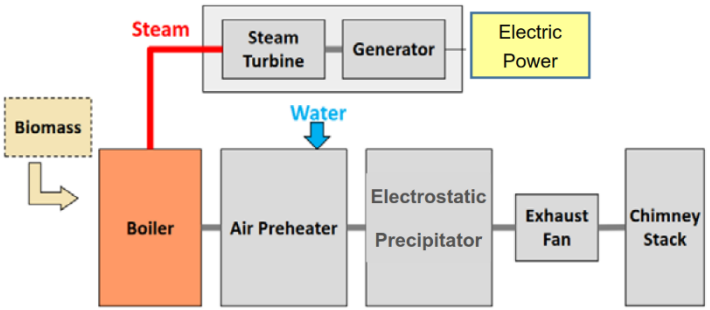
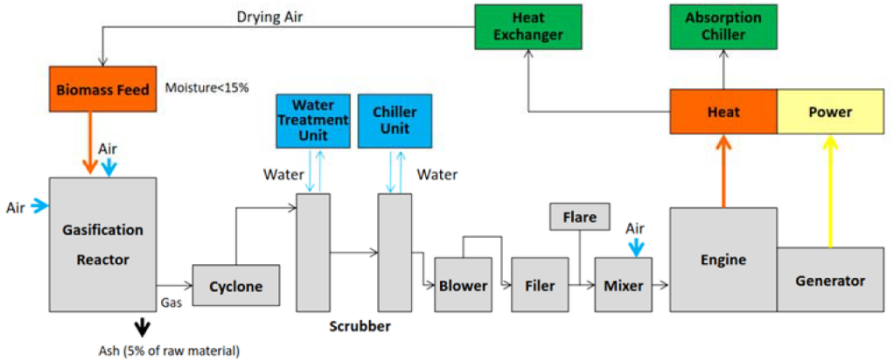
For the power generation method, in general there are two methods: 1) Direct combustion method in which rice husks are burned directly to create steam which spins the turbine, and the gasification method in which rice husks undergo pyrolysis to create gas which is then used by a gas engine to generate electricity.

When the power generation scale is 2MW or higher, as shown in Table 3.2.2-2 and Figure 3.2.2-1, the direct combustion method was selected from the aspects of initial cost, running cost, maintainability, and environmental conservation.

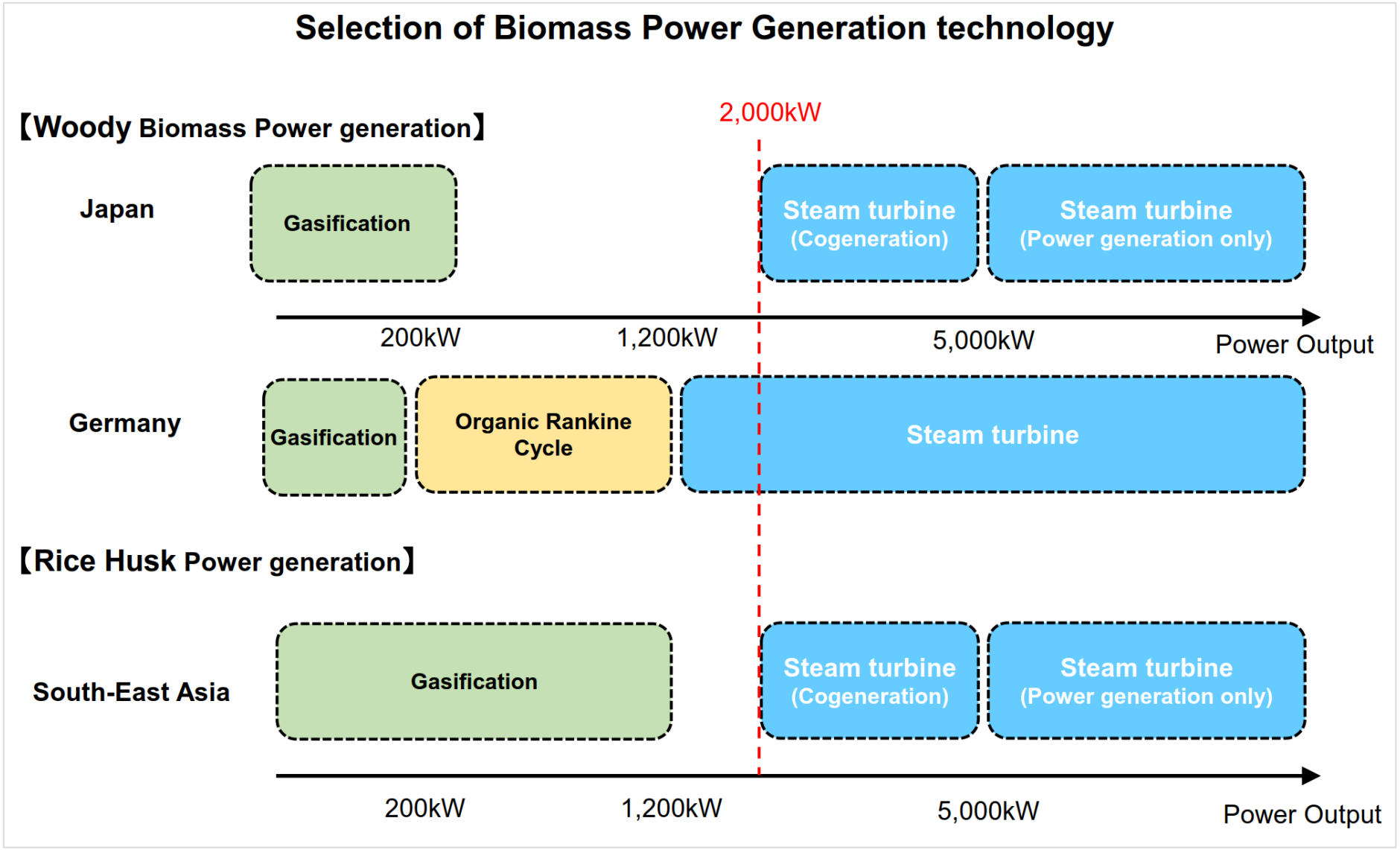
Table 3.2.2-1 Results of hearing at rice processing plant

Item		Details
Company outline	Company name	Golden Rice Co., LTD
	Start of business operation	2009
	Number of employees	300 people
	Plant site area	20ha (including working area of 3ha)
Operating conditions	Processed rice amount (In-husk amount)	1) Rice-processing machine capacity: 40t/h 2)Processed rice amount (current) : High season (Sept. to Jan.) : About 800t/day Low season (Feb. to Aug.) : About 200t/day
	Amount of generated rice husks	・High season (Sept. to Jan.) : 200t/day ・Low season (Feb. to Aug.) : 50t/day
	Rice husk self-consumption amount (for the purpose of rice husk utilization)	・High season (Sept. to Jan.) : 80t/day (Utilized as fuel for dryer and biogas power generation facility. Biogas power generation facility consumes 48t/day.) ・Low season (Feb. to Aug.) : Entire amount is consumed by biogas power generation facility
	Purchaser of remaining rice husks ・Selling price	・High season (Sept. to Jan.) : 100～120t/day Sold to cement factory/brick factory for 12.5 USD/t (Since the purchaser picks up the rice husks there are no transportation costs.) ・Low season (Feb. to Aug.) : Since the entire amount is consumed by the biogas power generation facility, there are no remaining husks.
	Operating time/number of days	・High season (Sept. to Jan.) : 24 h × 5 months (140 days) ・Low season (Feb. to Aug.) : 16h × 7 months
Electrical power	Power consumption amount (kWh)	・High season (Sept. to Jan.) : 35,300 kWh/day ・Low season (Feb. to Aug.) : 15,400 kWh/day (around 40% of High season)
	Power generation composition	Home generators : 100% (Diesel generators or biomass gas generators)
	Home generator equipment (Diesel generators)	1) Fuel : Light oil; 2) Diesel generators: 500kVA × 10 units 3) Maker: Cummin (China); New units
	Power grid electricity price	Power grid electricity is not used.
	Home generator equipment fuel consumption and cost	＜High season (Sept. to Jan.)＞ Fuel consumption : 9,000L/day (For 10 diesel generators) Fuel cost: : 5,400 USD/day (For fuel price of around 0.6 USD / 1L) ＜Low season (Feb. to Aug.)＞ Fuel consumption : 5,000L/day (For 10 diesel generators) Fuel cost : 3,000 USD/day (For fuel price of around 0.6 USD / 1L)
	Biomass power generation	・Gasification generation (1 MW scale) ・Installed by Chinese company ・Tar accumulated inside the engine, etc. is cleaned around once every 10 days. (Tar is discharged untreated.)
Logistics	In-hull rice procurement source	・Procured from sources all over Japan at around 300 USD/t (undried in-hull rice.
	Customers of processed rice	・High-quality rice (80 to 90% of total) : Exported to overseas ・Broken rice, etc. (10 to 20% of total: Sold within Japan
Remarks		・In-hull rice dryer: 6 units with 30t capacity each (Installed in 2014; Manufactured in Vietnam)

Table 3.2.2-2 Comparison of Power Generation System (Target：Above 2MW scale)

	Direct Combustion	Gasification (Existing Power Generation etc.)
System Diagram		
Initial Cost	· In the case of 2 MW or more, as compared with the gasification power generation system, many ready-made products are circulating, so it is easy to procure and the initial cost can be suppressed.	· For the reasons listed on the left, the gasification power generation system is higher than the direct combustion power generation system.
Running Cost	· The running cost is around 15 million yen per year.	· It is necessary to clean the tar accumulating in the engine and the cleaning cost is required. · The running cost is around 30 million yen per year.
Maintenance	· The frequency of periodic inspection and repair exchange is about once a month. · Continuous operation of around 24 hours, 300 days is possible.	· In general, complete removal technology of tar has not been established. · Multiple processes are required to prevent tar from entering the gas engine. · Frequent tar removal cleaning is necessary.
Environmental	· Rice husk ash is available for sale as a cement admixture. · Dust is contained in the exhaust gas, but it can be handled with a dust collector.	· Current situation, rice husk coals continue to be piled up. · At present, tar wash water is untreated and there is concern about the influence on the surrounding environment.
over-all judgement	○ The direct combustion power generation system should be adopted because it is more advantageous in each comparison item in case of 2MW or more.	×

Source) The chart of FY2014 Feasibility Studies on Joint Crediting Mechanism Projects towards Environmentally Sustainable Cities in Asia -Feasibility Study (Rice Husk Power Generation System for Low-carbon Communities in Ayeyarwady Region, Myanmar(Mitsubishi Research Institute, Inc.)) was modified and posted.



Source: Materials provided by Yanmar Green System Co., LTD.

Fig.3.2.2-1 Selection of Biomass Power Generation Technology(Result of interviewing with an engineering company)

(2) CO_2 reduction effect

1) Reference emissions

The reference emission amount was calculated using the following equation and referring to past study reports. The setting parameters and reference emission amount are shown in Table 3.2.2-3

$$RE_y = EG_{PJ,y} \times EF_{FF,y}$$

where

RE_y : Reference emissions in a year (tCO_2)

$EG_{PJ,y}$: Quantity of net electricity generated in a year by the renewable energy unit installed under the project activity (MWh)

$EF_{FF,y}$: Emission factor of fossil fuel replaced by the project activity (tCO_2/MWh)

Table 3.2.2-3 Reference emission amount: Parameter setting values

	Value	Basis/source for setting
RE_y	5,962(tCO_2)	—
$EG_{PJ,y}$	High season (Sept. to Jan.) : 2,000kW×15hour×140day =4,200,000(kWh)	2,000kW is the power generation capacity of the power generation equipment planned to be installed. Operating time will be set by referring to the current power consumption.
	Low season (Feb. to Aug.) : 2,000kW×8.3hour×196day =3,252,000(kWh)	Same as above.
$EF_{FF,y}$	0.8(tCO_2/MWh) :	2012 JCM realization feasibility study "Small-scale biomass power generation using Stirling engine" (Cambodia), etc.

2) Project emissions

In this project, since it is assumed that power generation at the factory will be performed using only the rice husks discarded by the same factory, there are no rice husk transportation costs. Therefore, for the project emission amounts, if it is sufficient to determine the CO2 emission amounts generated by the fossil fuel consumed by the new power generation facility, it can be calculated from the following formula. The setting parameters and project emission amount are shown in Table 3.2.2-4.

$$PE_y = \sum_i FC_{i,y} \times EF_{CO2,i}$$

where、

PE_y : Project emissions due to fossil fuel in a year (tCO_2)

$FC_{i,y}$: Fossil fuel i consumed in a year(t)

$EF_{CO2,i}$: Emission factor of fossil fuel i (tCO_2/t)

Table 3.2.2-4 Project emission amount: Parameter setting values

	Value	Basis/source for setting
PE_y	163 (tCO_2)	—
$FC_{i,y}$	Fuel consumption amount at startup (90L/hour × 2 hours) × Number of operating days per year (336 days) × Fuel specific gravity (0.8439kg/L) = 51,039kg	・Equipment standalone consumption amount (light oil) per hour : Equipment specifications ・Number of operating hours per year: Based on results of hearing with rice processing company ・Fuel specific gravity (Light oil) : International Energy Agency et al,2004
$EF_{CO2,i}$	3.2(tCO_2/t)	CDM methodology AMS-I.B

3) Emission reduction amounts

The emissions amount reduction was calculated as the difference between the reference emission amount and the project emission amount. In addition, the emission reduction amounts for the project period (legal service life) is determined by multiplying the annual emission reduction amounts by the project period (number of years). For the legal service life, the biomass power generation equipment utilizing rice husks, etc. can be considered to be equivalent to the rice husking equipment in the "Ministry directive on service life, etc. for depreciating amortization assets" and was set at 10 years.

【Annual emission reduction amounts】

$$ER_y = RE_y - PE_y$$
$$= 5{,}962(tCO_2) - 163\ (tCO_2)$$
$$= 5{,}798(tCO_2)$$

where、

ER_y : Emission reductions in a year (tCO_2)

RE_y : Reference emissions in a year (tCO_2)

PE_y : Project emissions due to fossil fuel in a year (tCO_2)

【Emission reduction amounts during project period】

$$ER_p = ER_y \times P$$
$$= 5{,}798(tCO_2) \times 10\text{years}$$
$$= 57{,}980(tCO_2)$$

where、

ER_p : Emission reductions during the period P (tCO_2/year)

P : Project Period (year)

(3) Cost effectiveness of JCM equipment subsidies

Since the initial costs for a 2MW biomass power facility is expected to be approximately 6 million USD, and if a JCM equipment subsidy ratio of 50% is assumed, the JCM subsidiary amount would be 3 million USD. Therefore, the JCM equipment subsidy cost effectiveness becomes 51.7USD/tCO_2 (approx. ¥5,170/tCO_2).

- Overall project cost：Approx. 6 million USD
- Subsidy amount：Approx. 6 million USD × Subsidy ratio of 50%＝ Approx. 3 million USD
- Reduction amount during project period：57,980tCO_2
- Cost effectiveness = Approx. 3 million USD/57,980tCO_2 ＝ Approx. 51.7 USD/tCO_2 (Approx. ¥5,170/tCO_2)

(4) Project profitability

By introducing a biomass power generation facility, the purchasing costs of fuel (light oil) that would be consumed by the diesel generator are drastically reduced (Figure 3.2.2-5). On the other hand, since rice husks which were previously sold will be consumed as fuel for the biomass power generator, the sales profits will be reduced (Table 3.2.2-6), and running costs will occur. When the above merits, demerits, and running costs are taken into consideration, with the introduction of a biomass power generation facility, a profit of 1.042 million USD per year can be expected.

If the JCM equipment subsidy ratio is assumed to be 50%, initial cost would be approximately 3 million USD, and since the annual profit will be 1.042 million USD, the initial cost can be recovered in approximately 3 years (= 3 million USD/1.042 million USD)

【Annual profit】

Annual profit ＝ Profit due to reduction of fuel consumption amount
－Loss of rice husk sales profit － Running cost※
= 1,307,712USD－116,463USD－149,040 USD
= 1,042,209USD

※Running cost＝ Unit source cost for direct combustion power generation
× Power generation capacity × Annual operating hours
＝0.02USD/kW/hr×2,000kW×3,726hr/year
＝149,040 USD/year

Table 3.2.2-5 Benefit of reducing fuel consumption

	Before (Existing Diesel Power Generation)	After (Rice Husk Power Generation)
High Season (Sep.-Jan. 140days)	756,000USD (9,000L/day×140days×0.6USD/L)	15,120USD (90L/hour×2hours/day×140days×0.6USD/L)
Low Season (Feb.-Aug. 196days)	588,000USD (5,000L/day×196days×0.6USD/L)	21,168USD (90L/hour×2hours/day×196days×0.6USD/L)
Total	1,344,000USD	36,288USD
Annual Benefit	1,344,000USD－36,288USD＝1,307,712USD	

Table 3.2.2-6 Loss of benefit from sales of rice husk

	Before (Existing Diesel Power Generation)	After (Rice Husk Power Generation)
High Season (Sep.-Jan. 140days)	0	65,625USD (2.5ton/hour×15hours/day×140days×12.5USD/ton)
Low Season (Feb.-Aug. 196days)	0	50,838USD (2.5ton/hour×8.3hours/day×196days×12.5USD/ton)
Total	0	116,463USD
Loss of Benefit	116,463USD－0＝116,463USD	

Notes：Operation time of rice husk power generation in a day
＝Amount of fuel consumption (L/day) / Fuel consumption per generation amount (L/kWh)
/ Capacity of rice power generation
→High Season: 9000 (L/day) /0.3 (L/kwh) /2,000kW =15 hours/day
→Low Season]: 5000 (L/day) /0.3 (L/kwh) /2,000kW=8.3 hours/day

(5) Project funding procurement methods

Aside from JCM subsidies, funding would be procured through self-investment by co-participants.

3.3 Study of project implementation organization

Based on the above study results, for the projects to which JCM equipment subsidy projects are applicable: 1) Project for introduction of electric tricycles and 2) Project for introduction of biomass power generation facilities, a study of the project implementation organization such as the representative businesses, selection of co-participants, etc. and contract types was conducted.

3.3.1 Implementation structure of electric tricycle project

It is assumed that an international consortium of the representative businesses (Japanese companies) and the taxi company (Phnom Penh) will be formed and will operate the project.

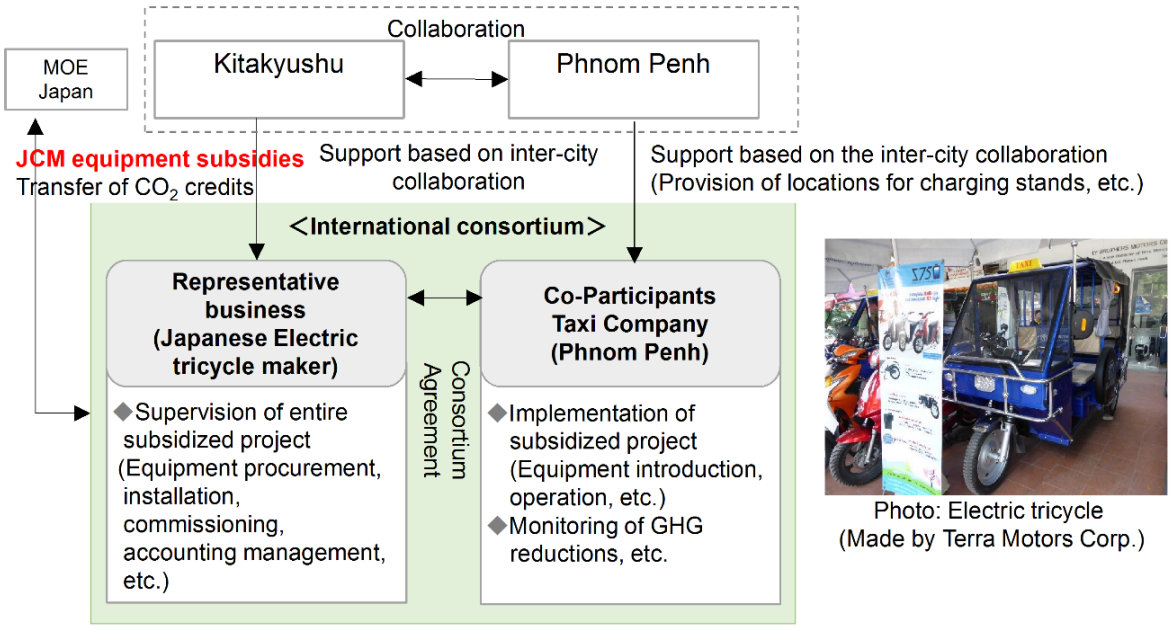


Fig.3.3.1-1 Implementation structure of electric tricycle project

3.3.2 Implementation structure of biomass power generation project

・The representative company (Japanese company) and the co participant (Cambodian company) will organize the international consortium to do the project.

・This project will be applied JCM subsidized project supported by MOE of Japan.(Maximum Subsidy: 50% of the initial equipment installation costs)

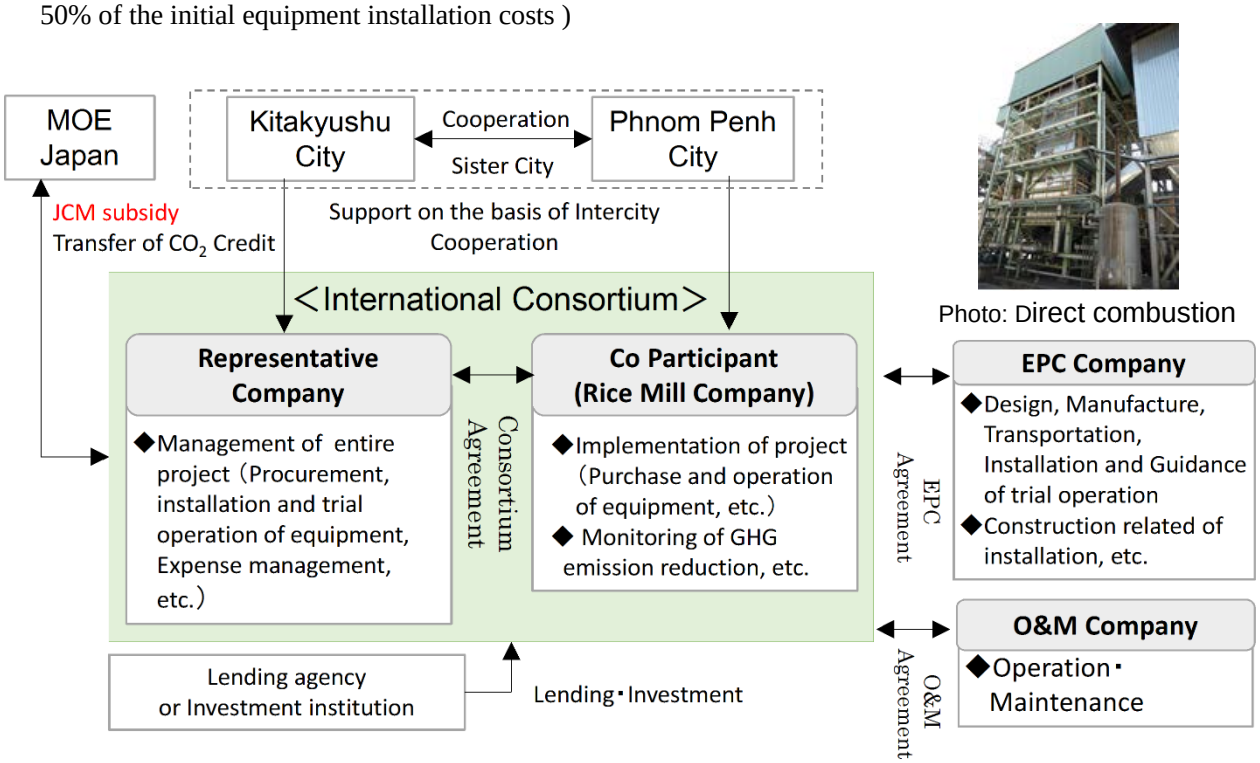


Fig.3.3.2-1 The implementation structure of biomass power generation project

3.4 Study of monitoring methods

3.4.1 Monitoring method for electric tricycle introduction project

a) When solar charging stands are not introduced (charging from power grid power)

The calculations for the reference emission amounts and project are shown below. The parameter setting methods are described in Tables 3.4.1-1 and 3.4.1-2.

The parameters which require monitoring are average driving distance for project vehicles DD_y and project vehicle power consumption $SEC_{PJ,y}$. For DD_y, distance-measuring devices (GPS) which can measure the daily driving distance will be installed in all electric tricycles introduced by the project and the distances measured and tabulated. For $SEC_{PJ,y}$, the driving distance of all electric tricycles introduced by the project will be measured with a GPS and the power consumed when charging the batteries will be measured with an electrical power meter, and the results tabulated.

【Reference emissions amounts】

$$RE_y = \sum_i ((DD_y / SFC_{RE}) \times IR_y \times NCV_{gasoline} \times EF_{gasoline} \times N_y)$$

【Project emissions】

$$PE_y = \sum_i ((DD_y / SEC_{PJ,y}) \times EF_{grid} / (100\,\% - TDL_y) \times N_y)$$

Table 3.4.1-1 Parameter setting methods for reference emission amounts calculations

Parameter	Data explanation	Setting method
DD_y	Average project vehicle driving distance (km) for the project introduced in year y	Distance-measuring devices (GPS) which can measure the daily driving distance will be installed in all electric tricycles introduced by the project and the distances measured and tabulated.
SFC_{RE}	Reference vehicle fuel consumption (Km/L)	The default value (31.6km/L) set in past reports ※ is used.
IR_y	Reference vehicle fuel consumption improvement factor (-) for year y	The default values for C D M AMS-111.C will be checked. If the country has published fixed values, those data will be used.
$NCV_{gasoline}$	Net caloric volume from gasoline (MJ/L)	The default values for IPCC 2006 guidelines will be checked If the country has published fixed values, those data will be used.
$EF_{gasoline}$	Gasoline CO2 emission factor (tCO_2/MJ)	Same as above
N_y	Number of project vehicles (units) for the project introduced in year Y	Number of vehicles introduced by the project.

※Past reports: 2014 JCM large-scale project creation feasibility study project "Study for support of creation of environmental cultural city in Cambodia Angkor ruins region utilizing JCM""; March 2015 (Overseas Environmental Cooperation Center)

Table 3.4.1-2 Project emission amounts and parameter setting values

Parameter	Data explanation	Setting method
DD_y	Average project vehicle driving distance (km) for the project introduced in year y	Value from parameter setting values for reference emission amount
$SEC_{PJ,y}$	Project vehicle power consumption (km/kWh)	Measurement and tabulation of the daily driving distance of electric tricycles introduced by the project and power consumption during charging
EF_{grid}	Grid power CO_2 emission factor ($kgCO_2/kWh$)	Public stated values from Cambodia Ministry of the Environment
TDL_y	Transmission power loss ratio (%)	Public stated values from Cambodia Energy Department
N_y	Number of project vehicles (units) for the project introduced in year Y	Number of vehicles introduced by the project

b) When solar charging stands are introduced

Reference emission amounts are required in the same way as for a). Since the project emission amounts are zero, the reference emission amounts will become the emission reduction amounts.

3.4.2 Monitoring methods for biomass power generation facilities introduction project

The calculation methods for the reference emission amount and project are shown below. The parameter setting methods are described in Tables 3.4.2-1 and 3.4.2-2.

The parameters which require monitoring are the annual amount of generated electricity due to project activities $EG_{PJ,y}$ and the annual fossil fuel consumption amount $FC_{i,y}$. For $EG_{PJ,y}$, the amount of generated electricity due to the power generation facility introduced by the project will be measured with an electrical power meter and tabulated. For $FC_{i,y}$, the amount of fossil fuel consumption will be measured with a flow meter, etc. and tabulated.

【Reference emission amounts】

$$RE_y = EG_{PJ,y} \times EF_{FF,y}$$

【Project emission amounts】

$$PE_y = \sum_i FC_{i,y} \times EF_{CO2,i}$$

Table 3.4.2-1 Parameter setting methods for reference emission amounts calculations

Parameter	Data explanation	Setting method
$EG_{PJ,y}$	Annual power generation amount due to project activities (MWh)	The amount of generated electricity due to the power generation facility introduced by the project will be measured with an electrical power meter and tabulated.
$EF_{FF,y}$	Emission factor for fossil fuels substituted for in the project (tCO_2/MWh)	The default value from past reports (0.8 tCO_2/MWh) ※ will be used

※ Past report: 2012 JCM realization feasibility study "Small-scale biomass power generation using Stirling engine" (Cambodia)

Table 3.4.2-2 Parameter setting methods for project emission amounts calculations

Parameter	Data explanation	Setting method
$FC_{i,y}$	Annual fossil fuel consumption amount	The amount of fossil fuel consumption will be measured with a flow meter, etc. and tabulated.
$EF_{CO2,i}$	Fossil fuel emission factor (tCO_2/t)	The default values for IPCC 2006 guidelines will be checked If the country has published fixed values, those data will be used.

3.5 Study results and summary

Based on the results of grasping the current situation in the climate change strategic action plan, a study of needs for projects that will contribute to reductions in energy-derived CO2 emissions, JCM project studies were conducted for 2 projects: the introduction of electric tricycles and the introduction of biomass power generation facilities. The issues for each project are described below.

(1)Introduction of electric tricycles

・As a result of studying the CO_2 reduction effect and subsidy cost effectiveness, the results for cost effectiveness were extremely low. However, since locally the air pollution due to gasoline-powered vehicles has been deteriorating, the realization of a transportation field project that can contribute not only to CO2 reductions but also for suppressing air pollution is extremely important. Incidentally, when a subsidy of 30% of initial expenses is accepted, the unit reduction price for CO2 relative to the subsidy is around ¥100,000/CO_2

・ Regarding project profitability, since the electric tricycles being considered for introduction are low-priced, if an income of 12 to 24 USD/day (2 to 4 USD fare x 6 times) is achieved, sufficient profitability can be expected. However, in hearings conducted with the local Remorque association and 2 taxi companies, for project realization securing trust in the electric tricycles (driving distances, safety, etc.) funding procurement, and development of charging stations are major issues.

(2)Introduction of biomass power generation facilities

・For a biomass power generation facility with a generating capacity of 2MW scale, as the results of studies on the CO2 reduction effect, subsidy cost performance, and business profitability, it was determined that the feasibility as a JCM subsidy project was high. Incidentally, when a subsidy of 50% of the initial costs

is accepted, the unit cost of CO2 emission reduction for the subsidy amount is around ¥5,000/CO_2.

・The issue is how to appeal the fact that the economic merits of this project are large to local rice processing companies and whether this project can be achieved. In addition, with inexpensive biomass generation facilities※ being available from China, etc., it is important to introduce environmentally friendly biomass power generation facilities while suppressing initial and running costs is important.

※ The local rice processing companies used as study subjects are already equipped with gasification engine type generator facilities, but the water generated when cleaning tar is left untreated, which has a deleterious effect on the surrounding environment.

Chapter4　Hosting workshops in the country surveyed

(1)Workshop

Four workshops were held in the surveying country (Phnom Penh capital) to discuss the Phnom Penh Climate Change Strategic Action Plan and the pilot project by utilizing JCM etc. with related organizations such as administrative organ of Phnom Penh capital. The outline of the consultation results is shown in Table 4-1.

Table 4-1 Outline of the consultation results of workshops (1/4)

Times Date and time Venue	The outline of the consultation results
First May 12, 2016 10:15-11:50 Phnom Penh capital hall	(1) The Japanese side explained the purpose and outline of the project, the procedure for formulating the action plan, and the JCM subsidized project. (2) Phnom Penh capital side requested construct a waste treatment facility. → At this stage, it is important to raise awareness of separation and reduction of waste of citizens, and to reduce waste when waste is discharged. (Kitakyushu city) (3) Deputy Governor said that it was important for not only the Japanese side but also companies, citizens and students of Phnom Penh capital to participate in formulating this plan.
Pictures	 

Table 4-1 Outline of the consultation results of workshops (2/4)

Times Date and time Venue	The outline of the consultation results
Second Sep.26,2016 14:10-17:00 Phnom Penh capital hall	(1) The Japanese side explained outline of the action plan. (2) Phnom Penh capital side requested to implement a pilot project of waste sorting and collection. → We would like to decide model area and carry out a sorting-collection pilot project by using JICA Partnership Program (Kitakyushu city) (3) From the Phnom Penh side, the industrial development of Phnom Penh is important, and concerns were raised as to whether it would affect the economic activity if the cost was imposed on the business when trying to control the exhaust gas. → Even if a pollution prevention facility is installed, it is possible to reduce the total cost by reviewing the production process by the cleaner production and saving energy. (Kitakyushu city) (4)In addition, opinions were exchanged on energy conservation for existing old buildings, wastewater treatment at hospitals, and introduction of solar panels to hospitals.
Pictures	 

Table 4-1 Outline of the consultation results of workshops (3/4)

Times Date and time Venue	The outline of the consultation results
Third 15 Dec.,2016 9:00～13:00 Phnom Penh capital hall	(1) The Japanese side explained draft of the plan, centering on pilot projects in each field and cases of efforts in Kitakyushu city. (2) The Phnom Penh capital gave an opinion that was in general approval of the plan. The main opinions are as follows. · Concern about the feasibility of the pilot project at Phnom Penh without knowledge of waste management was shown. (University of Phnom Penh/Professor) → It is feasible from achievement in Surabaya.(Kitakyushu city) · I would like to reflect specific measures of the Japanese side in the capital master plan at the final stage of formulation. As for waste, sewage, and transportation, we need to consider detailed measures, and we want to fulfill our role as Phnom Penh capital. (Urban Management Division/ Deputy Director) · To realize the introduction of electric tricycle, the recognition that charging stations are necessary was shown. In addition, there was concern about the travel distance of the electric tricycle. (Remorque association / Chairman) →Terra Motors Company explained about the travel distance and sales performance in Bangladesh. · Department of Phnom Penh, Ministry of Agriculture, Forestry and Fisheries agreed to the project of organic vegetable cultivation using compost produced from household garbage. (3)Deputy Governor showed the necessity of considering the mechanism to realize the project.
Pictures	 

Table 4-1 Outline of the consultation results of workshops (4/4)

Times Date and time Venue	The outline of the consultation results
Fourth Feb.14,2017 14:00～17:00 Phnom Penh capital hall	(1) The Japanese side explained mainly pilot projects in each field. (2) The Phnom Penh Province side gave opinions in favor of the plan. The main opinions are as follows. · I would like to support the pilot project introducing the atmosphere / noise monitoring system. (Ministry of the Environment) · Opinions were exchanged on the town (model area) where the pilot project (the reduction and recycle of urban waste) would implemented. (Waste Management department) · We would like to collaborate on pilot projects introducing the atmosphere / noise monitoring system. (Royal University of Phnom Penh) · I would like to cooperate on the pilot project in the waste field (NGO) (3) Deputy Governor agreed to the action plan and asked the Japanese side to realize the pilot projects.
Pictures	 

(2)Meetings with related organization.

Outline of the consultation result at the meeting in Phnom Penh capital are shown in Table 4-2-Table4-6.

Table 4-2 Outline of the consultation results (The First Meetings (May 9-12, 2016))

Date & Time		Organization	Outline of the consultation results
May 9 (Mon.)	14:10-16:20	Phnom Penh Capital Urbanization Division	· Urban Development Division explained about their roles and the capital master plan. · It was decided to hold an Inception Meeting which gathered relevant organizations.
	16:20-17:00	Phnom Penh Capital Planning & Investment Division	・Planning & Investment Division explained about their roles.
May 10 (Tue.)	9:30-10:30	Japanese Embassy	・Japanese investigative team explained about outline of the project. ・Japanese Embassy explained about current status and tasks of Phnom Penh Capital.
	11:00-12:00	Phnom Penh Water Supply Authority	・Japanese investigative team explained about outline of the project. ・The authority explained about current status of water supply, water purification plant and existing solar power facilities.
	11:00-12:00	Ministry of Mines and Energy	・Japanese investigative team explained about outline of the project. ・The ministry explained about solar power business which has already been implemented in Cambodia.
	16:10-17:00	Ministry of Public works and Transport	・Japanese investigative team explained about outline of the project. ・The ministry explained about progress of planning the waste water master plan supported JICA and current situation of flood.
May 11 (Wed.)	9:10-10:30	Ministry of Environment	・Japanese investigative team explained about outline of the project. ・The ministry explained about current status and tasks regarding environmental conservation, sewage and transportation of Phnom Penh Capital.
	14:00-15:30	Calmette Hospital	・Japanese investigative team explained about outline of JCM subsidized project. ・Japanese investigative team interview about facilities of the hospital.
	16:30-18:00	Khmer-Soviet Friendship Hospital	・Japanese investigative team explained about outline of JCM subsidized project. ・Japanese investigative team interview about facilities of the hospital.
May 12 (Thurs.)	8:55-13:00	1st Workshop (Inception Meeting)	・Japanese investigative team explained about outline of the project. ・Deputy Governor agreed to this project and indicated the need for Cambodian companies, citizens of Phnom Penh capital and students to participate in this project.
	16:00-17:10	Ministry of Water Resources and Meteorology (WRM) Department of WRM of Phnom Penh	・Japanese investigative team explained about outline of the project. ・Japanese investigative team explained about roles of Department of WRM.
	16:00-17:00	JICA	・Japanese investigative team explained about outline of the project. ・JICA explained about current status and tasks regarding waste and energy of Phnom Penh Capital.

Table 4-3 Outline of the consultation results (The Second Meetings (July 19-22, 2016))

Date & Time		Organization	Outline of the consultation results
July.19 (Tue.)	9:00-11:20	Golden Daun Keo Rice Mill(Rice Milling Company)	＜**Pilot project for introduction of biomass power generation facilities to Rice Mill factory**＞ ・Japanese investigative team interviewed about the company profile and operating status, power consumption and logistics of rice milling factory.
	16:30-18:30	Mr. Sophnna Nun (Green Move Consulting, Staff of MoE at previous job)	・He explained that the organizational structure regarding climate change was changed. ・He contacted the department of Climate Change, MoE for us.
July.20 (Wed.)	9:00-11:00	Ministry of Environment Department of Climate Change	・The department explained about the organizational structure regarding climate change. ・The department provided materials regarding the target of GHG reduction in Cambodia.
	17:15-18:10	Calmet Hospital	＜**Pilot project for introduction of septic tank to Hospital**＞ ・Japanese investigative team confirmed that waste water including medical liquid waste was drained without purification in the hospital.
July.21 (Thurs.)	8:55-13:00	Terra Motors Cambodia for Confederation Development Association(CCDA)	＜**Pilot project for introduction of E-Remorque**＞ ・Terra Motors explained about performance and cost of their product (E-Remorque). ・CCDA explained about performance and cost of gasoline remorque used generally in Phnom Penh and drivers' income, etc.
	16:00-17:10	Khmer-Soviet Friendship Hospital	＜**Pilot project for introduction of septic tank to Hospital**＞ ・Japanese investigative team confirmed that waste water including medical liquid waste was drained without purification in the hospital.
July.22 (Fri.)	10:00-12:00	Golden Rice Co., Ltd (Kampong Speu Province) (Rice Milling Company)	＜**Projects for Introduction of biomass power generation facilities to Rice Mill factory**＞ ・Japanese investigative team interviewed about the company profile and operating status, power consumption and logistics of rice milling factory. ・It was decided that Japanese investigative team suggest two biomass power generation facilities (2MW×2)
	14:25-15:40	JICA	・Japanese investigative team talk about gratis fund aid for introduction of septic tank in hospital and Environment monitoring facility in Phnom Penh Capital with JICA.

Table 4-4 Outline of the consultation results (The Third Meetings (September 26-29, 2016))(1/2)

Date & Time		Organization	Outline of the consultation results
Sep.26 (Mon.)	14:10-17:00	2nd Workshop	・Japanese investigative team explained about outline of action plan. ・Japanese investigative team mainly answered questions regarding the way to gather waste and advantage of cleaner production.
Sep.27 (Tue.)	9:00-10:30	Ministry of Health Phnom Penh Municipal Health Department	・Japanese investigative team explained about outline of action plan. ・Japanese investigative team talked about pilot project of introduction septic tank to Hospital with the department.(Introduction cost, etc.)
	10:55-12:30	Department of Agriculture of Phnom Penh Municipality	・Japanese investigative team explained about outline of action plan. ・Japanese investigative team talked about pilot project of green agriculture with the department. (planning target area, production method of compost from garbage)
	14:40-16:00	Phnom Penh Capital Waste Management Department	・Japanese investigative team explained about outline of action plan. ・Japanese investigative team talked about pilot project of compost business of waste and waste incineration power generation with the department.
	16:30-17:30	Ministry of Public works and Transport	・Japanese investigative team explained about outline of action plan. ・The ministry explained about the sewage master plan and the waste water master plan.
Sep.28 (Wed.)	9:10-11:30	Ministry of Public works and Transport (PWT) Department of PWT of Phnom Penh	・Japanese investigative team explained about outline of action plan. ・The department explained about the transportation master plan. ・Japanese investigative team talked about pilot project of E-Remorque and septic tank for hospital with the department.
	13:30-14:30	Ministry of Environment Department of Climate Change	・Japanese investigative team explained about outline of action plan. ・The department explained about JCM subsidized project which had already done and progress of making GHG inventory.
	15:30-16:30	Phnom Penh Water Supply Authority	・Japanese investigative team explained about outline of action plan. ・The authority explained about water supply master plan and JCM feasibility study which had been done by Japanese company (METAWATER Co., Ltd) .
	16:50-18:00	Ministry of Environment Department of Air Quality & Noise Management	・Japanese investigative team explained about outline of action plan. ・Japanese investigative team talked about pilot project regarding waste and environmental monitoring with the department.
Sep.29 (Fri.)	9:00-10:00	CINTRI Co. Ltd	・Japanese investigative team explained about outline of action plan. ・The company explained about current status and tasks regarding separation and collection of waste in Phnom Penh.
	14:00-15:30	Golden Rice Co., Ltd (Kampong Speu Province) (Rice Milling Company)	・Japanese investigative team explained about system, cost and construction period of biomass power generation (4MW).

Table 4-5 Outline of the consultation results (The Forth Meetings (December 12-16, 2016))(1/2)

Date & Time		Organization	Outline of the consultation results
Dec.12 (Mon.)	9:15-10:20	Phnom Penh Capital PR & International Cooperation Office	・Japanese investigative team confirmed attendance and venue of the 3rd workshop. ・Japanese investigative team talked about the 4th workshop with the office.
	10:45-1:30	Phnom Penh Capital Urbanization Division	・The division spoke the they would like to reflect climate change strategic action plan in the capital master plan.
	10:45-1:30	Phnom Penh Water Supply Authority	・Japanese investigative team explained about the draft plan. ・The authority explained about JCM subsidized project which had been doing by Japanese company (METAWATER Co., Ltd). ・The authority explained about installation condition of solar power generation equipment and installation unit price of this.
Dec.13 (Tue.)	9:00-10:30	KANSAI CORPORATION	・Japanese investigative team asked the company to cooperate on the pilot project of green agriculture and they agreed it. ・They explained about their business activities in Cambodia.
	13:20-15:00	Golden Rice Co., Ltd (Kampong Speu Province) (Rice Milling Company)	・Japanese investigative team explained about system, cost and construction period of biomass power generation (2MW). It was decided that Japanese investigative team would suggest the presentation materials of this generation.
Dec.14 (Wed.)	10:00-11:10	Ministry of Health Phnom Penh Municipal Health Department	・Japanese investigative team explained about the pilot project and exchange opinions about it ・The department requested the Japanese team to reconfirm the positions of the hospitals
	14:00-15:10	nrg solutions (Solar power generation equipment company)	・Japanese investigative team explained about the pilot project regarding E-Remorque. ・Japanese investigative team interviewed about the installation cost of PV facilities for solar charging stands.
	14:00-15:10	Ministry of Public works and Transport (PWT) Department of PWT of Phnom Penh	・Japanese investigative team explained about the draft plan. ・Japanese investigative team talked about pilot project of E-Remorque and septic tank for hospital with the department.
	16:00-17:40	Department of Agriculture of Phnom Penh Municipality	・Japanese investigative team explained about the draft plan. ・Japanese investigative team talked about pilot project of green agriculture with the department. (planning target area, the necessity of organic vegetable market research)

Table 4-5 Outline of the consultation results (The Forth Meetings (December 12-16, 2016))(2/2)

Date & Time		Organization	Outline of the consultation results
Dec.15 (Thurs.)	9:00-13:00	3rd Workshop	・Japanese investigative team explained about the draft plan. ・The participants in Phnom Penh gave opinions largely in favor of the plan. ・The deputy governor showed the necessity to consider how Kitakyushu city and Phnom Penh would realize the project in a system.
	14:00-15:20	Ministry of Environment Department of Climate Change	・Japanese investigative team explained about the draft plan. ・The department explained about the progress of implementing Cambodia Climate Change Strategic Plan and Action Plan
	15:45-17:00	Ministry of Environment Advisor and Director of Cabinet, General Department of Environment Protection	・Japanese investigative team explained about the draft plan. ・The department explained the JCM subsidized project which had already been done and the current situation of waste management in Phnom Penh Capital.
Dec.16 (Fri.)	9:30-11:00	Phnom Penh Capital Waste Management Department	・Japanese investigative team explained the plot project regarding waste ・It also reconfirm the duty of CINTRI and this department ・They exchanged opinions about target site of the pilot project
	14:00-15:00	Ministry of Mines and Energy	・Japanese investigative team explained about the draft plan ・They exchanged opinions about the pilot project regarding energy
	16:00-17:00	Ministry of industry and handicraft	・Japanese investigative team explained about the draft plan. ・They exchanged opinions about the draft plan and the pilot projects
	10:00-11:30	I.M.B(Cambodia)Group Co.,LTD	＜Interview with three Solar power generation equipment companies＞ ・Japanese investigative team explained about the pilot project regarding E-Remorque. ・Japanese investigative team interviewed about the installation cost of PV facilities for solar charging stands.
	12:20-13:00	RYOSHIN DENKI Co., Ltd.	
	14:00-16:00	KAMWORKS	

Table 4-6 Outline of the consultation results (The Fifth Meetings (February 13-15, 2017))

Date & Time		Organization	Outline of the consultation results
Feb.13 (Mon.)	9:00-10:00	Phnom Penh Capital PR & International Cooperation Office	・Japanese investigative team confirmed attendance and venue of the 4rd workshop. ・Japanese investigative team talked about the future plan regarding pilot projects.
	10:40-11:30	Japanese Embassy	・Japanese investigative team asked the Japanese embassy for cooperation with the project and got their consent.
	14:00-16:00	Angkor Rice	・Japanese investigative team inspected the rice husk power plant introduced by using CMD.
Feb.14 (Tue.)	14:00-17:40	4rd Workshop	・Japanese investigative team explained about the final draft plan. ・The participants in Phnom Penh gave opinions largely in favor of the plan. ・Deputy Governor agreed to the action plan and asked the Japanese side to realize the pilot projects.
Feb.15 (Wed.)	9:40-10:30	Cam Go(Taxi Company)	・Japanese investigative team explained about the pilot project the electric tricycle. ・The company was interested in the project and we decided to continue negotiations.
	13:20-15:00	Golden Rice Co., Ltd (Kampong Speu Province) (Rice Milling Company)	・Japanese investigative team explained about system, initial and running cost and business structure of biomass power generation (2MW). We decided to continue negotiations to implement the project.