MOEJ/GEC JCM Feasibility Study (FS) 2015

Development of District Energy Supply Business by Introducing Co-generation

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List of Abbreviations

AMDAL	Analisis Mengenai Dampak Lingkungan
BCP	Business Continuity Planning
BKPM	Badan Koordinasi Penanaman Modal
CO2	Carbon Dioxide
COP	Coefficient of Performance
ESDM	Kementerian Energi dan Sumber Daya Mineral
IMB	Izin Mendirikan Bangunan
IP	Izin Prinsip
IUKS	Izin Usaha Ketenagalistrikan untuk Kepentingan Sendiri
IUKU	Izin Usaha Ketenagalistrikan untuk Kepentingan Umum
JCM	Joint Crediting Mechanism
PALYJA	PAM Lyonnaise Jaya
PGN	Perusahaan Gas Negara
PLN	Perusahaan Listrik Negara
SIPPT	Surat Izain Penunjukan Penggunaan Tanah
SLO	Sertifikat Laik Operasi
WU	Wilayah Usaha

1. Project background

A local real estate developer plans to develop complex buildings consisting of office, apartment and hotel in central Jakarta. JGC plans to introduce a co-generation system into the buildings.

The advantages of co-generation system are as follows

- Highly-efficient operation by utilization of waste heat in the presence of heat consumer in nearby area.
- Cost-competitive system compared with grid electricity by utilization of city gas whose price is lower than that
- Contribution to environmental friendliness (CO_2 emission reduction)
- Stable energy supply
- Contribution to BCP (Business Continuity Planning)

2. Objective of the FS

The objective of this project is to introduce highly-efficient city gas fuelled cogeneration system into complex buildings consisting of office, apartment and hotel in central Jakarta, and to develop a model of district energy supply that contributes to CO_2 emission reduction and stable energy supply.

In order to meet this objective, the feasibility study (FS) focused upon the following points.

- Current situation of the co-generation system or gas engines in Jakarta
- Perspective of stakeholders (central government, local government, PLN and PGN) on co-generation system
- Energy price Trend
- Regulation and licences
- Business scheme
- Condition for the Feasibility study
- Feasible co-generation system
- Economic Performance
- CO_2 emission reductions

3. Project description:

a. Project location
   Central Jakarta

b. Indonesian partner(s)
   A local real estate developer (A company)

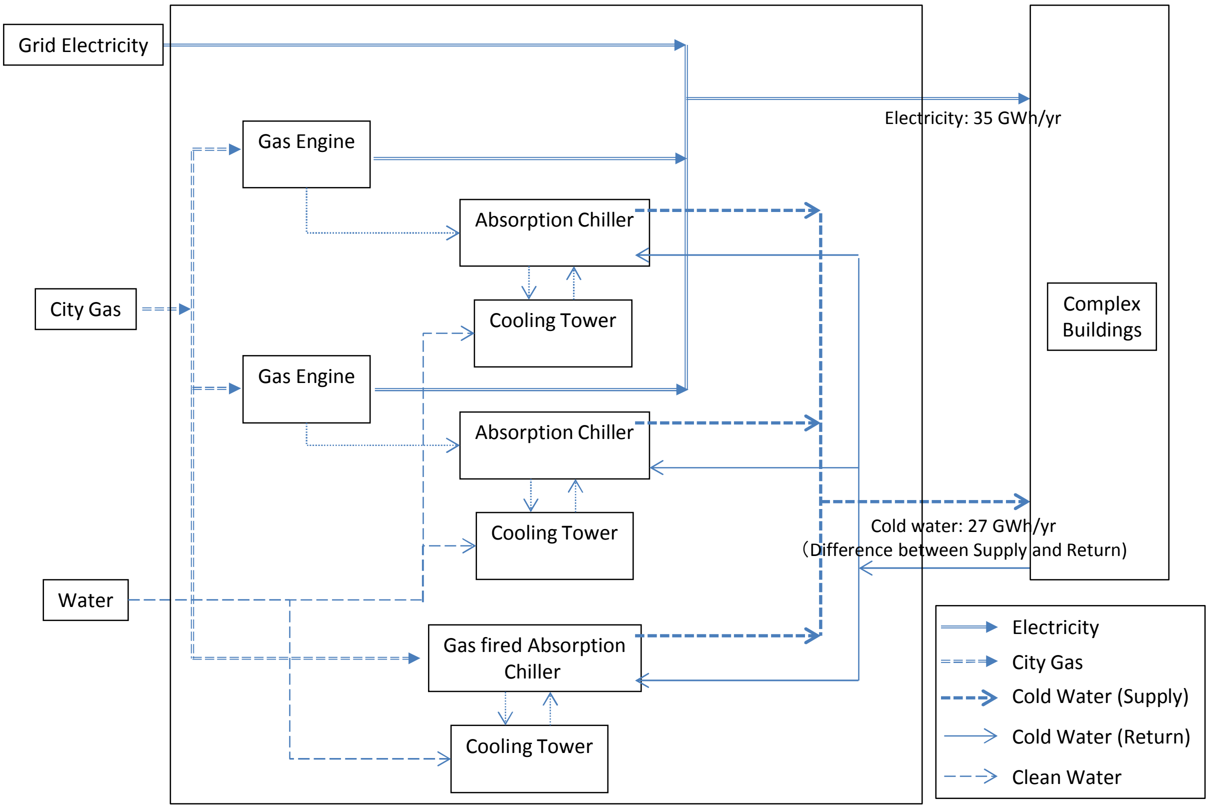
c. Description of the technology

   The co-generation system applied in this project is indicated in the following figure.
   This system consists of;
   - 2 gas engines (2,000 kW × 2 = 4,000 kW)
   - 2 absorption chillers that utilized waste heat from engines (1,884 kW × 2 = 3,768 kW)
   - 1 gas fired absorption chillers (3,869 kW)

The system supplies;

- 35 GWh/yr of electricity
- 27 GWh/yr of cold heat for air-conditioning

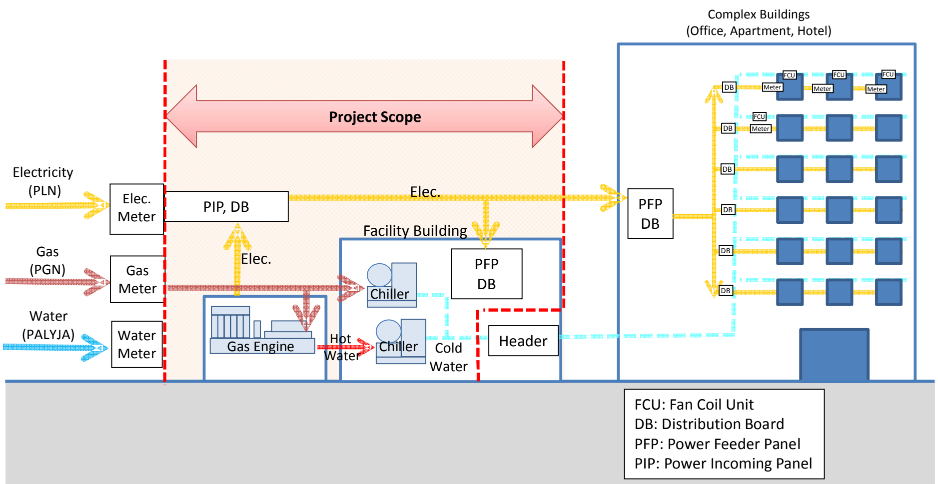
Figure 1 Co-generation System Flow



d. Project details

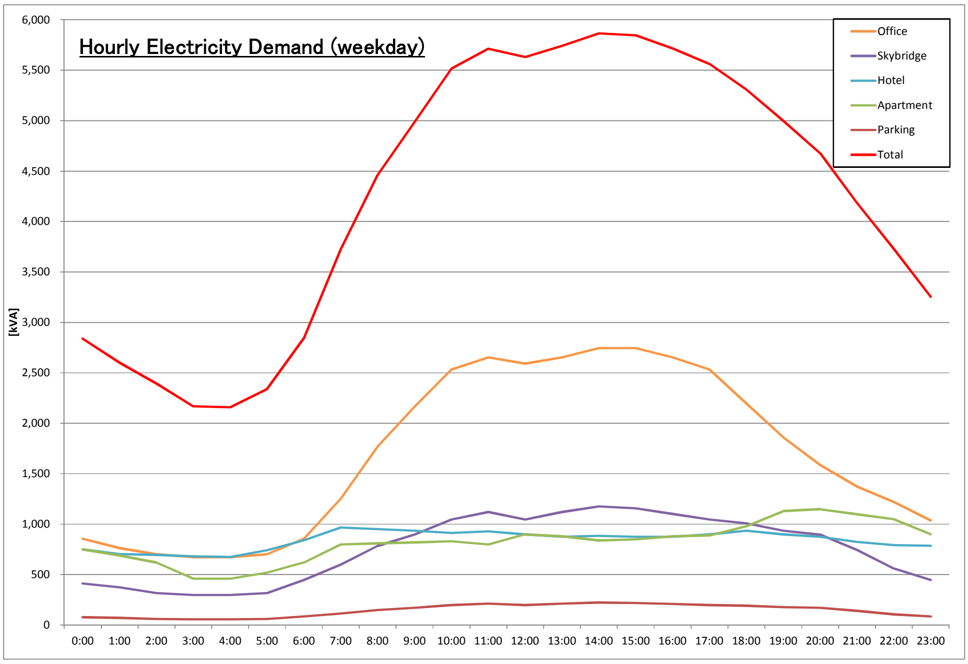
The scope of the project is illustrated below.

Figure 2 Scope of the Project



The electricity demand was estimated from floor area of the complex buildings. As an example, the hourly electricity demand for weekday is shown below.

Figure 3 Hourly Electricity Demand (Weekday)



The cold heat demand estimated from building plan is shown below.

Table 1 Cold Heat Demand

Building/Facility	Floor Area [m^2]	Annual Demand [TJ/year]
Office	26,464	33
Sky Bridge	7,110	16
Hotel	11,880	11
Apartment	37,584	37
Total	83,038	98

The input and output condition for this co-generation system is shown in the following table.

Table 2 Input and Output Condition

INPUT	Electricity Consumption	6.5 [GWh/year]
	Gas Consumption	6.9×10^6 [m^3/year] (73 [GWh/year])
	Water Consumption	1.4×10^5 [m^3/year]
OUTPUT	Electricity Sale	35 [GWh/year]
	Cold Heat Sale	98 [TJ/year] (27 [GWh])

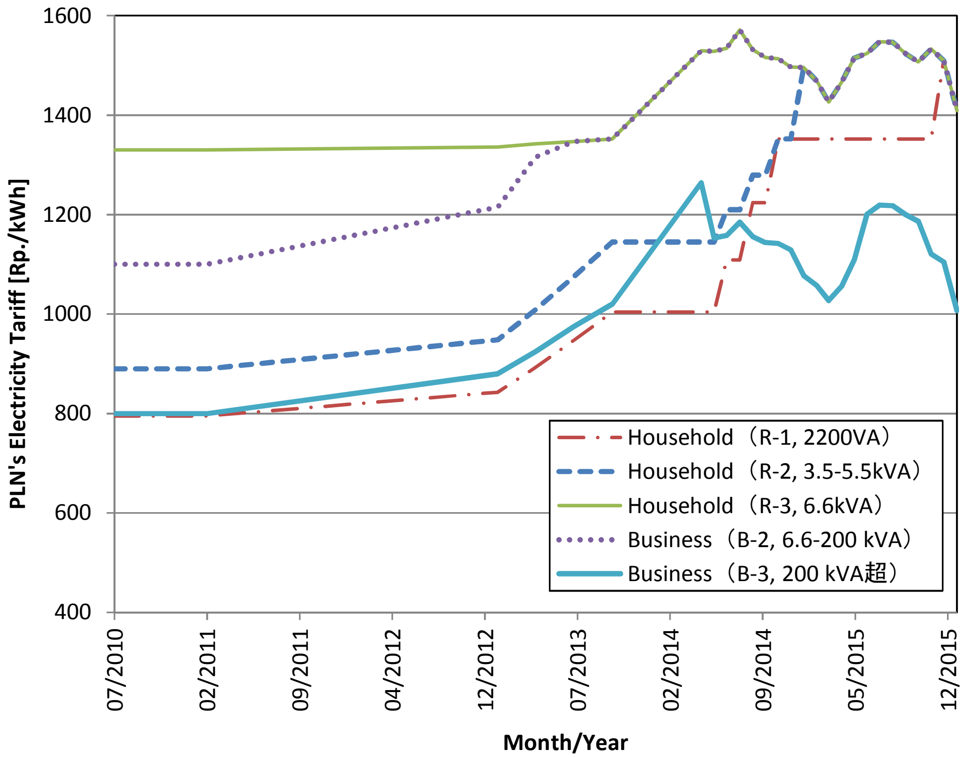
4. The result of the study

a. Current condition in Indonesia

Co-generation system is still unpopular in Jakarta especially commercial market. Spread of energy saving system also contributes to sustainable society in parallel l to power plant expansion.

The following figure shows the past trend of electricity tariff. After the tariff increased with government subsidy cut by around 2014, the tariff fluctuated due to tariff adjustment based on ICP(Indonesian Crude Price), exchange rate and inflation.

Figure 4 Trend of Electricity Tariff (PLN)



To understand stakeholders' perspectives, our study conducted interview with central government, local government, PLN and PGN. Each stakeholder's perspective is shown below.

Table 4 Stakeholders' Perspectives

ESDM	ESDM anticipates private sector's investment on electricity business as the electricity generation capacity is not sufficient in Indonesia. Basically one electricity Company shall be in one business area for public electricity supply under the current electricity regulation. If current electricity company's supply is not enough, other company is able to obtain business area.
PLN	PLN supposes the electricity capacity is sufficient in Jakarta. Business area may be given to private company where it is difficult for PLN to supply.
PGN	PGN is supportive for installing co-generation system.

b. Regulation(s) and policy(ies) related to the project

Indonesia Government announced the plan to increase the electricity supply capacity by 35 GW during 2015-2019. Japanese Prime Minister agreed on cooperation of this plan in March 2015. Corresponding to this plan, ESDM promote policy to stimulate private sector's investment.

The main permits necessary for the project is shown in the table below.

Table 5 Main Permits Necessary for the Project

Time to Apply	Name of Permit	Where to Apply	Content
Before and After Company Foundation	IP, Location Permit, etc.	BKPM	Permits of Foreign Investment and Company Foundation
Before and After Construction	SIPPT, etc.	DKI Jakarta	Permits related to land development
	AMDAL, etc.	DKI Jakarta	Environmental Permits
	IMB, etc.	DKI Jakarta	Construction Permits
After Construction	SLO, IUKU,WU, etc.	DKI Jakarta	Permits related to Electricity Business

The following three business schemes are possible for this project.

Table 6 Supposed Business Scheme for the Project

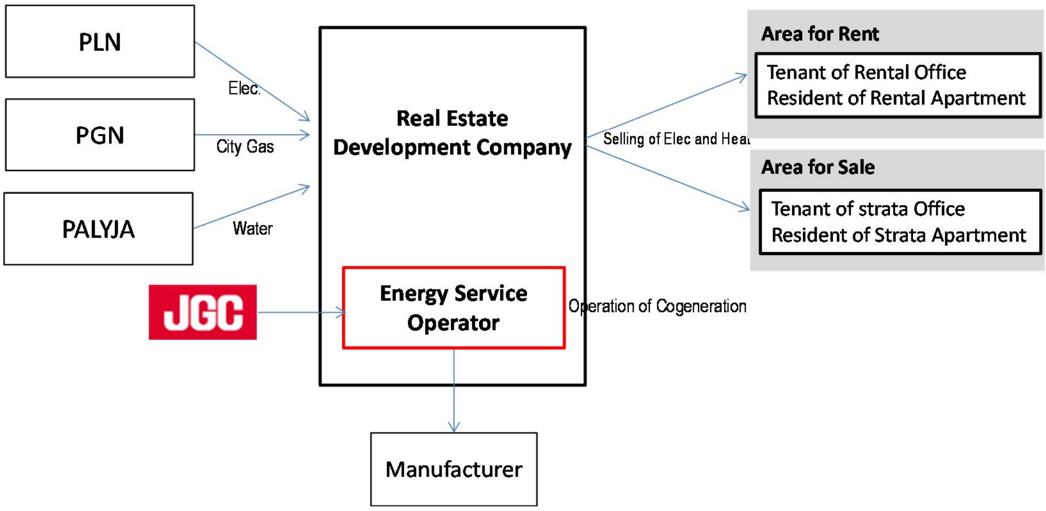
Business Scheme	Permit	Remark
In-house Electricity Generation	Permit of Electricity for Own Use (IUKS)	Supply area is limited to company-owned area.
Electricity Generation and Selling	Business Area and Permit of Electricity for Public (IUKU)	Need to obtain business area. It is possible if PLN agrees on it.
Independent Power Producer (IPP)	Permit of Electricity for Public (IUKU)	100 % of generated electricity is supplied to PLN.

Since IPP scheme can supply only to PLN, it does not meet the project's purpose. Although the scheme of In-house Electricity Generation is easier to obtain permits, the supply area is limited to the area owned by the company. In this feasibility study, the scheme of Electricity Generation and Selling is selected under the assumption that business area is obtained from PLN.

If the business area license were open to private company, more business opportunity born and energy efficient technology could be adopted.

c. Role of each participants

Figure 5 Business Scheme



The development purchases utilities and sell electricity and cold heat to tenants of rental/strata title offices and residents of rental/strata title apartment.

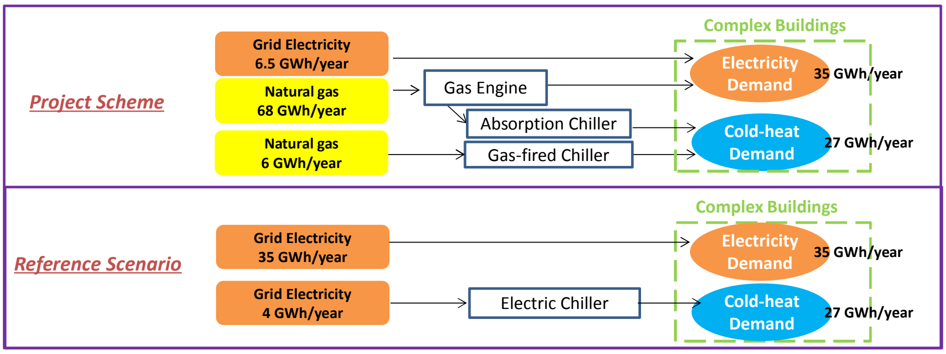
d. Reference scenario setting

Reference scenario of the project is that the electricity is supplied from the national power grid, and that cold-heat is produced by centrifugal chiller, which is operated by electricity from the national power grid.

Characteristics of this project is that (1) to produce electricity by gas-engine, which is operated by natural gas, to supply electricity to the complex buildings, and (2) to produce cold-heat by absorption chiller, which is operated by waste heat out of the gas-engine, to supply air-conditioning service to the complex buildings. Insufficient electricity demand of the complex buildings is planned to be supplied from the national power grid, and the insufficient cold-heat demand is covered by gas-fired absorption chiller, which will be operated by natural gas.

The figure below shows the project scheme and reference scenario with energy balance.

Figure 6 Project Scheme and Reference Scenario



e. Monitoring methods

Parameters required to be monitored in the project are such as following: the amount of natural gas purchased by the project in a year; the amount of grid electricity purchased by the project in a year; and CO2 emission factor for the regional grids and natural gas.

In terms of monitoring methods, natural gas and electricity amount are to be monitored by the meters, crosschecked by the invoices. Monitoring devices shall be calibrated based on national or international standards. In addition, the project operator shall check the latest value of the relevant CO2 emission factor.

Table 7 Monitoring Methods

Category	Check Item	Technical manager・Staff	Financial manager	Calibration Staff	Reference
Natural Gas	Supply status / Amount	〇	-	〇 (International standards)	Gas meter Invoices
	Price / Amount	-	〇	-	Invoices
Electricity	Supply status / Amount	〇	-	〇 (International standards)	Electricity meter
	Price/ Amount	-	〇	-	Invoices
CO2 Emission		〇	〇	-	MRV report
Maintenance Cost		〇 (Operation cost)	〇 (maintenance cost)	-	Invoices Working records
Feasibility check		-	〇	-	Reference electricity price check

f. Quantification of GHG emissions and their reductions

Reference emissions are calculated based on the following conditions;

Table 8 Condition for Calculation of Reference Emissions

ITEMS	VALUE	SOURCE
CO_2 emission factor for JAMALI	0.843 t CO_2/MWh	The latest value released by Indonesian Government
COP of Centrifugal Chiller	5.94	ID_AM002 "Energy Saving by Introduction of High Efficiency Centrifugal Chiller"
Electricity Demand of the complex Buildings	35 GWh/year	FS Study Team
Cold-heat Demand of the complex Buildings	98 TJ/year	FS Study Team

Reference emissions calculation:

Electricity; 35×10^3 MWh/year × 0.843 t CO_2/MWh ≈ 29,466 t CO_2/year

Cold-heat; 98TJ/year / 5.94 ≈ 16TJ/year

16 TJ/year × 0.278 kWh/MJ ≈ 4.6 GWh/year

4.6×10^3 MWh/year × 0.843 t CO_2/MWh ≈ 3,847 t CO_2/year

TOTAL; 29,466 t CO_2/year + 3,847 t CO_2/year = 33,313 t CO_2/year

Project emissions are calculated based on the following conditions;

Table 9 Condition for Calculation of Project Emissions

ITEMS	VALUE	SOURCE
Electricity received from the national power grid	6.5 GWh/year	FS Study Team
Consumption amount of natural gas for gas-engine	6.4×10^6 m^3/year	FS Study Team
Consumption amount of natural gas for gas-fired absorption chiller	0.6×10^6 m^3/year	FS Study Team
Calorific value	38.2 MJ/m^3	Calculated by FS Study Team based on information received from PLN
CO_2 emission factor for JAMALI	0.843 t CO_2/MWh	The latest value released by Indonesian Government
CO_2 emission factor for natural gas	56.1 t CO_2/TJ	2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2 Energy

Project emissions calculation:

Electricity; 6.5×10^3 MWh/year × 0.843 t CO_2/MWh ≈ 5,490 t CO_2/year

Cold-heat; (6.4×10^6 m^3/year + 0.6×10^6 m^3/year) × 38.2 MJ/m^3 ≈ 264 TJ/year

264 TJ/year × 56.1 t CO_2/TJ ≈ 14,831 t CO_2/year

TOTAL; 5,490 t CO_2/year + 14,831 t CO_2/year = 20,321 t CO_2/year

Therefore, the reduction of GHG (CO_2) emissions by this project is reference emissions minus project emissions. The calculation formula is as below;

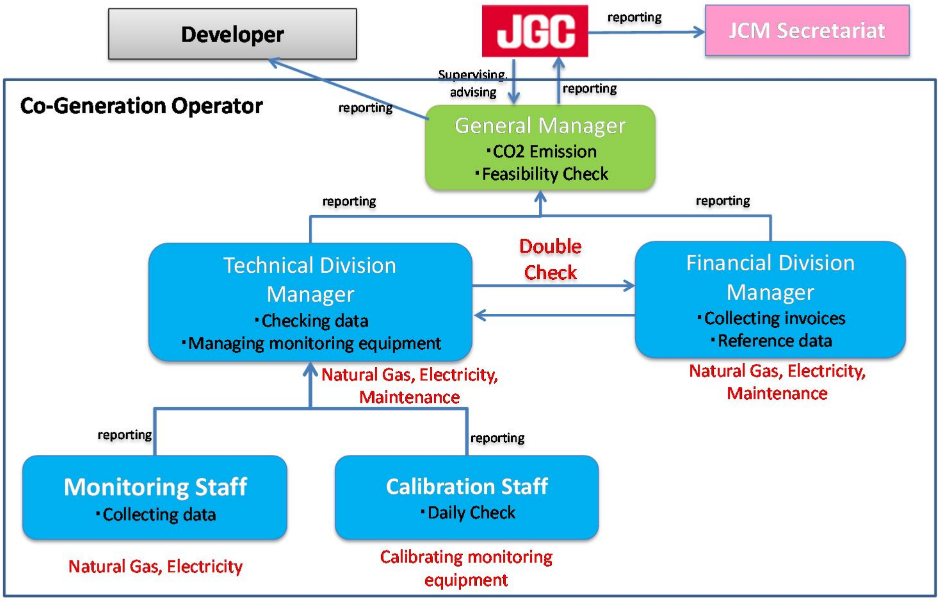
33,313 t CO_2/year - 20,321 t CO_2/year = 12,992 t CO_2/year

hence, the annual reduction amount of GHG (CO_2) emissions by implementing this project is 12,992 t CO_2.

g. MRV methods

The temporal MRV structure is described as follows:

Figure 7 MRV Structure



Monitoring Staffs in the technical division mainly check the amount of electricity and natural gas purchased by the project as well as generating amount of electricity and cold-heat by co-generation system. The system will be operated 24 hours a day, so that 3 to 4 monitoring staffs will be assigned for operation and monitoring activities. Data collection shall be reported to Technical Division Manager every month. Calibration staffs in the technical division calibrate for monitoring devices such as electricity and gas meters based on the national standard (or international standard, or a manual of device's maker). Technical Division Manager is in charge of supervising and managing these activities to ensure the data is accurate. Financial Division manages invoices of natural gas and electricity purchased by the project, which is very important data as the reference for cross check of electricity and gas meter's figures.

JGC Corporation, the proposer of the project, receives and checks the original or copied data recorded through monitoring process for double-check and prepares for report to submit to JCM Secretariat. Also, JGC Corporation checks other monitoring parameters such as CO_2 emission factor of national power grid as well as emission factor for natural gas time to time.

Electricity meters are necessary not only for JCM project as its monitoring device, but also essential logging devices for measuring electricity amount supplied to tenants; therefore, the selected devices will be highly reliable and durable.

From the viewpoint of JCM management, both monitoring data and invoices of electricity and natural gas are required to be stored in longer term, compared to the conventional operation of power stations. JCM Manager and staffs need to take a special care to handle and store those data. Therefore, the data handling and storage manual are planned to be prepared. In addition, an educational program for these monitoring activities and management method will be held once a year or after staff re-assignment.

h. Scale of investment & financial viability

The conditions and results for the feasibility study are indicated below.

<Investment>

Equipment [billion Rp]	64
Building [billion Rp]	5
Total [billion Rp]	69

<Other Conditions>

Corporate income tax	25%
Depreciation Period	Buildings: 20 years (straight-line) Facilities: 16 years (strait-line)
Exchange Rate	UDR-USD: 13,333 IDR/USD (average of year 2015) IDR-JPY: 110 IDR/JPY (average of year 2015)
Business Period	Construction: 2 years Operation: 15 years

<Result of Economic Analysis>

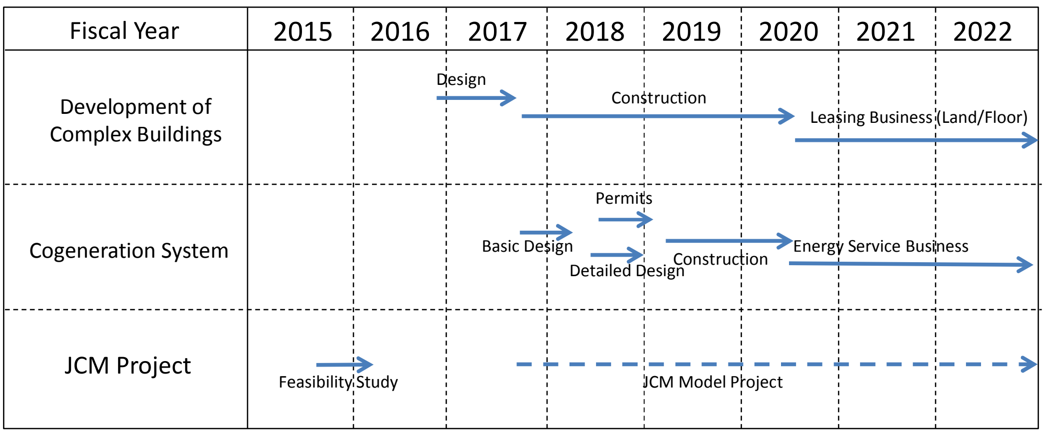
Pay Back Period : 11 years

i. Contribution to Indonesian Sustainable Development

Since this co-generation operate with higher efficiency than mono-generation including large scale fossil fuel fired power plant, it contributes to energy saving and CO2 emission reduction.

j. Proposed implementation schedule

Figure 8 Proposed Schedule of the Project



k. Capacity building to the host country

From hearing investigation of co-generation operator, this feasibility study found that the co-generation operation is not simple. For example, gas engines sometimes need careful maintenance to cope with variety types of troubles. In addition, to keep appropriate operation of absorption chillers, it is essential to monitor the operation intensively. Under the current

situation where there exist only a few examples of co-generation system for commercial buildings, human resource for the operation is not enough.
In the project, one of possible capacity building plan is to train operators of co-generation system and to transfer conduct capacity building program by technical know-how of co-generation operation in order to cope with the above-mentioned issue.

5. Conclusion and Next Steps

This feasibility study found that the co-generation system proposed in the study could archive following points.

- Energy Cost reduction
- 40% of Carbon dioxide emission reduction

However, since there a few example of co-generation system installed in Jakarta, the benefit of co-generation is sometimes hardly understood. Once the business circumstances prepared, we propose this system to the local real estate company then move on to the next step.