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2017 Intercity Cooperation Project to Realize a Low-Carbon Society

Project of Methane Fermentation and Power Generation Using Organic Waste Discharged from Markets

Project Report

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Kojimaguchi Co., Ltd.

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List of Abbreviations

Abbreviation	Name of Organization
ADB	Asian Development Bank
ASEAM	Association of South - East Asian Nations
CDC	Council for the Development of Cambodia
COMPED	Cambodian Education and Waste Management Organization
CSARO	Cambodia Sanitation and Recycling Organization
DOE	Department of Environment
DPWT	Department of Public Works and Transport
DSD	Drainage and Sewerage Division
EDC	Electricite du Cambodia
EIA	Environmental Impact Assessment
FDI	Foreign Direct Investment
FRC	Final Registration Certificates
GDP	Gross Domestic Product
IEIA	Initial Environmental Impact Assessment
IGES	Institute for Global Environmental Strategies
IPP	Independent Power Producers
ISWM	Integrated Solid Waste Management
ITC	Institute of Technology of Cambodia
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forestry and Fisheries
MDGs	Millennium Development Goals
MIME	Ministry of Mines and Energy
MOC	Ministry of Commerce
MOE	Ministry of Environment
MOEF	Ministry of Economy and Finance
MOI	Ministry of Interior
MPWT	Ministry of Public Works and Transport
NGO	Non-Governmental Organizations
NSDP	National Strategic Development Plan
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
pH	Potential Hydrogen
PKO	United Nations Peacekeeping Operations
PMIS	Province-Municipal Investment Sub-Committee
PPCC	Phnom Penh Capital City
REE	Rural Electricity Enterprises
SLM	Sustainable Land Management
UNCRD	United Nations Centre for Regional Development
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNTAC	United Nations Transitional Authority in Cambodia
WB	World Bank
WHO	World Health Organization
WMD	Waste Management Division

1 Background and Contents

1-1 Project Background

1-1-1 Adverse impact of increase in waste generation and characteristics of waste on the environment

The population of Cambodia is markedly increasing and its average age, 24 years old, is the lowest figure among the ASEAN nations. The population of Phnom Penh Capital City, the biggest city in Cambodia, increased by about 70 percent in 15 years, from 0.999 million in 1998 to 1.68 million in 2013. On the back of the increasing population, 2.800 tons of waste is generated in Phnom Penh every day, and of that, 2.000 tons of solid materials is landfilled without being separated in the Dangkao final disposal site, which is located about 10 km south from the central of the city. Waste is open-dumped in the landfill site for reasons such as that the site is surrounded by rice paddy fields and sand as soil covering material cannot be procured easily, and that valuable resources are separated from waste manually.

One of the characteristics of waste in Cambodia is a significantly high proportion of organic waste such as food scraps in waste. The table below shows a comparison of waste composition between Phnom Penh and Yokohama City, Japan. In Phnom Penh, the percentage of kitchen garbage, which is easily decomposed, is significantly high. When this kitchen garbage is landfilled as it is, it decays and generates bad odor, pests, toxic gases such as hydrogen sulfide, and others. Roughly 600 children step into the disposal site every day to collect waste plastic and other valuable resources, creating extremely dangerous situations. Moreover, organic waste in some inner part of the landfill that is in anaerobic condition is decomposed by bacteria, with time, and methane is generated, causing fires. When methane is emitted as it is without igniting into the air, its Global Warming Potential becomes 21 times larger than that of CO2 and makes extremely bad impacts on global warming.

Table 1-1-1 Waste composition in Phnom Penh (Cambodia) and Yokohama City (Kanagawa Prefecture, Japan)

waste group	Non-separated waste to be landfilled	Waste discharged from markets	Waste to be burnt in Yokohama
Organic waste（kitchen garbage）	72.8	84.8	36
Pruned branches/mowed grass	0	1.5	
Wooden waste	0.4	0.2	(total with the figure above） 14
Plastic	12.2	9.2	11
Paper	4.1	3.1	26
Glass	1.8	0.1	
Iron	0.1	0.1	
Aluminum	0	0	
Fabric	1.9	0.4	
Hazardous waste（batteries, etc.）	0	0	

Others	6.8	0.6	13

1-1-2 Chronic shortage of electric power

In Cambodia, a power infrastructure has not been in place yet, which hinders the advancement of the nation's industrialization. For its large young workforce and labor costs lower than neighboring countries, it is expected that Japanese corporations will make inroad into Cambodia with their factories in the future. However, stable and low-cost power supply is a precondition for that. Currently, the country depends on import from Thailand, Vietnam and other nations for 40 percent of electric energy it needs, which is an obstacle to cost reduction.

Renewable energy resources including hydraulic power, solar light, and biomass, which the country have abundantly, are capturing attention. In particular, development of unexploited resources such as solar power generation by solar light and biomass power generation by biomass is a future task.

1-2 Purposes of the research

In December 2015, all countries in the world participated in the 2015 United Nations Climate Change Conference (COP 21), which was held in Paris, France, and adopted the Paris Agreement, a legal framework as of 2020 for fair and effective measures against climate change. This agreement aims to keep a global temperature rise well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius, calling for further efforts toward decarbonation. Also, in COP 21, it was agreed to recognize actions by non-party stakeholders including cities, uphold efforts by non-party stakeholders including cities and other subnational authorities, and promote those efforts.

In the Marrakech Action Proclamation for Our Climate and Sustainable Development, which was adopted in COP 22 held in Marrakech, Morocco, November 2016, the state parties also affirmed that the global temperature is rising at an unprecedented rate and emphasized once again that urgent measures must be taken against it. In addition, it was affirmed that global actions not only by governments but also by non-party stakeholders including subnational authorities and transformation of economies will create positive opportunities for further prosperity and sustainable development.
Cities function as a place for activities to support the development of social economies as well as a place for a great number of people to live. Roughly 50 percent of the world's population takes up cities, which account for less than 2 percent of the entire land area on the globe, and that percentage is forecast to increase to as much as 70%. As of 2006, it is estimated that cities emit 70% or more of the global carbon dioxide emissions, thus cities take a large role in the mitigation of climate change. To achieve the goals of the Paris Agreement, it is important to ensure that measures against climate change are implemented to reduce greenhouse gas emissions in peripheral urban areas.

Under this project, Japanese research institutes, private sectors, universities and others along with Japanese local governments that have experience and know-how on the development of a low-carbon society will support cities in developing countries to develop low-carbon societies, based

on inter-city cooperation. To advance the development of a low-carbon society, the project will also promote the capacity building of cities in developing countries which involves Japanese municipalities.

Phnom Penh has the urgent task of treating increasing waste in a proper way. Using the experience, knowledge and technologies that Kanagawa Prefecture has acquired through its longstanding waste management, we will implement the following tasks for the purpose of working out solutions for Phnom Penh's problems:

(1) Convert organic garbage that accounts for more than 70% of the waste composition in Phnom Penh into practical energy by methane fermentation
(2) Produce biogas by methane fermentation and use the compost of fermentation residues to reduce the volume of waste to be landfilled largely
(3) Cogenerate power and heat from biogas, a raw material, about 55% of which is methane gas, to cut energy generation cost

1-3 Outline and methods of the research

1-3-1 Outline of the research

Research on the local law system, approvals and licenses

We will check the local law system, approvals, licenses and others that should be clarified in order to develop a proposal and aim to introduce planned low-carbon technologies in a smooth manner.

Research on cooperation and support systems that the local government and relevant business operators have

Through meetings with Phnom Penh's authority and waste collection operators, we will request for their cooperation so that the project plan progresses smoothly.

Research on the types of raw materials and procurement methods

We will understand the accurate amount and composition of discharged organic waste to confirm the generation amounts and characteristics of biogases by type. Also, we will examine the best combination of raw materials and the optimum input amount.

Research on plant specifications and construction costs

We will examine construction methods, survey the foundation to estimate construction costs, and examine accompanying facilities as well as possibility of procuring construction materials and equipment on the spot.

Research on management and operation methods

We will examine operation methods and management personnel requirements in connection with the management, control and maintenance of the plant and estimate an operation cost for a case where local human resources are used.

Research on business feasibility and the application of the same business model to other areas

We will, based on uses of the generated energy and various costs for such energy, examine the balance and payments of the project and business expansion to regional core cities.

Research on the degree of contribution that the project can make as a JCM project

We will assess the effectiveness of greenhouse gas reduction and the degree of contribution to both nations as well as exchange information to realize a low -carbon society.

Others

We will run workshops in Cambodia and present the efforts.

We will conclude a MOU based on intercity coordination and hold a signing ceremony. (host nation to be decided)

1-3-2 Research methods

(1) Research on local laws, approvals and licenses

1) hearing survey on related laws and approvals and licenses for construction (the Ministry of Environment of Cambodia)

2) hearing survey on the planned construction site (Phnom Penh Capital City)

3) hearing survey on the purchase of generated energy (EDC)

(2) Research on the cooperation and support systems of the local government and related business operators

1) confirmation of support and cooperation systems based on intercity coordination (Phnom Penh Capital City, Kanagawa Prefecture)

2) hearing survey with waste disposal operators (CINTRI LTD)

3) confirmation of the current state off the final disposal site and hearing survey on the degree of contribution to volume reduction (Phnom Penh)

(3) Research on types and procurement methods of raw materials

1) research to check the total generation amount and composition of organic waste and confirmation of the current collection system (CINTRI LTD)

2) Research to check biogas generation amounts and their characteristics by waste type and the estimation of the best combination of raw materials and their input amounts. (Institute of Technology of Cambodia)

(4) Research on plant specifications and construction costs

1) Estimation of plant specifications and construction costs

2) On-site verification survey on accompanying facilities

3) Research on the local procurement of plant materials and equipment. (local corporations)

(5) Research on management and operation methods

1) hearing survey on plant operation, maintenance and management method, operation costs and the procurement of local human resources (Kojimagumi Cambodia Co., Ltd.)

2) On-site verification of the treatment of fermentation residue

(6) Research on business feasibility and the application of the same business to other areas

1) hearing survey on business expansion within Phnom Penh and information gathering and instructors on the application of the same business to regional core cities and neighboring countries

2) Estimation and other duties in connection with energy utilization, waste treatment costs,

business balance and payments (Kojimagumi Cambodia Co., Ltd. and CINTRI LTD)

(7) Research on the degree of contribution the project will make as a JCM project

1) Calculation of a greenhouse gas amount to be reduced and the effectiveness of greenhouse gas reduction to be achieved by the project (professionals will participate in calculation) (Institute of Technology of Cambodia)

2) Assessment of degree of the contribution to Cambodia and Japan of greenhouse gas reduction (Phnom Penh municipality Environment department and Japan's Ministry of the Environment)

3) We will introduce Kanagawa Prefecture's comprehensive efforts and actual measures toward the realization of a low-carbon society for municipalities to develop activities they can work on.

1-4 Issues to be clarified in this research

Table 1-4-1 Issues to be clarified

Issue	Confirmation method
Relevant laws, approvals and licenses	Confirmation of related laws, approvals and licenses on waste disposal facilities
	Confirmation of related laws, approvals and licenses on cogeneration projects
Cambodia's cooperation and support systems	Confirmation of cooperation and support of Phnom Penh Capital City
	Establishment of cooperation system with waste collecting operators
Types of raw materials and procurement method	Understanding of accurate total discharge amount and composition of organic waste
	Estimation of biogas generation amounts by waste type and confirmation of their characteristics
	Confirmation of current waste collection system
	Examination of the optimum combination of raw materials and input amounts
Plant specifications and construction cost	Specifications of main plant facilities
	Construction methods and estimation of their costs
	Examination of accompanying facilities (pretreatment, drainage, gas emissions, post-treatment facility, etc.)
	Examination of local procurement methods for materials and equipment
Operation and management methods	Requirement for plant management and local staff (including engineers)
	Examination of compost treatment of fermentation residue
	Examination of monitoring, control, and maintenance methods

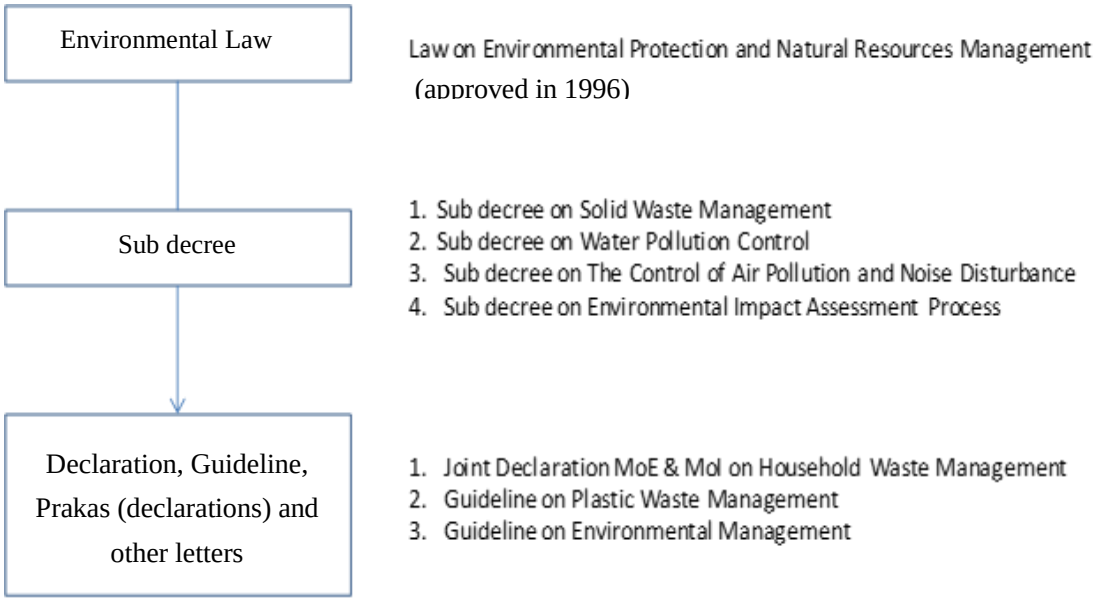
	Estimation of operation costs
Business feasibility	Examination of waste treatment costs
	Examination of utilization methods of generated energy and profit estimation
	Estimation of business balance and payments
Contribution that this project will make as a JCM project	Effectiveness of greenhouse gas (GHG) reduction
	Assessment of contribution degrees to Cambodia and Japan
Application of the same business model to other areas	Examination of business expansion within Phnom Penh
	Examination of business expansion to regional core cities (Battambang, Siemreab, Sihanoukville, etc.)

2 Relevant Laws, Approvals and Licenses

2-1 Environmental Laws and procedures for approval

2-1-1 Environmental law system

The following shows the system of environmental laws in Cambodia:



References: Ministry of Environment, Cambodia. Regional Workshop on Development of National and Strategy for Radioactive Waste Management 24-28 March 2014 IAEA, Vienna, Austria

Figure 2-1-1 Environmental law system

2-1-2 Laws on Environmental Protection and Natural Resources Management (approved in 1996)

Law on Environmental Protection and Natural Resource Management

The following are chapters related to the assessment of environmental impact and environmental protection:

(1) Chapter 1 GENERAL PROVISIONS

Article 1

The purposes of this law are:

- to protect and promote environmental quality and public health though the prevention, reduction, and control of pollution
- to assess the environmental impact of all proposed projects prior to the issuance of a decision by the Royal Government
- to ensure the rational and sustainable conservation, development, management and use of the natural resources of the Kingdom of Cambodia

•to encourage and enable the public to participate in environmental protection and natural resource management

•to suppress any act that cause to the environment

(2) Chapter 3　ENVIRONMENTAL IMPACT ASSESSMENT

Article 6

An environmental impact assessment shall be carried out on every project and activity, private or public, and shall be assessed by the Ministry of Environment before being submitted to the Royal Government for decision.

This assessment shall be made for existing and ongoing activities that have not yet been assessed for environmental impact.

The procedures of the environmental impact assessment process shall be determined by Sub-decree following a proposal of the Ministry of Environment.

The nature and size of the proposed projects and activities and existing and in-process activities, both private and public that shall be subject to that environmental impact assessment shall be determined by Sub-decree following a proposal of the Ministry of Environment.

Article 7

All investment project applications and all projects proposed by the State shall have an initial Environmental Impact Assessment or an Environmental Impact Assessment as specified in Article 6 of this law. The Ministry of Environment shall review and provide recommendations on the initial Environment Impact Assessment or the Environmental Impact Assessment to the competent organization within the period determined in the Law on Investment of the Kingdom of Cambodia.

(3) Chapter 5 ENVIRONMENTAL PROTECTION

Article 12

The Ministry of Environment shall collaborate with concerned ministries to develop an inventory that indicates:

- the sources, types, and quantities of pollutants and wastes that are imported, generated, transported, recycled, treated, stored, disposed of, or released into the airspace, water, land, or on land.
- the sources, types and quantities of toxic substances and hazardous substances that are imported, generated, transported, recycled, treated, stored, disposed of, or released into the airspace, water, land, or on land.
- the sources, types and degrees of noise and vibration disturbances.

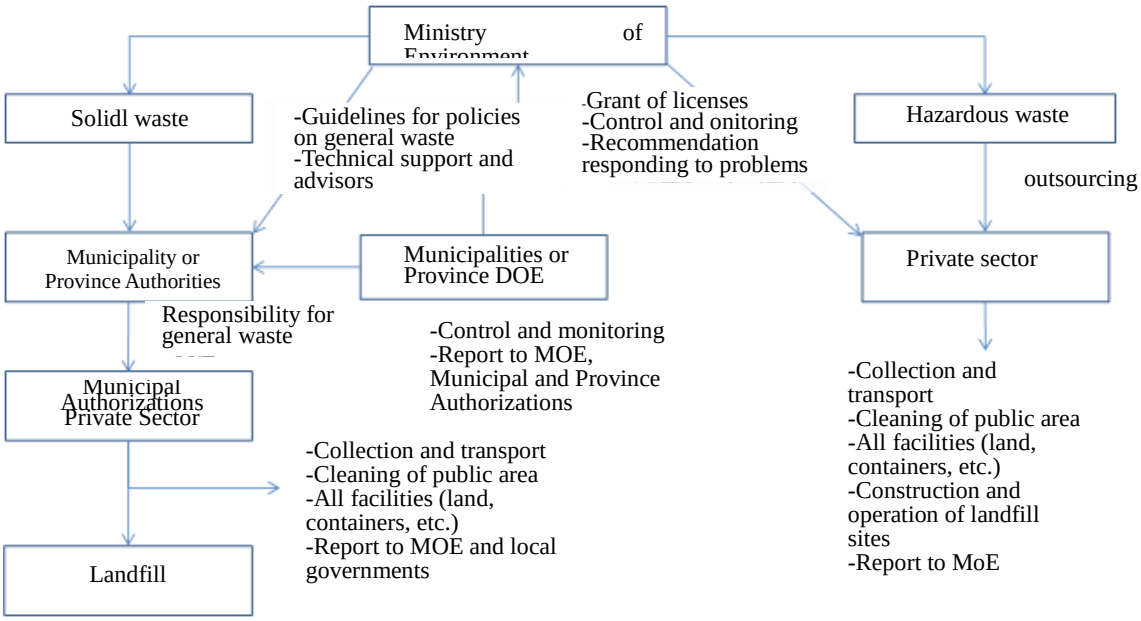
Article 13

The prevention, reduction and control of air, water and soil pollution, noise and vibration disturbances, waste, toxic substances and hazardous substances shall be determined by Sub-decree following a proposal of the Ministry of Environment.

2-1-3 Solid Waste Management

Sub decree on Solid Waste Management Royal Government of Cambodia Council of Ministers No: 36 ANRK.BK

The following figure shows organizations that are currently responsible for the policies, control and operation of Cambodia's solid waste management. The proposed project is related to the flow on the left of the control of general waste. If you wish to operate the business of collecting, transporting and disposing of general waste, you need to be selected as a responsible organization in the private sector.



References: prepared by Mizuho Information & Research Institute, Inc. on the basis of Ministry of Environment, Cambodia. Regional Workshop on Development of National and Strategy for Radioactive Waste Management 24-28 March 2014 IAEA, Vienna, Austria

Figure 2-1-2 Responsible organizations for solid waste management in Cambodia

The following are governing laws that supports the division of responsibilities shown above, in particular, chapters that are related to the purpose of the law and the proposed project:

Royal Government of Cambodia Council of Ministers No: 36 ANRK.BK
Sub decree on Solid Waste Management

(1) Chapter 1 General Provisions

Article 1: The purpose of this Sub-decree is to regulate solid waste management by technical means and in a safe manner in order to ensure the protection of human health and the conservation of bio-diversity.

Article 2: This Sub-decree shall apply to all activities related to the disposal, storage, collection, transport, recycling and landfill of garbage and hazardous waste.

Article 3: Technical terms used in this Sub-decree shall have the following meanings:

a Solid waste: solid objects, solid substances, products or waste that consist of waste objects to be disposed of and/or objects to be or required to be disposed of;

b Household waste: part of solid waste that contains no toxin and/or hazardous substances, and is discharged from households, public buildings, factories, markets, hotels, business buildings, restaurants, transport facilities, recreation sites, etc.;

c Hazardous waste: radioactive substances, explosive substances, toxic substances, inflammable substances, pathogenic substances, irritating substances, corrosive substances, oxidizing substances, or other chemical substances which may cause danger to human (health) and/or animals or damage plants, public property and/or the environment. The types of hazardous waste are listed in the Annex of this Sub-decree.

(2) Chapter 2 General Waste Management (Household Waste Management)

Article 4: The Ministry of Environment shall establish guidelines for the disposal, collection, transport, storage, recycling, minimization, and landfill of household waste in provinces and municipalities in order to ensure the safe management of general waste. The authorities of provinces and municipalities shall develop waste management plans for short-, medium- and long-terms.

Article 5: The authorities of provinces and municipalities shall assume responsibility for the collection, transport, storage, recycling, minimization and landfill of waste in such provinces and municipalities. The implementation of the operations described in the previous paragraph of Article 5 shall be subject to the Guideline on the Sound Management of Waste Specified by the Prakas (declaration) of the Ministry of Environment.

Article 6:The Ministry of Environment shall monitor the implementation by provinces and municipalities of collection, transport, storage, recycling, minimization and landfill-related disposal of general waste.

Article 7:The disposal of waste in all public sites and sites in which such disposal of waste is not permitted by concerned authorities shall be strictly prohibited.

Article 8:The execution of domestic investments in construction of landfill sites, incinerators, storage sites or recycling plants for general waste shall be subject to prior approval of the Ministry of Environment.

Article 9: No general waste shall be exported from the Kingdom of Cambodia without the approval

of the Ministry of Environment, an export license issued by the Ministry of Trade and the authorization of the destination country.

Article 10: The import of general waste to the Kingdom of Cambodia shall be strictly prohibited.

2-1-4 Water Quality Control

Sub decree on Water Pollution Control

(1) Chapter 1

Article 1

The purpose of this Sub-decree is to regulate the water pollution control in order to prevent and reduce the water pollution of the public water areas so that the protection of human health and the conservation of bio-diversity should be ensured.

Article 2

This Sub-decree applies to all sources of pollution and all activities that cause pollution of the public water areas.

Article 3

Technical terms used in this Sub-decree shall have the following meanings:

a. "public water areas" refer to water areas that are for public use such as Tonle Sap Lake, Stung River, streams, gullies (small channels), lakes, ponds, wells, sea, river mouths and include canal irrigation system and other waterways that are for public use and ground water;
b. "source of pollution" refers to any type of places such as dwelling houses, public administrative buildings, buildings, transport facilities, business areas or service places from which effluent, pollutants or hazardous substances are directly or indirectly discharged into public water areas or public drainage systems;
c. "waste water" refers to water discharged from any source of pollution into public water areas or public drainage systems either it is treated or untreated;
d. "sewage" refers to contaminated water discharged from dwellings and public buildings;
e. "solid waste" refers to prohibited substances or objects that are disposed of from pollution source;
f. "garbage" refers to prohibited substances or objects that are disposed of from dwellings and public buildings;
g. "pollutant" refers to solid, liquid or gaseous substances or all kind of wastes that cause physical, chemical, biological or other changes to the components or characteristic of water when it is intentionally or unintentionally released into the water (public water areas);
h. "pollution load" refers to the load or the content of pollutant and heat containing in wastewater released from any sources of pollution into public water areas or public drainage systems;
i. "hazardous substances" refer to any substances that cause danger to living organisms, damage or break down any objects or building or adverse impact and damage the environment. The types of hazardous substances are listed in the Annex 1 of this Sub -decree.

(2) Chapter 2　Provisions on discharge of waste and hazardous substances

Article 4

Standards for effluent discharge from any sources of pollution shall be specified in the annex 2 of this Sub-decree.

Article 5

Where necessary or in response to the requirements of each area for the purpose of human health protection and the conservation of bio-diversity, the Ministry of Environment shall set up separated standards for effluent discharge for sources of pollution, which are located around the public water area.

The separated standard for effluent discharge as mentioned in the first paragraph of the article 5 of this sub-decree shall be specified in the Prakas of the Ministry of Environment.

Article 6

The discharge of waste water from any sources of pollution that is not consistent with the standards for effluent discharge as mentioned in the article 4 and article 5 of this sub-decree shall be strictly prohibited.

Article 7

In order to ensure the human health protection and bio-diversity conservation, the Ministry of Environment shall establish the standard of pollution load contained in liquid waste that could be allowed to be released from any sources of pollution into designated protected public water areas.

The pollution load standard as mentioned in the paragraph 1 of the article 7 of this sub-decree shall be specified in the Prakas of the Ministry of Environment.

Article 8

The disposal of solid waste or any garbage or hazardous substances into public water areas or into public drainage systems shall be strictly prohibited.

The storage or disposal of solid waste or any garbage and hazardous substances that lead to the pollution of water of the public water areas shall be strictly prohibited.

Article 9

The discharge of sewage from dwellings and public buildings into public water areas without passing through public sewerage systems or other treatment systems shall be strictly prohibited.

(3) Chapter 3

Effluent discharge permit

Article 10

The discharge or transport of wastewater from any sources of pollution to other places for any purpose is subject to a prior permit of the Ministry of Environment. The application for this permit shall be copied to the concerned ministries or agencies.

Article 11

The types of any sources of pollution that shall be required to have a permit from the Ministry of Environment before discharging or transporting their effluent to other places as mentioned in the article 10 of this sub-decree shall be listed in the annex 3 of this sub-decree and are classified into two following categories:

The sources of pollution of category I: the amount of their effluent exceed ten cubic meter per day (10 M3 /day) but not including the amount of water volume used for cooling the engine

The sources of pollution of category II: an application for the permission of the Ministry of Environment is required

Article 12

Permit requirement for discharge or transportation of effluent to other places as stipulated in the article 10 of this sub-decree shall apply to both new or existing sources of pollution except any pollution source originated from new projects of which environmental impact assessment report have been approved may be exempted from the requirement of a permit for discharge or transportation of effluent to other places.

Article 13

The owner or responsible person of pollution sources as mentioned in the article 11 of this sub-decree who intend to release or transport his/her effluent to other places shall apply for a permit of the Ministry of Environment:

- Forty (40) days before the beginning of operation, for new sources of pollution located in Phnom Penh, and sixty (60) days for new sources of pollution located in provinces and cities.

- Within thirty (30) days after being required by the Ministry of Environment, for existing sources of pollution located in Phnom Penh, and within forty (40) days for new sources of pollution located in provinces and cities.

Article 14

Permits to discharge or transport effluent from pollution sources to other places are granted when the application forms meet the technical requirement guidelines determined by the Ministry of Environment.

Article 15

When an owner or person responsible for the source of pollution effluent from which is permitted to be discharged or transported to other places by the Ministry of Environment intends to modify the effluent discharge system, he/she shall reapply for a new permit to the Ministry of Environment within thirty (30) days before beginning the modification.

Article 16

Any person who takes a lease on or takes over the ownership of the source of pollution from the previous owner or the previous responsible person who already obtained a discharge or transportation permit from the Ministry of Environment shall continue to comply with criteria points described in the application form that was submitted to the Ministry of Environment.

The new owner or responsible person shall inform the Ministry of Environment about the lease or such possession within thirty (30) days after taking a lease or ownership.

Article 17

The permit for the discharge or transportation of effluent that is provided to the owner or responsible person of the pollution source may be revoked temporarily or definitively by the Ministry of Environment after consultation with other concerned ministries or agencies, if they violate seriously the articles 14, 15 and 16 of this sub-decree.

(4) Chapter 4

Monitoring of the pollution sources

Article 18

The monitoring of the discharge or transportation of effluent from any sources of pollution is the responsibility of the Ministry of Environment.

Article 19

The Ministry of Environment shall take samples at every discharge point of pollution sources. The owner or responsible person of pollution sources shall collaborate with and facilitate the environmental official to take samples while carrying out their technical task.

Article 20

The analysis of effluent samples taken from any pollution sources shall be done in the Laboratory of the Ministry of Environment during the monitoring or inspection periods.

Article 21

The owner or responsible person of pollution sources shall bear the cost of the analysis of his/her own wastewater sample following the tariff determined by the Ministry of Environment and the

Ministry of Economy and Finance. This income shall be included into the national budget in order to allocate to the Environmental Endowment Fund Account.

Article 22

The owner or responsible person of pollution sources may have other public or private laboratories test his/her effluent sample, provided that it is officially recognized that such laboratories carry out the same analytical method as those used by the Ministry of Environment.

Article 23

The owner or responsible person of the pollution sources as stipulated in the article 11 of this sub-decree shall:

A. be responsible for determining the method of the treatment and the discharge of their effluent so that it responds to the effluent standard as stipulated in the article 4 and 5 of this sub-decree as well as the standard of pollution load as stipulated in the article 7 of this sub-decree;

B. have enough facilities and means to prevent the pollution of the public water area when there is potential danger caused by his/her pollution source;

C. Hold the responsibility for installing equipment for the measurement of the flow, concentration and amount of pollutant contained in his/her effluent and keeping the record of the results.

Article 24

When discharge of effluent from any pollution source does not respond to the effluent standard as stipulated in the article 4 and 5 or is not in consistent with the pollution load standard as stipulated in the article 7 of this sub-decree, the Ministry of Environment shall:

issue a written order requiring the owner or responsible person of such pollution source to correct the violation activities immediately within a specified time period, if that activity has not caused a harmful impact to human health or an adverse effect to the water quality yet;

issue a written order requiring the owner or responsible person of such pollution source to stop his/her activities temporarily until the violation is corrected, if that activities cause an adverse impact to human health and water quality.

Annex 1

Type of Hazardous Substances

1. Organophalogen compounds and substances which may form such compounds in the aquatic environment
2. Organophosphorous compounds
3. Organotin compounds
4. Substances that possess carcinogenic (cancer causing) properties in or via the aquatic environment
5. Mercury and its compounds

6. Cadmium and its compounds
7. Persistent mineral oil and hydrocarbons of petroleum origin
8. Persistent synthetic compounds which may float remain in suspension or sink and which may interfere with any use of waters
9. Radio activated substances
10. Metals and their compounds

Table 2-1-1 Metals and their compounds

Zinc (Zn)	Selenium (Se)	Tin (Sn)	Vanadium (V)
Copper (Cu)	Arsenic (As)	Barium (Ba)	Cobalt (Co)
Nickel (Ni)	Antimony (Sb)	Beryllium (Be)	Tellurium (Te)
Lead (Pb)	Titanium (Ti)	Uranium (U)	Silver (Ag)

11. Toxic or persistent organic compounds of silicon
12. Inorganic compounds of phosphorous and elemental phosphorous
13. Non-persistent mineral oils and hydrocarbons of petroleum origin
14. Cyanides and fluorides
15. Substances which may have an adverse effect on the oxygen balance, particularly ammonia, and nitrites, etc.

Annex 2

Table 2-1-2 Effluent standards for pollution sources discharging wastewater to public water areas or sewer

No.	Parameters	Unit	Allowable limits for pollutant substance discharging to	
			Protected public water area	Public water area and sewer
1	Temperature	0C	< 45	< 45
2	pH		6 - 9	5 - 9
3	BOD5 (5 days at 200 C)	mg/l	< 30	< 80
4	COD	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 50	< 80
6	Total Dissolved Solids	mg/l	< 1000	< 2000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15
9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO3)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulphate (as SO4)	mg/l	< 300	< 500
14	Sulphide (as Sulphur)	mg/l	< 0.2	< 1.0

15	Phosphate (PO4)	mg/l	< 3.0	< 6.0
16	Cyanide (CN)	mg/l	< 0.2	< 1.5
17	Barium (Ba)	mg/l	< 4.0	< 7.0
18	Arsenic (As)	mg/l	< 0.10	< 1.0
19	Tin (Sn)	mg/l	< 2.0	< 8.0
20	Iron (Fe)	mg/l	< 1.0	< 20
21	Boron (B)	mg/l	< 1.0	< 5.0
22	Manganese (Mn)	mg/l	< 1.0	< 5.0
23	Cadmium (Cd)	mg/l	< 0.1	< 0.5
24	Chromium (Cr)+3	mg/l	< 0.2	< 1.0
25	Chromium (Cr)+6	mg/l	< 0.05	< 0.5
26	Copper (Cu)	mg/l	< 0.2	< 1.0
27	Lead (Pb)	mg/l	< 0.1	< 1.0
28	Mercury (Hg)	mg/l	< 0.002	< 0.05
29	Nickel (Ni)	mg/l	< 0.2	< 1.0
30	Selenium (Se)	mg/l	< 0.05	< 0.5
31	Silver (Ag)	mg/l	< 0.1	< 0.5
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	>2.0	>1.0
36	Polychlorinated Byphemyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<150	<200
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachloride	mg/l	<3	<3
40	Hexachloro benzene	mg/l	<2	<2
41	DTT	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01
44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.5	<2.5
47	Hexachloro butadiene	mg/l	<3	<3
48	Chloroform	mg/l	<1	<1
49	1,2 Dichloro ethylene	mg/l	<2.5	<2.5
50	Trichloro ethylene	mg/l	<1	<1
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyclohexene	mg/l	<2	<2

Remark: The Ministry of Environment and the Ministry of Agriculture, Forestry and Fishery shall collaborate to set up the standard of pesticides which discharged from pollution sources.

Annex 3 Table 2-1-3 Type of pollution sources requiring permission from Ministry of Environment before their waste water is discharged or transported

No	Type of pollution sources	Category
1	Canned food and meat manufacturing	I
2	Canned vegetable and fruit manufacturing	I
3	Aquatic production processing	I
4	Frozen manufacturing	I
5	Flour manufacturing	I
6	Sugar manufacturing	I
7	Pure drinking water manufacturing	I
8	Brick manufacturing	I
9	Soft drink manufacturing and brewery	I
10	Wine and alcohol manufacturing	I
11	Feed mill manufacturing	I
12	Oil and fat manufacturing	I
13	Yeast manufacturing	I
14	Cake and sweet manufacturing	I
15	Cigarette manufacturing	I
16	Garment manufacturing without chemical washing	I
17	Hotel	I
18	Restaurant	I
19	Animal farm	I
20	Slaughter house	I
21	Garage and car cleaning	I
22	Business center	I
23	Hospital and clinic	I
24	Plastic manufacturing	I
25	Sewage treatment plant	I
26	Gelatin and Glue manufacturing	I
27	Natural resin manufacturing	I
28	Glass manufacturing	I
29	Cement manufacturing	I
30	Macadam quarrying	I
31	Gravel quarrying	I
32	Wood processing	I
33	Fertilizer manufacturing	I
34	Mixed concrete manufacturing	I
35	Ship carrying liquid substances	II
36	Acetylene derivative manufacturing	II
37	Leather manufacturing	II

38	Soap and detergent manufacturing	II
39	Oil store house and filling station	II
40	Landfill site	II
41	Textile or synthetic textile	II
42	Garment manufacturing with using chemical wash	II
43	Pulp and paper manufacturing	II
44	Printing house	II
45	Mining and coal washing	II
46	Battery manufacturing	II
47	Inorganic pigment manufacturing	II
48	Electronic manufacturing	II
49	Coal tar product manufacturing	II
50	Film product manufacturing	II
51	Chemical organic substance manufacturing	II
52	Pharmaceutical manufacturing	II
53	Solvent (for cleaning) manufacturing	II
54	Pesticide manufacturing	II
55	Oil refining factory	II
56	Iron and steel Industry	II
57	Non-ferrous metals manufacturing	II
58	Metal product manufacturing	II
59	Plating factory	II
60	Incinerator or waste recycling plant	II
61	Night soil treatment plant	II
62	Waste oil treatment plant	II
63	Industrial waste treatment plant	II
64	Laboratory and Research center	II
65	Power plant	II
66	Wood processing manufacturing	II
67	Shrimp farm	II

Annex IV

Water Quality Standard in Public Water Areas for Bio-Diversity Conservation

1- Rivers

Table 2-1-4 Rivers

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 - 8.5
2	BOD5	mg/l	1 - 10
3	Suspended Solid	mg/l	25 - 100
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coli form	MPN/100ml	< 5000

2- Lakes and Reservoirs

Table 2-1-5 Lakes and reservoirs

No	Parameter	Unit	Standard Value
1	pH	mg/l	6.5 - 8.5
2	COD	mg/l	1 - 8
3	Suspended Solid	mg/l	1 - 15
4	Dissolved Oxygen	mg/l	2.0 - 7.5
5	Coli form	MPN/100ml	< 1000
6	Total Nitrogen	mg/l	1.0 - 0.6
7	Total Phosphorus	mg/l	0.005 - 0.05

3- Coastal water

Table 2-1-6 Coastal water

No	Parameter	Unit	Standard Value
1	pH	mg/l	7.0 - 8.3
2	COD	mg/l	2 - 8
4	Dissolved Oxygen	mg/l	2 - 7.5
5	Coli form	MPN/100ml	< 1000
5	Oil content	mg/l	0
6	Total Nitrogen	mg/l	1- 1.0
7	Total Phosphorus	mg/l	0.02 - 0.09

Annex V

Table 2-1-7 Water Quality Standard in public water areas for public health protection

No	Parameter	Unit	Standard Value
1	Carbon tetrachloride	µg/l	< 12
2	Hexachloro-benzene	µg/l	< 0.03
3	DDT	µg/l	< 10
4	Endrin	µg/l	< 0.01
5	Diedrin	µg/l	< 0.01
6	Aldrin	µg/l	< 0.005
7	Isodrin	µg/l	< 0.005
8	Perchloroethylene	µg/l	< 10
9	Hexachlorobutadiene	µg/l	< 0.1
10	Chloroform	µg/l	< 12
11	1,2 Trichloroethylene	µg/l	< 10
12	Trichloroethylene	µg/l	< 10
13	Trichlorobenzene	µg/l	< 0.4
14	Hexachloroethylene	µg/l	< 0.05
15	Benzene	µg/l	< 10
16	Tetrachloroethylene	µg/l	< 10
17	Cadmium	µg/l	< 1
18	Total mercury	µg/l	< 0.5
19	Organic mercury	µg/l	0
20	Lead	µg/l	< 10
21	Chromium valent 6	µg/l	< 50
22	Arsenic	µg/l	< 10
23	Selenium	µg/l	< 10
24	Polychlorobiohenyl	µg/l	0
25	Cyanide	µg/l	< 0.005

2-1-5 Control of Air Pollution and Noise Disturbance

Sub decree on The Control of Air Pollution and Noise Disturbance

(1) Chapter 1

General Provisions

Article 1

The purpose of this sub-decree is to protect the environmental quality and public health from air pollution and noise pollution through monitoring, curbing and mitigation activities.

Article 2

This sub-decree applies to all movable sources and immovable sources of air and noise pollutions.

Article 3

Technical terms used in this sub-decree shall have the following meanings ascribed thereto:

a) "Source of pollution" is divided into two terms:

- "movable sources" refer to emission sources without any permanent installment location, such as aircrafts, ships, vehicles, machines and all kinds of speakers
- "immovable sources" refer to emission sources with a permanent location, such as factories, enterprises, warehouses, construction sites, incinerators, speakers, handcrafts, and all kinds of farming plants

b) "pollutant" refers to smoke, dust, ash particle substances, gas, vapor, fog, odor, or radio-active substances

c) " flammable substances" refer to combustible fuel oil, coal and natural gas

d) "standard" refers to the maximum pollutant level that is permissible for the environment or can be released into the environment.

(2) Chapter 2 Provisions on emission of air and noise pollutions

Article 4

The standard for air pollutant shall be specified in Annex 1 of this sub-degree. The maximum amount of hazardous substances allowed to be discharged into the air shall be specified in Annex 2 of this sub-decree.

Article 5

The maximum amount of pollutants allowed to be discharged into the air from immovable sources shall be specified in Annex 3 of this sub-decree.

The standards for smoke emitted from movable sources shall be specified in Annex 4 of this sub-decree.

Article 6

The standards specified in Article 4 and 5 of this sub-decree shall be, as needed, approved and revised every 5 years, based on proposals of the Ministry of Environment.

Article 7

The standards for noise emission from various sources including vehicles and manufacturing plants and the maximum noise levels for public and residential areas shall be specified in Annex 5, 6, and 7.

Article 8

The emission of pollutants that exceeds the standards specified in Annex 3 and 4 of this sub-decree into the air shall be strictly prohibited.

Article 9

Noise emission that exceeds the standards specified in Annex 5 and 6 of this sub-decree shall be strictly prohibited.

Article 10

The import and production of flammable substances that contains sulfur, lead, benzene and carbon hydride shall be subject to provisions specified in Annex 8 of this sub-decree.

Article 11

The import, use and production in Cambodia of vehicles and all kinds of machinery that emit pollutants and/or noise exceeding the standards specified in Annex 4 and 5 of this sub-decree shall be strictly prohibited.

Article 12

The discharge or leakage of various flammable substances, fuel oils, radio-active or chemical substances into the atmosphere, water and land shall be strictly prohibited.

(3) Chapter 3 Application for Authorization

Article 13

The emission of pollutants and noise from immovable sources into the atmosphere shall be authorized by the Ministry of Environment and a copy of such application shall be sent to the relevant ministries and institutions.

Article 14

The application for importation of flammable substances shall be accompanied by analytic results indicating the quantities of pollutants, such as sulfur, lead, benzene, or hydrocarbon from the original source of importation or production.

Article 15

The application for authorization to discharge pollutant substances and noise as stipulated in Article 13 of this sub-decree shall be applicable to both new pollutant sources and existing and on-going activities, provided that there is an evaluation report of environmental impacts.

Article 16

The owner or person who is responsible for pollution sources as stipulated in Article 13 of this sub-decree shall apply for the authorization of the Ministry of Environment:

- - 40 days before the commencement of a project in Phnom Penh;

- - 60 days before the commencement of a project in a province or municipality.

Annex 1

Table 2-1-8 Ambient air environment standards

No.	Parameter	1 Hour Average mg/m3	8 Hours Average mg/m3	24 Hours Average mg/m3	1 Year Average mg/m3
1	Carbon Monoxide (CO)	40	20		
2	Nitrogen dioxide (NO2)	0.3		0.1	
3	Sulfur dioxide (SO2)	0.5		0.3	0.1
4	OZone (O3)	0.2			
5	Lead (Pb)			0.005	
6	Total Suspended Particulate(TSP)			0.33	0.1

Note:

- This standard is applicable to the monitoring of the atmosphere and air pollution status.
- Methods to analyze the ambient air is specified in the guideline of the Ministry of Environment.
- TSP = Total Suspended Particles

Annex 2

Maximum Allowable Concentration of Hazardous Substance in Ambient Air

Table 2-1-9 Maximum allowable concentration of hazardous substance in ambient air

No.	Name Chemical Substance	Formula	Maximum Level (mg/m3)
1	Aniline	C6H5NH2	0.03
2	Ammonia	NH3	0.2
3	Acetic Acid	CH3COOH	0.2
4	Sulfuric Acid	H2SO4	0.3
5	Nitric Acid	HNO3	0.4
6	Ben Zene	C6H6	1
7	Ben Zidine	NH2C6H4C6H4NH2	
8	Carbondisulfide	CS2	0.02
9	Chloroform	CHCl3	0.01
10	Carbontetrachloride	CCl4	3
11	Particle containing Asbestos	-	

12	DDT	C8H11Cl4	0.5
13	Formaldehyde	HCOH	0.012
14	Hydrogen Arsenic	AsH3	0.002
15	Hydrogen Cyanide	HCN	0.01
16	Hydrogen Fluoride	HF	0.002
17	Hydrogen Sulfide	H2S	0.001
18	Phenol	C6H5OH	0.01
19	Styrene	C6H5CHCH2	0.003
20	Tetra Chloroethylene	C2Cl4	0.1
21	Tetraethyle Lead	Pb(C2H5) 4	0.005
22	Tri Chloroethylene	ClCHCCl2	0.2
23	Toluene	C6H5CH3	0.4
24	Vinyl Chloride	ClCHCH2	0.05
25	Arsenic (Compound organic)	AS	0.00001
26	Cadmium (Compound & Oxide)	Cd	0.003
27	Chromium(Compound & Metal)	Cr	0.0015
28	Nickel (Compound &Metal)	Ni	0.0002
29	Mercury (Compound& Metal)	Hg	0.0001
30	Petrol		5

Note:

This standard is applicable to hazardous substances that are allowed in the ambient air.

Annex 3

Maximum Allowable Levels of Pollution

Substances in Ambient Air for Immovable Sources

Table 2-1-10 Maximum allowable levels of pollution substances in ambient air for immovable sources

No.	Parameter	Maximum Level of Discharge
1	Particulate in smoke of:	
	Incinerator	400 mg/m3
	Heating Metal	400 mg/m3
	Bad Stone lime cement manufacturing	400 mg/m3
	Asphalt concrete plant	500 mg/m3

2	Dust	
	Containing silica (SiO2)	100 mg/m3
	Containing Asbetos	27mg/m3
	Chemical in organic substance	
3	Aluminum Al	(dust) 300mg/ m3; (Al) 50mg/m3
4	Ammonia NH3	100 mg/m3
5	Antimony Sb	25 mg/m3
6	Arsenic As	20 mg/m3
7	Berylium Be	10 mg/m3
8	Chloride Cl	20 mg/m3
9	Hydrogen chloride HCl	200 mg/m3
10	Hydrogen Fluoride HF	10 mg/m3
11	Hydrogen Sulfide H2S	2 mg/m3
12	Cadmium Cd	1 mg/m3
13	Copper Cu (dust)	300 mg/3 (Cu) 20 mg/m3
14	Lead Pb (dust)	100 mg/m3 (Pb) 30 mg/m3
15	Zinc Zn	30 mg/m3
16	Mercury Hg	0.1 mg/m3
17	Carbon Monoxide CO	1000 mg/m3
18	Sulfur dioxide SO2	500 mg/m3
19	Nitrogen Oxide (all kinds) NOx	1000 mg/m3
20	Nitrogen oxide NOx (emitted HNO3 product)	2000 mg/m3
21	Sulfuric Acid H2SO4	35 mg/m3
22	Nitric Acid HNO3	70 mg/m3
23	Sulfur Trioxide SO3	35 mg/m3
24	Phosphoric Acid H3PO4	3 mg/m3
	Chemical organic substance	
25	Acetylene tetra bromide CHBr2	14 mg/m3
26	Acrolein CH2=CHCHO	1.2 mg/m3
27	Aniline C6H5NH2	19 mg/m3
28	Benzidine NH2C6H4C6H4NH2	None
29	Benzene C6H6	80 mg/m3
30	Chloro benzyl C6H5CH2Cl	5 mg/m3
31	Butyl Amine CH3(CH2)2CH2NH2	15 mg/m3
32	Cresol (o- m- p-) CH3C6H6H4OH	22 mg/m3
33	Chloro benzene C6H5C l	350 mg/m3

34	Chloroform CHCl3	240 mg/m3
35	Chloropicrin CCl3NO2	0.7 mg/m3
36	O-dichlorinbenzene C6H4Cl2	300 mg/m3
37	1.1-dichloro ethane CHCl2CH3	400 mg/m3
38	Di methyl sulfate (CH3)2SO4	0.5 mg/m3
39	Di methyl hydrazine (CH3)2NNH2	1 mg/m3
40	Di nitro benzene (o- m- p-)C6H4(NO2)2	1 mg/m3
41	Ethylene di amine NH2CH2-CH2NH2	30 mg/m3
42	Ethylene Chlorohydrine CH2ClCH2OH	16 mg/m3
43	Ethylene oxide CH2OCH2	20 mg/m3
44	Formaldehyde HCHO	6 mg/m3
45	Methyl Acrylate CH2=CHCOOCH3	35 mg/m3
46	Methanol CH3OH	260 mg/m3
47	Methyl bromide CH3Br	80 mg/m3
48	Monomethyl Aniline C6H5NHCH3	9 mg/m3
49	Nitro Benzene C6H5NO2	5 mg/m3
50	Nitroglycerine C3H5(NO2)3	5 mg/m3
51	Nitrotoluene NO2C6H4CH3	30 mg/m3
52	Phenol C6H5OH	19 mg/m3
53	Phenylhydrazine C6H5NHNH2	22 mg/m3
54	Pyridine C5H5N	30 mg/m3
55	Pyrene C16H10	15 mg/m3
56	Quinone C6H4O2	0.4 mg/m3
57	Styrene C6H5CHCH2	420 mg/m3
58	1.1;2.2-tetrachloroethane CL2HCCHCl2	35 mg/m3
59	Tetrachloromethane CCl4	65 mg/m3
60	Toluene C6H5CH3	750 mg/m3
61	Tetranitromethane C(NO2)4	8 mg/m3
62	Toluidine CH3C6H4NH2	22 mg/m3
63	Toluene-2.4-D-isocyanate CH3C6H3(NCO)2	0.7 mg/m3
64	Trichloro ethylene ClCH=CCl2	110 mg/m3

65	Xylidine (CH3)2 C6H3NH2	50 mg/m3
66	Vinylchloride CH2=CHCl	150 mg/m3

Annex 4

Table 2-1-11 Gas emission standard of mobile sources

No.	Kind of vehicle	Kind of fuel	Level of Emission				
			CO(%)		HC(ppm)		Dark Fume (%)
			A	B	A	B	
1	Motorcycle contain 2 stroke combustion	Petrol	4.5	4	10	3000	
2	Motorcycle contain 4 stroke combustion	Petrol	4.5	4	10	2400	
3	All kinds of vehicles	Petrol	4.5	4	1200	800	
4	All kinds of vehicles	Diesel					50

Note:

This Standard is applicable to gas emission from mobile sources into the atmosphere.

A）Refer to all kinds of vehicles used over 5 years counting from their production years.

B）Refer to all kinds of vehicles that are newly imported in the first 5 years counting from their production years.

Annex 5

Table 2-1-12 Maximum noise emission levels allowable for vehicles on public roads

No.	Category of Vehicles	Maximum Noise Level permitted (dB (A))
1	Motorcycles cylinder capacity (cc) of engine <125cm3	85
2	Motorcycles cylinder capacity (cc) of engine >125cm3	90
3	Motorize Tricycles	90
4	Cars taxi bus with capacity of < 12 passengers	80
5	Bus with capacity of > 12 passengers;	85
6	Truck with loading capacity of <3.5 tons	85
7	Truck with loading capacity of > 3.5tons	88
8	Truck with engine capacity of > 150 kw	89
9	Other machinery (tractors/trucks) that are not listed above	91

Note: This standard is applicable to the control of noise emission of all types of vehicles on public

roads.

Annex 6

Table 2-1-13 Maximum noise levels allowable
in public and residential areas (dB(A))

No.	Areas	Period of Times		
		From 6AM through 18PM	From 18PM through 22PM	Form 22PM through 6AM
1	Quiet Areas - Hospitals - Libraries - School - Kindergarten	45	40	35
2	Residential Areas - Hotels - Administrative office - Villa, flat	60	50	45
3	Commercial and Service Areas and Area of multiple business	70	65	50
4	Small industrial factories mingling in residential area	75	70	50

Note: This standard is applicable to the control of noise level of any source or activity that emits noise into the public and residential areas.

Annex 7

Table 2-1-14 Noise Control Standard for workshop, factory and industry

Noise Level (dB (A))	Maximum Period of Time	Level
75	32	Ear protection equipment shall be provided to worker who works at a location with noise level over 80dB(A)
80	16	
85	8	
90	4	
95	2	
100	1	
105	0.5	
110	0.25	
115	0.125	

Note: This standard is used to control noise levels in workshops and factories.

Annex 8

Table 2-1-15 Standard for sulfur, lead, benzene, and hydrocarbon permitted in fuel and coal

No.	Combustible Substances	Sulfur (S)	Lead (Pb)	Benzene	Hydrocarbon
1	Dark Fuel	1.0%			
2	Diesel	0.2%			
3	Petrol	-	0.15 g/l	3.5%	50%
4	Coal	1.5%			

Note: This standard is applicable to the control of sulfur, lead, benzene and hydrocarbon permitted in fuel and coal.

2-1-6 Environmental Impact Assessment (EIA) Process on All Projects and Activities, Both Private and Public

Sub-decree on Environmental Impact Assessment Process

(1) Chapter 1

General Provisions

Article 1

An environmental impact assessment (EIA) shall be done on every project and activity, private or public, and shall be reviewed by the Ministry of Environment before being submitted to the Royal Government for decision.

The type and size of proposed and ongoing projects, both private and public, shall be determined before undergoing environmental impact assessment.

Public participation in the environmental impact assessment (EIA) process shall be promoted to consider conceptual inputs and proposals for re-examination prior to the implementation of projects.

Article 2

This Sub-decree applies to all projects that are proposed by the public, joint-ventures, provincial governments, or any governmental agencies listed in Annex of this sub-decree and ongoing projects and activities, except special cases that are approved by the Royal Government.

(2) Chapter 2

Institutional Responsibilities

Article 3

The Ministry of Environment (MoE) shall be responsible for the following duties:

evaluate and review the environmental impact assessment reports in collaboration with other Governmental Institutions

implement follow-up, monitoring and appropriate measures to ensure that project owners will, during the development period of the project, follow an Environmental Management Plan (EMP) in compliance with an approved EIA.

Article 4

Governmental Institutions and agencies in their capacity as an approval institution for proposed projects shall have the right to examine and approve any projects listed in Annex of this sub-decree, after the Ministry of Environment have assessed their EIA reports and made recommendation on them.

Particle 5

Local Governmental Institutions in their capacity as an approval institution for proposed projects shall:

obtain EIA reports to be submitted to Provincial Environmental Departments from project owners of private, joint-venture and public sectors.

Examine and approve proposed projects after discussing with provincial or urban authorizations and making recommendation in accordance with MoE's Prakas (declaration).

(3) Chapter 3

Proposed projects shall be required to undergo an EIA.

Article 6

Project owners shall conduct Initial Environmental Impact Assessment (IEIA) in order to comply with the EIA requirement as stated in Annex of this sub-decree.

Article 7

Project owners shall submit the IEIA report of the relevant project and a Pre-Feasible Study Report in order to have their project examined.

Article 8

Project owners shall apply to MoE for the full report of an EIA report and pre-feasibility study report, when the relevant project may cause a serious impact to the natural resources, ecosystem, health and public welfare.

Article 9

Project owners shall, as described in Article 7 and 8, apply to the Provincial/Urban Environmental Office (PEO) for the reviewing of their EIA reports and pre-feasibility study reports when their project will be carried out at the provincial level.

Article 10

Guidelines for preparing an IEIA and EIA report shall be defined in the Prakas of the MoE.

Article 11

All service fees for the reviewing and monitoring of projects shall be borne by project owners. These service fees shall be approved by the Ministry of Economy and Finance following a proposal of the MoE. The said fees shall be incorporated into the national budget.

Article 12

Project owners shall make a donation to the Environmental Endowment Fund as described in

Article 19 of Chapter 8 of the law on Environmental Protection and Natural Resources Management.

Article 13

An Environmental Application Form (EAF) shall be prepared and submitted to the MoE by project owners when the projects are dealt at the ministry level. When the projects are dealt at provincial/urban levels, the EAF shall be submitted to PEO.

(4) Chapter 4

Procedures of EIA Process for Reviewing Proposed Projects

Article 14

Project owners shall prepare a report, as described in Article 7, and submit it to the MoE and its copy to a project approval ministry/institution.

Article 15

The MoE reviews EIA reports specified in Article 14 and provides project owners and relevant project approval ministries/institutions with findings and recommendations within 30 work-days, commencing from the date of registration of their IEIA reports and pre-feasibility study reports.

Article 16

Project owners or responsible person shall, as required, submit a full EIA report for the relevant project along with an application for project investment to the MoE, as specified in Chapter 8.

Article 17

The MoE reviews the report specified in Article 16 and provides project owners and relevant project approval ministries/institutions with findings and recommendations within 30 work-days, commencing from the date of receipt of EIA reports and pre-feasibility study reports.

Article 18

If the MoE fails to provide findings and recommendations as described in Article 15 and 17, project approval ministries/Institutions may assume that the revised IEIA or EIA report complies with the criteria of this sub-decree.

Article 19

In its capacity as a project approval ministry/institution and project owner, project owners shall implement all procedures described in Chapter 3 and 4 of this sub-decree.

Article 20

Those who implement projects shall, before proceeding with their projects, acknowledge the findings and recommendations on their IEIA or/and EIA reports that were approved by the MoE.

Table 2-1-16 Requirements for implementation of EIA

No.	Type and activities of the projects	Size / Capacity
A	Industrial	
I	Foods, Drinks, Tobacco	
1.	Food processing and caned	≥ 500 Tones/year
2.	All fruit drinks manufacturing	≥ 1,500 Litres / day
3.	Fruit manufacturing	≥ 500 ones/year
4.	Orange Juice manufacturing	All sizes
5.	Wine manufacturing	All sizes
6.	Alcohol and Beer brewery	All sizes
7.	Water supply	≥ 10,000 Users
8.	Tobacco manufacturing	≥ 10,000 Boxes/day
9.	Tobacco leave processing	≥ 350 Tones/ year
10.	Sugar refinery	≥ 3,000 Tones / year
11.	Rice mill and cereal grains	≥ 3,000 Tones / year
12.	Fish, soy bean, chili, tomato sources	≥ 500,000 Litres/ year
II.	Leather tanning, Garment and Textile	
1.	Textile and dyeing factory	All sizes
2.	Garments, washing, printing, dyeing	All sizes
3.	Leather tanning, and glue	All sizes
4.	Sponge- rubber factory	All sizes
III.	Wooden production	
1.	Plywood	≥ 100,000m3/year(log)
2.	Artificial wood	≥ 1,000 m3/year (log)
3.	Saw mill	≥ 50,000m3/year (log)
IV.	Paper	
1.	Paper factory	All sizes
2.	Pulp and paper processing	All sizes
V.	Plastic, Rubber and Chemical	
1.	Plastic factory	All sizes
2.	Tire factory	≥ 500 Tones /year
3.	Rubber factory	≥ 1,000 Tones /year
4.	Battery industry	All sizes
5.	Chemical production industries	All sizes
6.	Chemical fertilizer plants	≥ 10,000 Tones /year
7.	Pesticide industry	All sizes
8.	Painting manufacturing	All sizes
9.	Fuel chemical	All sizes
10.	Liquid, powder, solid soaps manufacturing	All sizes

VI	Mining production other than metal	
1.	Cement industry	All sizes

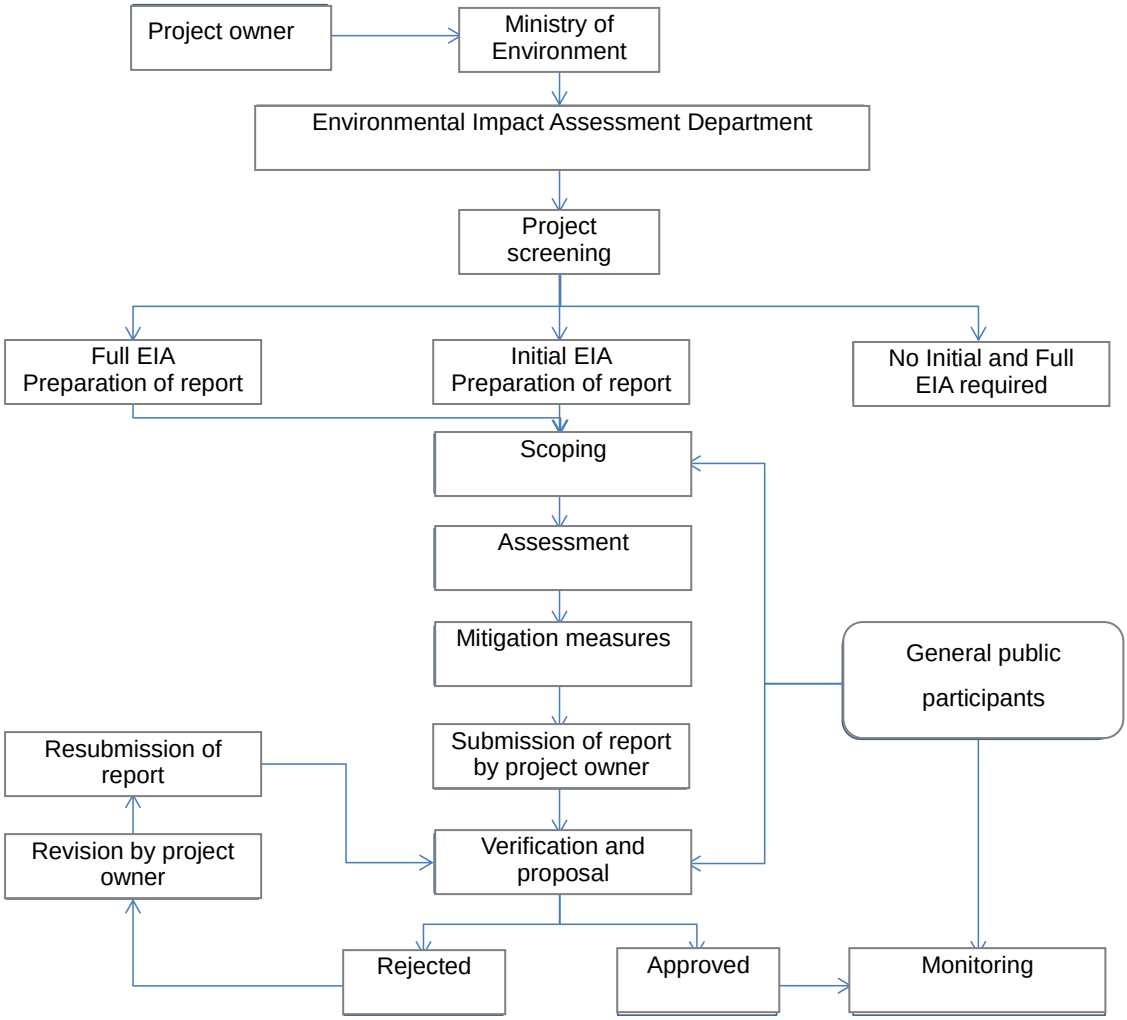
2.	Oil refinery	All sizes
3.	Gas factory	All sizes
4.	Construction of oil and gas pipeline	≥ 2 Kilometers
5.	Oil and gas separation and storage facilities	≥ 1,000,000 Litres
6.	Fuel stations	≥ 20,000 Litres
7.	Mining	All sizes
8.	Glass and bottle factory	All sizes
9.	Bricks, roofing tile manufacturing	150,000 piece /month
10.	Flooring tile manufacturing	90,000 piece /month
11.	Calcium carbide plants	All sizes
12.	Producing of construction materials(Cement)	900 tones/month
13.	Cow oil and motor oil manufacturing	All sizes
14.	Petroleum study research	All sizes
VII	Metal industries	
1.	Mechanical industries	All sizes
2.	Mechanical storage factory	All sizes
3.	Mechanical and shipyard enterprise	All sizes
VIII	Metal Processing Industrials	
1.	Manufacturing of harms, barbed wires, nets	≥ 300 Tones/month
2.	Steel mill, Irons, Aluminum	All sizes
3.	All kind of smelting	All sizes
IX	Other Industries	
1.	Waste processing, burning	All sizes
2.	Waste water treatment plants	All sizes
3.	Power plants	≥ 5 MW
4.	Hydropower	≥ 1 MW
5.	Cotton manufacturing	≥ 15 Tones/month
6.	Animal's food processing	≥ 10,000 Tones/year
B.	AGRICULTURE	
1.	Concession forest	≥ 10,000 Hectares
2.	Logging	≥ 500 Hectares
3.	Land covered by forest	≥ 500 Hectares
4.	Agriculture and agro-industrial land	≥ 10,000 Hectares
5.	Flooded and coastal forests	All sizes
6.	Irrigation systems	≥ 5,000 Hectares
7.	Drainage systems	≥ 5,000 Hectares
8.	Fishing ports	All sizes
C.	TOURISM	
1.	Tourism areas	≥ 50 Hectares
2.	Goal field	≥ 18 Holes

D.	INFRASTRUCTURE	
1.	Urbanization development	All sizes
2.	Industrial zones	All sizes
3.	Construction of bridge-roads	≥ 30 Tones weight
4.	Buildings	Height ≥ 12 m or floor ≥ 8,000 m2
5.	Restaurants	≥ 500 Seats
6.	Hotels	≥ 60 Rooms
7.	Hotel adjacent to coastal area	≥ 40 Rooms
8.	National road construction	≥ 100 Kilometers
9.	Railway construction	All sizes
10.	Port construction	All sizes
11.	Air port construction	All sizes
12.	Dredging	≥ 50,000 m3
13.	Damping site	≥ 200,000 people

2-1-7 EIA Application and Approval Process

（1） Extracts from Guidebook on EIA

Guide Book on Environmental Impact Assessment in the Kingdom of Cambodia



Source) GUIDEBOOK on Environmental Impact Assessment in the Kingdom of Cambodia

Figure 2-1-3 Approval process of EIA

A. Project Proposal

During the initial stage, a project owner or an investment company should submit investment project information with documents regarding the project site and other relevant documents attached to the Ministry of Environment (MoE) or the Municipal Department of Environment (for a project less than 2 million US dollars) for discussion on the project.

At this stage, the project owner wish to know what legal obligations the investment project proposed by the owner to the MoE or the Department of Environment need to fulfill. Therefore, the MoE (Environmental Impact Assessment Department) or the Municipal Department of Environment should screen and select such projects based on conditions as mentioned in (B) below.

B. Project Screening

Generally, as a project screening, the MoE determines whether the project requires Initial or Full EIA according to the type or the size of the project based on laws and sub-decrees.

In a case where the investment project is not mentioned in the annex list of the legal instrument, the MoE can use an alternative list to determine the extent of the impact. This list shows whether the project requires implementation of EIA or not as described in details below:

- For a project with serious environmental impact, the project owner is required to prepare a Full EIA report;
- For a project with medium environmental impact, the project owner is required to prepare an Initial EIA report; or
- For three types of projects described below, project owners are not required to prepare an EIA report. Such three types of projects are as follows:

1. Project determined by the government to be special and urgently needed;
2. When requiring an Environmental Management Plan (EMP);
3. When requiring an environmental protection contract for projects not stipulated in the Annex of the sub-decree but having minor environmental impact such as a garment factory.

C. Project Scoping

Project scoping is a first stage to be conducted in an EIA after the conclusion of the project screening. This stage is extremely essential in an Initial EIA or a Full EIA because it determines some components as follows.

- Determine parameters to be examined in the environmental impact assessment;
- Determine stakeholders and provide them with information;
- Determine a scope of study;

- Agree on methods for public participation and study methods;
- Determine concept of impact to be studied;
- Establish terms of reference.

Who are stakeholders in the scoping stage of this project?

Stakeholders of the environmental impact assessment in the scoping stage of the project are as follows:

- Ministry of Environment, Environmental Impact Assessment Department;
- Project owner;
- Environmental impact assessment consultants and other experts;
- Other responsible agencies;
- Communities and public affected by the project;
- Community and public beneficiaries

D. Environmental Impact Assessment

To analyze environmental impact in the Initial or Full EIA, the following three items should be analyzed: (1) Type of impact; (2) Prediction of scale and scope of impact at a possible level; and (3) Determination of concept of impact.

Environmental impacts may change the form of the existing environment and such impacts can be accumulated directly or indirectly. These changes may undergo further changes beyond limitation on the study or time and can be seen in different ecological systems (types of ecological systems) and at different social levels (from individual to community) having both positive and negative impacts. Such impacts can be seen in different ecological systems and at different social levels that may vary beyond limitation on the study or time, and they include negative and positive impacts.

Direct impacts include changes in environmental components caused by direct interaction between the environment and project activities.

Indirect impacts are caused by indirect interaction between the environment and direct causes. Cumulative impacts include combination of environmental changes caused by human activities. Environmental damages may not only cause extreme changes in existing resources and place heavy burdens on human and animal health but also cause present and future disasters.

E. Environmental Impacts Mitigation Measures

Environmental impacts mitigation measures are activities or measures included in a plan to avoid or reduce negative environmental impacts caused by project activities.

(2) EIA Application of Object Project

Based on hearing with Sustainat Green on August 8, 2017.

The object project is to generate electricity (less than 5MW) and supply heat using methane gas generated by anaerobic fermentation seeing municipal solid waste as fuel resources and the fermentation residues are assumed to be used as fertilizer.

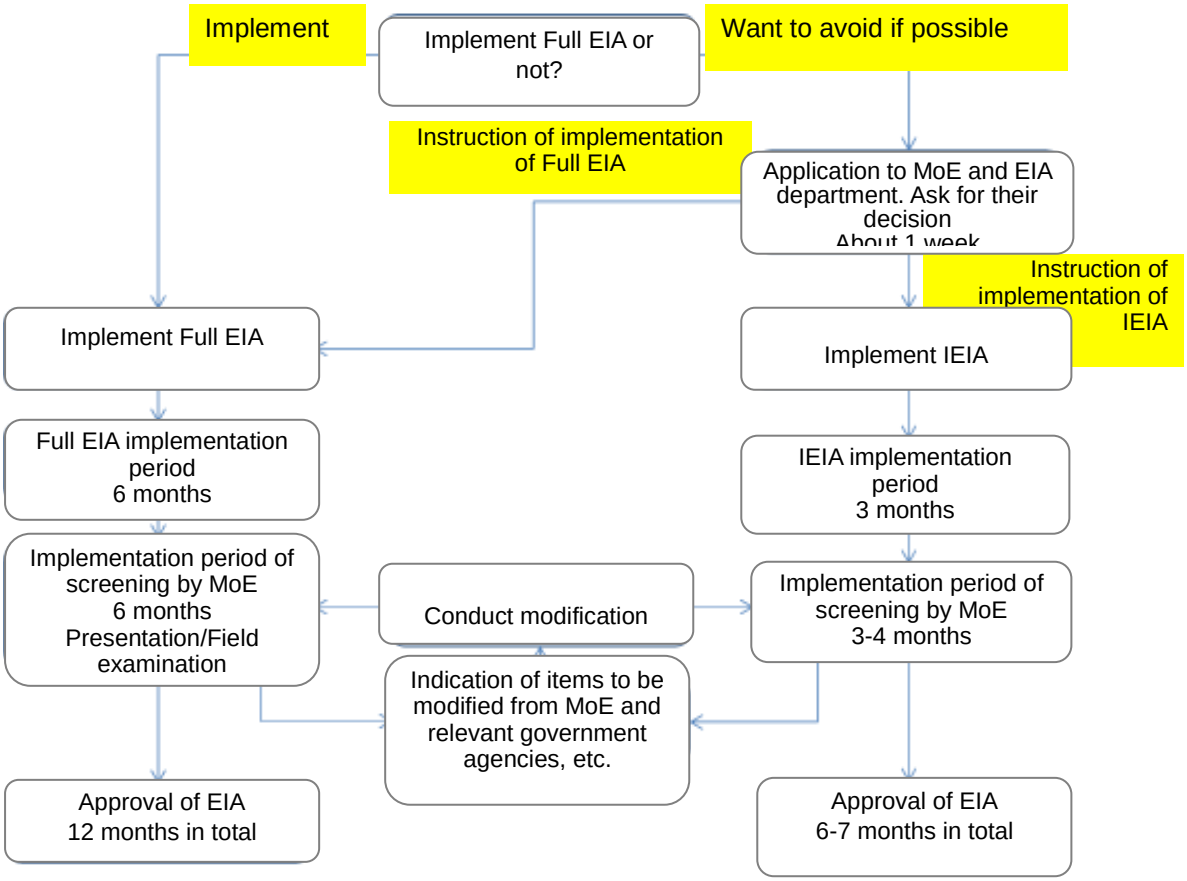
First, required documents are submitted to the Ministry of Environment. The documents include a master plan of the project, an FS report and technical reports (for each process of the project and warehouses (existence or non-existence of roof, etc.)). After they are submitted to the Ministry of Environment, the Ministry determines whether an impact assessment is conducted or not and also its scope when it is conducted.

The environmental impact assessments in Cambodia are divided into two types: IEIA and EIA. A full EIA is always required for waste treatment.

Even in the case of an intermediate treatment, a full EIA is required since it is a treatment of waste. It is because offensive odor from temporary stock should also be taken into account.

The following is a flow chart of expected periods required for processes and screening of EIA

procedures.



Source) Prepared by Mizuho Information & Research Institute based on hearing

Figure 2-1-4 Implementation Procedures of IEIA and EIA

EIA: Environmental Impact Assessment

IEIA: Initial Environmental Impact Assessment

(3) Application for Waste Treatment Business

Application for waste treatment business operator

The following is based on the results of hearing with the Phnom Penh Municipality Environment Department (on August 9, 2017).

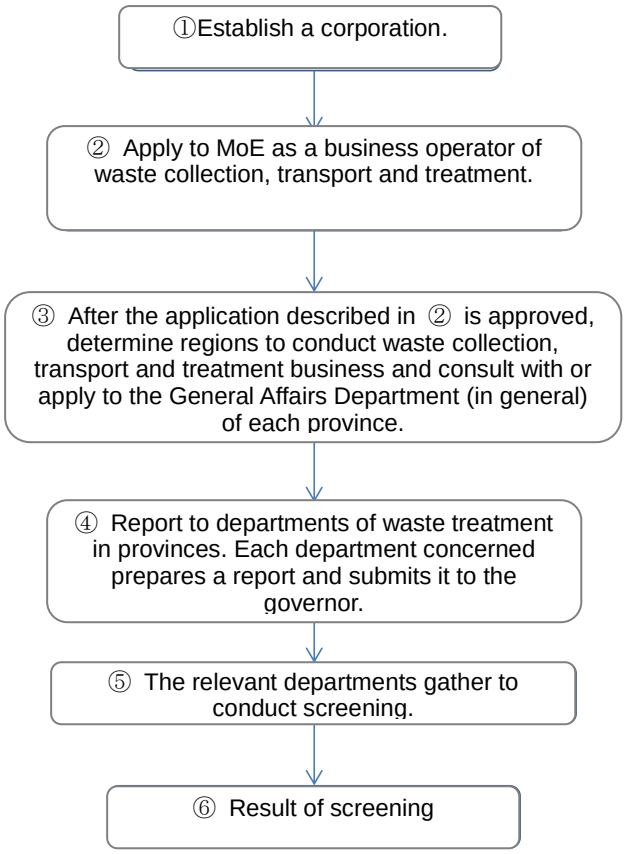
Establish a corporation. No problem with a 100% foreign-owned corporation. No laws to regulate it cannot be found.

Apply to the Ministry of Environment as a business operator.

After the application described in ② is approved, determine regions to conduct waste collection, transport and treatment business and consult with or apply to generally the General Affairs Department of each province.

Report to departments of waste treatment in provinces. Each department concerned prepares a report and submits it to the governor.

The relevant departments gather to conduct screening.



Source) Prepared by Mizuho Information & Research Institute based on hearing

Figure 2-1-5 Application Procedures for Waste Treatment Business Operator

Phnom Penh Capital City owns municipal solid waste transported to landfill sites. Currently, Phnom Penh Capital City entrusts 100% of waste collection in Phnom Penh Capital City and transport of them to waste treatment plants to a private company, CINTRI. For that entrustment, Phnom Penh Capital City made a contract directly with CINTRI. Initially, the term of the contract between these two was 50 years but the contract term was limited to 10 years or less pursuant to Article 32 of the Government Ordinance 1135 issued in 2015. From that point, it is inferred that it has become possible for other business operators to apply as a waste treatment business operator to Phnom Penh Capital City every ten years.

2-2 Fundamental Laws and Regulations in Power Sector

2-2-1 Electricity Law of the Kingdom of Cambodia

The Electricity Law of the Kingdom of Cambodia was adopted by the National Assembly on November 6, 2000. This law was finally promulgated by the Royal Decree No. NS/RKM/0201/03 on February 2, 2001.

The purpose of this law is to govern and organize a framework of electric power supply throughout the Kingdom of Cambodia. This law includes provision of electricity and services, use of

electricity and other relevant activities of the power sector.

This law authorizes the establishment of the Electricity Authority of Cambodia (EAC). EAC is a legitimate public institution approved by the Government of the Kingdom of Cambodia and a self-governing body with authority related to the regulation of the power sector.

Any operators at electric power plants or providers of electric power services must observe the terms of the license issued by EAC.

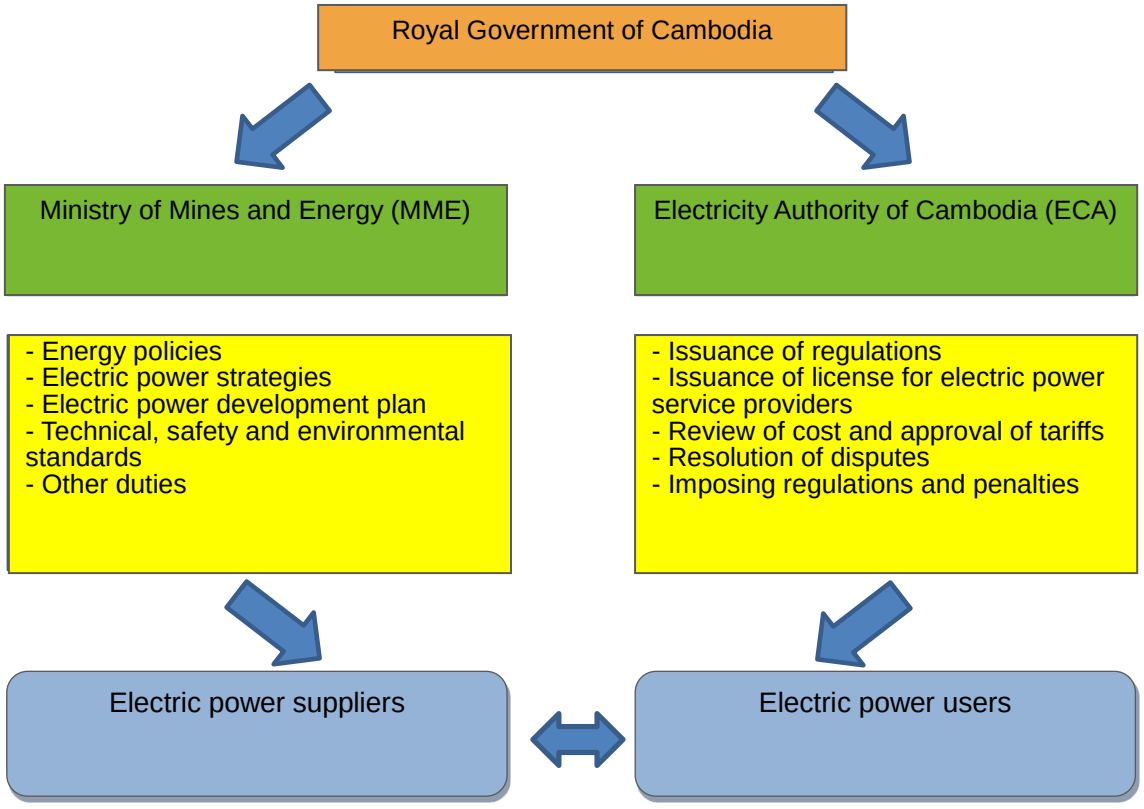
Regulations, orders and decisions issued by EAC can be enforced according to the Electricity Law. EAC has the authority to file a complaint against any breach to the court of the Kingdom of Cambodia.

This law provides authorities, duties and penalties to not only consumers but also service providers for the purpose of establishing fair conditions in business related to electric power use.

The responsibility of the Ministry of Mines and Energy is to develop a path to which the power sector proceed through duties to set and administer policies, strategies and plans of the government. Furthermore, it also takes responsibility to set technical standards for the power sector.

The responsibility of EAC is to take responsibility to put rules, regulations and procedures into force as well as to monitor, guide and adjust both electric power suppliers and consumers and also includes responsibility to make both of them observe policies, guidelines and technical standards developed by the Ministry of Mines and Energy.

EAC must ensure that service provisions and electric power use are implemented in an efficient, high-quality, sustainable and transparent manner.



Source) Report on Power Sector of the Kingdom of Cambodia 2016 Edition

Figure 2-2-1 Separation of Roles between MME and EAC

2-2-2 Powers and Duties of Electricity Authority of Cambodia

Powers and Duties of Electricity Authority of Cambodia

EAC has the following powers and duties according to Article 7 of the Electricity Law of the Kingdom of Cambodia:

a) To issue, revise, suspend, revoke or deny licenses for electric power supply by electric power services as provided in Article 29 of the Electricity Law;
b) To approve tariff rate, charges and terms and conditions of electric power services by licensees, except in cases where EAC considers that those rates, charges or terms and conditions are established according to procedures based on competitive markets.;
c) To enforce regulations, procedures and standards for investment programs by licensees;
d) To review financial activities and corporate organization structures of licensees to the extent that these activities and organization directly affect the operation of the power sector and the efficiency of electric power supply;
e) To approve and enforce the performance standards for licensees;
f) To evaluate and resolve consumer complaints and contract disputes involving licensees, to the extent that the complaints and disputes relate to the violation of the conditions of the license;
g) To approve and enforce a uniform accounting system for all licensees;
h) To prepare and publish reports on the power sector and relevant information received from licensees for the benefit of the Government and the public interest;
i) To prescribe fees applicable to licensees;
j) To determine procedures for informing the public about affairs of the Electricity Authority of Cambodia within its duties, in order to ensure that the Authority complies with the principle of transparency as set forth in Article 3 of this law;
k) To issue rules and regulations, create appropriate orders, and issue temporary and permanent injunction for electric power services;
l) To disconnect power supply, suspend or revoke the license in order to impose monetary penalty for the violation of the standards and regulations according to the law of the Electricity Authority of Cambodia;
m) To require the electric power service providers and the customers to obey the rules relating to the national energy security, economy, environment and other Government policies;
n) To perform functions incidental or consequential to any of the duties as describes above; and
o) To establish the terms and conditions of employment of officers or employees including experts/advisors of the Electricity Authority of Cambodia.

2-2-3 Legal Documents

Legal Documents for Regulating Electric Power Services and Use of Electricity

Table 2-2-1 Legal Documents Concerning Electric Power Services and Use of Electricity

Classification	Outline
1. Law	The Electricity Law of the Kingdom of Cambodia and other laws to manage and regulate the power sector. Laws are main laws to regulate all activities of the power sector as well as a main foundation to prepare other legal documents required for managing and regulating the power sector.
2. Legal Documents of Government Class	Sub-decrees, Decisions, Notifications, etc. of the Royal Government These documents are issued by the Royal Government under the provisions of the Electricity Law to determine policies of the power sector and regulate activities in the field of electric power. The main principles of the power sector, which are not defined in the Law can also be issued as a standard document of the Royal Government.
3. Legal Documents of Ministry Class	Declaration (Prakas) and Decisions of the Ministry of Mines and Energy. These are the documents for managing the works, which are under the duties of the Ministry of Mines and Energy such as policy, development, planning, strategy, technical standards and other determinations in the field of electric power as described below: - Investments in short-, medium- and long-term rehabilitation and development of the power sector; - Restructuring, participation of the private sector, and privatization of public utilities; - Promotion of the use of indigenous energy resources in the generation of electricity; - Planning and agreements on the export and import of electricity; - Subsidies to specific classes of customers and priorities regarding consumers of electricity; - Promotion of efficiency in generation, transmission, distribution and consumption of electricity, and measures taken to create a Comprehensive Electricity Conservation Program for Cambodia; and - Emergency responses and energy security strategy for the power sector.
4. Legal Documents of EAC	Licenses, regulations, procedures and decisions of EAC, which are issued by EAC under the framework of the Electricity Law. These documents are for managing and regulating the electric power services and the use of electricity in the Kingdom of Cambodia.

Source) Report on Power Sector of the Kingdom of Cambodia 2016 Edition

The legal documents prepared and put into force for managing and regulating the provision of electric power services and use of electricity in the Kingdom of Cambodia up to the end of the year

2015 are shown in the table 2 below:

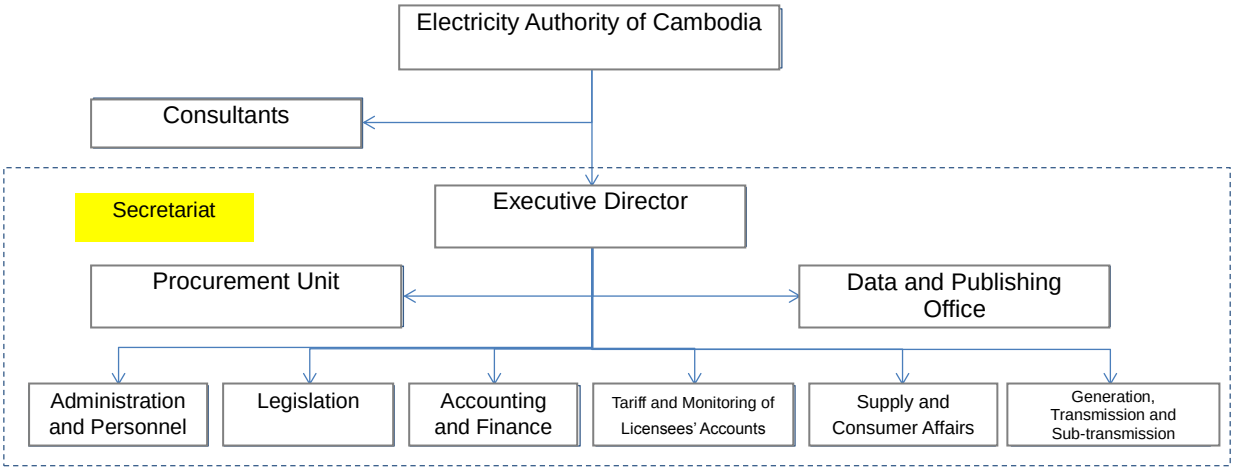
Table 2-2-2 Legal Documents for Managing and Regulating Provision of Electric Power Services and Use of Electricity

No.	Name of Standard Documents	Promulgated by	Date Promulgated
1	- Electricity Law of the Kingdom of Cambodia - Amendment of Article 9 of the Electricity Law of the Kingdom of Cambodia - Amendments of Articles 3, 4, 5, 26, 27, 28, 42 and 74 of the Electricity Law of the Kingdom of Cambodia	The King	February 2, 2001 June 22, 2007 May 18, 2015
2	- Sub-Decree on the Rate of Maximum License Fees Applicable to Electric Power Service Providers in the Kingdom of Cambodia	Royal Government	December 27, 2001
3	- Procedures for Issuing, Revising, Suspending, Revoking or Denying Licenses - Revision 1 - Revision 2	EAC	September 14, 2001 December 12, 2002 March 16, 2004
4	- Regulations on General Conditions of Supply of Electricity in the Kingdom of Cambodia - Revision 1	EAC	January 17, 2003 December 17, 2004
5	Regulatory Treatment of Extension of Transmission and Distribution Grid in the Kingdom of Cambodia	EAC	October 28, 2003
6	Regulations on Overall Performance Standards for Electricity suppliers in the Kingdom of Cambodia	EAC	April 2, 2004
7	Procedures for Filing Complaint to EAC and for Resolution of Complaint by EAC	EAC	April 2, 2004
8	General Requirements of Electric Power Technical Standards of the Kingdom of Cambodia Revision 1	Ministry of Industry, Mines and Energy	July 16, 2004 August 9, 2007
9	Sub-Decree on Creation of Rural Electricity Fund of the Kingdom of Cambodia	The King	December 4, 2004
10	Sub-Decree on Principles for Determining the Reasonable Cost in Electricity Business	Royal Government	April 8, 2005
11	Parkas on Principles and Conditions for Issuing Special Purpose Transmission License in the Kingdom of Cambodia	Ministry of Industry, Mines and Energy	July 21, 2006
12	Specific Requirements of Electric Power Technical Standards of the Kingdom of Cambodia	Ministry of Industry, Mines and Energy	July 17, 2007
13	Regulations on General Principles for Regulating Electricity Tariffs in the Kingdom of Cambodia	EAC	October 26, 2007
14	Procedures for Data Monitoring, Application, Review and Determination of Electricity Tariff	EAC	October 26, 2007
15	Grid Code	EAC	May 22, 2009

Source) Report on Power Sector of the Kingdom of Cambodia 2016 Edition

Organization of the Electricity Authority of Cambodia

The organization chart of the Electricity Authority of Cambodia is as shown below.



Source) Report on Power Sector of the Kingdom of Cambodia 2016 Edition

Figure 2-2-2 Organization chart of EAC

2-2-4 Licenses for Providing Electric Power Services

Information on licenses and licensees in the Kingdom of Cambodia

As per the provisions of the Electricity Law, each electricity service provider is required to have a license issued by EAC and to abide by the provisions of the Electricity Law, its license, and regulations and procedures issued by EAC. A License authorizes the licensee to provide electric power services as per the provisions stated in the license (called the Conditions of License). A license has two main parts:

a) Decision to grant the right to provide the electric power service, and

b) Conditions of license.

Types of licenses that can be issued and regulated by EAC are stated below.

1) The Generation License: It grants the right to generate electric power from specified generation facilities.

2) The Transmission License: It grants the right to provide transmission service. There are 2 types of Transmission Licenses: National Transmission License and Special Purpose Transmission License.

2-1) The National Transmission License can be issued only to a state power transmission company which is under the Government control, to have the right to provide the transmission service for delivering the electric power to the distribution companies and bulk power consumers throughout the Kingdom of Cambodia.

2-2) The Special Purpose Transmission License grants the right to construct, own, and operate specified transmission facilities in the Kingdom of Cambodia for the specified purpose.

3) The Distribution License: It grants the right to provide the electricity distribution services in a

determined contiguous territory.

4) The Consolidated License: It is a license, which may be the combination of some or all types of licenses. The Consolidated License can be issued to EDC and to the isolated systems to grant the right to generate, transmit, dispatch, distribute and sell electric power to the consumers. In issuing the Consolidated License, EAC shall consider long term planning and the objectives of Government policy to reduce long run marginal cost for supply of electricity to consumers, establish a national grid and progressively expand this grid throughout the Kingdom of Cambodia.
5) The Dispatch License: It grants the right to control, manage, and operate the dispatch facilities for facilitating delivery and receiving of electricity to and from the generation, transmission and distribution systems.
6) The Bulk Sale License: It grants the right to buy electricity from any Generation Licensee or from the power systems of neighboring countries for sale to Distribution Licensees or to large customers in one connected power system.
7) The Retail License: It grants the right to engage in the sale of electric power to consumers in a contiguous service territory.
8) The Subcontract License: It grants the right to provide electric power services according to the subcontract agreement with the existing licensee.

Type and Number of Licenses issued and valid

Table 2-2-3 Type and Number of Licenses issued and valid

No.	Type of license issued	Licenses valid at end of 2014	Issued during 2015	Revoked during 2015	Change of type during 2015	Valid at end of 2015
1	Consolidated License consisting of Generation, Distribution and National Transmission Licenses	1				1
2	Generation License	21		1		20
3	Special Purpose Transmission License	7				7
4	Consolidated License consisting of Special Purpose Transmission and Distribution Licenses	139	10	3	+21	167
5	Distribution License	4	1			5
6	Retail License					
7	Consolidated License	181	2	5	-21	157

	consisting of Generation and Distribution Licenses					
	TOTAL	360	15	9		366

Source) Report on Power Sector of the Kingdom of Cambodia 2016 Edition

2-2-5 The Budget of EAC and License Fees

The Electricity Authority of Cambodia is an autonomous agency working for the interest of all electric power service providers and electricity users in the Kingdom of Cambodia. Therefore the expenditure of EAC for its operation is to be borne by all electric power service providers in the form of payment of license fees. Article 27 of the Electricity Law provides that EAC shall have an autonomous budget for its operation. This budget shall come through License Fees paid by applicants and licensees as determined by EAC.

For governing the license fees charged by EAC, The Electricity Law has further provisions that "The maximum license fees are to be determined by a Sub-Decree of the Royal Government". Under the provisions of the Electricity Law of the Kingdom of Cambodia, the Royal Government have issued sub-decree No. 131-OR-N-KR/BK dated December 27, 2001 determining the maximum license fees applicable to the electric power service providers in the Kingdom of Cambodia.

According to Electricity Law, EAC shall determine the rate of the license fees to be paid by the licensees every year based on the maximum license fees determined by the sub-decree. For the year 2015, EAC has determined the license fees to be paid by licensees vide Notification No. 082-SR-15-EAC dated March 16, 2016; which reduced the rates of license fees for some types of licenses. The license fees determined for the years 2014 and 2015 are given in the table below.

Table 2-2-4 License Fees to be paid by Licensees

Type	Riel /kWh	
	Year 2014	Year 2015
Generated power or power purchased from any other country	1.20	1.15
Transmission	0.50	0.40
Distribution and sale	0.60	0.50
Retail	0.30	0.30
Other services license fee	0.1%	0.1%

Press Release

Power Purchase Agreement Signing Ceremony Between

Electricité Du Cambodge (EDC) and Sunseap Asset (Cambodia) Co., Ltd

for 10MW Solar Farm in Bavet City, Svay Rieng Province, Cambodia

on 29th August 2016 at Sofitel Phnom Penh Phoketra, Phnom Penh, Cambodia

The total power demand of Bavet City and Svay Rieng Province is about 40MW and only 20MW is imported from Vietnam. To meet the power demand, EDC has to construct 115kV transmission line (around 140 km) from Phnom Penh with 115/22kV Chrak Metes Substation near Bavet City. In the meantime, the RGC launched the first project of 10MW Solar Farm as renewable energy on BOO basis for a period of 20 years to supply electricity to this Bavet City and the surrounding area. This project will be connected to the EDC's national grid, once the 115kV transmission line from Phnom Penh is commissioned.

This 10MW Solar Farm Project bidding was launched on 3rd February 2016 by inviting the National and International bidders for participation. A total of 35 companies collected the bid documents and 5 companies submitted the proposals on 22nd March 2016, out of which 3 companies were technically qualified. The financial proposals of the 3 qualified companies were opened on 17th May 2016 for evaluation and Sunseap International Pte Ltd. (Parent Company of Sunseap Asset (Cambodia) Co., Ltd) won the bid with the lowest tariff rate of 9.1 US cents per kWh.

The total project cost will be 12.5 million USD with potential financial support from Asian Development Bank. According to the present schedule, this project will be put into commercial operation within 12 months from the date of signing of the PPA. However, the company is directed to make all arrangements to complete the project in the 1st semester of 2017 (construction around 6 months) itself so as to meet the power demand of Bavet City and Svay Rieng Province during the dry season.

Solar energy generated through this project will not only provide clean renewable energy to the community but also help diversify Cambodia's energy mix which is currently made up fossil fuels, Bio mass, hydro and coal.

This solar project is expected to create employment for more than 100 people in the solar sector in addition providing additional source of income for the population which currently relies mainly on tourism and manufacturing as its main economic activities in Bavet City.

Figure 2-2-3 Signing ceremony for 10MW Solar PPP between EDC and Sunseap Asset Co., Ltd.

2-3 Collection of Information on Land Ownership

2-3-1 Restriction on Foreign Nationals

In Cambodia, foreign nationals are not permitted to directly own land pursuant to the following law.

Law to ensure restriction on land ownership by foreign nationals

The Constitution _930921

THE CONSTITUTION OF THE KINGDOM OF CAMBODIA

This Constitution was adopted by the Constitutional Assembly in Phnom Penh on September 21, 1993 at its 2nd Plenary Session.

Article 44:

All persons, individually or collectively, shall have the right to ownership. Only Khmer legal entities and citizens of Khmer nationality shall have the right to own land. Legal private ownership shall be protected by law. The right to confiscate properties from any person shall be exercised only in the public interest as provided for under the law and shall require fair and just compensation in advance.

2-3-2 Summary of Land Ownership

(1) Hard title:

A hard title is the strongest form of property ownership in Cambodia and the best land ownership in Cambodia.

Hard titles are an ownership certificate provided by the Ministry of Land Management, Urban Planning and Construction (MLMUPC).

Hard titles contain detailed information that has been duly recognized and certified at a national level by MLMUPC and a cadastral office. When a hard title transaction occurs, a transfer tax of 4% is applied.

According to the General Department of Taxation of the Ministry of Economy and Finance, the registration tax is levied at a rate of 4% on transfer of ownership of real property or transfer of occupancy right of land without building in the form of sale, exchange, receiving gift and capital investment in company.

http://www.tax.gov.kh/en/breg.php

(2) Soft title:

It is a Cambodian land title that is recognized at the local government level. Soft titles are provided by the local Sangkat or district office and are not registered at a national level. They are still considered a possessory status in business practices and it has been reported that many of real estate transactions are still conducted as soft titles to avoid ownership transfer taxes and fees.

However, for most of new major development projects, hard titles have been transacted because they are the most reliable land title in Cambodia.

Private ownership:

Private ownership in co-owned buildings is the most recent form of ownership and allows foreigners to legally own property in Cambodia. This ownership is known more commonly as a strata title. It is a less common Cambodian land title, but the number of them are growing fast.

The "Law on Foreign Ownership" was promulgated on May 24, 2010.

This law limits foreign ownership to co-owned buildings. Foreigners still cannot own land. Co-owned buildings are defined as a building or construction in which several owners reside, consisting of some parts that are the exclusive ownership of each co-owner (private unit) and some other parts that are common spaces for the common use of co-owners. In recent years, the strata title has also been expanded to commercial buildings, especially complex co-owned office facilities.

Law on Providing Foreigners with Ownership Rights in Private Units of Co-Owned Buildings Promulgated : May 24, 2010

Note) A province is subdivided into districts (srŏk). A district consists of khum and sangkat and Phnom Penh is subdivided into sections (khan) and a khan is subdivided into sangkat. A khum and a sangkat are subdivided into villages.

LMAP title:

In Cambodia, the Land Management and Administration Project called LMAP has been introduced by the World Bank to improve security of land ownership by the Ministry of Land Management, Urban Planning and Construction (MLMUPC).

Under this scheme, GPS coordinates are registered to all land plots in the country.

If an LMAP title has already been owned, the boundary of the property has been agreed on with the owner of the contiguous property and the boundary dispute has been resolved. This is also assumed to be a land title of a safe type.

Land Lease

Term of lease

The Civil Code which was put into force in December 2011 refers to a long term lease as Permanent Lease and limits the term of it to be for not more than 50 years (Article 247 of the Civil Code). On the other hand, this Permanent Lease may be renewed, but every renewal may not be for more than 50 years.

Withholding Tax

Instruction No. 18410
Obligations to withhold taxes on film businesses and real estate companies

General Department of Taxation, Instruction No. 18410
Obligations to withhold taxes on film businesses and real estate companies

The General Department of Taxation (GDT) has issued Instruction No. 18410 to provide guidelines on the implementation of Articles 25 (new) and 26 (new) of the Law on Taxation for film production companies and subleasing businesses of real estate companies. Under this Instruction, the implementation of withhold tax (WHT) obligations is as follows:

A real estate company that subleases real estate in Cambodia has obligations to withhold 10% WHT on payments of rental fees to the original owner of the property. If the real estate company subleases the property to a self-declaration taxpayer client, the client is not required to withhold the tax on rental payment to the real estate company. The WHT is applicable only one time, when the real estate company pays the rental fee to the original owner of the property.

2-4 Supporting Overview in Cambodia

2-4-1 Waste Management Overview in Cambodia

Waste management in Cambodia is done based on Cambodia law, sub-decree, and prakas. General waste management is done by related parties regarding the duties determined in sub-decree 36 and 113.

(1) Sub-Decree No.36: Solid Waste Management

CHAPTER 2

Management of General Waste

Article 2:

Article 4:

The Ministry of Environment shall establish guidelines on waste disposal sites, collection, transport, storage, recycling, and minimizing of general waste in order to ensure the management of general waste in the provinces and the city with safe way. The authorities of the provinces and the city shall establish the waste management plan in their provinces and city for short, medium and long term.

Article 5:

The management of waste disposal sites, collection, transport, recycling, and minimizing of waste in the provinces and the city are the responsibility of the authorities of the provinces and the city. The implementation as mentioned in the first paragraph of the article 5 shall comply with the guideline on the sound management of waste specified by the Prakas (declaration) of the Ministry of Environment.

Article 6:

The Ministry of Environment shall evaluate the implementation in collection, transport, storage, recycling, minimizing and disposal of the general waste in the provinces and the city.

Article 7: (Not related)

Article 8:

The domestic investment in construction of landfill, incinerator, storage sites or recycling plant for general waste shall be subject to prior approval from the Ministry of Environment.

(2) Sub-Decree No.113: Management of Garbage and Solid Waste of Downtowns

The goal of this sub-decree is to enhance the management of garbage and solid waste of downtowns with effectiveness. The other goals are to determine roles of relevant parties regarding the management and to delegate the function of the management from provincial and city administrations to khan, city and district administrations. In addition, the sub-decree aims to construct systems where waste generators can deepen the knowledge and understanding of waste management and contribute to the environment. By the sub-decree, responsible institutes are determined as follows:

1) Ministry of Environment(MOE): The responsible ministry for national environmental problems determined by the law on environmental protection.

-In cooperation with relevant ministries and institutions, prepare national strategic plans relating to the management of garbage and solid waste of downtowns.
-Provide technical advice and capacity building to responsible khan, city, and district administrations on the waste management.
-Solicit and cooperate for support and investment for waste management.
-Support and cooperate with relevant ministries and institutions and khan, city, and district administrations to promote education of waste management and programs to reduce, reuse and recycle (3R).
-Check and evaluate actions regarding waste management.

2) Ministry of Interior(MOI): The ministry responsible for the direct management of khan, city, and district administrations (lower branches of the provinces and the city). The roles are as follows:
-Support and cooperate with the MOE in capacity building and experience sharing with khan, city and district administrations about waste management.
-Support khan, city and district administrations' waste management.
-Check and evaluate the implementation of waste management.

3) Provincial Administrations: Support and cooperation for waste management implemented by khan, city and district administrations.
-Prepare guidelines and others necessary for the implementation of laws regarding waste management.
-Advise khan, city and district administrations to prepare action plans and budget plans for waste management.
-Support the creation of waste disposal sites and cleaning, collecting and transporting services of waste.
-Solicit support for khan, city and district administrations.
-Support actions regarding 3R.
-Support waste management services of khan, city and district administrations.
-Check and assess waste management.

4) Capital and Provincial Department of Environment: Support for waste management implemented inside capital and provincial administrations area.
-Disseminate information about environment and promote implementation of 3R.
-Participate in preparing the waste management plans of the sub nation administration.
-Provide technical advice on proposals, business, or projects of waste management.
-Check and evaluate waste management.
-Prepare yearly reports on the situation and process of waste management.

5) Khan, city, and district administrations

-Prepare yearly action plans and budget plans for waste management within its territorial jurisdiction.

-Provide documents and implement waste management.

-Establish and operate waste disposal sites and cleaning, collecting, and transporting services within its territorial jurisdiction.

-Provide education on 3R. Support actions regarding 3R.

-Each khan, city and district administration may establish a specific unit responsible for waste management under control of its administration.

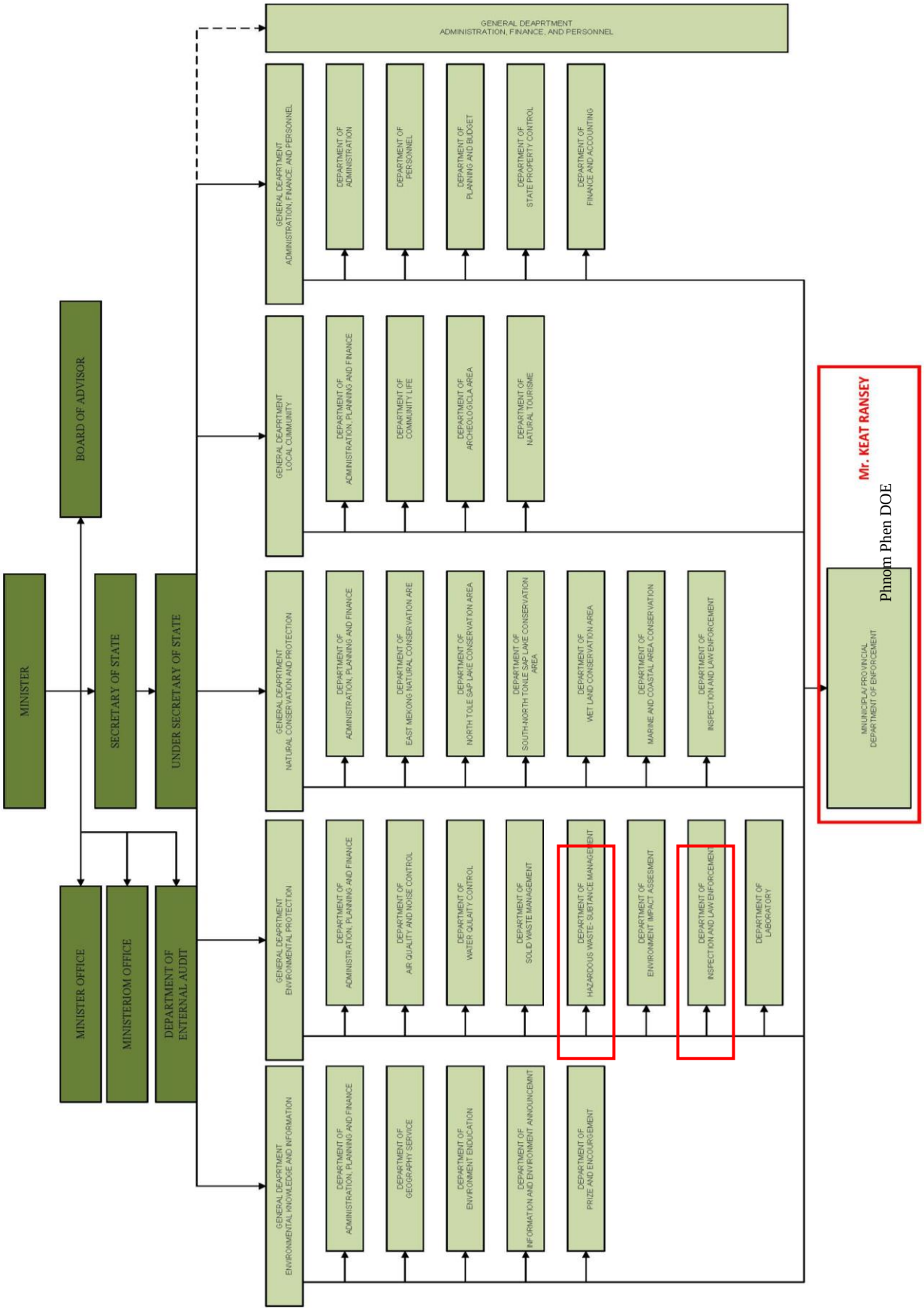
6) Sankat and Commune Administration: Lower branches of khan, city and district administrations.

-Implement functions delegated by the khan, city or district administration.

-Check matters regarding cleaning, collecting and transporting.

-Resolve problems relating to cleaning, collecting and transportation services.

-Cooperate for implementation of laws


MINISTER
SECRETARY OF STATE
UNDER SECRETARY OF STATE
BOARD OF ADVISOR
MINISTER OFFICE
MINISTERIOM OFFICE
DEPARTMENT OF ENTERNAL AUDIT
GENERAL DEAPRTMENT ADMINISTRATION, FINANCE, AND PERSONNEL
GENERAL DEAPRTMENT ADMINISTRATION, FINANCE, AND PERSONNEL
DEPARTMENT OF ADMINISTRATION
DEPARTMENT OF PERSONNEL
DEPARTMENT OF PLANNING AND BUDGET
DEPARTMENT OF STATE PROPERTY CONTROL
DEPARTMENT OF FINANCE AND ACCOUNTING
GENERAL DEAPRTMENT LOCAL CUMMUNITY
DEPARTMENT OF ADMINISTRATION, PLANNING AND FINANCE
DEPARTMENT OF COMMUNITY LIFE
DEPARTMENT OF ARCHEOLOGICLA AREA
DEPARTMENT OF NATURAL TOURISME
GENERAL DEAPRTMENT NATURAL CONSERVATION AND PROTECTION
DEPARTMENT OF ADMINISTRATION, PLANNING AND FINANCE
DEPARTMENT OF EAST MEKONG NATURAL CONSERVATION ARE
DEPARTMENT OF NORTH TOLE SAP LAKE CONSERVATION AREA
DEPARTMENT OF SOUTH-NORTH TONLE SAP LAKE CONSERVATION AREA
DEPARTMENT OF WET LAND CONSERVATION AREA
DEPARTMENT OF MARINE AND COASTAL AREA CONSERVATION
DEPARTMENT OF INSPECTION AND LAW ENFORCEMENT
GENERAL DEAPRTMENT ENVIRONMENTAL PROTECTION
DEPARTMENT OF ADMINISTRATION, PLANNING AND FINANCE
DEPARTMENT OF AIR QUALITY AND NOISE CONTROL
DEPARTMENT OF WATER QULAITY CONTROL
DEPARTMENT OF SOLID WASTE MANAGEMENT
DEPARTMENT OF HAZARDOUS WASTE SUBTANCE MANAGEMENT
DEPARTMENT OF ENVIRONMENT IMPACT ASSESMENT
DEPARTMENT OF INSPECTION AND LAW ENFORCEMENT
DEPARTMENT OF LABORATORY
GENERAL DEAPRTMENT ENVIRONMENTAL KNOWLEDGE AND INFORMATION
DEPARTMENT OF ADMINISTRATION, PLANNING AND FINANCE
DEPARTMENT OF GEOGRAPHY ASERVICE
DEPARTMENT OF ENVIRONMENT ENDUCATION
DEPARTMENT OF INFORMATION AND ENVIRONMENT ANNOUNCEMNT
DEPARTMENT OF PRIZE AND ENCOURDEMENT
Mr. KEAT RANSEY
MIKUNCIPLA/PROVINCIAL DEPARTMENT OF ENFORCEMENT
Phnom Phen DOE

Source)MOE web site

Figure 2-4-1 Waste Management Overview and System in Phnom Penh

2-4-2 Overview of Waste in Phnom Penh

Regarding Sub-decree 113, Phnom Penh Capital Hall (PPCH)'s Waste Management Division (WMD) is responsible for the waste management in Phnom Penh. The Phnom Penh Capital Hall signed up to a 50-year-contract with the CINTRI on general waste collection and transportation services starting from 2002, and the CINTRI has been implementing the services in commission. In the contract, the CINTRI is supposed to collect and transport waste in the entire area of Phnom Penh. However, the company actually covers only 70%. The uncoverage area 30% is those situated outside the city and far from landfill that have less population dentity. In this case, the treatment expenses are free. Currently, companies must get licenses to provide waste collection and transportation services, and there are 4 license groups. Collected general waste is transported to the Dangkor landfill and disposed of by landfill, and the amount of waste transported to the landfill have been increasing. The Dangkor landfill is divided into block A, B, C and D. When we asked for their opinions, block A and B had been already used and covered with soil, block C would soon be full, and block D was being prepared for landfill. Judging from the current amount and increasing rate of waste, the existing landfill site will be full within 3 to 5 years. The PPCH is considering finding new potential landfill sites. In order to use the existing site longer, the PPCH does their best to support and cooperate with proposals of small-, medium-, and large-scale projects on waste recycle and waste treatment. Therefore, the Dangkor landfill has about 2 hectares of areas for treatment and recycle companies. Note that permission of the Phnom Penh Capital Hall is needed for the use of the areas.

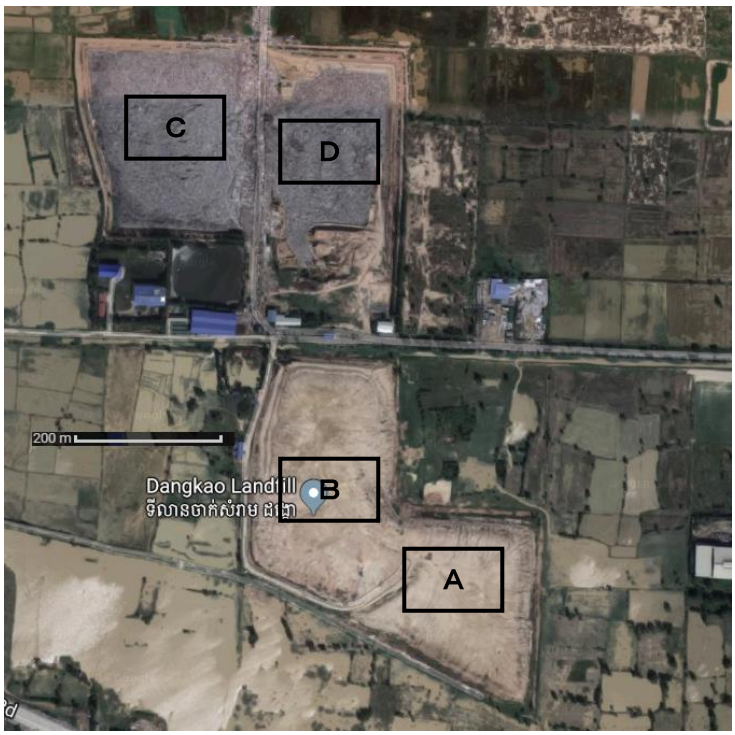
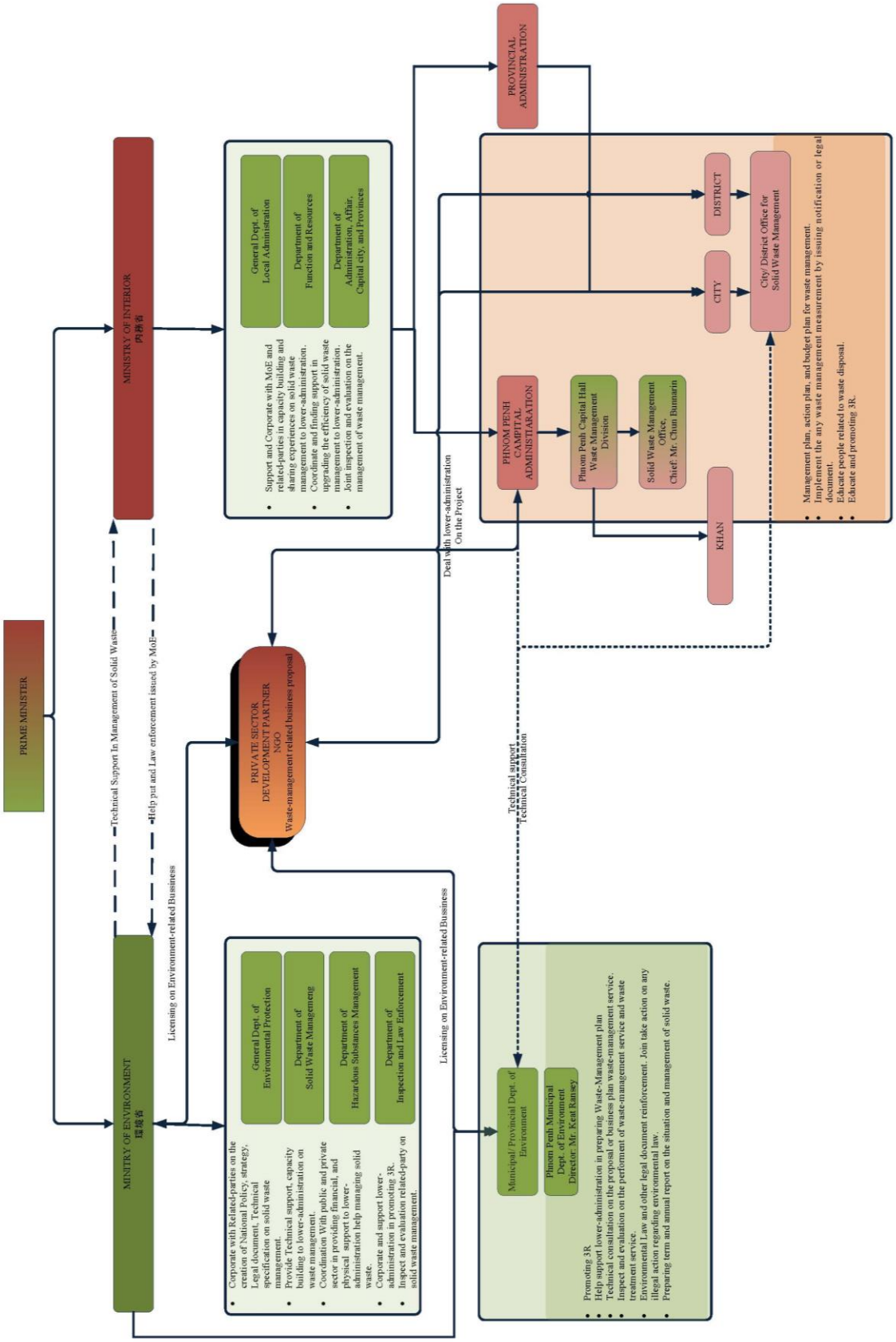
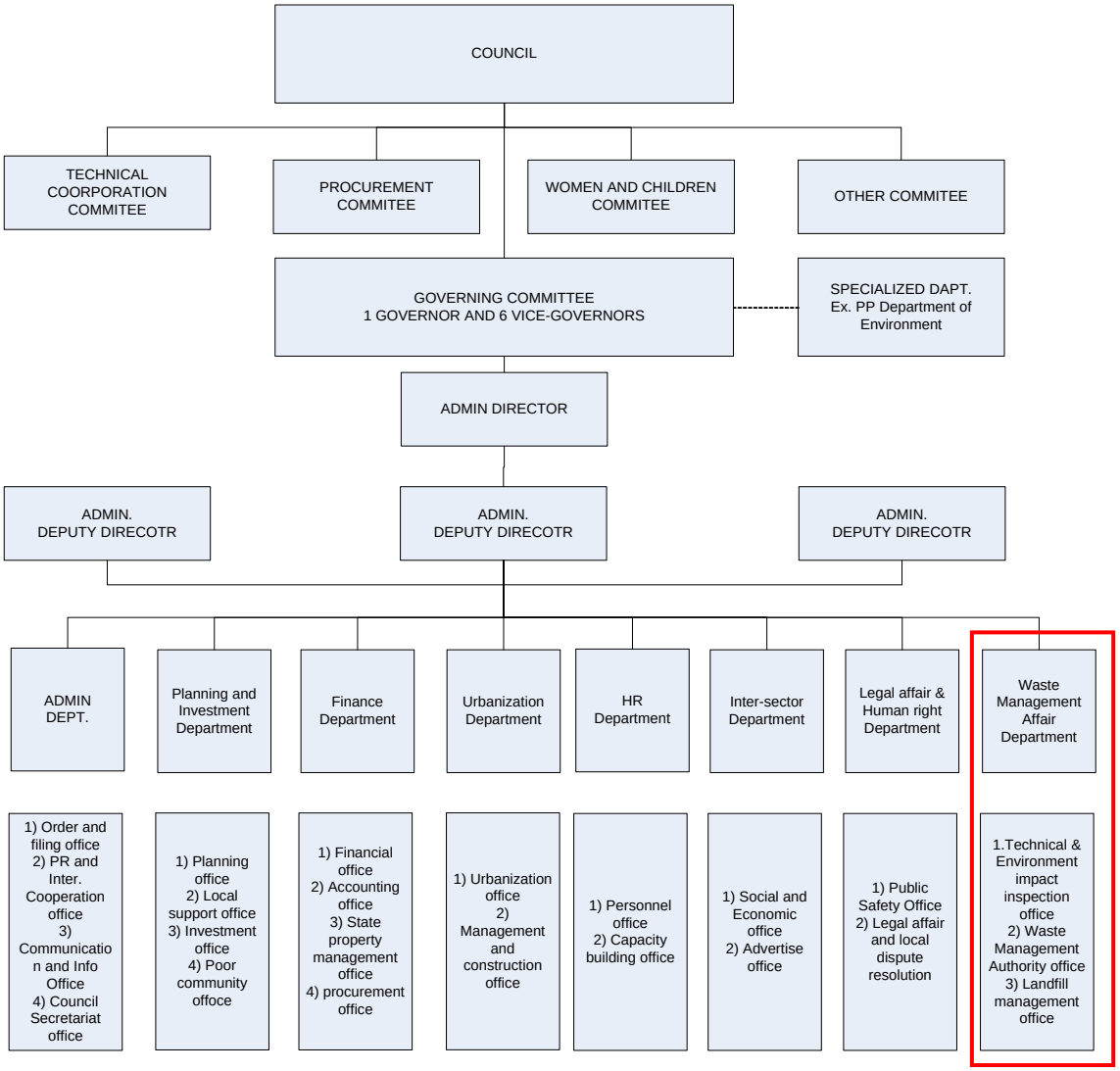


Figure 2-4-2 Dangkao landfill site



Source)Phnom Phen Capital web site

Figure 2-4-3 Waste management relation map



Source)Phnom Phen Capital web site

Figure 2-4-4 Organizational chart of Phnom Penh Capital

Table 2-4-1 Phnom Penh Waste collector and amount (Red Cross: Not Related to our Study)

Type of Waste	Company	Amount （T/Day）
House hold waste	CINTRI(2017)	2,200 T
Slough House	Unkonw, is no under the control Phnom Penh Capital Hall. Shall be under MAFF	9.5 T

Medical Waste	Cambodian Red Cross, Medical Waste Management Unit	2 T
Live Stock Residue	Private	-

Table 2-4-2 Dangkao Landfill information

Item	Descriotion
Estblishment, Start Operation	2009
Operation & Management	PPCH Waste Management Division, Landfill Management Office.
Number of Dumping	Approx. 150 time/ day
Amountdaily	Approx.1,850-2,000 Gradually increasing
Approx of Udage	Year, 2020～2022
Sorting	Household waste have no Medical waste have incineration facility inside

In Phnom Penh, NGOs such as CSARO and COMPED does recycling activities including composting of organic waste. CSARO receives about 4 tons per day of food waste generated by households around the Daeum Kor market, which is a vegetable market in Phnom Penh, for free and composts it. Compost they make is sold for 160 to 180 USD per ton (the price varies according to with or without bags) . On the other hand, COMPED had owned the composting facility in previous landfill, SMC which was used as waste disposal site until 2009. There, they accepted one or two trucks of food waste per day from the Daem Kor market and produced approximaly 200 tons of compost fertilizer per year. However, since the disposal site was relocated in 2010, COMPED have also closed and moved its composting facility; Now they are operating composting business in Battambang and selling compost for 100 to 130 USD per ton.

Table 2-4-3 COMPED Compost Fertilizer Production

Item	Description
Start	2009
Area of Site	Approx8,000 ㎡ pprox8,000eoladfill of Battambnag City
Household Waste based	2t/d t/sehold Waste based raw material
Annual Production	Approx. 25t
Client	Farm, State, Hotels, Fertizer stores
Price	100～130USD/t

Waste in Phnom Penh has been increasing with advancement of urbanization. However, though waste should be segregated according to the laws, 3R activities have been failed because of some reasons

There is no actual regulation on waste sorting

Even the waste have been sort from the source, collector will mix and transport togather.

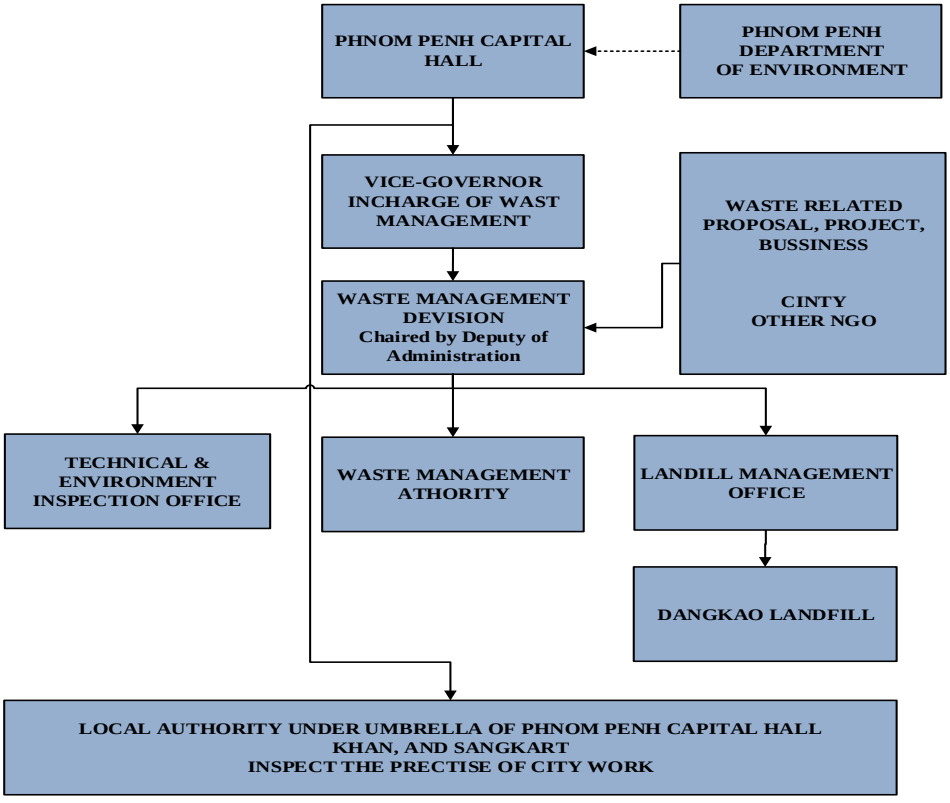
There is no recycle facility.

During the meeting with Vice-Governor in charge, he has stated that along with the development and poplation growth of Phnom Phnom, there is also sharp increase in waste produced by the whole city. PPCH is now facing the seeking of proper area to for Waste Dumping Site. PPCH is doion the best to strength the service waste related activity as well as give support for thos business project proposal related to waste management.

2-4-3 Organizations related to waste management in Phnom Penh.

Phnom Penh Capital Hall (PPCH) is under the jurisdiction of Ministry of Interior (MOI), and projects in Phnom Penh are supposed to be conducted in cooperation with the relating Ministries and departments. Waste Management Division (WMD) incharge of perfoming this roles including collection of waste, management of waste disposal sites, and waste management planning. Regarding, sub-decree No.113, to effectively performing the role of management inside its territory, PPCH have 3 technical office under WMD, it included Technical and Environment impact Office, Waste Manaagement Authority Office, and Dang Kao Lanfill Managemnt Office. Lowwer administration district (Khan) , commune (Sangkat) under the juricition of PPCH, also have role in the waste management such determind waste collecting schedule with CINTRI, insepceting on waste collecting service of CINTRI, get reaction from people inside territory and discuss with CINTRI for solution or report to PPCH.

Phnom Penh Department of Environment (PPDOE) is a lower branch of Ministry of Environment (MOE). MOE is responsible for the protection of the environment and natural resources, and they enact legislations, nation environmental startergy plan regarding the environment in general, implement the policies, and promote the environmental assessment. Note that the activities are actually carried out by Provincial/Municipal Department of Environment (P/M DOE). PPDOE is in charge of matters regarding the environment in Phnom Penh on behalf of Ministry of Environment. The roles include management of general waste and the roles mentioned above.



Source)Phnom Phen Capital web site

Figure 2-4-4 PPCH Waste Management Organisation Chart

2-5 Procurement for raw material (Organic Waste)

2-5-1 Generation situation of raw material

(1) Waste General Amount

Phnom Penh is divided into 12 districts. It has a population of 1,497,246 as of 2013 and the population density is about 2,200/Km2, which is the highest in Cambodia. The population growth rate is 2.34%. Note that the population is concentrated to the city center.

Chamkar Mon, Doun Penh, Prampil Makara and Tourl Kok have high densities of restaurants, hotels, offices, apartments, houses, markets and shopping malls and is creasing, a long with population is also sharply inceasing.

Dangkao, Pousen Chay, Chroy changva, Prek Pnow, and Chbar Ompov are newly established districts from a part of Phnom Penh at the time and a part of neighboring Kandal district. They still have many houses and newly developed housing complexes. Some part of this district is still out of coverage of CINTRI. Gabage is seen burnt along the side of the road. The center part is well managed while the outside part still have some problem.

Table2-5-4 Dangkor Landfill Usage

No.	Description (2016)	Amount of trucks/day	T/day	T/month	Note
1	CINTRI	165	1914,25	700,613.89	Average waste amount to Dangkor landfill: 1964.29T/day
2	Doeum Kor market	01	28,39	10,390.91	
3	Prek Phnov market	02	3,58	590.10	
4	New Mean Chey Market	01	2,48	131.38	
5	Slaughter houses	02	9,38	3,433.33	
6	Public Work Dep.	02	4,85	1.776,36	
7	Other sources	01	1,36	498.80	
8	Medical waste	02	1,8	534.10	Located in Dangkor Landfill
9	Industrial waste	140	210	6380	Located in Kanthok
	Total	316	2176,09	724,348.87	

Table 2-5-5 Year 2016 Waste Collection Performance in Phnom Penh by District

WASTE AMOUNT COLLECT-2016 (CINTRI)						
No.	Khan-Code	Khan Name	Ave. trucks/day	Ave. Time/day	Eve. Daily (T)	2016-Total (T)
1	1201	Khan Chamkar Mon	27	49	318.66	116,311.92
2	1202	Khna Doun Penh	18	25	175.80	64,168.30
3	1203	Khan 7Makara	9	16	106.68	38,938.98
4	1204	Khan Tuol Kork	22	35	238.80	87,162.00
5	1205	Khan Dangkor	5	7	42.83	15,634.42

6	1206	Khan Mean Chey	23	45	235.50	85,955.95
7	1207	Khan Ressey Keo	21	27	142.34	51,954.04
8	1208	Khan Sen Sok	19	26	136.99	50,000.90
9	1209	Khan Por Sen Chey	33	52	284.57	103,869.86
10	1210	Khan Chroy Chang Wa	6	7	32.23	11,765.19
11	1211	Khan Chba Ampov	8	13	76.40	27,884.30
12	1212	Khan Prek Phnov	7	12	128.68	46,968.58
Total				315	1,919.49	700,613.63

Table 2-5-6 Based on 2008 Date, Projection of Phnom Penh Population 2013, 2018

No.	Khan Code	Khan Name	POPULATION 2008	POPULATION 2013	POPULATION 2018
01	1201	Chamkar Mon	182,004	204,319	229,369
02	1202	Doun Penh	126,550	142,066	159,484
03	1203	Prampir Meakkakra	91,895	103,162	115,810
04	1204	Tuol Kouk	171,200	192,191	215,753
05	1205	Dangkao	73,287	82,272	92,360
06	1206	Mean Chey	194,636	218,500	245,289
07	1207	Russey Keo	135,470	152,079	170,725
08	1208	Saensokh	125,536	140,928	158,206
09	1209	Pur SenChey	159,455	179,003	200,953
10	1210	Chraoy Chongvar	61,214	68,718	77,144
11	1211	Praek Pnov	47,313	53,113	59,625
12	1212	Chbar Ampov	133,165	149,491	167,821
TOTAL			1,685,842	1,892,539	1,892,539

As for the quality of waste in Phnom Penh, Mr. Yim Mongtoeun in the Royal University of Phnom Penh researched the quality of waste generated by streets and households. According to the research, composting is an effective way to treat waste in Phnom Penh because food waste accounts for 60 to 70% of waste, and waste in Phnom Penh is rich in organic material with the C/N ratio (carbon ratio) of 20:1. On the other hand, he also conducted research on business-related waste, and he collected samples from 52 business sectors including hotels, restaurants, cyber cafes, guest houses, beer gardens, markets, schools, microfinance institutions, and shops. As the result, food waste accounts for 50 to 60%, plastics and paper account for 30 to 40%, and glass accounts for 5 to 6%. He has concluded that if food waste and other recyclable things are perfectly segregated from waste, 61% of waste will be reduced. The Monthly Average Consumption composition per capita in 2015 is about 102 dollars in entire Cambodia and about 153 dollars in Phnom Penh.

According to the research on general waste generation in Phnom Penh conducted by Asia Foundation under the coloboration of Institute of Technology of Cambodia (ITC) in 2013, the

estimation of waste amount producing is said to be increase and the prediction waste in 2030 is said to be at approximately 2,800 t/ day. While the prediction for 2017 is at around 1,700 t/day, the actcaul data from landfill is 2,200 ton/day wich is at 1.5 time as high as the prediction. According, the prediction for 2020 shall be at approximately 3,000 t/day. With this regard, a quick response shall be conciderated.

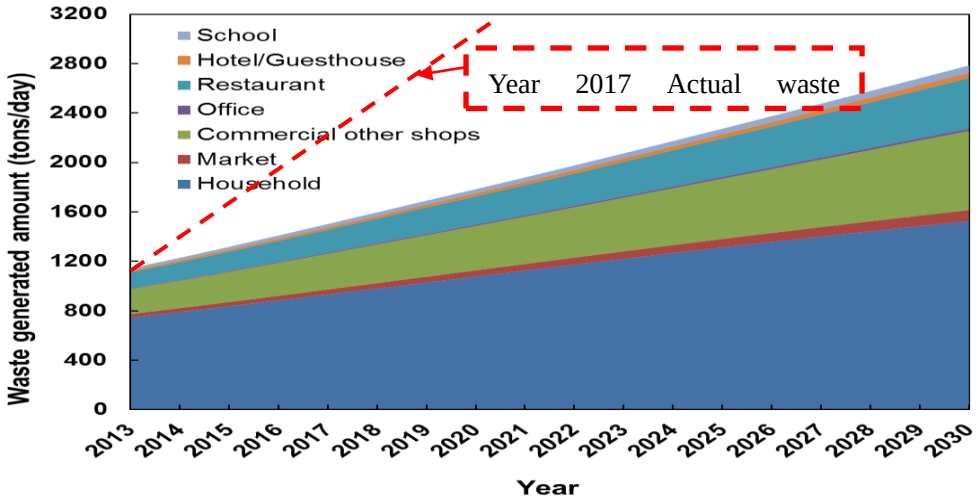


Figure 2-5-1 2013-Asia Foundation Research basd, Waste Amount Prediction by Source

(2) Waste Sampling

In Cambodia including Phnom Penh, waste generators put out waste without segregation. Though segregation of waste is not mandatory by law, the government provides support for activities regarding 3R and segregation according to the sub-decree No.113. In the 3R activities which have been done so far, waste generators roughly segregate aluminum cans, plastic bottles, and organic materials from other waste and sell them to recycling shops. In addition, many of medium- and large-scale restaurants and hotels whose waste includes much vegetable, food, and food debris use their waste as feed and segregate the rest of waste. The rest of waste is said to have much organic material.

Markets and shopping malls are one of main waste generators. Markets mainly include fresh food markets such as vegetable, fruit, and meat markets. Waste generated by these markets consists of organic materials, but it contains much water. Moreover, the amount of waste generation differs according to the scale of the market. In Phnom Penh, main markets which generate large amounts of waste are Deumkor Market and Neakmeas Market. The two markets import fresh vegetable and fruit from Vietnam and provide them to other provinces of Cambodia. The daily amount of waste generation is 30 to 40 tons. In order to study about the characteristics, density Gas of the waste from the markets, sample of waste have been taken and tested.

Figure 2-5-2 Stall inside Market (L: Vegetable, R: Fish)

Figure 2-5-4 Deum Kor Market Inside Collection

Figure 2-5-3 Neak Market Waste Temp. Storage








Figure 2-5-5 Waste Sampling from Market,

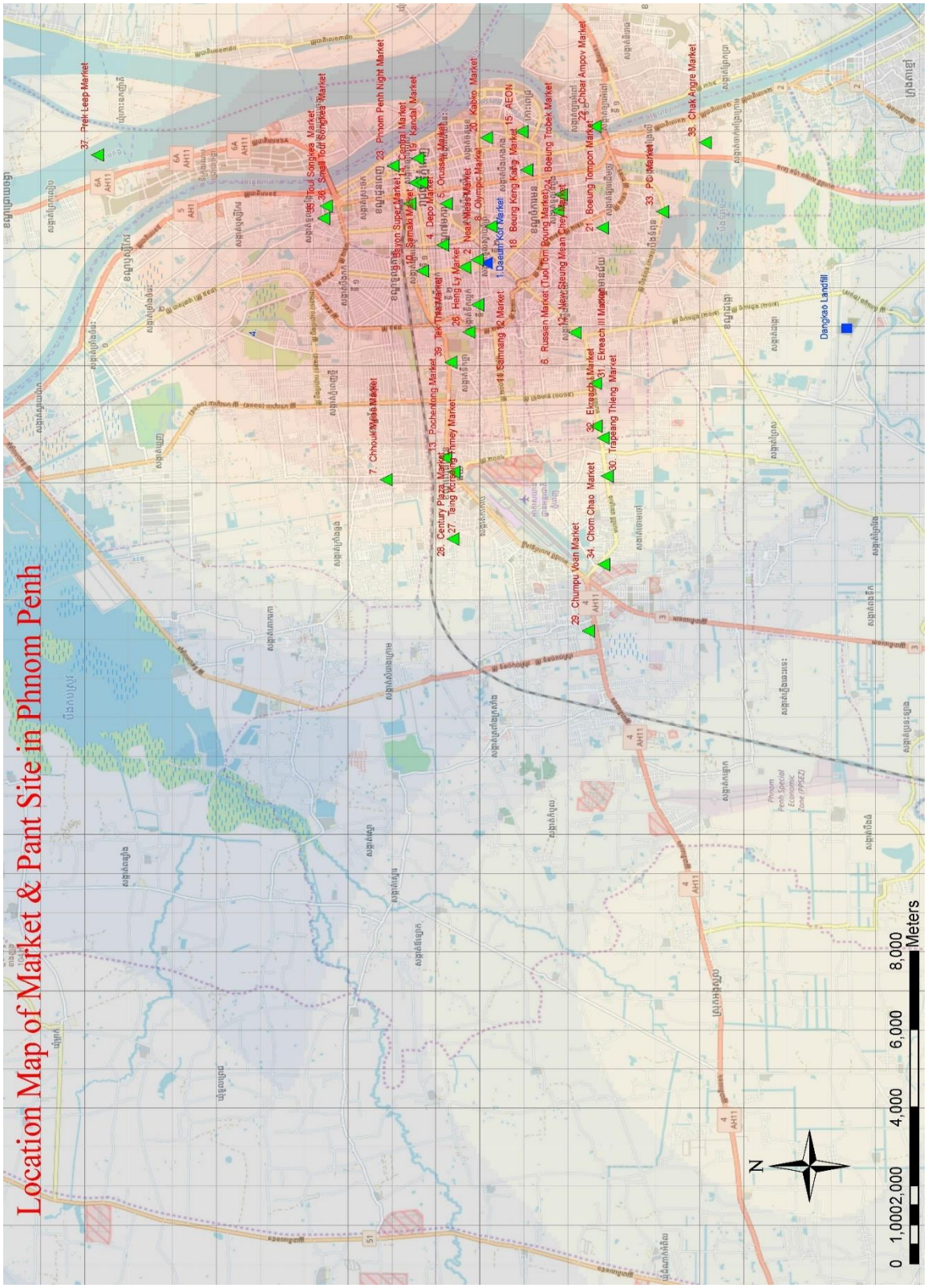


Figure 2-5-6 Main Market Position in Phnom Penh

(3) Collecting and Transporting

Collection and transportation: The only collecting and transporting company is the CINTRI, and they have obtained the license to collect and transport general waste in the entire Phnom Penh. Though the license is for the entire Phnom Penh, they haven't collected and transported waste in the entire Phnom Penh yet. The main reason for this is that collecting and transporting waste in remote areas from the disposal site doesn't make business profitable. They have collected and transported waste in areas that they can cover according to the decided schedule. The schedule was decided by the discussions between the CINTRI and the 12 districts (Khan) of Phnom Penh Capital Hall according to sub-decree No.113. Based on data of Waste collection 2016, the district (Khan) that have produce amount of waste lagest amount of waste is Chamka Mon.

Source) Asia Foundation Research basd

Figure 2-5-7 Phnom Penh Waste Collection

Table 2-5-4 Waste disposal cost in Phnom Penhof Capital City

Item	Payment	Note
Houshold	1USD/month	Fixed, Contract with CINTRI
Campany	20-40USD/month	Contract with CINTRI
Tipping fee	0.75USD/t	Payment for PPCC

2-5-2 Suppliers of raw material

Because of the way people in Phnom Penh put out waste, waste which can be used as material and waste which cannot be used as material are mixed up. The composition of waste differs according to the area. According to the CITRI Operation Director, areas where much of the waste can be used as material are as follows.

1) Deumkor and Neakmeas Markets: They import fresh vegetable and fruit from Vietnam and provide them to retailers in other provinces. Waste generated by this 2 market mainly includes vegetable and fruit waste. The CINTRI collects it every day from 8:00 to 9:00.
2) Large-scale Hotels: Waste generated by most large-scale hotels is collected and transported by a truck. It doesn't contain waste generated from households or other sourec. Waste generated by hotels are said to mainly include food, food debris, and vegetable waste. Example: The daily amount of waste generated by the Naga World Hotel is at around 10 to 15 tons. The CINTRI collects it every day at night.
3) Large-scale shopping malls: The AEON Mall has many customers, and a large amount of food debris is generated from its restaurants and the food court. The daily amount of waste generation is about 8 tons. The CITRIN collects it every day.
4) Restaurants and Fast Food Restaurants: Districts in the city center have high densities of restaurants and fast food restaurants. Much of the waste transported by trucks from these areas can be used as raw material. Waste is usually collected and transported at night.
5)Wedding Halls: There are 5 main wedding halls in the city. Much of the waste can be used as material. Waste is generated every day in the city. Example: The daily amount of waste generated by the Diamond Island Wedding Hall and Diamond Island area is about 10 to 15 tons.

Based on the size of the plant, waste sources to be used for supplying to the plant may be changed. It can be those area with high density of market and restuarent.

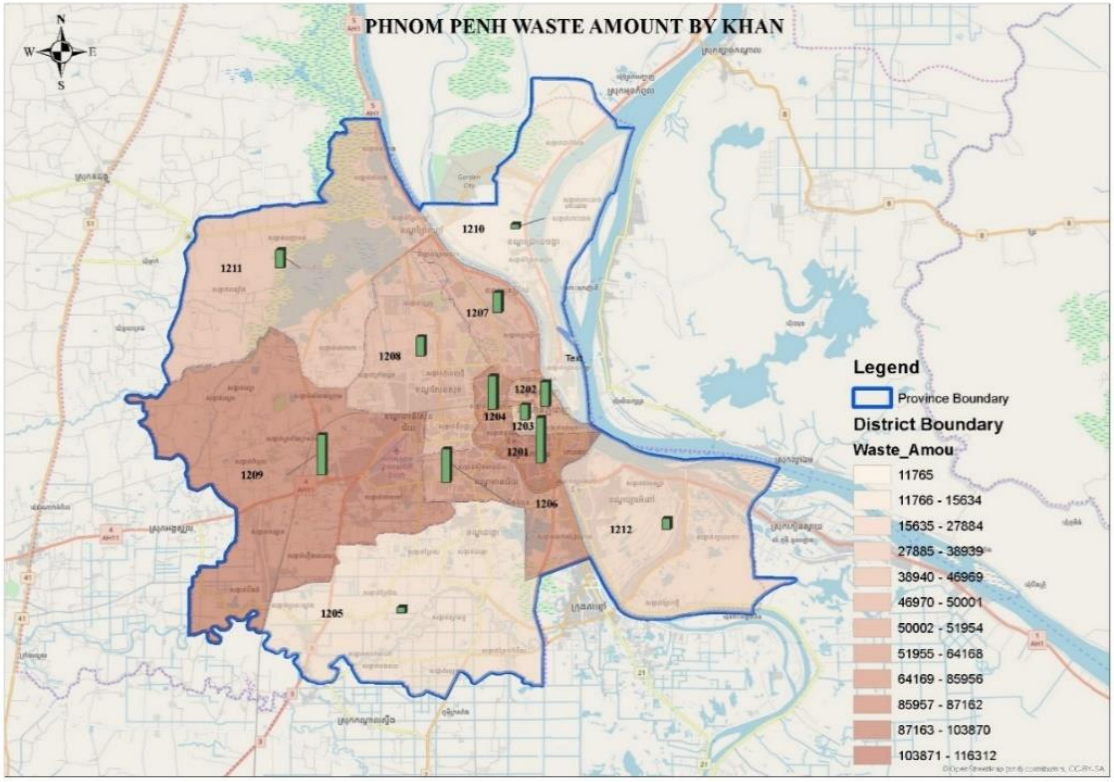


Figure 2-5-8 Map of Waste Producerd by Khan

2-5-3 Method of collecting and transporting raw material

1) Collecting and Transporting Companies: Material can be collected and transported by obtaining the cooperation of the CINTRI, which is a collecting company. However, it may be impossible to organize the schedule of collecting waste and transporting it to the plant. The CINTRI cannot decide its collection schedule alone because the schedule should be decided by the discussion between related districts. Moreover, the time of collection and transportation is decided with considerations of traffic situations. According to the CITRI's collection and transportation schedule, waste in Phnom Penh city center and districts around city center is collected and transported everyday between night and early morning. Waste generated in the areas where waste is collected and transported during the period of time can be used as material.
2) Plant Owned Waste Collecting-Transportation: The CINTRI is supposed to cover the entire Phnom Penh. This means that waste generators throughout Phnom Penh basically have to pay a service fee to the CINTRI for collection and transportation of waste. Plant collection and

transportation means that plant shall have staff to collect and transport waste while waste producer still pay a service fee to the CINTRI. With prior coordination with CINTRI, COMPED and SCARO have being using this for collecting waste that can be used to produce compost fertilizer. Throuhg this practice, amount of raw material and time of feeding the raw material can independly coordinate by the plant itself.

2-6 Plant Specifications and Construction Cost

2-6-1 Plant Site

It is necessary to select plant site upon considering the following points.

① Conveying distance from waste pickup location should be short.

It is necessary to make distance from waste pickup location to be short/ to take frequent rotation of pickup/ damping due to the shortage of the number of transportation vehicles. In addition, the running cost and transport distance influences the running cost because vehicle fuel cost is expensive.

② Access to landfill site should be easy.

Remove methane fermentation unsuitable waste such as metal, glass, cloth, plastic, etc., at preprocessing. Deliver recyclable waste to recycling contractors but easy access to landfill site is important because of unrecyclable waste transportation to landfill site for landfill.

③ Connection to energy use destination should be easy.

In case of selling electric power, it is important that connection to EDC power distribution network should be easy because the electric power selling is only to EDC. In case of selling heat, it is important that isolation from demand destination should be small. Site location in the vicinity of high thermal demand plant (brickmaking plant, food/ beverage related plant and so on) and facilities (shopping mall, hotel complex, warm bath facilities and so on) is necessary.

4) Site area and shape shall not have disadvantage against plant installation and should be easy to be procured (purchasing or long-tern rental).

Since the entrance and exist of large size vehicles are all day long as well as every day, it is necessary to secure site area without giving disadvantage to plant installation but also to vehicle operation in the facility. In addition, it is important that site shape should be easy to install architectural building and plant which leads to cost reduction.

The population increase in Phnom Penh is remarkable in these days, building construction and redevelopment is performed throughout the city, and land price is inflated. In addition, land price at suburban area is also inflated because main road upgrading is underway. Since this project requires the comprehensive land with the degree of 0.5ha, project feasibility is degraded remarkably depending on land procurement cost. It is important to procure land with cheaper price as possible while considering the above conditions, ① through ③.

(1). Site Location Reviewed

* Required Area: Larger than 4,000m^2

Table 2-6-1: Location Candidate and Evaluation

	Location	Condition	Evaluation against Condition
1)	Recycling Facility Site for Dangkao Landfill Site (2ha municipal government domain)	① ② ③ ④	No increase/ decrease of transportation time and effort due to abutment to landfill site. Access is extremely easy. Energy demand is very few in the vicinity. Sufficient energy demand will occur if intermediate treatment facilities for waste such as crush/ segregation, incineration, etc., are installed. 2ha municipal government domain for recycling facility exists but whether it is usable or not is still suspended because there is the plan to use for incineration facility and so on. In addition, land cost is set higher.
2)	Phnom Penh Special Economic Zone (PPSEZ) (Industrial Park)	① ② ③ ④	Distance to pick up location is apart and is distant than landfill site. Landfill site is near than returning to city center, less traffic jam and access is good. There are many food plants which consume a lot of energy (both electric power and heat) in the vicinity. There is no problem for connection to EDC. It is easy to construct because land creation was already been done but land price is high.
3)	Nearby National Polytechnic Institute of Cambodia (NPIC) (Private Land)	① ② ③ ④	Distance to pick up location is apart and is the same as PPSEZ. Access will be better if outer road is completed even it is far. NPIC as large energy demand facility exists in the vicinity but its energy usage is limited to daytime. Connection to EDC distribution line is easy. Housing land development gets underway together with the road completion and land price is inflated.
4)	Nearby AEON MALL II (Private Land)	① ② ③ ④	Distance to pick up location is near. It is located in the reverse direction of landfill site and it takes time because moving down through city center is required for access. AEON MALL II consumes a lot of energy (both electric power and heat). Infrastructure is in-place because it is redeveloped area but land price is high.
5)	Prek Chrey (Private Land)	① ② ③ ④	It is located near landfill site and distance becomes a little bit far but access is easy. It is located beyond landfill site from pickup location but distance to landfill site is not so long and access is easy. Energy demand in the vicinity is few. Connection to EDC distribution line is easy. It is near to the state border of Kandal, there are unused lands and land price is still cheap.

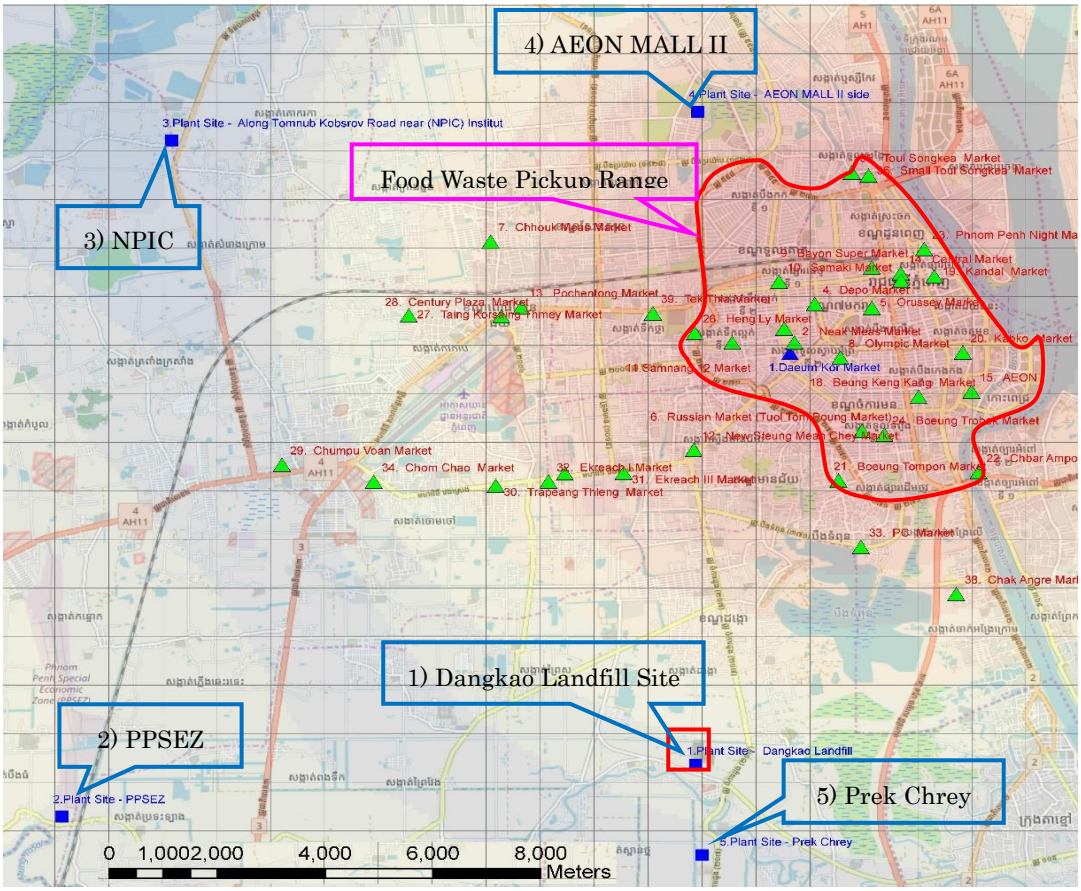


Fig. 2-6-1: Location Drawing of Location Candidate Land

It was decided to perform project assembling at 5) Prek Chrey as the most appropriate project land among 5 candidates as the result of review. Aspects of other project candidate lands are shown below;

1) Land for Recycle Facility at Dangkao Landfill Site (2ha)

Source)PPCC DOE

Fig. 2-6-2: Layout Drawing of Dangkao Landfill Site

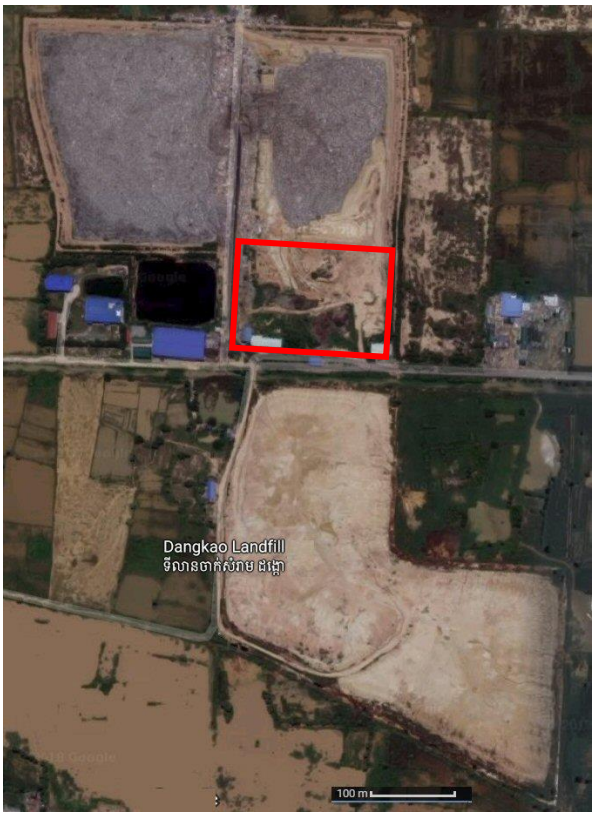


Fig. 2-6-3: Current State of Dangkao Landfill Site
Landfill completed at L-shape part below (Cover soil completed)
Upper-left side is full and remained right-hand side is under filling now

Aspects are as follows;

* The remaining number of years for landfill site is not so long but alternate site has not been decided yet.
* The municipal government will newly introduce intermediate treatment facility and it is planned to extend the remaining number of years.
* As for the waste treatment, project proposal has been done by the degree of 30 companies so far. The proposals are making volume reduction mainly by incineration.
* The municipal government is forecasting the commission of intermediate treatment project to private sector and business operator will be decided by bidding.
* Several groups from China are currently proposing 2,000 tons/ day incineration facility and 50MW waste power generation.
  They want electricity sales price of 0.1USD ~ 0.13USD per 1KWh (buying upper limit by EDC is 0.1USD/KWh) and collection of waste treatment cost in addition. As for the collection of waste treatment cost, Phnom Penh municipal government makes it unacceptable condition.
* This site has the possibility of using by the bit planned intermediate treatment project and there is the high possibility of not moving into the project in this case. In addition, the possibility of using this site as landfill site if a new landfill site is not secured

.

2) Inside of PPSEZ

Source)PPSEZ website

Fig. 2-6-4: Location Drawing of PPSEZ

Table 2-6-2: Plan Progress Status of PPSEZ

Project Size (Final):357.3 ha		
Phase I (137.9 ha)	Phase II (161.6ha)	Phase III (57.8 ha)
* Completion of Subdivision for Sale * 95% is for plant construction	* Subdivision for Sale almost completed * 90% is for plant construction	* Under Development Since May 2015

Source)PPSEZ website

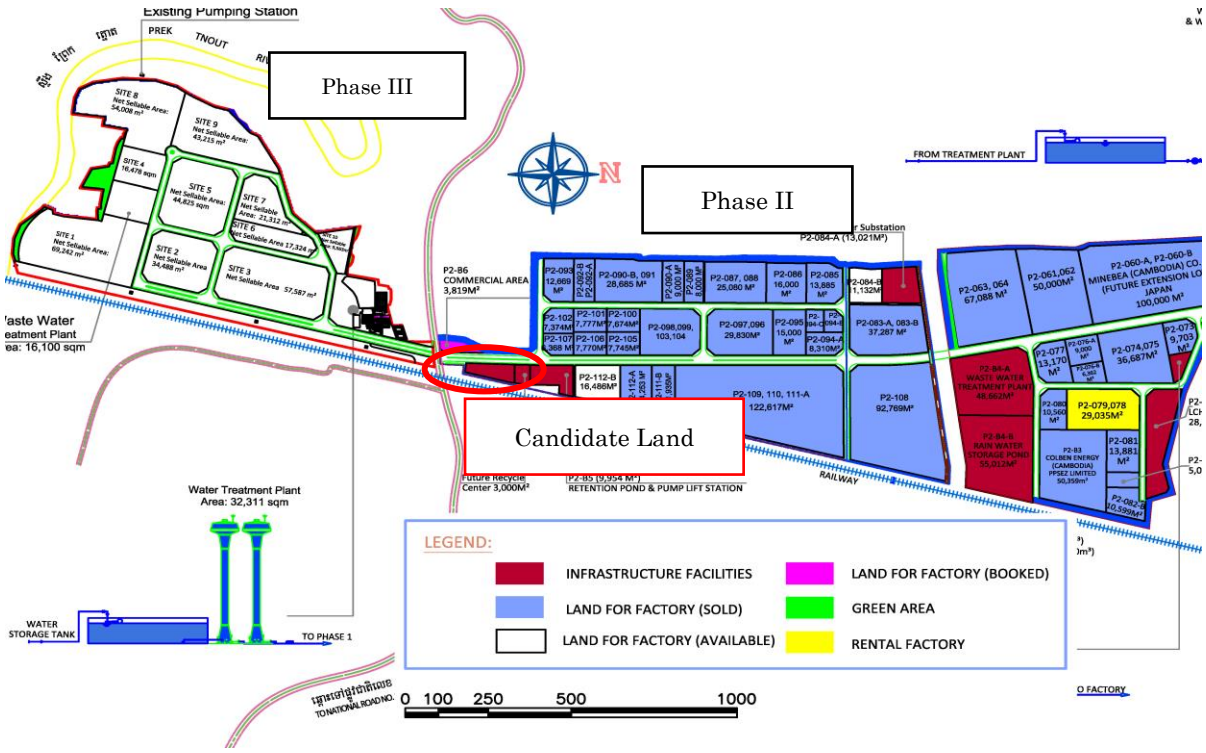


Fig. 2-6-5: Land for PPSEZ

Statuses are as follows;

* The land is located along Route-4 where it is 8Km west of Phnom Penh International Airport and is located near the border of Kandal State. This is the only one SEZ in Phnom Penh and the moving numbers of Japanese companies are many because of the joint operation of Cambodian companies with Japanese companies.

Fig. 2-6-6: Land for PPSEZ

* The candidate land is located at the south most edge of Phase II in the south-north long ground. The south side is Phase III area under construction across the public road.
* Many food and beverage companies which are utilizing a lot of thermal energy are located in Phase II area. Project feasibility will be built up if heat is sold to these plants,
* The candidate land is the land prepared for treatment business of waste occurred in SEZ from recycle business and so on. For the reason, it is necessary to review not only the methane fermentation but also the parallel establishment of treatment facility for hazardous waste (industrial waste). Incineration facility is raised as candidate but making no business sense only with the quantity in SEZ.
* Concrete cost negotiation has not been performed but the possibility of making no business sense is high because land cost is expensive for small size plant like this project.

3) NPIC Adjoining Land

Fig. 2-6-7: Land of NPIC

Statuses are as follows;

* The land is facing outer road, easy to get around and the access to landfill site will be increased dramatically if road improvement is completed.
* There is no large thermal energy demand around and the demand is a little even at adjoining NPIC.
* The parallel establishment of facilities such as a brick-making plant and so on is possible because there is a lot of farmland round but the inflation of land price is sharp recently and there is the high possibility of land cost making business feasibility to be worse.
* It is necessary to pay attention to banking and water discharge because the north side is low and is easy to impound water.

4) AEON MALL II Adjoining Land

Fig. 2-6-8: AEON MALL II Adjoining Land

Statuses are as follows;

* This is located at north-west edge of new metropolitan city (Camko City) where the lake region at the north of Phnom Penh was landfilled. It is in adjacent to the north side of AEON MALL II under construction.
* Camko City interrupted the plan due to cash schedule problem and so on for a period of time but the project gets rolling now. Surrounding area will be the housing area with low story and high story in future, embracing a lot of population and will be the area where a lot of food

waste which are the material for methane fermentation are discharged along with AEON MALL II.

* Since AEON MALL II consumes a lot of energy, the energy feeding from this facility leads to cost reduction and this will be a large merit for the mall. Looking from this project, the business feasibility will be increased because the generated heat is able to be used as the driving source of natural chiller for cold/ hot water feeding by cogeneration same as electric power and heat selling together with electric power becomes capable.
* Leading to the avoidance feeling of residents I concerned in future because waste treatment facility will be existed in housing area in future.
* Since it was developed as high class residential area, land cost is expensive and this will be large burden for the project.

(2) Most Suitable Commercial Land

Prek Chrey, 5), will be the most suitable land.

Fig. 2-6-9: Land for Prek Chrey

Statuses are as follows;

* This is located along the Chamkar Doung road toward Dangkao landfill site from city center, at 3Km ahead to south from the entrance of landfill site. Development on surrounding area has not been promoted and it is relatively cheap land cost area in Phnom Penh.
* It is close to landfill site, trouble-free for the pick-up/ conveyance labor hour and taking out of ferment process unsuitable articles (plastic, cloth, metal, ceramics, glass and so on). There is no need to change existing waste pickup/ conveyance route and goods arrival schedule is easy

to plan because the change of waste conveyance route is almost nothing.

* The new landfill site construction plan has been reviewed at prior governor general to construct at Poen, Chuang Lang in Kandal State going southward of this road (interflowing with Route-2) but the plan is interrupted now. A plan to build a new airport by filling large lake region (national land) in this area was reported recently. If this plan is promoted, is considered that the new landfill site plan Phnom Penh will be resumed. If so, this land will be an excellent location as an intermediate treatment facility because the land is locating at the middle between city center and the new landfill site, and is perfect as far as access is concerned.
* Since there is some room in surrounding land, it will be able to correspond to all quantity of food waste process in Phnom Penh by expanding size in future. In addition, since Krong Ta Khmau city, the provincial capital of Kandal State, where population increase is remarkable as the satellite city of Phnom Penh is in near distance, acceptance of food waste from the city will be capable.

Fig. 2-6-10: Chamkar Doung Highway (Near Candidate)
EDC power distribution line is located at roadside.

Fig. 2-6-11: Candidate Area

2-6-2 Process Overview

(1) Process Flow

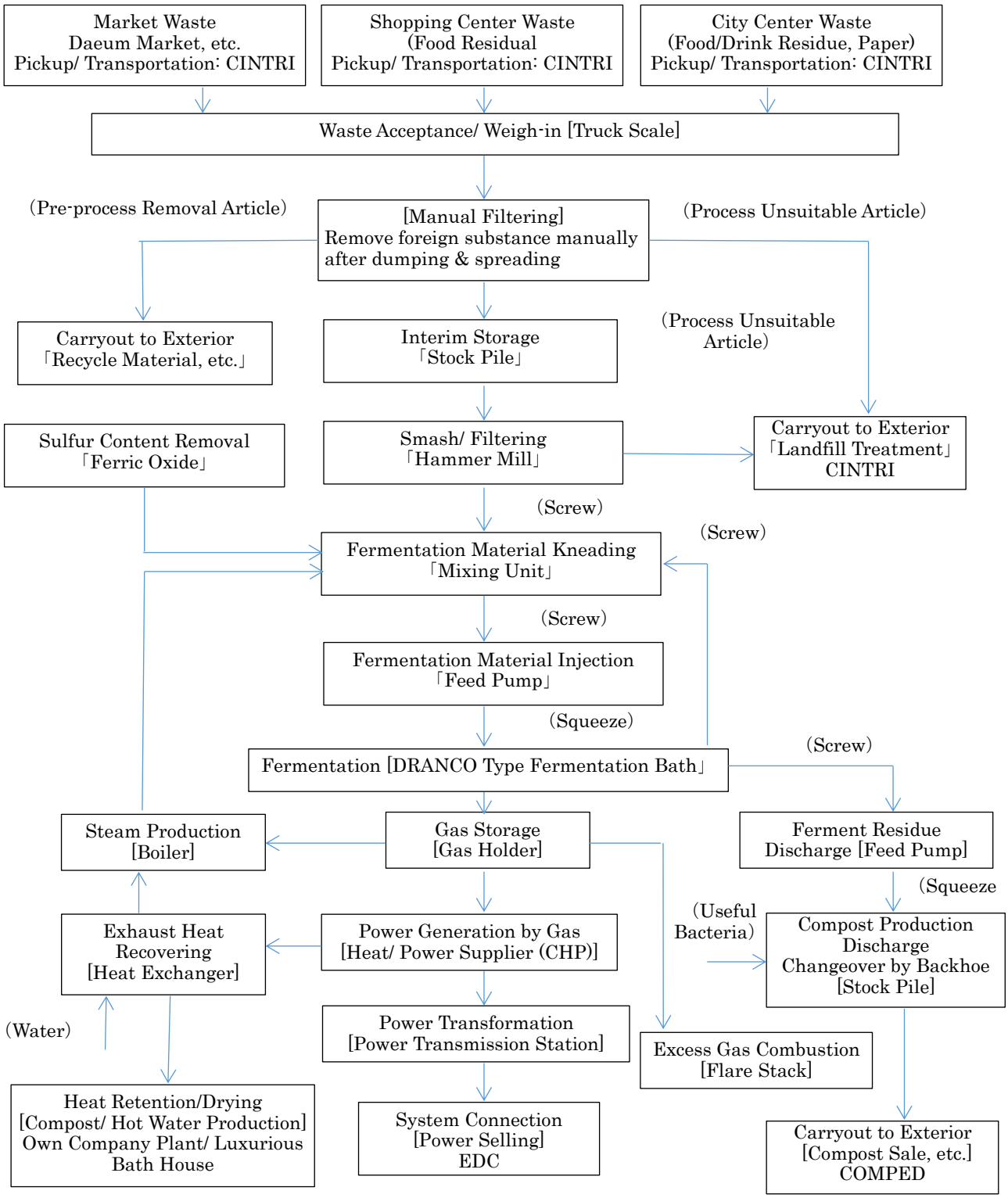


Fig. 2-6-12: Process Flow

(2) Type of Raw Material and Process Quantity

Currently, residential waste of more than 2,000 tons per day is conveyed to landfill site in Phnom Penh and landfilled by open-dumping. Most of pickup/ conveyance are performed by CINTRI and concluded pickup/ conveyance consignment contract for 50 years with Phnom Penh municipal government in 2002.

CINTRI is performing pickup/ conveyance 99% of landfill waste for Dangkao landfill site and the cooperation of CINTRI is essential in order to secure food waste stably which will be the raw material of this project and the cooperation was able to be obtained at project execution.

Table 2-6-3: Waste Landfill Amount by Business Operator (The data during July 1 and September 24, 2017)

NBR	Landfill Disposal Business Operator	Number of Transportation Vehicles (units)	Total Transportation Number of Times (units)	Landfill Amount in the Period (tons)	Assumed Annual Landfill Amount (tons)	Assumed Daily Landfill Amount (tons)
1	CINTRI	251	31,689	202 -793	810,372	2,220.20
2	Deum Kor Market	6	254	2-771	10,285	28.18
3	Praek Pnov Market	1	86	287	1,149	3.15
4	Slaughterhouse	2	244	875	3,500	9.59
5	Department of Public Work and Transport	5	230	790	3,160	8.66
6	Dangkao Landfill	2	9	12	49	0.13
7	Others Entity	1	1	2	8	0.02
	Total	268	32 - 713	207,131	828,523	2,270

※ Deum Kor Market consigned pickup/ conveyance which has been performed by itself to CINTRI since October 2017

Table 2-6-4: Procurement End and Quantity of Raw Material (food waste) required by the Project

Procurement End			Waste Acceptance Quantity		Raw Material after Foreign Material Removed	
		Area	tons/ day	tons/ year	tons/ day	tons/ year
1	Market Waste (Deum Kor Market, etc.)	Tuol Kouk	30.0	10,950.0	25.5	9,307.5
2	NAGA WORLD	Chamkar Mon	8.0	2,920.0	6.4	2,336.0
3	AEON MALL	Chamkar Mon	10.0	3,650.0	8.0	2,920.0
4	City Center Waste (Restaurant & Office Complex)	Prampir Meakkakra Doun Penh	25.0	9,125.0	20.6	7,528.1
	Total		73.0	26,645.0	60.5	22,091.6

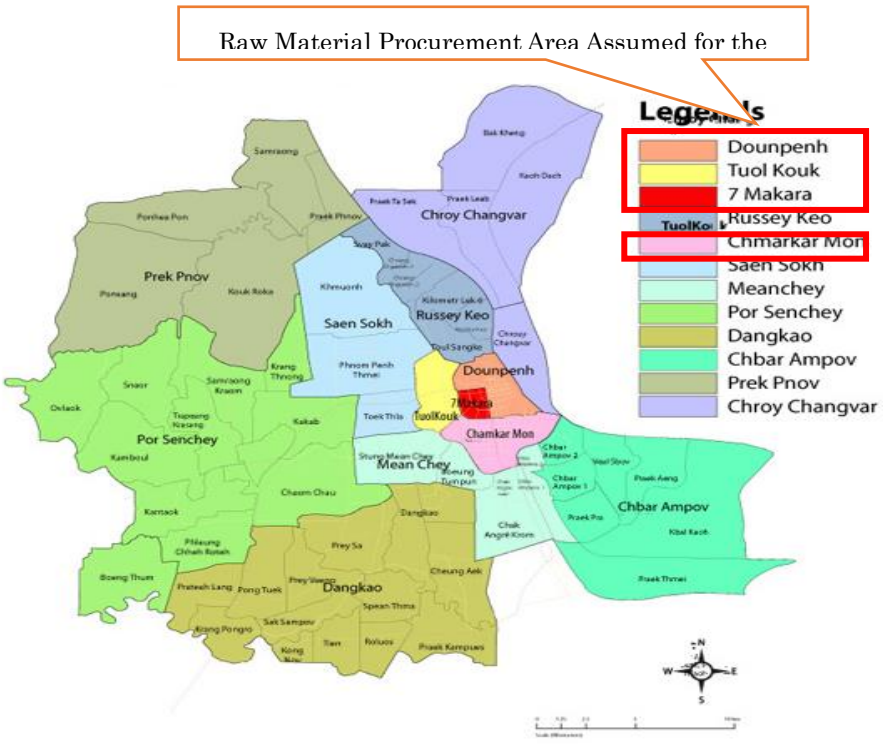
Waste as raw material is picked up from the 4 sections of Phnom Penh central part.

The distance from pickup location to the plant is the degree of 15Km ~ 20Km in one way. The waste amount needed by the plant is as small as the degree of 8/3% while the waste mount occurred in 4 sections is 883 tons/day.

Table 2-6-5: CINTRI Waste Pickup/ Conveying Amount by Area (The data during July 1 and September 24, 2017)

NBR	Area Name	Averaged Number of Vehicles per Day (units)	Transportation Number of Times per Day (units)	Waste Emergence Amount in the Period (tons)	Averaged Waste Emergence Amount per Day (tons)
1	Chamkar Mon	26	50	28,629	333
2	Doun Penh	21	29	16,113	187
3	Prampir Meakkakra	9	13	9,108	106
4	Tuol Kouk	21	37	22,135	257
5	Dangkao	5	9	5,246	61
6	Mean Chey	24	48	23,069	268
7	Russey Keo	27	45	19,053	222
8	Saensokh	22	39	32,735	381
9	Pur SenChey	37	67	31,951	372
10	Chraoy Chongvar	8	9	3,306	38
11	Chbar Ampov	6	18	9,901	115
12	Praek Pnov	3	3	1,345	16
Total			367	202,793	2,356

Raw Material Procurement Area



Source)Asia Foundation Resarch Report

Fig. 2-6-13: Area allocation where CINTRI Performs Pickup/ Conveyance

Table 2-6-6: Pickup/ Conveyance Schedule of CINTRI in Procurement Section

No.	Code	Ranking Group	Khan Name	Sangkat Name In English	Daily			
					Day		Night	
					start	finish	Start 2	Finish 3
1	1201	Khan	Chamkar Mon	Chamkar Mon	05:30	15:00	23:00	00:30
2	120101	Sangkat	Chamkar Mon	Tonle Basak	05:00	08:00	20:00	05:00
3	120102	Sangkat	Chamkar Mon	Boeng Keng Kang Ti Muoy			18:00	05:00
4	120103	Sangkat	Chamkar Mon	Boeng Keng Kang Ti Pir			19:30	05:00
5	120104	Sangkat	Chamkar Mon	Boeng Keng Kang Ti Bei			21:00	05:00
6	120105	Sangkat	Chamkar Mon	Olympic			18:00	05:00
7	120106	Sangkat	Chamkar Mon	Tuol Svay Prey Ti Muoy			20:00	05:00
8	120107	Sangkat	Chamkar Mon	Tuol Svay Prey Ti Pir			18:00	05:00
9	120108	Sangkat	Chamkar Mon	Tumnob Tuek			18:00	03:00
10	120109	Sangkat	Chamkar Mon	Tuol Tumpung Ti Pir			18:00	05:00
11	120110	Sangkat	Chamkar Mon	Tuol Tumpung Ti Muoy			18:00	05:00
12	120111	Sangkat	Chamkar Mon	Boeng Trabaek			18:00	05:00
13	120112	Sangkat	Chamkar Mon	Phsar Daeum Thkov			18:00	05:00
14	1202	Khan	Doun Penh	Doun Penh				
15	120201	Sangkat	Doun Penh	Phsar Thmei Ti Muoy	08:00	11:00	18:00	05:00
16	120202	Sangkat	Doun Penh	Phsar Thmei Ti Pir	08:00	10:00	20:00	05:00
17	120203	Sangkat	Doun Penh	Phsar Thmei Ti Bei	07:00	14:00	18:00	05:00
18	120204	Sangkat	Doun Penh	Boeng Reang	10:00	12:00	18:00	04:30
19	120205	Sangkat	Doun Penh	Phsar Kandal Ti Muoy			18:00	04:00
20	120206	Sangkat	Doun Penh	Phsar Kandal Ti Pir			18:00	01:00
21	120207	Sangkat	Doun Penh	Chakto Mukh	06:00	16:00	20:00	05:00
22	120208	Sangkat	Doun Penh	Chey Chummeah	07:00	16:00	21:00	05:00
23	120209	Sangkat	Doun Penh	Phsar Chas			19:00	04:00
24	120210	Sangkat	Doun Penh	Srah Chak	07:00	18:00	18:00	05:00
25	120211	Sangkat	Doun Penh	Voat Phnum	06:00	15:00	18:00	04:40
26	1203	Khan	Prampir Meakkakra	Prampir Meakkakra				
27	120301	Sangkat	Prampir Meakkakra	Ou Ruessei Ti Muoy			18:00	03:40
28	120302	Sangkat	Prampir Meakkakra	Ou Ruessei Ti Pir			18:20	00:30
29	120303	Sangkat	Prampir Meakkakra	Ou Ruessei Ti Bei			20:00	02－70
30	120304	Sangkat	Prampir Meakkakra	Ou Ruessei Ti Buon			19:30	04:20
31	120305	Sangkat	Prampir Meakkakra	Monourom	03:00	03:30	18:50	03:20

32	120306	Sangkat	Prampir Meakkakra	Mittapheap	15:20	16:20	18:20	04:50
33	120307	Sangkat	Prampir Meakkakra	Veal Vong	08:30	14:00	18:00	05:20
34	120308	Sangkat	Prampir Meakkakra	Boeng Proluet			19:00	08:30
35	1204	Khan	Tuol Kouk	Tuol Kouk				
36	120401	Sangkat	Tuol Kouk	Phsar Depou Ti Muoy	14:00	15:30	20:30	04:00
37	120402	Sangkat	Tuol Kouk	Phsar Depou Ti Pir	16:00	17:00	22:00	05:00
38	120403	Sangkat	Tuol Kouk	Phsar Depou Ti Bei	09:00	09:20	00:00	05:30
39	120404	Sangkat	Tuol Kouk	Tuek L'ak Ti Muoy	08:00	10:00	00:00	03:30
40	120405	Sangkat	Tuol Kouk	Tuek L'ak Ti Pir	11:00	14:00	21:00	04:30
41	120406	Sangkat	Tuol Kouk	Tuek L'ak Ti Bei	07:00	17:30	18:00	05:00
42	120407	Sangkat	Tuol Kouk	Boeng Kak Ti Muoy	08:00	17:00	02:00	05:00
43	120408	Sangkat	Tuol Kouk	Boeng Kak Ti Pir	08:00	17:00	21:00	05:00
44	120409	Sangkat	Tuol Kouk	Phsar Daeum Kor	07:00	17:30	20:00	00:30
45	120410	Sangkat	Tuol Kouk	Boeng Salang	08:00	17:00		

: Service Schedule of Raw Material Pickup/ Transportation Vehicle

Select waste discharge end and pickup route not to contain fermentation unable substance as much as possible. About 60% of waste in Phnom Penh is food waste, a lot of vegetables and fruits which contain a lot of water. The waste with a lot of solid content (TS) is desirable for dry type methane fermentation and the selection of pickup route where less water waste such as paper, garbage and so on is required.

Nighttime pickup becomes central because raw material procurement area is urban area. The schedule will be waste pickup at nighttime and bring it to the plant in early morning. CINTRI breaks up pickup area and manages the schedule for transportation vehicle, pickup time/ route with control codes. Pickup time window is adjusted by the emission source business type in order to perform efficient pickup / conveyance. Waste from office, market, shop and so on is picked up during nighttime, waste from restaurant and home is picked up from morning until daytime. The raw material required for methane fermentation is able collect required amount for required type by using CNTRI's control code. Since the most of food waste is picked up at nighttime but since it contains a lot of water, picked up waste which contains a lot of paper group is accepted by plants

.

(3) Management of Raw Material Carry-in and Carry-out / Throughput

Dangkao landfill disposal site manages the control of landfilling amount by truck schedule. Waste carry-in business operator is paying 0.75USD per 1 ton of landfilling charge for carry-in amount. Since Phnom Penh municipal government summarizes truck scale data, controls landfilling amount (discharged waste amount) by carry-in business operator and by area, the link with this plant data is essential.

They control carry-in waste amount in detail based on CINTRI's control code/ pickup route by establishing the linkage to the plant data on truck schedule at the plant, too. In addition, landfill disposal amount to Dangkao disposal site is controlled not to perform inadequate processing by measuring at carry-out and compare Dangkao's data. The obtained management data is provided to Phnom Penh municipal government to aim mutual information sharing.

In addition, reflect the result to the plant operation management by performing the analysis of carry-in waste (type of waste, water amount, organic component amount, gas amount, etc.) periodically.

(4) Overview of Preprocessing

Methane fermentation inadequate substance is removed by the following steps at preprocessing and prepare good fermented raw material.

1) Manual Filtering

Guide a waste pickup truck entered into the facility to dumping yard in building and dump the waste. Even out dumped waste with heavy machine and worker will remove/ filter fermentation unsuitable waste (large size) contained in the waste manually. Recyclable waste among removed ones is supplied to recycle market via recycle contractor.

2) Interim Storage

Manual filtering completed waste is collected with heavy machine again and is stored in stockpile temporarily.

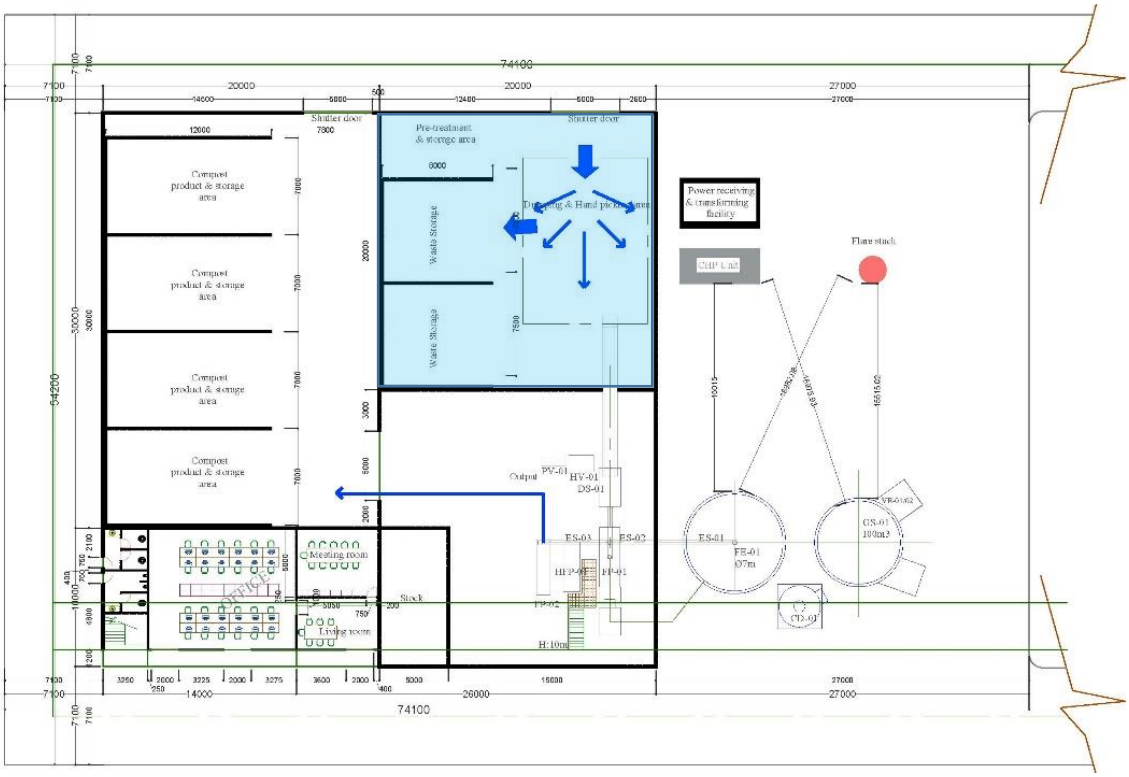


Fig. 2-6-14: Manual Filtering and Interim Storage Yard (part)

3) Fracturing/ Filtering

Inject the waste, which was stored in stock-pile, into the hopper with hammer mill with heavy machine.

Fracture the waste finely with the hammer mill and sort fermentation inadequate substance such as plastic group (vinyl bag, etc.), small metal, glass and ceramic scrap, cloth and so on which were unable to be removed from fermentation raw material. Fermentation raw material at screen under is crushed and is fed to the next process in paste form. Fermentation inadequate substance at screen top is stored in a container temporarily along with manually filtered removed substance, carried out to landfill site with waste pickup vehicle and buried.

Fig. 2-6-15: Example of Fracturing/ Filtering with Hammer Mill

(5) Overview of Methane Fermentation Process

1) Features of Dry Methane Fermentation (DRANCO Process)

・* DRANCO process is the one-step fermentation technique which is able to perform all phases of fermentation in one fermentation basin. For the reason, plant structure is simple and operation reliability is high, compared to multistage fermentation technique.

* Fermentation is performed by high-temperature fermentation fungi which are activated in the temperature range, 48°C ~ 55°C. Almost all of pathogens are extinct due to the environment of high temperature in fermentation bath and oxygen-free condition.

* Newly injected raw material and active residual are mixed at the external part of fermentation

bath (mixing unit). The mixing unit supported by this patent enables ideal raw material mixing and the device for mixing/ stirring is not required in the fermentation bath.

This feature enables the simplification of fermentation bath and trouble-free long term, stable operation of plant. Mixing of new raw material and a lot of active residual enables quick fermentation (resolution) just after reaching of mixing raw material into fermentation bath. For the reason, this is able to corresponding sudden change of supplied raw material without any problem.

* DRANCO process is performed by elect type (vertical type) fermentation bath. Hefty and rugged pump carries mixing raw material to the upper part of fermentation bath. Contents of fermentation bath move to downward by gravity force. The drawing screw installed at outer part of fermentation bath draws fermented residual to outside.
* DRANCO technique is able to process various types of wastes from fluidized waste up to extremely dry wastes with one fermentation bath. DRANCO process is able to perform semi-dry and dry fermentation and the operation of solid component rate (TS %) of contents in fermentation bath up to 40% is capable. The fermentation bath is actually operated with automatically adjusted solid component depending on TS % of raw material waste. It is able to avoid the occurrence of sedimentation and floating problems by keeping TS % of fermentation bath higher. This means that this prevents the forming of float by wood chip, foamed polystyrene, plastic and so on while sedimentation of sand, metal, glass and other heavy inactive substance are not caused.

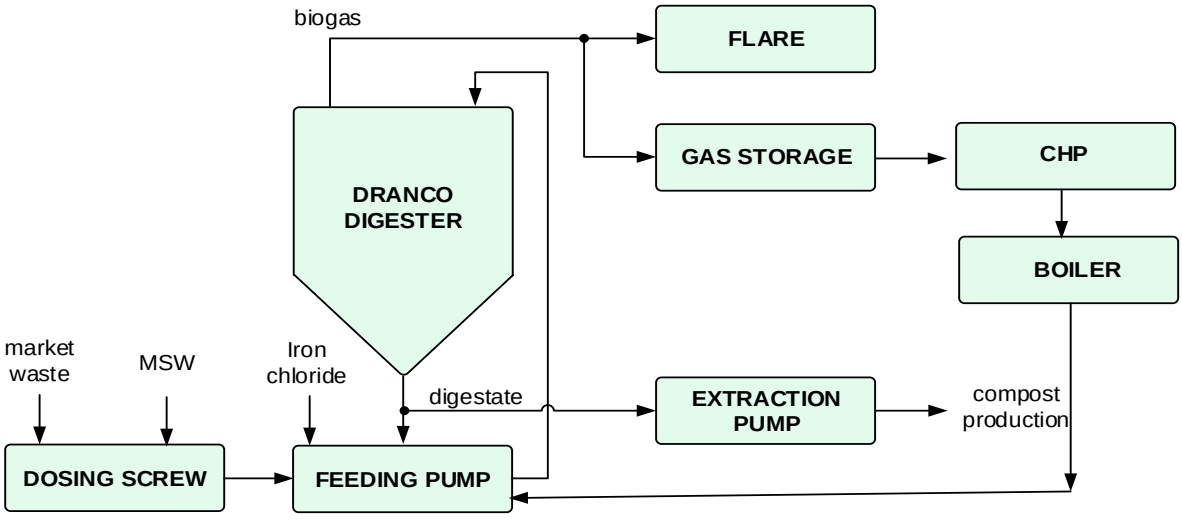


Fig. 2-6-16: DRANCO Process Flow

2) Volumetric Feeder

Broken piece (size less than 60mm) of already processed organic waste is conveyed to the hopper of volumetric feeding screw. Volumetric feeding screw conveys a certain amount of raw material to injection pump. Volumetric feeding screw is placed on measurement equipment and new raw material to be injected into fermentation bath is measured and recorded.

3) Anaerobic Fermentation

A mixing unit is placed on the upper part of injection pump and new organic waste is closely mixed with active residual. The active residue which is sent from fermentation bath which acting as seed sludge and smooth anaerobic fermentation starts as soon as mixed substance reaches to the fermentation bath. Small amount of iron chloride (FeCl2) is injected in order to reduce sulfur component concentration contained in biogas. Then, evenly mixed raw material is conveyed to fermentation bath via injection tube. The tube goes through the cone shape bottom part of fermentation bath and is extended to 1m below of fermentation bath roof. Mixed raw material is pushed out from the tube, dropped onto the raw material under fermentation and generates biogas actively. Anaerobic fermentation is performed at 20 ~ 40% of TS and the temperature of 48 ~ 55°C. The fermentation bath has the shape of vertical erect type cylinder, cone shape outlet exists at bottom and roof forms gradual cone shape.

The capacity of fermentation bath is about 1,500m^3. Entire fermentation bath is made of steel and insulation process is applied in order to prevent thermal loss. Fermented substance descends in the fermentation bath gradually depending on residue drawing rate from the bottom. Stirring device is not existed in the fermentation bath. Most of residual which leaves fermentation bath is extracted from cone shape outlet with drawing screw is conveyed to mixing unit as seed sludge and returned to fermentation bath again. Averaged residual time at fermentation bath is about 20 days. A part of fermented residual detours with drawing screw, and is sent to dehydrator. The drawing screw is double coated in order to keep fermentation bath at assumed temperature and hot water (about 90°C) is fed through this screw and shaft/ tube. In this way, fermented substance is indirectly heated and is returned to fermentation bath through injection pump. Biogas which is generated by anaerobic fermentation goes upward naturally through gap and is concentrated on the fermented substance. And the gas transits to gas storage processor from biogas outlet.

4) Biogas Storage (Gas Holder)

Biogas is continuously generated by the organic substance anaerobic fermentation in fermentation bath.

Biogas is accumulated on the residue of fermentation bath and flows out to gas storage container by pressure difference. The gas storage container is composed of double films and capacity is about 200m3. This gas storage container has double roles, one of which is to maintain minimum biogas amount and flowing back to fermentation bath if fermentation bath pressure is short, and another one is to level the peak of biogas.

The biogas in gas holder is guided to CHP and is burned by gas engine.

Excess amount of biogas is treated by combustion at flare stack when the biogas generated in gas holder got incapable to store at CHP stopping for maintenance, excess gas generation, etc.

(6) Overview of Composting Process

1) Process Flow

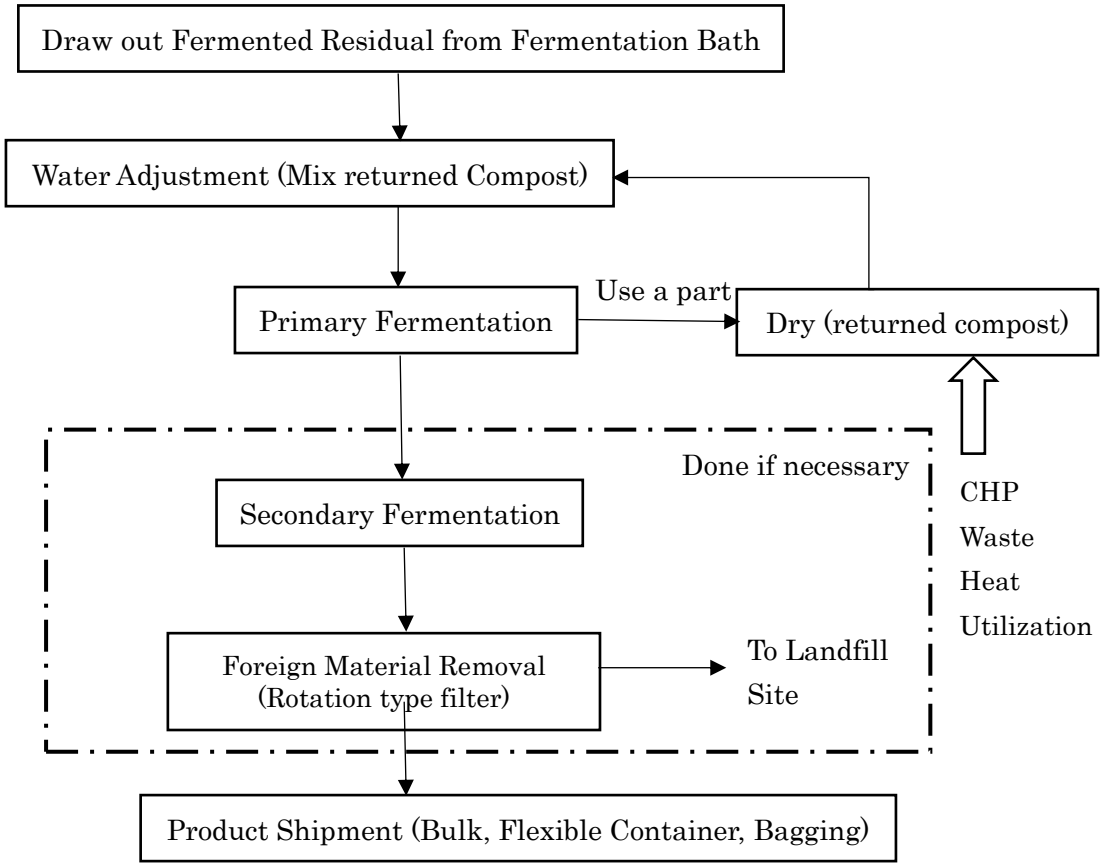


Fig. 2-6-17: Composting Flow

Residue by methane fermentation contains many organic components to be nutrient component in addition to fertilizer such as nitrogen, phosphorus, potassium and so on and becomes good compost feedstock. Composting after methane fermentation has advantages with respect to normal composting process which is produced from food waste under aerobic environment as shown below;

* Most of carbon contained in organic substance is discharged into air as unused CO2 at normal composting but the degree of 60% is able to be recovered as energy at methane fermentation as CH4.
* Since hazardous microbe is inactivated under anaerobic performance, production management is easy and contrast quality becomes stable.
* Since weed seed is also inactivated, possibility of growing weed is low.
* Since ripening (decomposition) is proceeded in fermentation bath, the time between production commencement and shipping is short. In addition, ripening degree is high and compost with high fertilizer effect (high recovery rate of nitrogen, phosphorus, potassium and so on, absorption to plants is also high) is obtained.
* Odor is reduced remarkably.

2) Compost Production/ Sales License

It is necessary to obtain license from Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF) in order to produce/ sell compost.

Table 2-6-7: Acquisition Condition for Compost Production/ Selling License and Related Service of MAFF

Item	Condition	
Prerequisite	* Agricultural engineer (higher than university faculty graduation) should be hired. * Component analysis should be performed at Lab. * Field test at agricultural land	
Required Days for Issuance	30 ~ 45 business days ❋ Terms of analysis at lab and field test are not included.	
Issuance Fee	Production Amount (tons/YR)	Expense (USD)
	100-5000	25
	5,000-10,000	50
	10,000-20,000	100
	20,000-50,000	150
	50,000-100,000	250
License Update	3Once for every 3 years ❋ Update frequency differs depending on each state.	
Lab Analysis Term	About 30 days	
Lab Analysis Expense	About 200 ~ 250USD for one fertilizer	
Others	* Registration Allocation after License Issuance * Display restriction on fertilizer exists. * Auditing of once a year exists/ * Training for sales agent and agricultural bureau is required.	

3) Compost Standard

Company standard should be set with COMPED based on Cambodian fertilizer standard and perform production control following to the company standard.

Table 2-6-8: Compost Component Standard

Analysis Item		Cambodian Fertilizer Standard	Value of COMPED Produced Compost
1	Total Amount of Nitrogen	Not eligible	2.26%
	Total Amount of Phosphorus	Not eligible	2.26%
	Total Amount of Potassium	Not eligible	1.74%
	Total	3-8%	4.61%
2	C/N Ratio	≧12:1	12:1
3	Water Component	≧35%	46.6%
4	Organic Substance Amount	≧20%	39.5%
5	pH	7-8	7.7
1	Zinc (Zn)	≦1,000	310
2	Lead (Pb)	≦100	54

3	Copper (Cu)	≦300	130
4	Total of Chrome (Cr)	≦50	34
5	Nickel (Ni)	≦50	20
6	Mercury (Hg)	≦0.15	0.079
7	Cadmium (Cd)	≦5	0.96
8	Cobalt (Co)	≦5	-
9	Molybdenum (Mo)	≦20	-
10	Arsenic (As2)	≦10	-

(7) Combined Heat and Power (Cogeneration)

Making biogas stored in a gas holder as fuel, take out 83% of energy held by biogas as electrical energy (about 40%) and as thermal energy (about 43%) by Combined Heat and Power (CHP). Electrical energy is generated by generator connected to CHP gas engine and a part of it is used in the facility but most of it is stepped up at power substation and transmit power to the line network system of electricity distribution company (EDC).

Fig. 2-6-18: Appearance of CHP

Table 2-6-9: CHP Specification

Type	avus600b (2G)
Electrical Output, Electrical Efficiency	637 kW 40.4 %
Thermal Output, Thermal Efficiency	675 kW 42.8 %
Voltage	φ3-400V 50Hz
Gas Engine Manufacturer	Jenbacher
Engine Type	Number of Cylinders, Type V70:12
Number of Revolutions	1500 rpm
Fuel Type	Biogas
Exhaust Gas Temperature	427 ℃
Gas Consumption Amount (CH_4) (at 100% load)	165 Nm3 / h
Generator Model	Leroy Somer LSAC 49.1 L9 Brushless, Single Bearing
Dimensions (L x W x H)	4700×2300×2300
Total Weight	9.1 t

In addition, hot water and burning

waste heat caused at engine cooling is used as thermalsource for fermentation bath temperature keeping (steam) and heat source for drying at the composting processing of fermented residue.

Most of biogas component to be the fuel of gas engine is methane (about 60%) and CO2 (about 40%), and foreign material such as hydrogen sulfide is a little but it is clean because soot and so on are not generated from combustion exhaust gas because foreign material has been removed by processor in advance.

(8) Odor Eliminating

Offensive odor emission source is centered to acceptance crush filtering area where food waste is accepted manually and performs interim storage. Perform odor countermeasure to outdoor from generation source while keeping status in negative pressure by installing walls around to block the part of odor leaking and suction with exhaust fan.

Exhaust the gas into air after performing chemical cleaning with carbonate hypochlorous acid solution with high odor eliminating by using deodorization equipment.

1) Odor Eliminating Technique

This is the chemical cleaning method to eliminate odor with oxidation reaction by using strong oxidation action of liquid sodium hypochlorite. This is effective for wide range odor such as ammonia, hydrogen sulfide, methyl mercaptan, methyl sulfide, etc.

The carbonate hypochlorous acid solution of chemical liquid used by this time removes odor with more strong oxidization action by mixing carbon rich-gas with sodium chlorite and increasing the liquid sodium hypochlorite content of oxidation acting molecule.

Ammonia deodorant principles by liquid sodium hypochlorite are shown below;

When ammonia (NH3) and liquid sodium hypochlorite (HClO) are reacted, mono-chloramine (NH2Cl), di-chloramine (NHCl2) and tri-chloramine (NCl3) are generated.

NH3 ＋ HClO ⇒ NH2Cl (Mono-chloramine) ＋ H2O・・・・・①

NH2Cl ＋ HClO ⇒ NHCl2 (Di-chloramine) ＋ H2O・・・・・②

NHCl2 ＋ HClO ⇒ NCl3 (Tri-chloramine) ＋ H2O ・・・・③

These reactions receive the influence of pH value and the reaction of ① becomes remarkable at pH = 7.5 or greater and maximum at pH = 8.3 Mono-chloramine and Di-chloramine are the same amount at pH = 7.

Generative formula 1 for mono-chloramine occurs within several seconds at pH = 7 ~ 9 and is the easiest.

2NH2Cl ＋ H ⇒ NH4 ＋ NHCl2

And the generated di-chloramine show complex behavior but is resolved by the formula below;

2NHCl2 ＋ H2O ⇒ N2 ＋ HClO ＋ 3H ＋ 3Cl

Table 2-6-10: Overview of Liquid Sodium Hypochlorite Deodorant Technique

2) Deodorant Method by Hypochlorous Acid Solution

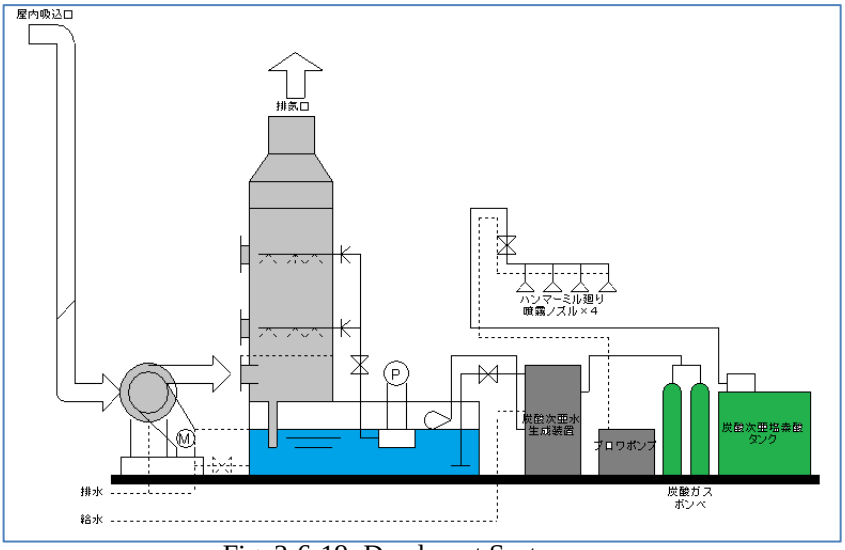


Fig. 2-6-19: Deodorant System

2-6-3 Major Facilities and Suppliers

Major equipment is procured from proven EU manufacturers because this will become the first plant in Cambodia. Localization will be aimed for expansion or the second plant an after as much as possible.

Table 2-6-11: Major Equipment/ Device and Supplier

Category	Quantity	Major Specification	Supplier (planned)

Deodorizing (Deodorization) Method	Principle	Feature	Major Application	Points to Remember
Deodorization/ Deodorizing Method by Carbonate Hypochlorous Acid Solution Twin-Fluid Atomization	Make it odorless by spraying carbonate hypochlorous acid solution for which the content amount of liquid sodium hypochlorite with strong oxidation action was increased by 8 times or more by mixing pH conditioning agent into alkaline sodium hypochlorite.	This is the sterilization deodorant which is able to spray carbonate hypochlorous acid solution with safe and high odor eliminating, also formulated in human body, directly into the facility during work.	Livestock Production Facilities (Reduction of infection by sterilization and odor eliminating are obtained by spraying the agent directly into pig house in rearing facilities.) Fertilizer/ Feeding Stuff Manufacturing Plant Food Manufacturing Plant Waste Treatment Site	Maintenance of Chemical Mixer is required.

Truck Scale	1	Unit	30t	Site
Hammer Mill	1	Set	15m^3/h 、Hopper equipped, crush down to 60mm or smaller	Germany, Wackerbauer Company
Dehydration Screw	1	Unit	Vertical Type, for Transfer	Site
Constant Amount Supply Screw	1	Unit	Hopper equipped	Belgium OWS Company
Raw Material Injection System	1	Set	Hopper/ Kneader/ Squeeze Pump Integrated Type; Hydraulic Unit	
Fermentation Bath	1	Unit	1,500m^3	
Draw Out Screw	2	Unit		
Residue Conveyer	1	Set	Transport to Compost Production Yard	
Hydraulic Valve	1	Set	Valve, Hydraulic Unit	
Air Pressure Valve	1	Set	Valve, Hydraulic Unit	
Biogas Cleaner	1	Set	Hydrogen Sulfide Removal	
Gas Holder	1	Unit	200m^3, Double Film Structure	
CHP	1	Unit	Power Output: 637kW Thermal Output: 675kW	Germany, 2G Company
Boiler	1	Set		Site
Flare Stack	1	Unit	Excess Gas Combustion	Site
Transmission Substation	1	Unit	Connection of EDC to MV/LV	

2-6-4 Construction System and Cooperative Companies

This is the first project for large scale and fully-fledged methane fermentation plant in Cambodia. For the reason, there is no construction company which has experienced methane fermentation plant in domestic Cambodia. However, facility construction related to plant construction work such as Beverage and bioethanol plants by overseas capital, beer factories by local capital and so on is increased recently and some engineering industries are grown.

Entrusting construction to domestic industries is important when considering the progress of methane fermentation in domestic Cambodia in future.

Table 2-6-12: Major Plant Engineering Industry

Name of Industry	Overview	Website
Camatec Engineering & Construction	* China originated engineering/ construction industry * Rich experience of plant related construction work such as ANCHOR Beer, MH, bioenergy, etc. * No actual experience with Japanese industries	http://www.camatec.com.kh
SOMA Construction &	* Construction company in SOMA group, conglomerate in Cambodia	http://smg.somagroup.com.kh:8669/page/homepage/

Development	* They has the experience of SOMA Energy Plant, the group company * Tie-up with KOBELCO ECO-Solutions	
Comin Khmere	* Denmark originated engineering/ facility industry * Comin Asia's industry, expanding SEA zone, in charge of Cambodia * Many experiences for architectural equipment such as Phnom Penh tower, etc. There is Coca Cola plant. * EU originated engineers are many.	http://kh158.yp.com.kh/

Table 2-6-13: In Charge of Design/ Operation

NBR	Scope of Work	Responsible Company
1	Plant Facility	
1-1	Design	OWS
1-2	Manufacturing	OWS
1-3	Installation	CAMATEC Engineering
1-4	Trial Operation/ Adjustment	OWS
2	Engineering/ Architectural Structure	
2-1	Design	CHIYODA KENKO Co., Ltd.
2-2	Construction	CAMATEC Engineering
3	Piping, Electric Construction	
3-1	Design	CHIYODA KENKO Co., Ltd.
3-2	Construction	Comin Khmere

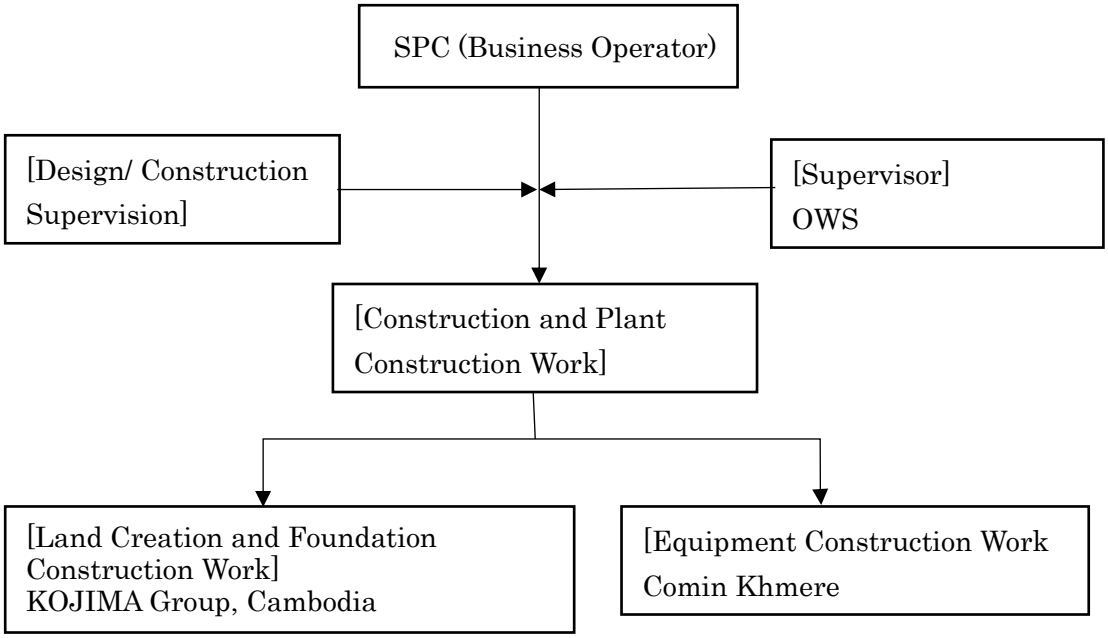


Fig. 2-6-20: Construction System

2-6-5 Estimation of Construction Cost

Estimation of construction cost in case of making candidate in Prek Chrey as business location is as follows;

Table 2-6-14: Construction Cost

	Item	Major Specification	Expense (USD)
1	Land Acquisition Cost	5,000m^2	500,000
2	Development Work	Filling Construction, Water Discharge Equipment	200,000
3	Construction Work: Construction, Foundation Road, Outdoor Facility	Plant Building Tank Foundation Circuit Road, Net Fence, Planting	950,000
4	Plant Construction Work: Equipment Procurement Electric Construction Work Equipment	Methane Fermentation Processor, CHP Piping, System Connection	7,350,000

	Assembly Piping, Instrumentation		
5	Heavy Machine, Vehicle Heavy Machine Business Vehicle	Backhoe, Wheel loader, Crane	500,000
6	Total		9,500,000
7	Tax Imposition	10%	950,000
8	Total		10,450,000

2-7 Plant Operation and Management

2-7-1 Plant Operation Management Method and System

(1) Operation Management

The plant is operated automatically. The management/ instrumentation system of plant are consisting of PC and PLC (Programmable Logic Controller) and connected each other with network. All digital and analog signals sent from the plant are gathered to PLC and converted as required external signals. Communication between plant manager and PLC is performed via PC. Operation at each part of plant is able to be remotely controlled from the flow sheet on screen.

(2) Operation Hours

Plant is operated 24 hours, 365 days since waste as raw material is put into store not only in daytime but also in nighttime. However CHP is operated for 330 days (8,000 hours) since 10% of annual number of days is allocated to maintenance. The maintenance for other equipment/ device is performed tailored to the timing of CHP maintenance.

(3) Plant Operation System

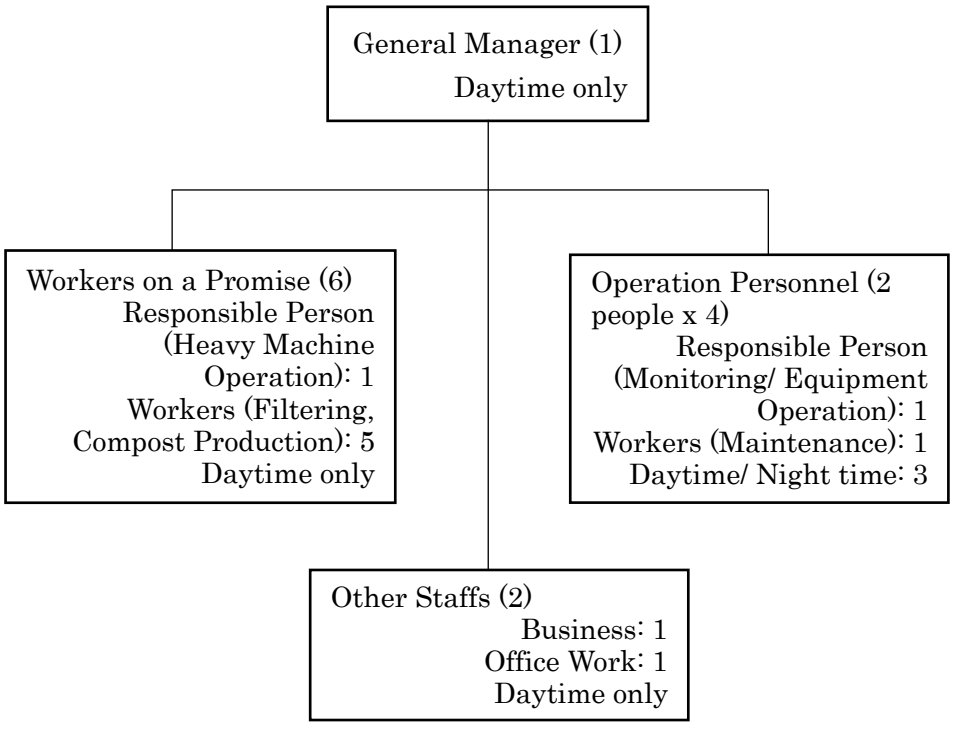


Fig. 2-7-1: Plant Operation System

Operation should be 365 day per year and 24 hours a day (3-shift system by dayshift and night shift)

2-7-2 Plant Management Method

(1) Operation Management

DRANCO plant operates in full automation. The management/ instrumentation system of plant are consisting of PC and PLC (Programmable Logic Controller) and connected each other with network. All digital and analog signals sent from the plant are gathered to PLC and converted as required external signals. Communication between plant manager and PLC is performed via PC. Operation at each part of plant is able to be remotely controlled from the flow sheet on screen.

(2) Equipment Inspection and Maintenance

Inspection frequency and maintenance contents of respective major equipment are as follows;

Table 2-7-1: Maintenance Contents of Major Equipment

Equipment Name	Inspection Frequency	Maintenance Contents
Fracture Filtering Equipment	Once/YR	Inspection and Replacement of Fracturing Sward
Constant Amount Supply Equipment	Once/YR	Inspection, Measurement Correction and Seal Replacement
Belt Conveyer Group	Once/YR	Inspection, Roller Replacement and Belt Repairing
Screw Conveyer Group	Once/every 2 to 3 years	Seal Replacement
Injector Auger Feeder	Once/YR	Seal Replacement

Injector Pump	Once/YR	Seal Replacement
Gas Engine Power Generator	Once/YR	Overhaul at every Setup Time
Boiler YR	Once/YR	Inspection, Extraneous Matter Removal and Burner Replacement
Blower	Once/ YR	Inspection, Extraneous Matter Removal and Filter Replacement

(3) Durability of Component

The equipment with structure for which attention is made to durability is less because high temperature part and high speed moving part are less.

Repair required equipment are crane, fracture filtering equipment, pump group, conveyer group, power generator and so on but there is no special equipment and maintenance/ inspection same as existing waste treatment facilities is acceptable. In addition, it is necessary to use biogas using equipment with hydrogen sulfide, siloxane and so on which are subjected to be removed with allowable concentration to respective equipment, or below.

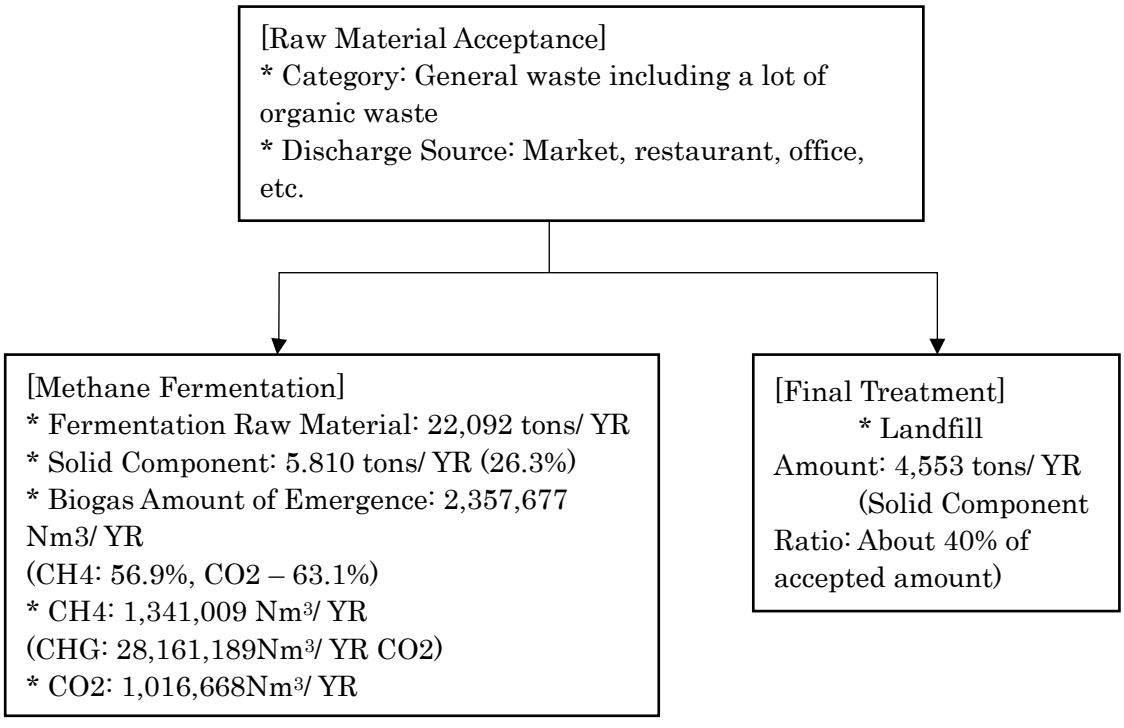
(4) Inspection Items for Routine Operation

* Gas leakage from tank, piping, etc.
* Abnormal noise, vibration from transfer equipment group such as conveyer, etc.
* Pressure and temperature of hydraulic unit
* Pressure in fermentation bath, biogas amount of emergence
* Pressure of fan group, flow rate

2-8 Review on Project Feasibility

2-8-1 Project Estimation

(1) Business Flow



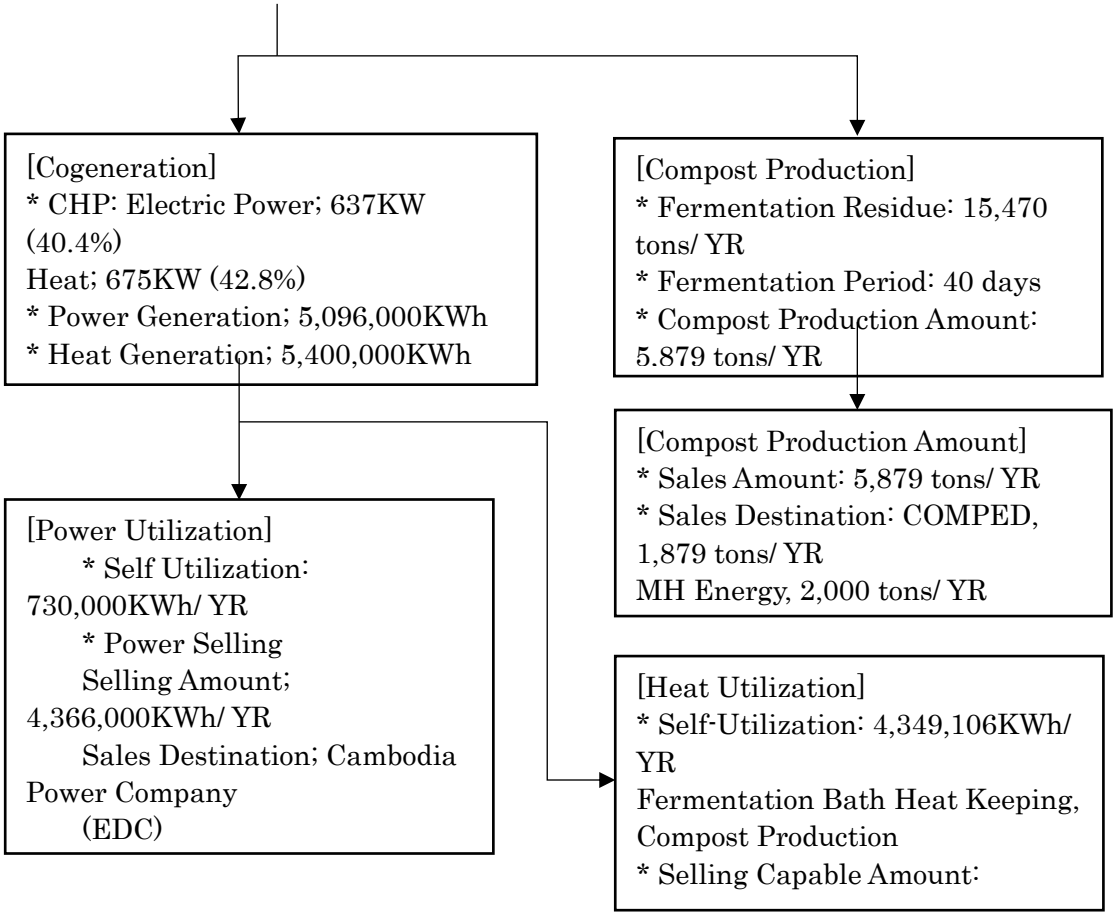


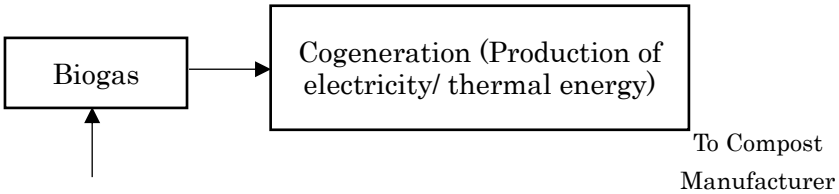
Fig. 2-8-1: Business Flow

(2) Stable Acquisition of Raw Material

Compost demand is strong in Cambodia and many business operators are focusing on abundant food waste and are going to produce compost from food waste. However know-how and professional knowledge such as fermentation enzyme in addition to water, temperature, and air amount are required to produce compost and it is difficult to produce good quality compost for non-experienced people, and cases of failure are many.

Realize raw material stable acquisition not by squabbling about food waste with compost manufacturer but by aiming cooperation with them who supply residue after methane fermentation and forming scheme of utilizing food waste more efficiently.

■ Raw Material Procurement Expense:: Free of charge



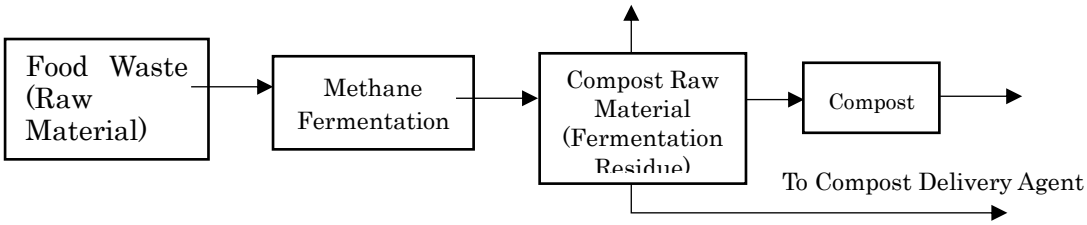


Fig. 2-8-2: Scheme to Secure Raw Material Steadily

(3) Stable Income Acquisition

1) Electric Power Selling

Produced electric power should be sold to EDC. Since there is no Power Purchase System (FIT) for recyclable energy in Cambodia, the upper limit of EDC power purchase cost is 0.1USD.

The purchase cost is decided by the Electricity Authority of Cambodia (EAC, Subsidiary of Ministry of Industry Mines and Energy, MIME) but is determined by the mutual consultation with EDC.

As the result of mutual consultation, the sales cost to EDC was determined as follows;

- Electric Power Selling Price to EDC: 0.08USD/kWh

  ❋ In fact, the change to 0.1 USD/KWh will be requested by State Minister of Environment at project execution phase. (Mutual consultation between Minister of Industry Mines and Energy, State Minister of Environment and director general of EDC)

Table 2-8-1: Estimated Income by electric Power Selling

Item	Amount	Unit
Power Generation Amount Generation Capacity (Efficiency)	5,096,000 637(40.4)	KWh/ YR KW (%)
Usage Amount in-Facility	730,000	KWh/YR
Electric Power Sales Amount	4,366,000	KWh/YR
Electric Power Sales Unit Price ❋ Desired Unit Price	0.08 0.10	USD/KWh
Electric Power Sales Income	379,280	KWh/YR

❊ Desired Income	436,600	

2) Thermal Utilization (Sales)

The feature of cogeneration by CHP is to take out thermal energy same as electricity or greater. When fully using electric energy and thermal energy, this means that about 85% of biogas having total energy is able to be utilized. One could argue that parallel establishment of beverage plant and food plant which consume a lot of thermal energy as well as electric energy, is the most effective utilization method but still it is rare case currently.

In addition, since cooling demand is large in hot temperature Cambodia throughout a year, the cooling with gas combustion natural chiller not depending on cogeneration leads to effective energy utilization. It is considered that construction plan for large scale facility such as large shopping center just like AEON-MALL; high-rise apartment building and so on will be increase in future. It is also considered that participation to these construction plans through the tie-up with natural chiller manufacturer like Panasonic leads to the usage expansion of this system.

As for the thermal utilization in addition to these, it is considered that thermal supply to brick plants which show remarkable increase than active housing demand is also effective thermal utilization. Firewood has been used as thermal source traditionally but the use of coal started at large brick plant since material wood rose suddenly due to destructive lumbering. It is able to utilize as the fuel for kiln in case of gas utilization and to dry process in case of CHP waste heat utilization.

Table 2-8-2: Usage Example of Thermal Energy

Utilization Method		Application Example
Direct Gas Utilization	Natural Chiller (Absorption Type Hot/Cold Water Service Machine)	Cooling/ Hot-Water Supply of Large Facility Shopping Mall, Hotel, etc.
	Gas Burning Appliances	Gas-Fired Kiln in Brick Plant
	CH_4, CO_2 Gas Separation	CH_4: Fuel CO_2: For welding, Medical Care and

		Beverage
Cogeneration	Hot Water Utilization	Hot-Water Supply for Hotel, High-Rise Apartment Building, Hot Spring, etc.
	Steam Utilization	Sterilization/ Drying and Various Heat-Retention of Food Milk, Snack, Various cup-noodle, etc.
	Hot Wind Utilization	Drying (Food, Bricks, etc.) Wood, Agricultural Products, Building Material, etc. Various Heat-Retention

In this project, thermal energy is taken out directly from thermal source (cooling water, exhaust gas) generated by CHP or by heat exchanger and utilized for heat retention in fermentation bath, compost heat retention and water component adjustment (Dry). Furthermore, the future utilization at warm bath facilities is considered for excess heat.

Table 2-8-3: Estimation of Thermal Utilization and Future Income

Item	Amount	Unit
Thermal Generation Amount Thermal Generation Capability (Efficiency)	5,400, 000 675(42.8)	kWh/YR KWh (%)
Used Amount in Facility	4,349,106	KWh/YR
Heat Sales Capable Amount	1,050,894	KWh/YR
Hot-Water Production Amount (50°C)	24,020	tons/YR
Hot-Water Sales Income ※ In Case of Warm Bath Facilities	36,030 1.5	USD/YR USD/tons

3) Compost Production/ Sales

The organizations where compost is manufactured organically in domestic Cambodia currently are NGO such as Community Sanitation and Recycling Organization (CSARO), COMPED and so on, and either production amount is less than 1,000 tons/ YR which is small size. Most of demand is purveyed by the 700 ~ 800 thousand ton compost per year imported from Vietnam, Thailand, Japan, China, etc.

The import is performed by fertilizer sales outlet and compost is imported in bulk and sold after bag packing. The sales outlet also imports/ sells chemical fertilizer. This was originally packed into a bag with instructions but there is a problem of users hard to understand how to use because the instruction has not been translated. In addition, sales outlet is interested in

compost made in domestic Cambodia for which cost reduction is expected because farmers have the tendency of loving familiar and safe compost and imported compost is expensive.

Table 2-8-4: Compost Production/ Sale Status

Item	COMPED	CSARO	Compost Sales Agent
Supplier	Food Waste in Battambang City (Filtering at landfill site)	Payed Purchasing of food waste from markets and restaurants in Phnom Penh City	Import from Vietnam, Thailand, Japan, China, etc.
Production Amount (Sales Amount)	100 tons/YR	300 tons/YR	700 ~ 800 thousand tons/ YR
Sales Price	100～120USD/ tons 40kg packed in a bag	160 ～ 180USD/tons in bulk or packed in a bag ❋ Phnom Penh is a little higher	13 ~ 28USD/bag 50Kg packed in a bag ❋ Price is different largely depending on the country of origin.

Table 2-8-5: Planned Compost Sales Destination and Sales Amount/ Sales Unit Price

Sales Destination	Sales Amount	Sales Unit Price	Target
Business Partner	30%	100 (USD/ton)	COMPED
Major Customer	30%	120 (USD/ton)	MH Bioenergy, etc.
Sales Agent	40%	130 (USD/ton)	Bayon Heritage, etc.
Average		118 (USD/ton	

Fig. 2-8-3: Battambang Compost Plant of COMPED

* Compost plant is located close to landfill site, collecting raw material from landfill site every half month by changing the spot and performs composting with every bundle. (Phot at left)
* Temperature and air are controlled but water is not controlled in a precise sense. Rather dry.
* Yield rate is low because the raw material is not fractured. Remove foreign matters with shifter and packed in bag before shipment. (Photo at right)

There are advantages for compost production by methane fermentation as shown below;

* Carbon is discharged into air as CO2 without converted to energy at compost production under existing aerobic situation. Meanwhile, carbon is converted to biogas (CH4 and CO2) by methane bacteria under anaerobic performance in methane fermentation first and extracted as energy. Organic amount converted to biogas is the degree of half of food waste (raw material) having organic amount, half of organic component stays in fermented residue and is the subject material as fertilizer.
* Since the fermented residue which will be the raw material of compost is taken out at the status of ripening proceeded in fermentation bath, it is able to shorten composting number of days and reduce production cost. In addition, fertilizer effect is high because active ingredient of nitrogen, phosphorus, and potassium and so on are easy to be detached and it is often shipped out only with primary fermentation in EU.
* Offensive odor emission is seldom because hazardous microbe is inactivated under anaerobic environment for long time and copulation of useful EM bacteria gets easy.
* Compost becomes homogeneous because material is cut finely by repeated squeeze at methane fermentation process after fracture and particles get constant. In addition, ripening progress is accelerated because air mixing by cutting back gets easy and good quality compost is able to be produced in short time.
* Heat retention/ drying of compost by using cogeneration waste heat are easy to be performed.

As the shortage;

* The shortage is that facility cost gets higher than independent compost facility. It is able to cover by effectively using electric power and thermal energy produced by cogeneration.

(4) Estimation Condition

Table 2-8-6: Raw Material Procurement Amount, Gas Generation Amount and Energy Amount

Raw Material Supplier		Acceptance Amount		Removing Amount	Raw Material Used Amount		Solid Component (TS)	
		tons/day	tons/ YR	tons/ YR	tons/day	tons/ YR	%	tons/ YR
1	Waste from Market	30.0	10,950.0	1,642.5	25.5	9,307.5	20.0%	1,861.5
2	Waste from NAGA WORLD	8.0	2,920.0	584.0	6.4	2,336.0	25.0%	584.0
3	Waste from AEON-MALL	10.0	3,650.0	730.0	8.0	2,920.0	25.0%	730.0

4	Waste from City Center (Restaurant & Office Complex)	25.0	9,125.0	1,596.9	20.6	7,528.1	35.0%	2,634.8
	Total or Average	73.0	26,645.0	4,553.4	60.5	22,091.6	26.3%	5,810.3

	Raw Material Supplier	CH_4 Amount	CO_2 Amount	Electric Energy Amount	Thermal Energy Amount
		Nm^3/YR	Nm^3/YR	KWh/YR	KWh/YR
1	Waste from Market	382,910.6	313,290.5	1,534,067.3	1,625,200.0
2	Waste from NAGA WORLD	144,973.6	100,744.4	580,812.6	615,316.4
3	Waste from AEON-MALL	181,217.0	125,930.5	726,015.8	769,145.5
4	Waste from City Center (Restaurant & Office Complex)	631,908.0	476,702.5	2,531,634.0	2,682,028.1
	Total or Average	1,341,009.2	1,016,667.8	5,372,529.8	5,691,690.0
	Raw Material Procurement Cost	Free of Charge			

Table 2-8-7: Energy Generation Amount by CHP, External Salable Amount and External Sales Unit Price

Item	Amount	Unit	Remarks
CHP Electrical Efficiency	40.4	%	avus 500b (By 2G)
CHP Thermal Efficiency	42.8	%	
CHP Power Generation Capacity	637	KW	
CHP Thermal Generation Capacity	675	KW	
CHP Operating Time	8,000	h/YR	
Annual Power Generation Amount	5,096,000	KWh/YR	<Electric Energy Amount: 5,372,529.8
Annual Thermal Generation Amount	5,400,000	KWh/YR	< Thermal Energy Amount: 5,691,690.0
Internal Power Used Amount	730,000	KWh/YR	14.3% of Power Generation Amount
Internal Thermal Used Amount	4,349,106	KWh/YR	80.5% of Thermal Generation Amount
Power Salable Amount	4,366,000	KWh/YR	
Heat Salable Amount	1,050,894	KWh/YR	
Compost Salable Amount	5,878.6	tons/YR	
Power Sales Unit Price	0.08	USD/kWh	Unit Price Agreed with EDC

Heat Sales Unit Price	2.5	USD/ton	Selling as Hot Water (Future) → Not included in estimation
Compost Sales Unit Price	118	USD/ton	Unit price may differ depending on average and supplier.

(5) Investment Money Amount

Business investment at each phase until operation is as follows;

Table 2-8-8: Investment Item and Investment Money Amount

Phase	Investment Item	Investment Money Amount (K USD)	Remarks
Preparation Phase	License Acquisition/ Various Permission and Authorization Power Generation Project EIA (Waste Treatment, Compost Production) Travel Expense/ Temporary Office Expense	150	Consigned to local consultant
	Various Surveys Site Measurement Geological Survey Travel Expense/ Temporary Office Expense	100	Consigned to local research company
Planning Phase	Design Fundamental Design Execution Design	300	Consigned to CHIYODA KENKO (civil engineering and construction) Consigned to OWS (Plant)
	Operation Preparation Labor Cost Training Cost Temporary Office Expense	200	
Construction Phase	Land Procurement	500	5,000m^2
	Land Development Construction	200	Consigned to KOJIMA Group, Cambodia
	Construction Work Foundation Construction Plant/ Office Building Construction Plant Construction Outdoor Facility Construction	8,300	Consigned to CAMATEC Engineering (entire construction) * KOJIMA Group, Cambodia (Foundation, Outdoor Facility) * Comin Khnere (Facility) * Plant Equipment (OWS) CHIYODA KENKO (Design, Construction Supervising)
	Heavy Machine Procurement Backhoe, Wheel loader, Crane	500	
Operation Phase	Running Cost Labor Cost Management Cost	500	Amount for 1 YR

	Sales Cost Plant Operation Cost		
Total		10,550	

(5) Business Operation Cost

Table 2-8-7: Business Operation Cost

	Item	Expense (USD/YR)	Amount	Unit
Plant Running Cost	Fermentation Inadequate Substance Landfill Cost Generation Amount	26,182	4,553.4	tons/ YR
	Chemical Cost (Iron Chloride) Amount Used	5,500	50.0	tons/ YR
	Water Duty Cost	3,000		
	Electric Power Cost (Reserved)	2,400		
	Fuel Cost	12,000		
	Plant Maintenance Cost	116,253		
	Subtotal	165,335		
Management Cost	Labor Cost Operator (3 shift, 4 crews) Workers on a Promise Manager, Sales Staff, Clerk	112, 800 (48,000) (25,200) (39,600)	 8 6 3	 people people people
	General Administrative Cost	33,840		
	Sales Cost	36,000		
	Fixed Asset Tax	5,800		
	Depreciation (10 years) Self-Investment Amount: 50% Facility Aid: 50%	237,500	5	%
	Subtotal	425,940		
	Total	591,275		

(7) Business Income and Expenditure

Annual business income and expenditure was estimated with prerequisite that 50% of

construction cost is brought by facility aid. This plant will be operated for long time but business income and expenditure was set to 20 years with setting conditions as follows;

* Income

  Electric Power Selling Price (Fixed): 0.08USD/KWh

  Compost Sales Price (Fixed): 118USD/ton

* Expenditure

  Labor Cost and General Administrative Cost: 5% Increase/YR

  Depreciation: Equal Depreciation for 10 years

* Tax Imposition

  Business Tax Exemption Period by Qualified Investment Project (QIP): 5 Years

[Estimation Result]

■ Investment Payout Number of Years: 16.5 Years ■ IRR：8.8%

As the result of estimation, it is determined that this project will fully come into effect as a project based on the points below;

* Since longer than 20 years of operation is required as a plant which handles general waste, 16.5 year investment payout number of years will not be a problem specifically.
* IRR is 8.8% and is higher than 8% by which it is typically determined that business feasibility exists.

Initial Investment Amount

Preparation/ Running Fund	1,050	(K USD)	
Construction Cost	4,750	(K USD)	(Facility Aid 50%)
Investment Total:	**5,800**	(K USD)	

Financing

Own Capital:	18%	1,050	(K USD)
Debt Loan:	82%	4,750	(KUSD)

Borrowing Condition		
Interest Rate on Borrowing	1.00%	
Payback Period:	10	(YR)
Period of Deferment :	2	(YR)

Annual Income

Expense Item	Amount	Unit	Unit Price (USD)	Money Amount (USD)
Power Selling	4,366,000	(kWh)	0.08	349,280
Heat Sales	0	(kWh)	0.00	0
Compost Sales	5,879	(tons)	118.00	693,675
Total				**1,042,955**

Tax

(Profit tax) :	20.0%	*0% by QIP tax exemption (for 5 YR)
(Value Added tax) :	10.0%	
(Patent tax) :	1.0%	
(Property tax) :	0.1%	
(Building & Structure) :	5.0%	

Annual Spending

Expense Item		Amount (USD)	Remarks
1)	Labor cost	112,800	Management, Mechanics, Work, Office Work, Insurance, etc.
2)	Plant maintenanc	116,253	Generator, Pump, Piping Group, etc.
3)		17,400	Power, Water, Fuel, etc.
4)		5,500	Iron Chloride
5)		26,182	Landfill at Final Disposal Site
6)		36,000	
7)		33,840	Sales Management Cost, Welfare Cost
8)		5,800	Fixed Asset Tax
9)		237,500	Building, Structure: 5% constant Rate
10)	Total	**591,275**	

Estimation Result

Business Profitability Index	Numerical Value	Calculation Base
Invested Capital Pay-Back Period	16.5 (YR)	Period: $\frac{\text{Fund Settlement Remains}}{\text{Capital Investment Amount}} = 1$
Internal Rate of Return (IRR)	8.8%	$\sum_{t=1}^{n} \frac{B_t - C_t}{(1+i)^t} = 0$ Calculated by B (=Business Profit + Depreciation Cost). C (= Investment Capital)

Table 2-8-10: Initial Investment and Annual Income and Expenditure

Table 2-8-11: Estimation of Gain or Loss/ Cash Flow (20 years)

Estimation of Gain or Loss/ Cash Flow (20 years) (K USD)

Expense Item \ Year			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Income	Power sale	(Increase Ratio/y 0%)	0.0	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3	349.3
	Heat sale	(Increase Ratio/y 0%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Compost sal	(Increase Ratio/y 0%)	0.0	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7
	Total		0.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0	1043.0
Spending	Labor cost	(Increase Ratio/y 5%)	0.0	112.8	118.4	124.4	130.6	137.1	144.0	151.2	158.7	166.7	175.0	183.7	192.9	202.6	212.7	223.3	234.5	246.2	258.5	271.5	285.0
	Plant maintenance cost		0.0	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3
	Water&Energy cost		0.0	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
	Chemical cost		0.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Waste disposal cost		0.0	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
	Sales cost		0.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
	Admin cost	(Increase Ratio/y 5%)	0.0	33.8	35.5	37.3	39.2	41.1	43.2	45.3	47.6	50.0	52.5	55.1	57.9	60.8	63.8	67.0	70.4	73.9	77.6	81.4	85.5
	Tax		0.0	5.8	5.6	5.3	5.1	4.9	4.6	4.4	4.1	3.9	3.7	3.4	3.2	3.0	2.7	2.5	2.2	2.0	1.8	1.5	1.3
	Depreciation cost	(5%/y)	0.0	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5
	Total		0.0	591.3	598.4	605.8	613.7	621.9	630.6	639.7	649.3	659.4	670.0	681.1	692.8	705.1	718.1	731.6	745.9	760.9	776.7	793.3	810.7
Business Profit			0.0	451.7	444.6	437.1	429.3	421.0	412.4	403.2	393.6	383.6	373.0	361.8	350.1	337.8	324.9	311.3	297.0	282.0	266.3	249.7	232.3
Non-Operating	Investment gains	5.00%	0.0	0.0	32.1	65.4	76.3	87.6	99.2	106.0	112.8	119.7	126.7	133.7	140.7	147.8	178.6	210.0	242.3	275.2	308.8	343.2	378.2
	Interest Rate	1.00%	0.0	47.5	47.5	47.5	42.8	38.0	33.3	28.5	23.8	19.0	14.3	9.5	4.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Non-Operating Income		0.0	(47.5)	(15.4)	17.9	33.5	49.6	66.0	77.5	89.0	100.7	112.4	124.2	136.0	147.8	178.6	210.0	242.3	275.2	308.8	343.2	378.2
Profit of the Term before Tax			0.0	404.2	429.2	455.0	462.8	470.6	478.3	480.7	482.7	484.3	485.4	486.0	486.1	485.6	503.5	521.4	539.3	557.2	575.1	592.9	610.5
Business Tax: 20%		(0% for 5 years by QIP)	0.0	0.0	0.0	0.0	0.0	0.0	106.1	106.6	107.0	107.3	107.5	107.6	107.7	107.6	111.1	114.7	118.3	121.9	125.4	129.0	132.5
Profit of the Term			0.0	404.2	429.2	455.0	462.8	470.6	372.2	374.1	375.7	377.0	377.9	378.4	378.5	378.1	392.3	406.7	421.0	435.3	449.6	463.9	478.0
Financial Inflows	Own capital		1050.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Borrowing		4750.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profit of the Term		0.0	404.2	429.2	455.0	462.8	470.6	372.2	374.1	375.7	377.0	377.9	378.4	378.5	378.1	392.3	406.7	421.0	435.3	449.6	463.9	478.0
	Depreciation Cost		0.0	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5
	Debt Loan at the Beginning of Period		0.0	0.0	641.7	1308.3	1525.9	1751.2	1984.3	2119.0	2255.6	2393.9	2533.3	2673.7	2814.6	2955.6	3571.1	4200.9	4845.1	5503.6	6176.4	6863.6	7564.9
	Total		5800.0	641.7	1308.3	2000.9	2226.2	2459.3	2594.0	2730.6	2868.9	3008.3	3148.7	3289.6	3430.6	3571.1	4200.9	4845.1	5503.6	6176.4	6863.6	7564.9	8280.4
FinancialOutflows	Equipment Investment		5800.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Repayment of Debt(2 years deferred)		0.0	0.0	0.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Total		5800.0	0.0	0.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	475.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Cash Flow Balance		0.0	641.7	1308.3	1525.9	1751.2	1984.3	2119.0	2255.6	2393.9	2533.3	2673.7	2814.6	2955.6	3571.1	4200.9	4845.1	5503.6	6176.4	6863.6	7564.9	8280.4
			(5800.0)	689.2	682.1	674.6	666.8	658.5	649.9	640.7	631.1	621.1	610.5	599.3	587.6	575.3	562.4	548.8	534.5	519.5	503.8	487.2	469.8

Dividend Resource(20years total) 8,280

Dividend Resource (average) 414

Dividend Yield/ IRR **7.1%** / IRR= **8.8%**

Payback period: **16.5** YR

2-8-2 Issue/ Risk at Industrialization

(1) Issue of Industrialization

1) Quick Execution of Project and Correspondence to Large Scale

Phnom Penh municipal government is going to consign intermediate treatment project which realizes volume reduction to private sector because of sudden increase of waste in Phnom Penh and short remaining life of Dangkao landfill site. Many project proposals are currently submitted to the municipal government with Chinese industries a core in addition to our company and the government is scheduled to decide policy of deciding business operator by bidding. Most of the proposed projects are making volume reduction by entire incineration, perform power generation project by incineration, and to work out the project with that income. If this consigned project is promoted under present plan, there may be the possibility of problems shown below;

* If bidding is promoted as scheduled, start the work within several years and the facility will start operation 2 years after work commencement. If so, waste flow may be changed and the possibility of raw material procurement by the project getting difficult will be higher.
* It is difficult to make water contained waste with incineration disposal as it is, a lot of energy is required to remove water (vaporing, dehydration), and this is the ultimate cause of refusing project closing. If water component is unable to be removed efficiently as the preprocessing of incineration, incineration project itself meets with setback and there may be the risk on waste treatment plan in Phnom Penh.

In order not to result in these problem occurrences, it is important to ferment food waste which is unsuitable to incineration and reduce landfill amount drastically. A lot of combustible material such as plastic is contained in the waste sorted as methane fermentation inadequate substance and it is possible to reduce more landfill amount by incineration process.

The waste treatment problem for entire Phnom Penh is not solved by the establishment of this project only but the landfill waste amount is able to be halved if the project is able to be connected to large scale facility which is able to correspond to the waste of entire metropolis by making this as a model and it is able to promote the plan carefully and properly by taking time to new landfill site.

2) Cooperation with other Intermediate Treatment Project

Proper waste treatment is impossible only by methane fermentation. It takes a lot of time and effort and cost for preprocessing in order to take out targeted food waste from general waste in which various sorts of wastes are mixed and the possibility of unsuccessful as project is high.

At his project, the extraction of pickup/ conveyance route where the food waste mixing rate is high was successful by obtaining the cooperation of CINTRI, the pickup/ conveyance business operator. As the result, the burden of preprocessing was mitigated and it became possible to obtain fermentation raw material by a simple machine. It is necessary to make clear whether what kind of facility is required and appropriate in order to apply this project to the waste

treatment of entire Phnom Penh. It is important to aim organic cooperation with the method of fractional recovery not performed yet, recycle facility, preprocessing facility for fracture filtering, waste treatment facility for fermentation inadequate substance (incineration and RDF) and landfill site.

Perception at this project will be helpful in the recycle and fracture filtering which will be planned in future and in various facility plans for incineration, and it is needed to enhance mutual merit by working together with service as well as devising proper waste treatment to be possible.

(2) Assumed Risk

1) Pickup/ Conveyance Schedule for Traffic Jam

Since the raw material id food waste, long term storage of raw material at plant is not performed and inject raw material into fermentation bath within short time after acceptance. For the reason, it is worried about the influence on stable plant operation such as manual filtering process, fraction filtering by machine, stable injection into fermentation bath if raw material acceptance is delayed due to traffic jam. It is also considered that reviewing of personnel system (working shift change, addition of workers) and facility adding (enhancement of processing performance per time) are necessary depending on situation.

It is necessary to review the IT utilization such as vehicle operation control by GPS, operation data analysis, etc.

2) Downturn Risk due to Compost Price Reduction

Since important dependent chemical fertilizer is expensive, the status for which supply is unable to catch up the demand due to active cheap compost continues. Specifically, the demand for compost suddenly increased due to the increase of vegetable production which require compost, and they import the degree of 700 ~ 800 thousand tons focusing on Vietnam and Thailand. A lot of Compost has been imported from China and Japan but the cost reduction of compost sales price due to competition is worried if domestic compost production is increased and cheap chemical fertilizer is increased.

Since the reduction of sales cost make Business income and expenditure worse because a lot of income relies on compost sales in this project, it is necessary to review the countermeasure in advance. There are methods below by increasing compost production amount and not to be fallen in income.

* Increase the acceptance amount of food waste to be raw material and decrease the number of retention days in fermentation bath. According to this, it is able to maintain biogas generation amount (maintain power generation amount) without changing plant size as well as increase compost production amount.
* Increase entire processing performance by expanding plant. New investment occurs but the merit of size expansion (sales initial cost reduction) due to size expansion is obtained. It is necessary to aim income expansion focusing on thermal utilization since FIT is not available.

In addition, if biogas production amount is a lot, separate and refine CH4 and CO2, and bring respective sales project into sight.

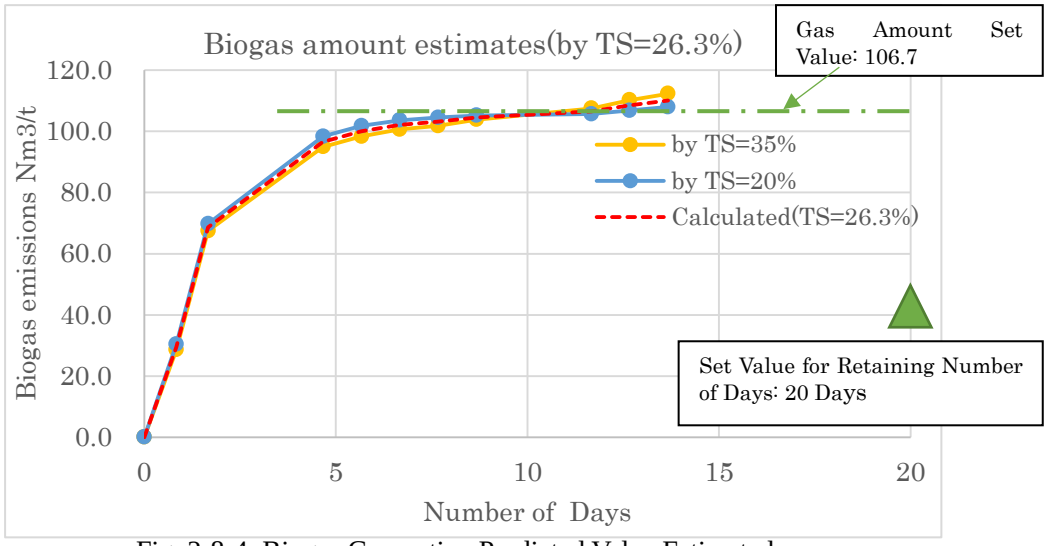


Fig. 2-8-4: Biogas Generation Predicted Value Estimated from the Result of Picked Up Waste Fermentation Test

Raw material retaining period in fermentation bath is set to 20 days in this plan. As the result of Lab Test by generating fermentation feedstock from waste picked up from Phnom Penh City, it was shown that about 90% of biogas was generated in a week or so.

It is considered that shortening of retaining period in fermentation bath is possible even if the error (variation due to raw material, season, water component and temperature, etc.) at actual plant is taken into consideration. Additional acceptance of 25% raw material will be possible if shortening of 5 days or so (20 days → 15 days) becomes capable by considering ripening degree as compost raw material.

Fig. 2-8-5: Sample for Fermentation Test
Left-hand side shows picked up waste, right-hand side shows fermentation inadequate substance

* Increase entire processing performance by expanding plant. New investment occurs but the merit by size expansion (sales initial cost reduction) due to size expansion is obtained. It is

necessary to aim income expansion focusing on thermal utilization since FIT is not available. In addition, if biogas production amount is a lot, separate and refine CH_4 and CO_2, and bring respective sales project into sight.

2-9 Expansion to Other Areas

Many regions in Cambodia expect Phnom Penh are facing power shortage, and there are great expectations for self-sufficient renewable energy as well as for thermal energy. Appropriate waste disposal is important also in terms of environmental hygiene. The condition that large amount of agricultural residue can be obtained from surrounding areas, and waste has high Total Solids (TS) because organic waste, which has high TS, account for 80% of waste is favorable for the dry methane fermentation system which is suitable for decomposition of cellulose. The demand is expected to rapidly increase if plants can be constructed at a lower price. For the time being, we will consider expansion to regional urban centers such as Battambang, Siem Reap, and Sihanoukville. Expansion to these cities is easy after the business succeeds in Phnom Penh.

Spreading the technology by the JCM scheme to surrounding countries which have the same problem as Cambodia such as Vietnam and Myanmar is expected to have a large effect on GHG reductions.

3 Actions for Commercialization

3-1 Criteria to Meet for Commercialization

In order to promote commercialization, the prospect of meeting following 4 criteria should to be found.

(1) Prospect of Securing the "Entrance"

The required amount of food waste as material of compost should be stably procured without fail throughout the business period.

(2) Prospect of Securing the "Exit"

Consumers and purchasers of generated electricity and thermal energy or gas (methane and carbon dioxide) should be secured.

(3) Prospect of Constructing Plants

Plant construction should be possible, permission for business, construction, and other necessary things should be obtained, and the site for business should be secured. Moreover, construction material should be procured, and the cooperation of skilled construction companies should be obtained.

(4) Prospect of Obtaining Profits

Sufficient returns on investment and running cost should be delivered for a long term.

3-1-1 System to Support the "Entrance"

Purpose: Stable Procurement of Material

【Cooperation of waste generators】

■Cooperation of the Phnom Penh Capital Hall

・Procure waste in the district where the government offices are located via collection and transportation trucks o

If CINTRI which is a waste collecting company.

・Procure waste from food markets

Main sources are markets which are operated by Phnom Penh Capital Hall including Deum Kor Market.

■Cooperation of major waste generators

・Procure waste generated by waste generators whose waste is stable in quality and quantity such as the Aeon Mall and Nagaworld via CINTRI.

【Cooperation of the waste collecting and transporting company】

■Cooperation of CINTRI

・Select collection routes to obtain needed amount of waste with required quality and procure it.

Consider reviewing the collection routes when it is needed.

・Consider future plant construction together to construct plants in all districts in Phnom Penh.

* CINTRI signed up for a long-term consignment contract regarding collection and transportation services of general waste (in almost all areas of Phnom Penh) starting from 2002 for 50 years with Phnom Penh Capital Hall, and the company has a great voice in Phnom Penh Capital Hall's waste disposal policy.

3-1-2 System to Support the “Exit”

Purpose: Stable Sales of Electricity and Compost (and Thermal Energy in Future)

【Cooperation of the company which purchases electricity】

■Cooperation of EDC (Cooperation of Electricity Authority of Cambodia (EAC) and Ministry of Industry Mines and Energy (MIME))

・EDC proposed purchasing electricity for 0.08 USD/kWh. Currently, we’re asking for cooperation to make the price 0.10 USD/kWh, which is the maximum amount.

We aim for the realization of it with support from Ministry of Environment (MOE) of Cambodia and Phnom Penh Capital Hall.

【Cooperation of compost sellers】

■Cooperation of COMPED

・Currently, COMPED produces compost from food waste at the landfill in Battambang with the cooperation of the Institute for Global Environment Strategies (IGES). Since the system has not been well mechanized, the high demand exceeds the compost supply.

・The demand for compost is far higher in areas around Phnom Penh where vegetable farming as agriculture in suburban areas flourishes than in Battambang where rice farming is the main farming and paddy straws can be used for fertilizer. Large markets include Kandal, Kampong Cham, and Kampong Speu, and there is a chance for COMPED to expand the composting business. (Currently, they produce compost in Battambang and sell it to consumers around Phnom Penh. Since the market price of compost around Phnom Penh is 160 to 180 USD/ton, they set the factory price at 100 to 130 USD/ton with consideration of transportation cost of 30 to 40 USD/ton.)

・COMPED learned the composting skills and the quality management skills with the cooperation of IGES and a compost maker in Germany and has their own route to analyze the quality. By obtaining the cooperation of COMPED, we can utilize these backgrounds regarding composting.

■Cooperation of large consumers

・The MH Bioenergy, which is a Korean company, produces 30 thousand tons of bioethanol per year by using sugar cans and others grown in its own plantation as material. Since their bioethanol is of high quality, they export it to EU and Korea mainly as production material of alcoholic beverage. Therefore, they put great importance on material and use composted residue of ethanol production as fertilizer instead of chemical fertilizer. They can’t produce enough amount of compost for them, and much of compost they use is imported. The company is one of potential consumers

3-1-3 System to Support Construction

Purpose: Construction of Low-price and High-quality plants

【Cooperation of approvers】

■Cooperation of electricity business approvers (EAC and MIME)

・We expect their support for the business including making the system to understand the value of renewable energy produced by the business and expand the business with related parties.

■Cooperation of waste disposal approvers（MOE and Phnom Penh Capital Hall）

・With the business as a starting point, we expect to promote appropriate waste disposal and utilization of renewable energy at the same time by actions such as improving waste collection and transportation methods including segregation, expanding the waste disposal business throughout Phnom Penh, and introducing it to local cities.

【Cooperation of companies related to construction】

■Cooperation of OWS

・Support for consideration on the plant structure which is adapted to local circumstances including the climate and material of compost, technical matters, education on operation, etc.

・In operation, support for stable operation of plants such as troubleshooting, maintenance services and remote monitoring is also expected.

・Effort to reduce the cost is needed because it accounts for a large proportion of the initial cost.

■Cooperation of plant engineering companies

・For domestic companies, aim higher by using technique and knowledge learned from foreign companies and spreading it in Cambodia.

・Develop a route to procure low-price and high-quality material and equipment by utilizing local information and connections.

・For foreign companies, obtain the cooperation for making full use of their excellent experience and management skills and leading the business to training for Cambodian companies.

3-1-4 System to Support Profits

Purpose: Securement of enough profits to maintain the business

【Cooperation for securing human resources】

■Cooperation of universities

・Excellent human resources are necessary for both reliable plant operations and stable securement of the "entrance" and "exit," and university play a great role in the supply of human resources. We are planning to cooperate with the Institute of Cambodia of Technology (ITC) and the Royal University of Phnom Penh (ITC) to secure human resources. (Both of the university presidents have studied in Japan and are positive about support for Japanese companies.)

【Cooperation of the purchaser】

■Cooperating of EDC

・If EDC sets their purchasing price higher, the profits will increase and the business will have higher profitability.

If EDC raises their purchasing price from 0.08 USD/kWh to 0.1 USD/kWh, the following effects will be obtained.

IRR: 8.8% → 10.2%

Payout period: 16.5 years → 14.2 years

Table 3-1-1 IRR Improvement When the Purchasing Price is 0.1 USD

Estimation of Gain or Loss/ Cash Flow (20 years) (K USD)

Expense Item \ Year			0	1	2	3	4	5	10	15	20
Income	Power sale	(Increase Ratio/y 0%)	0.0	436.6	436.6	436.6	436.6	436.6	436.6	436.6	436.6
	Heat sale	(Increase Ratio/y 0%)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Compost sal	(Increase Ratio/y 0%)	0.0	693.7	693.7	693.7	693.7	693.7	693.7	693.7	693.7
	Total		0.0	1130.3	1130.3	1130.3	1130.3	1130.3	1130.3	1130.3	1130.3
Spending	Labor cost	(Increase Ratio/y 5%)	0.0	112.8	118.4	124.4	130.6	137.1	175.0	223.3	285.0
	Plant maintenance cost		0.0	116.3	116.3	116.3	116.3	116.3	116.3	116.3	116.3
	Water&Energy cost		0.0	17.4	17.4	17.4	17.4	17.4	17.4	17.4	17.4
	Chemical cost		0.0	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
	Waste disposal cost		0.0	26.2	26.2	26.2	26.2	26.2	26.2	26.2	26.2
	Sales cost		0.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0	36.0
	Admin cost	(Increase Ratio/y 5%)	0.0	33.8	35.5	37.3	39.2	41.1	52.5	67.0	85.5
	Tax		0.0	5.8	5.6	5.3	5.1	4.9	3.7	2.5	1.3
	Depreciation cost	(5%/y)	0.0	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5
	Total		0.0	591.3	598.4	605.8	613.7	621.9	670.0	731.6	810.7
Business Profit			0.0	539.0	531.9	524.4	516.6	508.3	460.3	398.6	319.6
Non-Operating Income	Investment gains	5.00%	0.0	0.0	36.4	74.4	90.1	106.4	169.5	280.9	483.1
	Interest Rate	1.00%	0.0	47.5	47.5	47.5	42.8	38.0	14.3	0.0	0.0
	Non-Operating Income		0.0	(47.5)	(11.1)	26.9	47.3	68.4	155.3	280.9	483.1
Profit of the Term before Tax			0.0	491.5	520.9	551.3	563.9	576.7	615.6	679.5	802.7
Business Tax:	20%	(0% for 5 years by QIP)	0.0	0.0	0.0	0.0	0.0	0.0	134.4	147.2	171.8
Profit of the Term			0.0	491.5	520.9	551.3	563.9	576.7	481.2	532.3	630.9
Financial Inflows	Own capital		1050.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Borrowing		4750.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Profit of the Term		0.0	491.5	520.9	551.3	563.9	576.7	481.2	532.3	630.9
	Depreciation Cost		0.0	237.5	237.5	237.5	237.5	237.5	237.5	237.5	237.5
	Debt Loan at the Beginning of Period		0.0	0.0	729.0	1487.4	1801.2	2127.6	3390.7	5617.7	9662.3
	Total		5800.0	729.0	1487.4	2276.2	2602.6	2941.8	4109.4	6387.5	10530.6
Financial Outflows	Equipment Investment		5800.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Repayment of Debt(2 years deferred)		0.0	0.0	0.0	475.0	475.0	475.0	475.0	0.0	0.0
	Total		5800.0	0.0	0.0	475.0	475.0	475.0	475.0	0.0	0.0
	Cash Flow Balance		0.0	729.0	1487.4	1801.2	2127.6	2466.8	3634.4	6387.5	10530.6
			(5800.0)	776.5	769.4	761.9	754.1	745.8	697.8	636.1	557.1

Dividend Resource(20years total) 10,531

Dividend Resource (average) 527

Dividend Yield/ IRR 9.1% IRR= 10.8%

Payback period: 14.2 YR

Though labor costs in Cambodia are expected to rise in association with economic growth, development of human resources will stabilize the business by enabling actions such as insourcing of maintenance services and acquisition of good customers. In addition, expansion of the business by utilizing human resources in accordance with Phnom Penh Capital Hall's policy for promotion of appropriate waste disposal will also lead to profit improvement.

Moreover, the business can expand to other regional urban centers in Cambodia which have waste disposal problems just as Phnom Penh does, and even more cost-efficient businesses can be conducted by maintaining the cooperation system of the business (the "entrance" → CINTRI, the "exit" → COMPED, the plant → OWS).

3-2 Business System

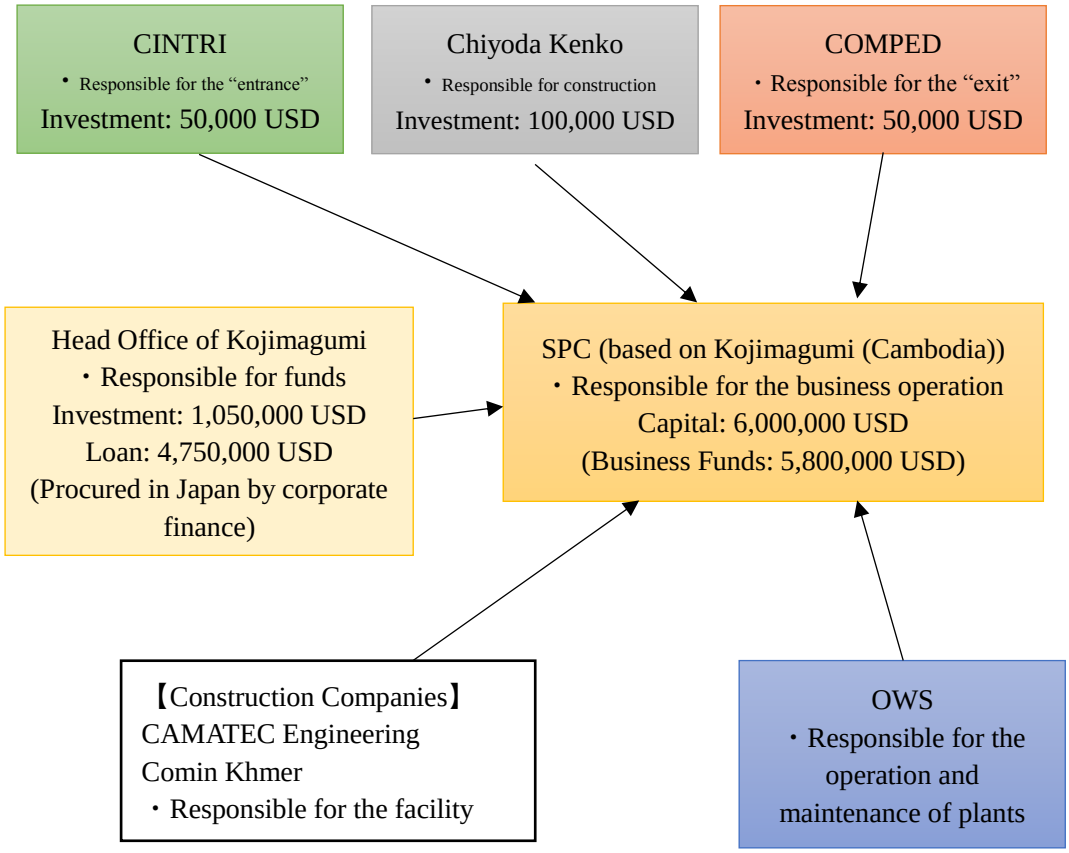


Figure 3-2-1 Business System Plan

3-3 Fund Procurement

3-3-1 Procurement of Business Funds

Table 3-3-1 Suppliers and the Amount of Necessary Funds

Supplier	Amount (USD)	Description
Kojimagumi	1,050,000	Investment
Chiyoda Kenko	100,000	
CINTRI	50,000	
COMPED	50,000	
Banks in Japan	4,750,000	Borrowings (as cooperate finance of Kojimagumi) *They will be project finance in future.
Total Amount	6,000,000	

3-3-2 Suppliers and the Amount of Funds for Construction

Table 3-3-2 Suppliers and the Amount of Funds for Construction

Necessary Amount (USD)	9,500,000	100%
Own Funds	4,750,000	50%
Capital Grant	4,750,000	50%

3-4 Business Schedule

Table 3-4-1 Business Schedule

Type of Works		First Year	Second Year	Third Year
Preparation	Preparation Plan			
	License Acquisition			
	Measurement and Geological Investigation			
Planning	Design			
	Preparation for Operations			
Construction	Land Purchase and Site Preparation			
	Land Development			
	Construction of the Plant			
Operation	Commissioning and Adjustment			
	Business Operation			

3-5 Effects Obtained from the Business

3-5-1 Effects Obtained from the Business

Table 3-5-1 Effects of the Business

Effect	Amount	Remarks
Methane Gas (CH_4) Recovery (Nm^3)	1,341,009	
Electricity Production (kWh)	5,096,000	On the assumption that CHPs operate 8,000 hours a year.
Heat Production (kWh)	5,400,000	On the assumption that CHPs operate 8,000 hours a year.
Compost Production (t)	5,878	
Employment (the number of people)	17	
Landfill Waste Reduction (t)	22,091	It corresponds to about 1.1 million m^3

3-5-2 Effects Obtained When the Business Expands to the Entire Phnom Penh

In the entire Phnom Penh, 828,523 tons of general waste is estimated to be disposed of every year by landfill. Assuming that 60% of this is used as material of methane fermentation, a business which is 22.5 times larger than the business can be conducted, and following effects are expected to be obtained.

Table 3-5-2 Effects Obtained When the Business Expands to the Entire Phnom Penh

Effect	Amount	Remarks
Methane Gas (CH_4) Recovery (Nm^3)	30,176,727	
Electricity Production (kWh)	128,000,000	8 CHPs with 2,000 kW each are in operation.
Heat Production (kWh)	126,528,000	On the assumption that CHPs operate 8,000 hours a year.
Compost Production (t)	132,272	
Employment (the number of people)	200	
Landfill Waste Reduction (t)	497,113	It corresponds to about 15 million m^3

4 Future Development toward Commercialization

4-1 MRV

[Title of methodology]

Introduction of an anaerobic digestion facility for electricity and heat supply from Municipal Solid Waste.

[Eligibility criteria]

This methodology is applicable to projects that fully satisfy the following cases.

Case1	The project activity replaces electricity from grid or fossil fuels based heat through introducing an anaerobic digestion facility for renewable energy generated by Municipal Solid Waste or Biomass residues.
Case2	Municipal Solid Waste and biomass residues used in the project facility are not stored for more than one year.
Case3	In case of co-combustion with fossil fuels, the amount of input fossil fuels can be recorded and does not exceed 10% of the total fuel fired on an energy basis.

[Referenced methodologies]

Organic Waste ACM0002, ACM0006, AMS-I.D, I.F, I.C, J-MRV(JBIC)

Japan Credit EN-R-007 Ver.1.0. Substitution of fossil fuels or grid-connected power by biogas (methane gas by anaerobic fermentation)

We apply a simplified approach of Methodological tool Emissions from solid waste disposal sites version 07 (UNFCCC, Tool04) to this methodology.

[Reference emissions]

Reference Emissions are calculated as follows

$$RE_y = RE_{CH4} + RE_{heat,y} + RE_{electricity,y}$$

RE_y	=	Reference emissions in year y (tCO2/y)
RE_{CH4}	=	CH4 emissions from landfill site when project is not executed (tCO2/y)
$RE_{heat,y}$	=	Reference emissions for heat supply in year y (tCO2/y)
$RE_{electricity,y}$	=	Reference emissions for electricity supply in year y (tCO2/y)
y	=	An arbitary year in the crediting period

[Emissions from landfill sites for municipal solid waste]

Refer to Methodological tool Emissions from solid waste disposal sites version 07 (UNFCCC, Tool04).

Use a monitoring methodology for organic waste by a simplified approach.

$$RE_{CH4} = \varphi_y \times (1 - f_y) \times GWP_{CH4} \times \sum_{x=1}^{y} Default_{org,x} \times W_{org,x}$$

RE_{CH4}	=	Reference methan emissions from landfill sie in year y (tCO2/y)
φ_y	=	Project or Leakage emissions : Default values
GWP_{CH4}	=	Global Warming Potential of methan
$Default_{org,x}$	=	Referred Default values on Table2 of Appendix 1 (Tool 04)
$W_{org,x}$	=	Total amount of organic waste disposal in year y

[Emissions when using grid electricity]

Reference emission for electricity supply (Replacement of grid electricity)

$$RE_{electricity} = RE_{e\_org,y} \times CM$$

$RE_{electricity,y}$	=	Reference emissions for electricity supply in year y (tCO2/y)
$RE_{e\_org,y}$	=	Net power supply from organic waste in year y (MWh/y)
CM	=	emission factor for grid (tCO2/MWh)

[Emissions at the time of heat supply using fossil fuels]

Replacement of fossil fuel based heat supply

$$RE_{heat,y} = RE_{h_{org},y} \times \frac{100}{\varepsilon_{def}} \times 3.6 \times EF_{Foss,def}$$

$RE_{heat,y}$	=	Reference emissions for heat supply in year y (tCO2/y)
$RE_{h\_org,y}$	=	Net heat supply from organic waste in year y (MWh/y)
$EF_{Foss,def}$	=	Default value for emission factors of fossil fuel (tCO2/GJ) assumed to be Diesel Oil in this methodology
ε_{def}	=	Default Value for efficiency of fossil fuel based heat generator(%)

[Project emissions]

Project emissions are calculated by using the following formula.

$$PE_y = PE_{FF,y} + PE_{EL,y}$$

PE_y	=	Project emissions in year y (tCO2/y)
$PE_{FF,y}$	=	Project emissions from on site fossil fuel consumptions in year y (tCO2/y)
$PE_{EL,y}$	=	Project emissions from on site electricity usage from grid in year y(tCO2/y)

Methane generated from residue after anaerobic fermentation is not subject to this project because it is considered not to be able to be collected. Such residue will be used as fertilizer. (Refer to EN-R-007.)

[Monitoring]

The project developers have to monitor parameters described in the table below.

Table 4-1 Monitoring Parameter

Parameter	Description	Measurement method
$RE_{e\_org,y}$	Net power supply from Municipal solid waste or biomass residues.	Direct measurement continuously by electricity meter with aggregating data appropriately.
$RE_{h\_org,y}$	Net heat supply from Municipal solid waste or biomass residues.	Direct measurement continuously by calorimeter with aggregating data appropriately.
$W_{org,x}$	Total amount of organic waste disposal in year y.	Direct measurement continuously by weight meter.

Table 4-2 Specific Values 1

Parameter	Description	values
CM	Emission factor for grid (Combined Margin) (tCO2/MWh)	0.6568 [tCO2/MWh] Grid Emission Factor of the Phnom Penh Electricity Grid (IGES)
	Model correction factor to account for model uncertainties for year y	Default value : 0.75
f_y	Fraction of methane captured at the SWDS and flared, combusted or used in another manner that prevents the emissions of methane to the atmosphere in year y	0.5 : IPCC 2006 Guidelines for National Greenhouse Gas Inventories
$EF_{Foss,def}$	Default value of emission factor for fossil fuel	In this methodology, assumed at Diesel Oil value : 74,100[kg/TJ] 2006 IPCC Guidelines for National Greenhouse Gas Inventories
	Global Warming Potential of methane	25 : 2006 IPCC Guidelines for National Greenhouse Gas Inventories
$Default_{org,x}$	Refer to following table	Methodological tool. Emissions from solid waste disposal site. Ver07.0

Table 4-3 $Default_{org,x}$

Year	Tropical Wet
1	0.008263
2	0.006066
3	0.004527
4	0.003324
5	0.002348
6	0.001657
7	0.001185
8	0.000862
9	0.000641
10	0.000489
11	0.000384
12	0.000309
13	0.000256
14	0.000218
15	0.000189
16	0.000167
17	0.00015
18	0.000136
19	0.000124
20	0.000114
21	0.000105

Ref: Methodological tool. Emissions from solid waste disposal site.

4-2 GHG Reduction Amount

Table 4-4 Assumption

Electricity	4,366	MWh/y	Substitute for the Phnom Penh Electricity Grid.
Heat Supply	5,400	MWh/y	Substitute for heat supply generated by diesel oil based boiler.
Organic Waste	12,092	t/y	Resources to generate Digestion gas

Table 4-5 The estimation for GHG reduction

Year	Electricity (t/CO2)	Heat (t/CO2)	landfill gas (t/CO2)	Total (t/CO2)
2019	2,868	1,441	1,711	6,019
2020	2,868	1,441	2,968	7,276
2021	2,868	1,441	3,905	8,213
2022	2,868	1,441	4,594	8,902
2023	2,868	1,441	5,080	9,388
2024	2,868	1,441	5,423	9,731
2025	2,868	1,441	5,668	9,977
2026	2,868	1,441	5,847	10,155
2027	2,868	1,441	5,980	10,288
2028	2,868	1,441	6,081	10,389
2029	2,868	1,441	6,160	10,469
2030	2,868	1,441	6,224	10,533
2031	2,868	1,441	6,278	10,586
2032	2,868	1,441	6,323	10,631
2033	2,868	1,441	6,362	10,670
2034	2,868	1,441	6,396	10,704
2035	2,868	1,441	6,427	10,736
2036	2,868	1,441	6,456	10,764
2037	2,868	1,441	6,481	10,789
2038	2,868	1,441	6,505	10,813
2039	2,868	1,441	6,527	10,835

4-3 Evaluation of Contribution to Cambodia and Japan

Benefits that both countries can obtain are listed in the table below.

Table 4-6 Benefits that both countries can obtain

Country name	Theme	Contents
Cambodia	Promotion for realization of environment-conscious society	Phnom Penh Capital City, which is a counter partner for this project, can obtain knowledge related to reduction of waste, reduction of greenhouse gas emissions and renewable energy business that Kanagawa Prefecture and persons concerned in this project have.
	Promotion of technology transfer	DRANCO process dry methane fermentation technology of OWS Instructions on construction given by KOBELCO ECO-SOLUTIONS
	Increase of foreign direct investment	Increase of foreign direct investment (FDI). 780 million yen is estimated as the amount of investment in plants.
	Employment creation	Employment creation on site through the project operation. The pilot project is scheduled to be implemented in Phnom Penh, but, as a medium- and long-term project plan, the project is assumed to be expanded throughout Cambodia.
Japan	Promotion of project for realization of low carbon society	Dissemination and promotion of low carbon technologies in developing countries in accordance with the policy of the Japanese government.
	Overseas cooperation of Kanagawa Prefecture	Contribute to promotion of cooperation between two cities through cooperating projects of Phnom Penh Capital City and Kanagawa Prefecture.
	Creation of business opportunities	The pilot project is scheduled to be implemented in Phnom Penh, but, as a medium- and long-term project plan, the project is assumed to be expanded throughout Cambodia. Contribute to creation of business opportunities for Japanese-owned companies including import of materials.

5 Conclusions

As for commercialization of "the power generation project using methane fermentation of organic waste generated by markets and others," an intercity-collaboration project for the realization of a low-carbon society in Phnom Penh, creation of the business system was considered difficult because of various reasons attributable to the fact that Phnom Penh is the capital of the Kingdom of Cambodia.

The Dangkor landfill is predicted to be full in several years because of increase of general waste resulting from the development of the capital Phnom Penh. Ministry of Environment and Phnom Penh Capital Hall were aware of the importance of reduction of waste transferred to the landfill.

The cogeneration project by dry methane fermentation which uses general waste as material, which we have proposed, was the first proposal to the Kingdome of Cambodia, and it attracted much interest from people in various fields.

Regarding profitability, the profitability of electricity generation by the plant was considered low because the purchasing price EDC proposed was lower than that of the original plan. However, the investigation has revealed that compost is in demand and has sufficient profitability in terms of the selling price. As for material procurement for the dry methane fermentation plant, we have a good outlook for stable supply of necessary amount of general waste with the cooperation of Phnom Penh Capital Hall, markets, COMPED and CINTRI. If the plant is constructed in the capital Phnom Penh, the business will be able to expand to other local cities such as Battambang and Sihanoukville.