Preliminary Feasibility Study
on
The Palm Oil Mill Wastes-fired
Power Generation Systems
and
CDM Project
for
Rural Electrification in Sumatra, Indonesia

Study Report

March 2009

Engineering and Consulting Firms Association, Japan
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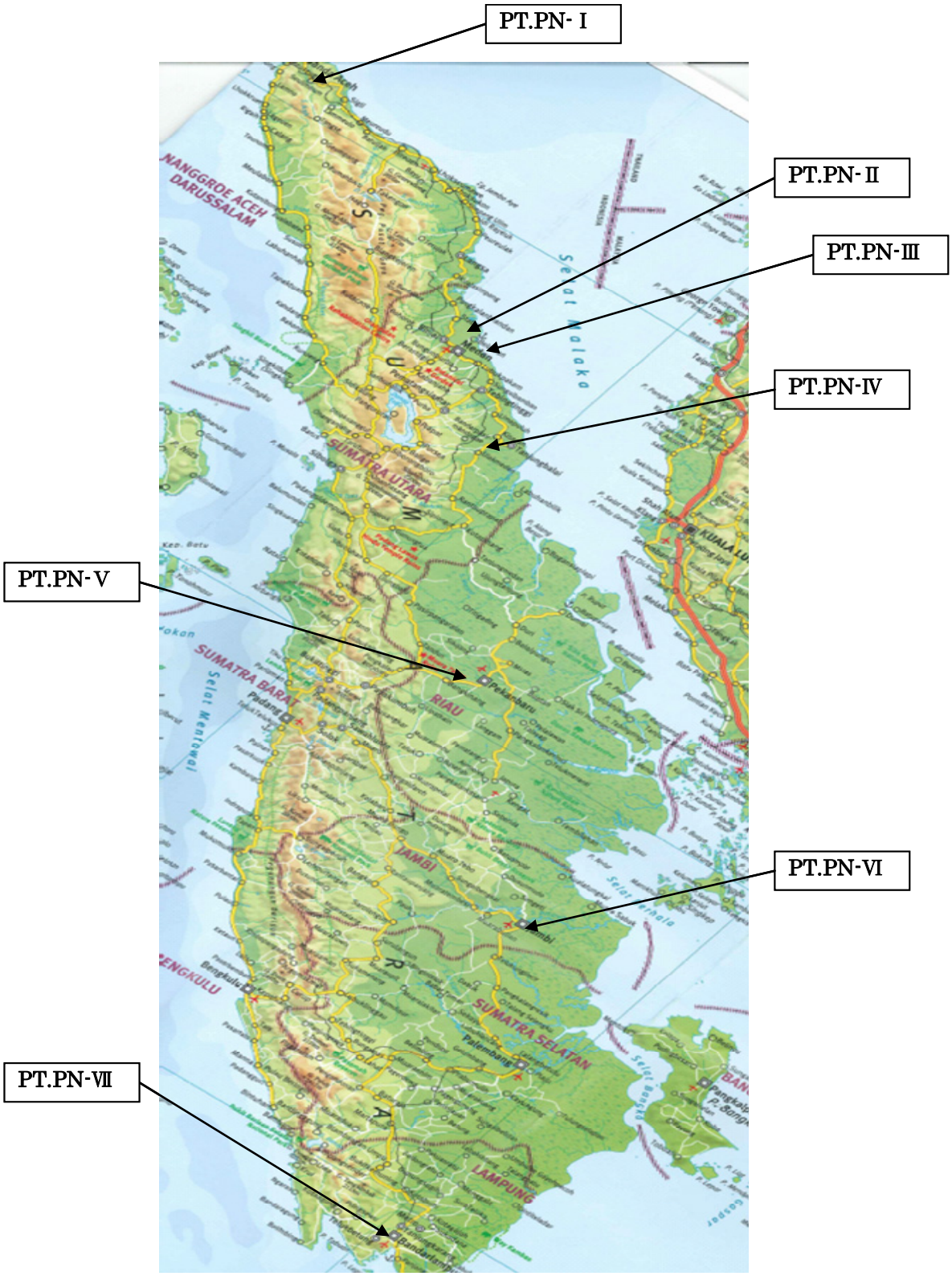

Project Area

EXECUTIVE SUMMARY

Executive Summary

1. Significance and Objectives of the Study

The Republic of Indonesia has experienced serious economic slumps in the late 1990s, due to Financial Crisis that happened in Thailand in 1997. Also, the Republic's financial status was seriously influenced by moving the Nation from the Oil Exporting Country to Oil Importing Country in the year of 2000. This situation made the Republic to take a motion to reduce its subsidies to Oil Products, Electricity and other utilities and encouraged to diversify the energy resources from fossil fuel to renewable energies such as Geothermal, Hydraulic, Solar, Wind and Biomass. In 2004, the Government has drawn up National Electric Master Plan (RUKN) and set the National Electrification Ratio. However, actual implementation of this Master Plan was left in the hands of the provincial offices of National Electricity Corporation or PLN, and they shall implement the program with close cooperation of the Provincial Governments. Thus, progress of this Master Plan was not progressed well, due to the lack of capacity for the planning works in the Provincial Governments and PLN Offices and the shortage of power supply capacity.

In 2006, the Government of Indonesia through the Ministry of Energy and Mineral Resources had issued Decree No. 002 of 2006 to encourage and support the Power Supply business by the Private Sector utilizing Renewable Energy. This Decree tasked PLN to purchase the electric power generated by the Renewable Energy and rules how the purchasing prices shall be determined. In addition to this Decree, the Government has introduced the concept of "Energy-independent Village Program (DME)" to guarantee the safety of domestic power supply to every habitant with an attempt to improve the life standards at the isolated islands and remote mountainous areas.

Although the launching the DME Program nation-wide by the initiatives of the Government, rural areas in Sumatra Island were not well entertained by this Program and some of them are still left behind to be improved. Meantime, Sumatra Island is rich in Biomass Resources, and Biomass Wastes at Palm Oil Mills (POMs) is one of the most potential resources to be utilized for the Power Generation in particular for the Off-grid Electric Districts.

Considering these factors, this Project aimed at exploring the possibility to develop a POM Wastes-fired Power Generation Project for reducing poverty and promoting regional development by enhancing Rural Electrification at the Off-grid Electric Districts in Sumatra. Through the implementation of this Project which materializes the concept of "Waste-to-Energy", may also improve the sanitary and environmental conditions at and around the POMs by capturing the Empty Fruit Bunches (EFBs) and Methane Gases from Palm Oil Mill Effluent (POME). This concept may also be applied to the United Nations for the Certified Emission Reduction (CER) of the Greenhouse Gas (GHG) under the Kyoto Protocol which in turn creates additional revenues to this Venture as a Carbon Credit.

2. Outline of Study outputs

This Study covers the Fact-finding on the Socio-economic conditions of Indonesia, Conducting survey over the existing and future development plans in the Power Sector and progress of the "Energy-independent Village" Plan, Appraisal of technology and man-power in the Power Sector and the Palm Oil Industry, Site Surveys at POMs in the Project areas, Analysis of Economical and Financial Viability, and others. As the results of this Study, the following findings are outlined;

(1) Significance of the Palm Oil Mill Wastes as an alternative resource for the Biomass Power Generation.

The republic of Indonesia being the largest Palm Oil Producer in the World, Indonesia in particular the provinces of Sumatra has vast potential to become the center of Biomass Power Generation and Supply Systems in the World as well. The Empty Bruit Bunche (EFB) which accounts about 23% out of Fresh Fruit Bunch (FFB) as residue, have been abandon or neglected since long as the wastes in the Palm Oil Mills (POMs) except few that are returned to the Plantation as fertilizer. Meantime, Methane Gases which influences the Climate Change as one of the Greenhouse Gas (GHG) have also been freely evaporated from the Palm Oil Mill Effluent (POME). This concept proposes to capture these "Wastes" and utilize them as the Resources under the concept of "Wastes to Energy". According to the Site Survey conducted, there is 61 POMs in Sumatra under the management of Seven (7) PTPekebunan Nusantasas (PT.PNs), the State Owned Plantation Corporations, and hundreds of POMs owned and run by the Private Sector. There is therefore tremendous potential to use these hidden resources for the Power Generation. It is worthwhile to consider to fully utilizing these resources

for the Electrification of rural areas especially for those Off-grid Electricity Districts in the remote areas along with the program of “Energy-independent Village” that is strongly enhanced by the Government.

(2) Confirmation of willingness to implement the scheme by the authorities and communities.

Through the series of discussions and interviews with the Coordinating Ministry for Economic Affairs, Ministry of Finance, BAPPENAS, Ministry of State Corporation, Ministry of Agriculture, Ministry of Energy and Mineral Resources, Ministry of Industry, PT. PNs, the Local Governments, and the Bank Mandiri, It was confirmed that the proposed concept was well accepted by all the authorities concerned and the Ministry of State Corporation and some of PT. PNs that the Study Team has met, have confirmed their intention to implement this scheme. Also, the Bank Mandiri who is one of the prominent state banks in the Republic has expressed their interest to act as a Conduit Organization for this Project, should there be any opportunity to deal with a Two-steps Loan. It is also assumed that this concept is attractive to the local communities so that the objectives of the Project aimed at the promotion of Rural Electrification and subsequent reduction of poverty in the rural areas, although there is no written evidence verifying the support of local community but the verbal one.

(3) Selection of the most suitable and optimal technical profile of the Biomass Power Generation Systems.

With due and careful consideration to the Technology and Capability of Human Resources available in the Project Areas, the Study Team, based on the results of the Site Survey, have exercised alternative examinations to several alternatives of the Power Generation and Supply Systems which is utilizing the EFBs and Methane Gases captured from the premises of POMs. The detailed explanation is presented in the Chapter 3 hereof.

(4) Project Implementation Models for the Projects owned by the Public and Private Sectors.

Besides the Project for the POMs that are owned by the Public Sector, the Study Team has tried to establish suitable Project Implementation Model for the POMs that

owned and run by the Private Sector. Major issues to establish this model were who will be responsible for functions of the Project Implementation Agency, and who will perform as a Conduit Organization for the Soft Loan to be provided. With recommendations from the Ministry of Finance and BAPPENAS, the Study Team made contact with the Bank Mandiri who is the largest state owned bank in the Republic, and they showed keen interest in the scheme to act as the Conduit Organization to provide the Soft Loan for this Project. However, the Study Team could not narrow down, due to time constraints, the candidate for the Project Implementation Agency, although some of line Ministries showed their interest in managing the Project.

(5) Analysis of the Financial Viability as a PoA Project.

The Financial Viability Analysis has been conducted with some assumption of the Parameters influencing the viability. Major pre-conditions for the analysis are; (1) Two Revenue Resources from the sales of Electricity to PLN and Certified of Emission Reduction (CER) for GHG under the Kyoto Protocol, and (2) Provision of the Soft Loan from the Government of Japan to cover the Initial Capital Outlays. As the results of Financial Viability Analysis, the Project with a processing capacity of Fresh Fruit Bunches for 30 tons per hour, Financial Internal Rate of Return was 11.7% before Tax, while the Project with 60 tons per hour processing capacity shows 31.7% in the same indicator. Sensitivity Analysis has also been conducted with some scenarios for changes on the parameters.

(6) Recommended Roadmap for the Implementation.

Although the results of this Preliminary Feasibility Study show positive indications, it is recommended to conduct a full scale Feasibility Study and Environmental Impact Assessment for this Project, utilizing a facility of the Technical Assistance from the Government of Japan. Roadmap for an application for the Technical Assistance, and implementation of the full-scale Feasibility Study and Environmental Impact Assessment is presented in Chapter 4 of this Report.

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Abbreviation

AMS	Approved Methodology
BAPPENAS	National Development Planning Agency Badan Perencanaan dan Pembangunan Nasional
BOD	Biochemical Oxygen Demand
CER	Certified Emission Reduction
CDM	Clean Development Mechanism
CDM EB	CDM Executive Board
COD	Chemical Oxidant Demand
CPA	CDM Project Activities
CPO	Crude Palm Oil
DNA	Designated National Authority
DOC	Degradable Organic Carbon
DOE	Designated Operational Entity
DME	Energy-independent Village Program Desa Mandiri Energi
EFB(s)	Empty Fruits Bunch
FFB(s)	Fresh Fruit Bunches
FIRR	Financial Internal Rate of Return
FTO	Free Trade Organization
GHG	Greenhouse Gas
HSD	High Speed Diesel
IMF	International Monetary Fund
JICA	Japan International Cooperation Agency
LHV	Low Heating Value
LSPO	Land Sustainable Palm Oil
O&M	Operation and Maintenance
OPEC	Organization of the Petroleum Exporting Countries
PoA	Programme of Activities
PDD	Project Design Documents
PLN	National Electricity Corporation, Indonesia Perusahaan Listrik Negara
POM(s) PKS	Palm Oil Mill Pabrik Kelapa Sawit

POME	Palm Oil Mill Effluent
PT. PN(s)	PT. Perkebunan Nusantara I～VII in Sumatra
RUKN	National Electric Master Plan Rencana Umum Kelistrikan Negara
SPC	Special Purpose Company
SSC-CDM	Small Scale CDM
UNFCCC	United Nations Framework Convention on Climate Change

MAIN TEXT

Chapter 1 : **Introduction**

1.1 **Background and Objectives**

The Financial Crisis of 1997 seriously hit Indonesian National Economy which led GDP growth rate of the nation to fall down to -13.1% in the succeeding year. This recession was the worst case among other neighboring nations in the South East Asia. In order to recover the economic slumps, the Government has accepted the Economy Re-construction Scheme initiated by IMF which includes abolishment of various subsidies to the Public Services and Infrastructures including the Oil and Gas Products and Electricity Charges.

Meantime, Indonesia has been net Oil Exporter since long as a member of OPEC, but in the years of 2000, the Republic becomes an Oil Importing country. Considering this situation, the Government of Indonesia has decided to reduce the subsidies to Oil Prices and set the new strategy for diversification of energy resources substituting the fossil energy such as Coal, Oil and Natural Gases by such renewable energy as Geothermal, Hydraulic, Solar, Wind, and various Biomass resources. In January 2006, the Government has introduced the Energy Diversification Target for the year of 2025.

The Electrification Rate of Indonesia is assumed as approx. Sixty (60) % which is lower than that of the neighboring countries. In 2004, the Government of Indonesia has introduced RUKN and set the targets for the National Electrification Ratio. Under this plan, the actual implementation of the program was however left in the hands of the provincial offices of PLN and they shall implement the program in the cooperation with provincial governments. Under such conditions, actual progress of the Master Plan has been so far limited, due to the lack of capability for the planning works at provincial offices of PLN and shortage of power supply capacity as a whole. As a result thereof, actual implementation was concentrated to the improvement of Electrification Rate in Java-Bali Areas and other areas were left behind.

Considering the situation as stated above, the Government of Indonesia, through Ministry of Energy and Mineral Resources Decree No. 002 of 2006, has introduced the policy to encourage and support the Power Supply business by the Private Sector utilizing renewable energy. This Decree tasked PLN for purchasing the Electric Power generated by Biomass fuels and how the purchasing prices shall be fixed for Electric Power generated by the Biomass. In addition to this Decree, the Government of Indonesia has introduced the concept of DME to guarantee the safety of domestic power supply to every habitant through the Presidential Decree No. 5 of 2006. This Decree was designed in particular for the improvement of life levels at the isolated islands and remote mountainous areas by realizing power supply systems in rather smaller scale,

utilizing such up-to-date technology as Solar, Wind, Mini Hydro and Biomass.

This concept aims at replacement of fossil fuels by locally produced renewable energy to provide the Electric Power to the Off-grid areas. The locally produced renewable energy resources may the transportation cost for the fossil fuels to such isolated mountainous and island areas. This Project will contribute greatly to reduce the subsidies by the Government for the transportation costs of fossil fuels and to maintain the environmental conditions in the regions. This program has been actively implemented by the initiative of Coordinating Ministry for Economic Affairs and other Six (6) line Ministries.

However the launching the DME Program nation-wide by the initiatives of the Government, rural areas in Sumatra Island were not well entertained by this Program and are still left behind to be improved. Meantime, Sumatra Island is rich in Biomass Resources and Biomass Wastes at POMs is one of the most potential resources to be utilized for the Power Generation and Supply systems to various Off-grid areas, while these resources have been less utilized.

Under such circumstances, this Project is aimed at reducing poverty and promoting regional development through enhancing Rural Electrification at the Off-grid areas by Power Generation and Supply systems utilizing Biomass Wastes at POMs in Sumatra, Indonesia. Through the implementation of this Project, sanitary conditions at and around the POMs may also be improved since EFB and Methane Gases shall be properly captured and managed as a fuel for the Project. This concept may be applied to the United Nations for CER of the Greenhouse Gas (GHG) under the Kyoto Protocol which in turn creates additional revenues to this venture as a Carbon Credit to be dealt in the Market.

1.2 **Scope of Works**

This study aimed at the formulation of a Biomass Power Generation Project for the purpose of Rural Electrification in Sumatra Island, Indonesia by changing the Biomass-based Industrial Wastes at the POMs into an Electric Power. The Project is at the same time sought to be applied as PoA for CER on GHG to the UNFCCC under CDM within the spectrum of Kyoto Protocol. This Study shall collect and analyze the data and information in the following fields among others, examine and select the most suitable Power Generation and Supply Systems, recommend necessary measures to realize, and drawn a implementation schedule for the Project;

- Present situation relative to the Power Sector in Sumatra Island,
- Progress of DME Concept in Sumatra,
- EFB and Methane Gases as a Potential Biomass Energy Resources,

- Needs for Waste-to-Energy concept at POMs,
- Potential Application of PoA to the Project,

1.3 **Study Area**

The Study Area covers the entire regions of Sumatra Island, the Republic of Indonesia. However, due to certain constraint in the study periods, site survey was conducted in the three locations; City of Jakarta, Pekanbaru, Capital City of Riau Province, and Medan, Capital City of North Sumatra Province. Pekanbaru and Medan were selected based upon the views that two areas are identified as the centers of Palm Oil Production in the Republic, thus they are expected to have a vast potential to realize the proposed concept into reality. As to the rest of other Provinces in Sumatra., Study Team has also gathered the secondary data and conducted subsequent analysis thereto.

1.4 **Study Schedule**

During the Study Periods, the Study Team has conducted the Field Survey at the Study Area for the periods from Sunday, December 14, 2008 to Wednesday December 24, 2008. The detailed Survey Schedule is shown in the Table attached hereto as the Appendix 1.

1.5 Study Team Member

This study was conducted by the following Study Team whose functions and areas of activities are shown in the following table.

Table 1-1: Member of the Study Team

No.	Name	Assignment
1	Junichiro MOTOYAMA, Ph.D.	Team Leader, Legal and Institutional Systems, Economic and Financial Analysis, Project Management
2	Masaru NAGAI	Socio-economic and Power Sector Analysis, Cost Estimation
3	Hiroyuki MONOBE	Biomass Power Generation/Supply Systems, Methane Gas Capturing Systems
4	Kei NIIDA	Domestic administrative, CDM
5	Nobuo NAKATA	Domestic administrative

Chapter 2 : **Issues of Rural Electrification and the DME Program**

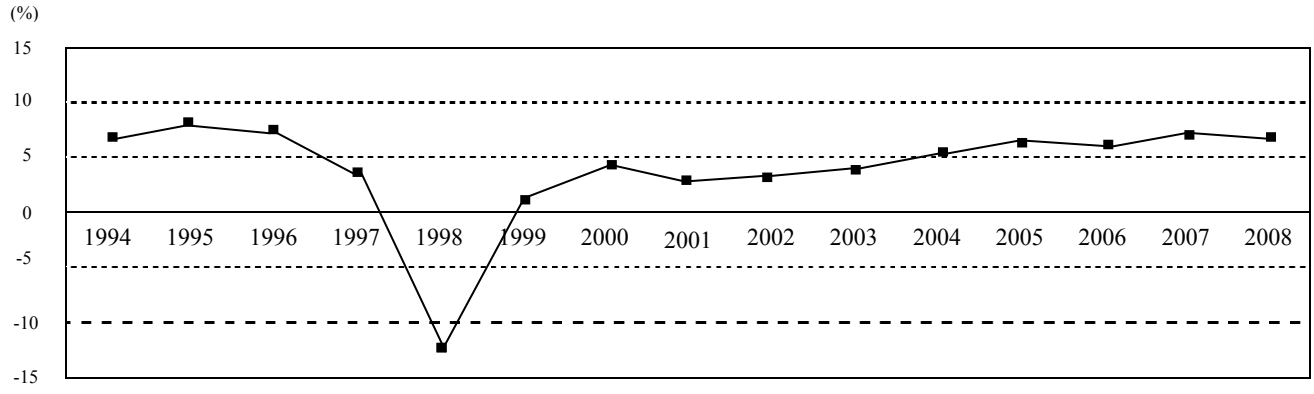
2.1 **Status of Economic Development and Energy in Indonesia**

From 1980's to the year of outbreak of Asian monetary crisis of 1997, Indonesia had accomplished a GDP growth of 7 to 8% per annum under the stable Suharto administration, with the aggressive introduction of foreign investment.

Table 2-1: GDP growth rate

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
9.0	8.9	7.2	7.3	7.5	8.2	7.8	4.7	-13.1	0.8	4.9	3.8	4.3	4.8	5.0	5.7	5.5	6.3	(6.0)

*tentative



Source : "Key Indicators for Asia & the Pacific 2008"
Asian Development Bank

However, the monetary crisis of 1997 hit Indonesia with a hard blow, then the GDP growth rate fell to -13.1% in the succeeding year, which was the worst case among the neighboring nations, and resulted in the crushing blow to its economy. Consequently Indonesian government accepted the economy re-construction scheme of IMF, and finally President Suharto had been obliged to resign in 1998.After years of political turmoil, the Indonesian economy took off for the stable economic growth in the year of 2000. During the period, in order to improve the finance of the country, several measures were taken under the guidance of IMF, such as, the abolishment of various subsidies. Especially for the oil products and electric charges, it was projected to abolish the subsidies as a rule. Indonesia had been the only one nation in Asia which took part in OPEC, and its export of crude oil had much contributed to the national

finance. However, starting from 1990's, the production of the crude oil had decreased, and in 2000's, Indonesia became an oil importing country reversely, and seceded from OPEC last year.

In order to curb the increment of oil consumption, and to reduce subsidies, Indonesia government had set the target of the diversification of energy resources, substituting coal, gas and renewable energy for oil, and in January 2006, by the presidential decree No.5, the target of the energy diversification by year 2025 was established as shown in Table 2-2 below.

Table 2-2: Energy Mix Present Value and Target

Energy Resources	As of 2004	Target for 2025
Oil	52.10%	< 20%
Gas	19.04%	> 30%
Coal	21.52%	> 33%
Bio fuel	-	> 5%
Geothermal	3.01%	> 5%
Renewable energy	3.93%	> 5%
Liquefied Coal	-	> 2%

Indonesian economy had satisfactorily developed until beginning of 2008. However due to the outbreak of the world simultaneous recession caused by US monetary upheaval in 2008, Indonesian economy, which much depended on the export to US, China etc., is supposed to be influenced for the worse by it.

2.2 Issues of Rural Electrification in Indonesia

The electrification rate of Indonesia is said approx. 60%, which is lower than the neighboring countries. Especially in the isolated rural area, such as mountainous remote area and islands, it is presumed that considerable amount of non-electrified indigent villages still remain. Indonesia government has, with the assistance of developed countries, promoted the electrification of such rural area starting from 1970's, in the manner of not only enriching power distribution network but also introduction of diesel power generation, micro hydro power station and solar energy generation to such Off-grid area.

In the government's RUKN which was created in 2004, the following target of electrification and necessary supporting organization for it were established. However, actual planning was left in the hand of the local office of PLN, and to be executed in the cooperation with local government.

Under such situation, due to the lack of capability for the planning work by local office of PLN and, in addition, shortage of power to be supplied by PLN, effort has been so far taken to manage the demand from Java-Bali area where power shortage is most conspicuous, and no special measure has been taken for the other areas.

Table 2-3: Target of National Electrification Ratio

（%）

Area		**2005**	**2010**	**2015**	**2020**	**2025**
Java-Bali area		62	71	85	100	100
Sumatra	Aceh	61	76	85	100	100
	North Sumatra	70	84	96	100	100
	West Sumatra	64	81	95	100	100
	Riau	41	52	60	75	100
	South Sumatra Jambi, Bengkulu	42	56	70	80	95
	Lampung	39	60	80	91	100
Bangka Belitung		63	78	90	100	100
Batam		81	100	100	100	100
Kalimantan	East	53	75	94	100	100
	Central/South	55	66	79	96	100
	West	47	65	81	93	99
Sulawesi	North/Central Gorontalo	49	57	68	88	95
	South/Southeast	54	57	68	88	95
Nusa Tenggara	West	29	36	45	70	85
	East	25	32	42	69	84
Maluku	Maluku North Maluku	53	73	91	100	100
Papua		30	37	48	75	90
Electrification ratio（%）		51	69	76	90	93

Source：National electric master plan（RUKN）2005

In the 10,000MW enlargement scheme compiled in the Presidential decree No.71 of year 2004 (so called “Crush Program”), only Java-Bali was taken up and other area has not been referred. The Second stage of 10,000MW enlargement scheme made in 2008 also has the same tendency.

2.3 The DME Program

As stated above, the orientation for energy saving, attaining effective energy utilization and diversification of energy resources, and target of the implementation of the scheme up to 2025

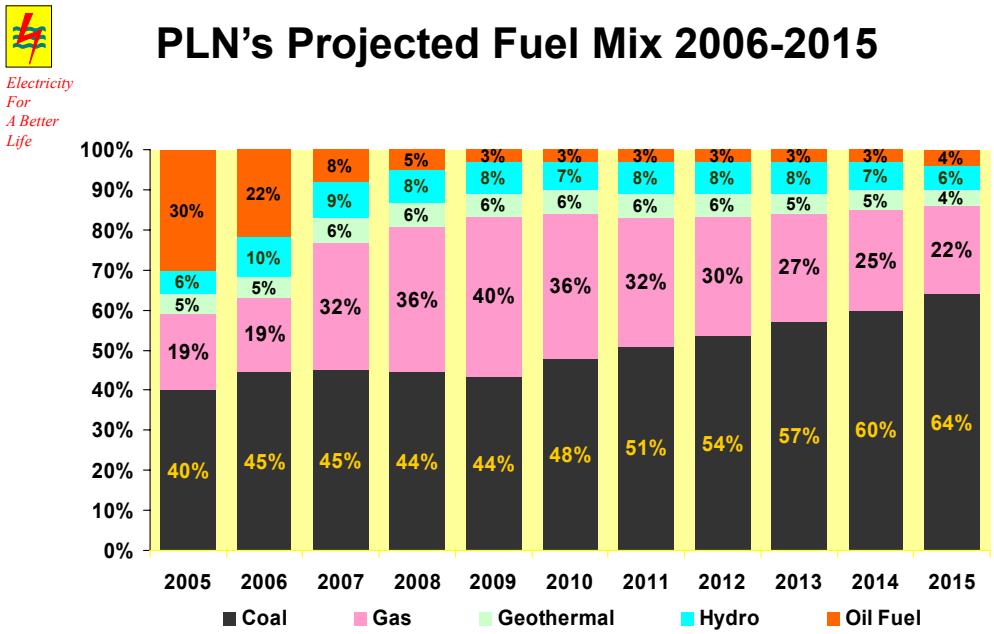
were set as main structure of the national energy policy in the Presidential Decree No.5 in 2006 to cope with rapid increment of the demand for energy of 7% per annum in an average.

As for the plan of Energy Mix prepared by PLN, it is stated that renewable energy shall be geothermal energy and hydraulic power, as shown in Fig. 2-1, which shall occupy 10% in the PLN at the year of 2015. Other energy resources, such as, solar energy, wind-generated electricity and biomass have not been referred. Under such situation, Indonesian government has, in the Decree No.002 of 2006 of the Ministry of Energy and Mineral Resources, proposed the definite measures to support and promote the electric generation business by private sectors utilizing renewable energy. This policy included the responsibility for purchasing generated power, deciding purchasing price, etc..

In addition, in order to fulfill the government's responsibility " to guarantee the safety of domestic power supply", prescribed in the Presidential Decree No.5 in 2006 as Energy-Independent Village Program, for the mountainous remote area and isolated islands which suffer from the shortage of power supply, government has planned to secure power to be necessary for lighting, cooking and industrial /productive activities, utilizing up-to-date technology, such as, solar energy, wind-generated electricity etc..

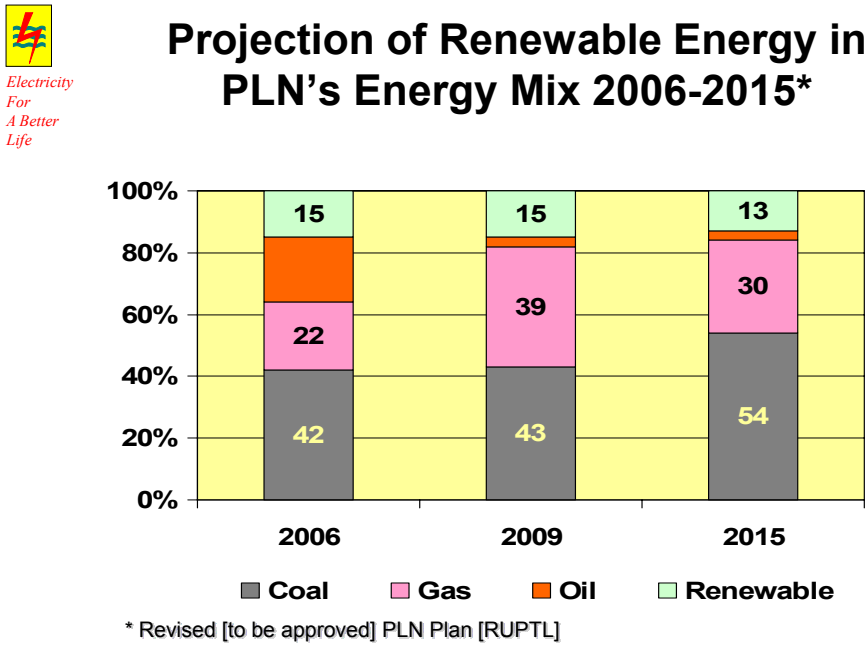
This is based on the consideration that the transportation of fossil fuel for power generation to mountain remote area or islands with high transportation cost is not efficient and will requires much subsidies, and that more effective way will be that fossil fuel is replaced with locally procured renewable energy and so generated power is supplied to off-grid area.

For the materialization of the scheme, Coordinating Ministry for Economic Sector shall take initiative and 6 ministries will cooperate. In the program, the villages that 60% of the demand for power can be managed by the renewable energy (Biomass fuel, geothermal energy, wind, micro hydro power and biomass from waste) are chosen as candidates and electrification work shall be carried out for them. Although the off-grid area of Sumatera where we have executed survey has not been chosen as an objective area, but the area always suffers from shortage of power supply and any measures have not been taken by the government so far notwithstanding the policy of the government, i.e. "to guarantee the safety of energy supply". However, this area constantly produces biomass fuel of palm tree, so called FEB, in large quantity, so it is anticipated that the utilization of EFF for power generation shall be quite effective and will contribute DME program in a wide sense.



Source : PLN

Fig. 2-1: Projected Fuel Mix 2006-2015

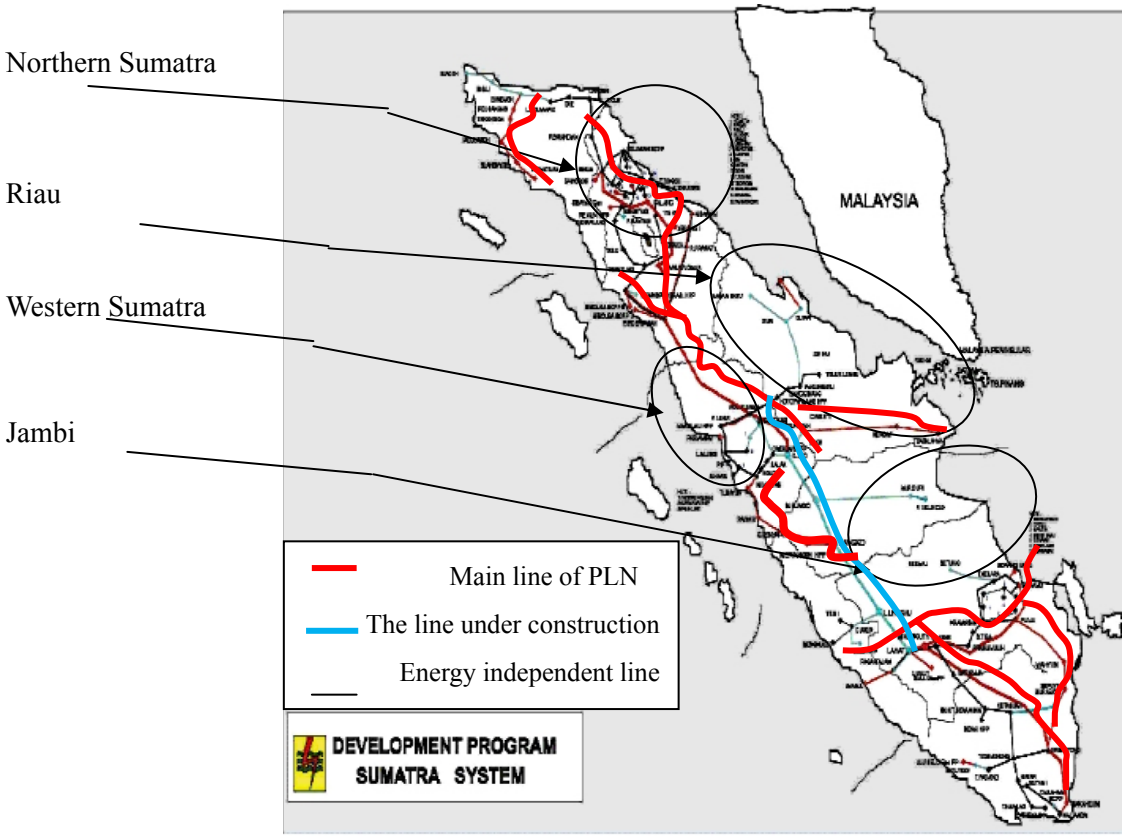


Source : PLN

Fig. 2-2: Projection of Renewable Energy 2006-2015

2.4 Outlines of the Surveyed Area

The selected surveyed areas are Riau Province which is the most far from Sumatera Electricity transmission line of PLN, Western Sumatera Province where transmission lines are dotted, Jambi and North Sumatera Provinces where the lines are concentrated. The common feature in these four provinces is that there are major palm producing areas, and in Riau, Jambi and West Sumatera province, private oil mills are dominant, while public ones are in North Sumatra. Therefore, survey has been conducted on a private mill in Riau and two public mills in Northern Sumatera, in order to complete the survey within the limited period. The data obtained from the survey which has been conducted on two private mills in Riau in the year of 2006 has also been considered as the supplementary data in this study, and that of other two provinces are analyzed according to the secondary data.



Source: National Energy Strategy Review

Fig. 2-3: Sumatra Power Supply Grid and Off-grid Area

The selected four provinces have a lot of off-grid Electricity Districts,, most of which are

under the umbrella of PLN. Although the electrification rate depends on the definition, it turned out that the area along the paved roads has the rate of 100% from the survey (according to Department of Agriculture and JICA specialists). Viability of electrical power supply to DME is also included in this project goal. DME project is designed to provide with such standalone-type as Solar PV and Micro Hydro Power Generation to the region which is located far from the road or transportation systems are not available. As to the Operation and Maintenance (O&M) for these Power Supply Systems, it is entrusted to the regional communities, and this concept is a little different from the objective of supplying the surplus electricity like this project. Therefore this Preliminary Feasibility Study shall be conducted along with the precondition that the surplus electricity of the POMs shall be connected to the off-grid Power distribution network as well as to the Sumatra grid of PLN. Over coming the shortage of energy in Sumatra by supplying surplus Electricity to the grid eventually might lead to supply the energy to DME.

Chapter 3 : **Profile of the POM Wastes-fired Power Generation Systems and PoA**

3.1 Results of the Site Survey at three (3) POMs

The Study Team has conducted the Site Survey for the periods from December 17 to 19, 2008 in the vicinity of Pekanbaru, Riau Province and Medan, North Sumatra Province. They have visited three (3) POMs; one is owned by Private Sector and two are owned by PT. PN-II and PT.PN-IV. The General descriptions of the POMs are illustrated in the Technical Sheets as shown in the Appendix 2 hereto. The Results of the Site Survey may be summarized as follows;

3.1.1 System Flow of the POM

The Processing Capacity of the Three (3) POMs were 60 tons/hour, 30 tons/hour and 60 tons/hour, but average Processing Quantity were 45 tons/hour, 30 tons/hour and 30 tons/hour respectively. The Process Flow of these POMs is common and conceptual flow diagram may be illustrated as follows;

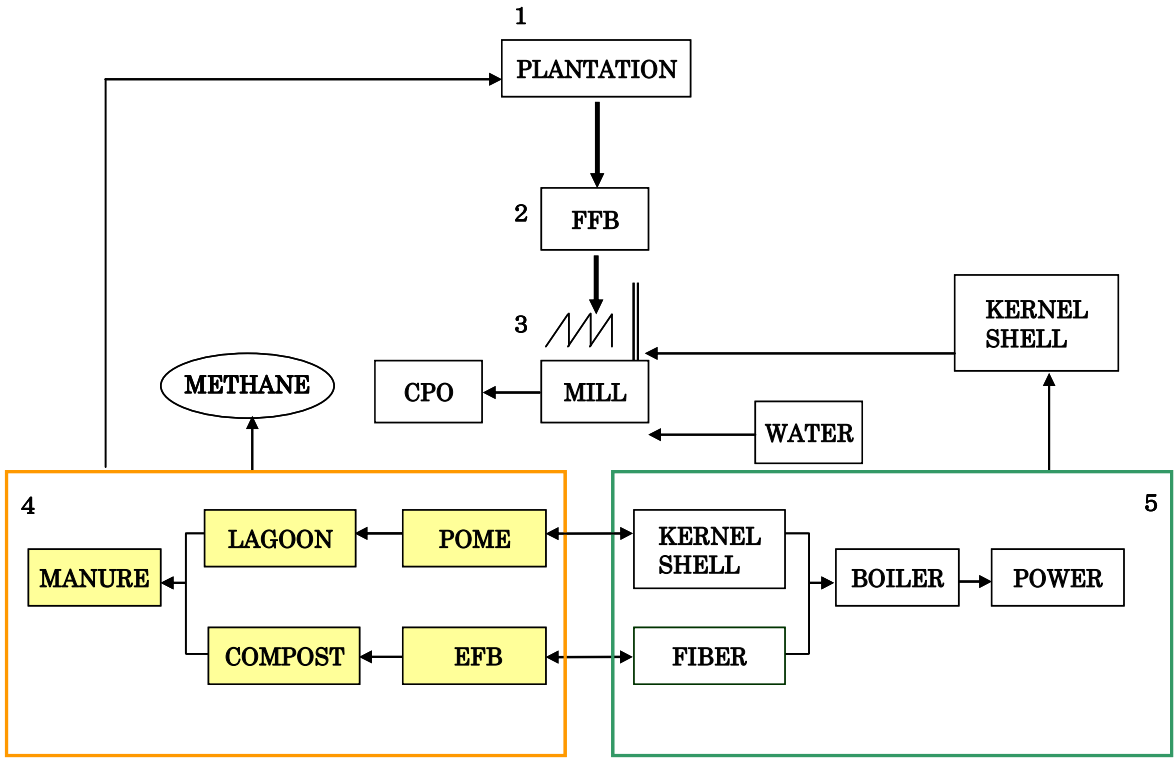


Fig. 3-1: Process Flow Diagram at the POM

3.1.2 **Fluctuation of Material Supply and POM Operation**

The supply of Fresh Fruit Bunches (FFBs) is varied by seasons and peak season is the months from May to August every year. Processing Quantity in FFB basis shows up-trends in the recent 3 years, due maybe to higher selling price of CPO, the major project of POMs. The Processing Quantity in 2008 reached to the almost same level of that of year 2003.The Operation ratio of POM shall be influenced heavily depending upon the quantity of FFB supply. Fluctuation between the peak season and low season was ±26% against the mean figure of 11,230 tons/month in case of the POM in North Sumatra. The following Figure shows the typical trends in the fluctuation of FFB supply to POM.

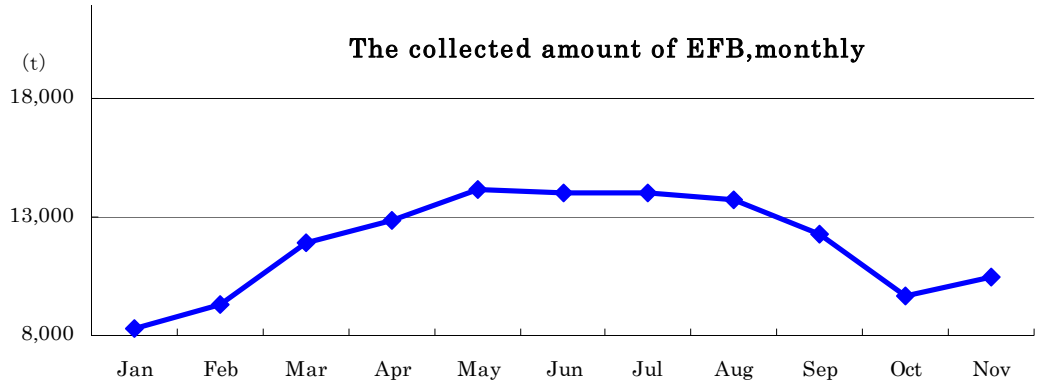


Fig. 3-2: Fluctuation of FFB Supply to POM by month

Meantime, relationship of the Operating Hours in POM and the proposed Power Generation Project are as follows;

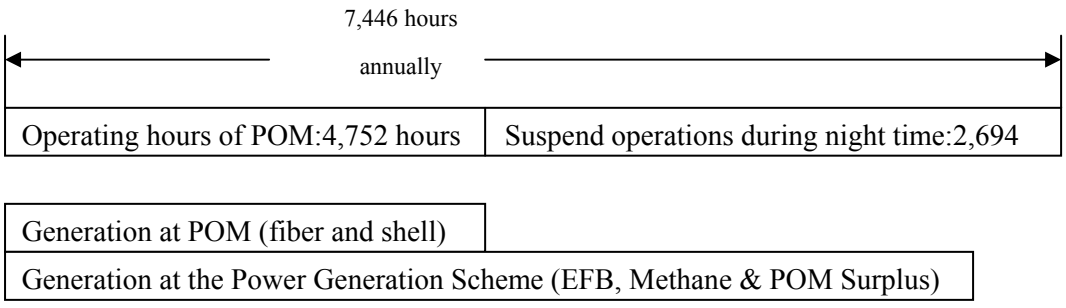


Fig. 3-3: Operating hours at POM and the proposed Power Generation Scheme

Each POM generates electricity by using Fiber and Kernel Shell during the operating hours for their own use. If the proposed Power Generation Scheme commences its Operation, POM will supply the surplus Biomass Wastes, Methane Gases and the proposed Power Generation Scheme generates the Electricity by using them.

3.1.3 Treatment of EFB and Environmental Issues

At present, EFBs are partly returned to the Palm Plantation without any treatment if the Plantation is attached to the POM. Since EFB takes several years to ferment and change itself to organic fertilizer, and during these periods, those abandon EFBs keep generating the Methane Gases. On the other hand, POM produces considerable amount of Effluent Waters through its CPO production process. These Effluent Waters are kept in the Lagoons located adjacent to the POM and the lagoons generate Methane Gases too. These Methane Gases, being one of the GHGs identified by the United Nations, affect adversely to the Climate Change in the global scale. Thus, Capturing the Methane Gases is one of the urgent countermeasures to be undertaken by the Government as well as by the Industry.

3.2 General description of the Biomass Wastes available for Power Generation in a POM

3.2.1 Types of Biomass Wastes and Gases available for Power Generation

There are about four types of biomass wastes in the Existing POM Systems.

- Fiber
  The fibrous carrier of oil which stretches seed coat of fruits and kernel
- Kernel Shell
  Skin of kernel, Core of fruits. Kernel holds and Kernel oil, which are separately extracted with Palm Oil
- EFB
  Fibrous material, which fruits were removed from the bunch with some hundreds of fruits

- POME
  The processed water at the POM which is consists of the condensed water of steam boiler and industrial cleansing water. It includes fibrous pieces, ones of seed coat, existing oil derived protein and muddy water contained seed coat. After storing at POME Lagoon, it generates Methane Gas through anaerobic fermentation.

The weight ratio of the above four biomass wastes is generally calculated based on weight of FFB, however, it varies on each POMs according to the disposing methods. At these POMs, regardless of its ownership either owned by Private or Public sectors, the expected amount of power generation is calculated by combining some of the above mentioned and converting the steam generated thereby and used for the power generation. Although the generated electricity is sufficient for internal use in general, it is necessary to purchase from commercial transmission lines in case of emergency.

(1) Fiber and Kernel Shell

Traditionally, fiber and kernel shell have been used effectively for the purpose of Power Generation to be used within POM, while EFB as well as POME have been disposed.

(2) EFB

Despite the fact, according to the survey which has been conducted for years, the sources to the mills replied that those wastes have been used effectively at any sites. Particularly, EFB is used as fertilizer at palm plantations, EFB contains a little amount of potassium, and for that reason, they say it is said to be reused at plantations. And it is some time used as heat generating source by boiler combustion, or sold as cut briquette materials after drying. From the point of transportation, the lump of fibrous like EFB has no choice but to be dumped in the plantation, but it takes several years to decompose, which generates Methane Gas through aerobic fermentation. If it is decomposed, it just contributes to reduction of chemical fertilizer of no more than 10 to 20% (excludes the composted fertilizer). In short, utilization of EFB as energy sources is rare, and dumping in plantation is the most cases.

(3) POME

The source of POME is mainly hot water from steam in the sterilizing process. In addition to this, drain from the back pressure tank, the water used for dividing the shell and the seed, industrial cleansing water with small pieces of EFB are among the sources. BOD of POME at he lagoon is 4 to 50 thousand ppm. POME is filtered through 5 to 6 lagoons gradually and reaches the level to be discharged into a river in a few months. Through these processes, gases such as methane are released from lagoons through anaerobic fermentation.

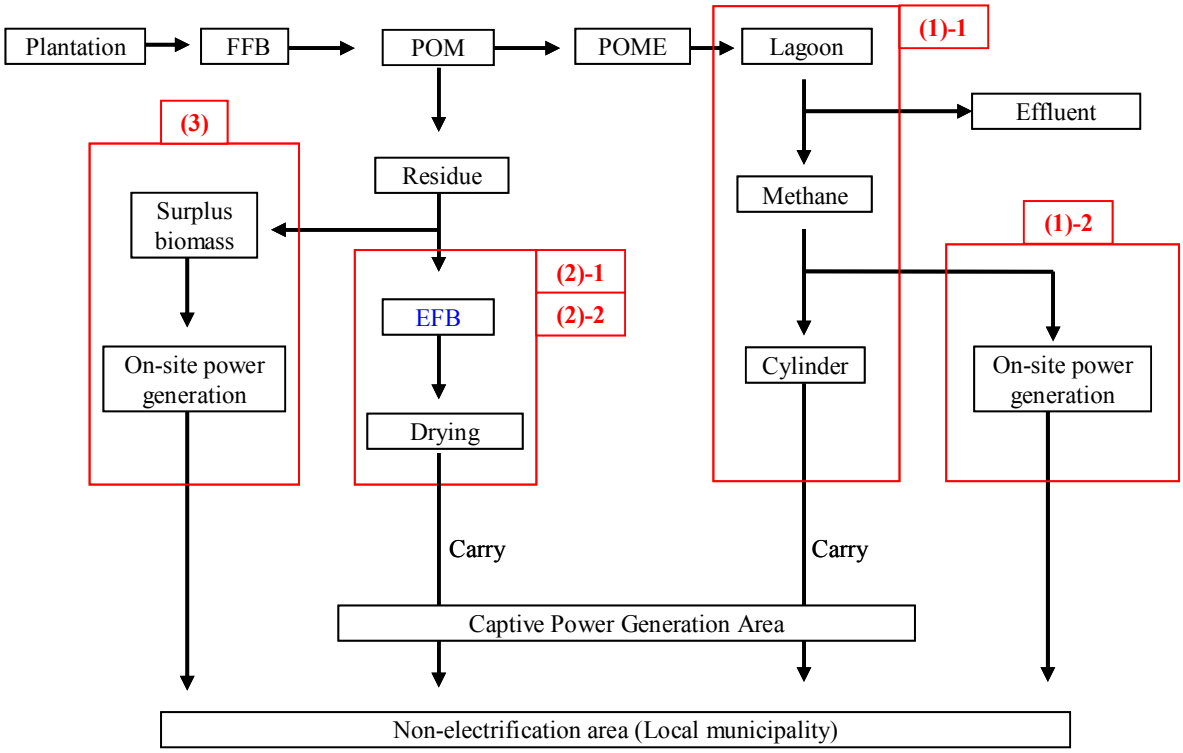


Fig 3-4: Questionaries for utilization of biomass residue

According to the POMs, POME is pumped into plantations from the POME Lagoons. It is used for irrigation as liquefied fertilizer. In many cases, plantations are not equipped with irrigation devices, and geographical difference of elevation leads the drained POME to stay at the low elevated areas as untreated water. Therefore, flooding in the rainy season will lead the untreated POME to pour into a river. In that case, it is not considered as the efficient use of POME, but the discharging the industrial waste waters in the plantation without treatment. As for possible treatment on POME, converting it into organic fertilizers might be applicable through anaerobic fermentation in the fermentation tank, and separating process of sludge and liquid after capturing methane. And then the liquid is discharged into a river after appropriate treatment is done, while the sludge is converted into organic fertilizers through aerobic disposing.

3.2.2 Current Material Balance at the POM Systems

The following figure shows the general weight ratio of amount of biomass residue against EFB, however in general these values vary widely by POMs. So, the amount of EFB varies widely in every year, month and day, which leads to unstable amount of biomass residue. In case that a

Power Generation scheme uses biomass wastes as the generating power source, it must be supplied to the Power Plant regularly, and operating schemes must be influenced depending upon the Operational fluctuation of POM. Thus, supply of power resources shall be regulated by the volume of stockpile as a buffer to fill the gaps that happened between the Operations of POM and a Power Generation Scheme. The correlations of Operating Hours by POM and a Power Generation Scheme are described in Fig. 3-3.

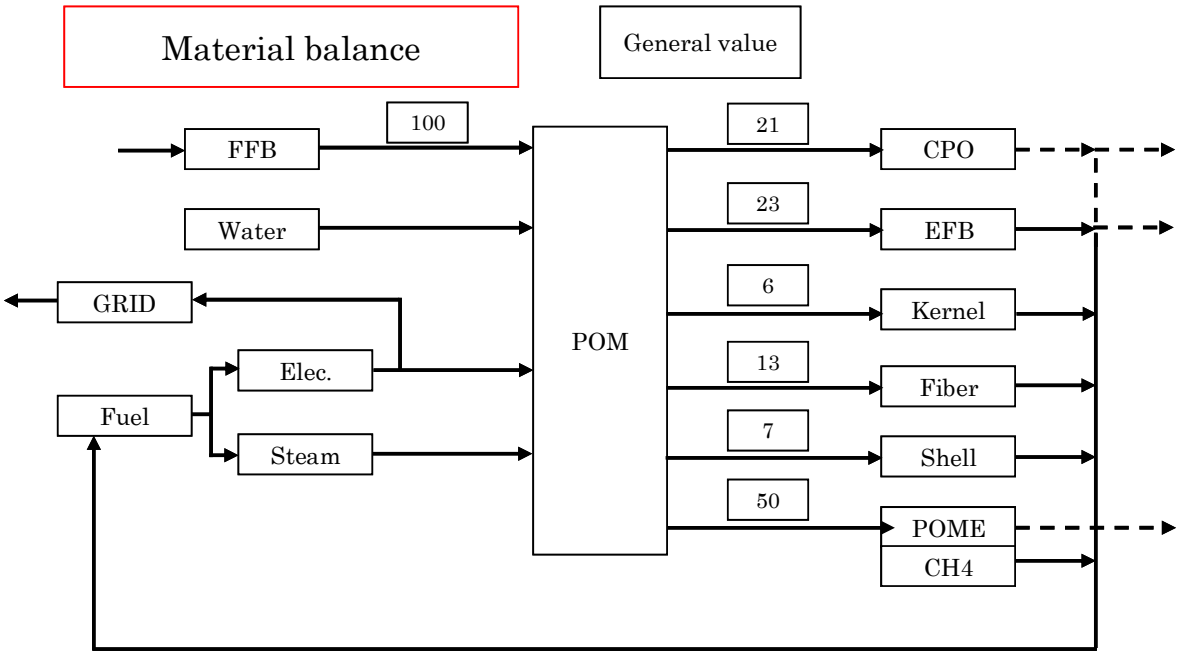


Fig. 3-5: General Material Balance at the Existing POMs

The fermentation amount of Methane Gases is not measurable because it is not captured yet, while generating source unit seems to be vulnerable to DOC, BOD, and COD in POME. Its generating source is the processed and cleansing water, and the composition changes through each process. The temperature is also vulnerable to the condensed water after sterilizing as well as the performance of cooling tower in POME.

3.2.3 **Heating Value of the Biomass Wastes and Methane Gas**

The Unit Rates of the Heating Values per one kilogram for different Biomass Wastes are calculated as shown in the following table, based upon the figures available in the Industry.

Table 3-1: The heating value by different Biomass Wastes

	The amount of heat MJ/kg	Remarks
Fiber	11.3	Condition of drain moisture of 30%
Shell	18.8	Condition of drain moisture of 30%
EFB	15.0	After drying moisture of 10%
POME	*	
Methane	35.8MJ/m^3	
The amount of heating input		

Source: Survey data on POM in Indonesia Japan Consulting Institute 2007

/cited the actual measured data by company A, 2007)

*The amount of generated Methane from POME varies according to POM, which is unstable. This specific value has been gained in the anaerobic fermenting tank which is owned by company A, for reference only.

For the calculation and determination of the Heating Value under the proposed Power Generation and Gas Capturing Systems, the following configurations are examined. The basic unit of the calculation was 10 t/h of EFB Processing Capacity.

(1) Heating Values in case of firing EFB, Fiber and Kernel and Methane Fermentation

Total amount of Biomass Emission as well as Heating Value are described in the following table.

Table 3-2: Total Heating Value and Methane Gas generated by all Biomass Wastes and Methane Gas

	Produced amount t/h	Heat value MJ/kg	Generated amount of heat GJ	Yield (general value)
FFB	10			
Fiber	1.3	11.3	14.7	13%
Shell	0.7	18.8	13.2	7 %
EFB (moistue of 10%)	2.3 (1)	(15.0)	(15.0)	23%
POME	5.0			50%
Methane	64.3 m^3	35.8MJ/m^3	2.3	
The amount of heating input			45.2	12.6MWth=12.6MJ/sec

The specific unit of methane fermentation shall be

12.86 Nm^3-CH_4/m^3・POME * 5m^3/h=64.3Nm^3-CH_4

(specific value, anaerobic fermentation tank)

2.3t of EFB with 60% moisture contains the one of 1.38t, and 0.92 when dried.

When biomass with 10% of water is x,

$0.1 = x/(0.92 + x)$ ∴x ≒ 0.1

Although the weight of dried EFB with 10% of moisture is 1.02 kg, unit rate of 1kg is used for the calculation purpose.

In short, when disposing capacity of EFB is 10t/h, Low Heating Value (LHV) of biomass emission is 12.6 MWth. When Efficiency of Biomass Boiler is approximately 80%, and Power Generating Efficiency is estimated as 20%, 2,016kWh of Electricity will be available. When Operating Hours is estimated as 7,446 Hours Annually (18 Hours per day and 22 days per month), Power Generation Capacity becomes to 1,287kWh. (18h/day * 22d/m * 12m/y ÷ 7,446hour * 2,016kWh = 965). This 2,016kWh is the operating hours of mills, in other words, the generation of electricity within the biomass generating hours.

(2) In case of EFB Firing only

Amount of Emission Reduction as well as Total Heating Value by dried EFB are described as follows;

Table 3-3: The Hating Value and Methane Fermentation

	Produced amount t/h	Heat value MJ/kg	Generated amount of heat GJ	Yield
EFB (moisture of 10%)	2.3 (1)	(15.0)	(15.0)	23%
POME	5.0			50%
Methane	64.3 m^3	35.8MJ/m^3	2.3	
The amount of heating input			17.3GJ	4.8MWth=4.8MJ/sec

When boiler efficiency is 0.8, and power generating efficiency is 0.2, the production of power generation will be 768 kW. When Operating Hours is estimated as 7,446 hours annually, the production capacity will be 493 kW. In the universal program for PoA, Methane Capturing from POME lagoons is hesitated to implement, given the conditions that Certification of Reduction is rather complicated and sophisticated equipments are required.

(3) In case of Methane from Lagoon only

Methane Gas can be fed into the Biomass Boiler directly without combusting. Emission Reduction as well as Total Heating Value by biomass are described as follows;.

Table 3-4: Gas based power generation by methane

	Produced amount t/h	Heat value MJ/kg	Generated amount of heat GJ	Yield
FFB	10			
Fiber	1.3	11.3	14.7	13%
Shell	0.7	18.8	13.2	7 %
The amount of heating input			27.9	7.75MJ

(4) In case of EFB and Methane Gas from Lagoon

Amount of Emission Reduction as well as Total Heating Value of EFB are described as follows;.

Table 3-5: The Heating Value by mixed combustion of EFB and Methane

	Produced amount t/h	Heat value MJ/kg	Generated amount of heat GJ	Yield
POME	5.0			50%
Methane	64.3 m^3	35.8MJ/m^3	2.3	
The amount of heating input			2.3GJ	0.64MWth=0.64MJ/sec

When Efficiency of Gas Engine Generator is 0.3, the production of Power Generation will be 192kW. When operation hour is estimated as 7,446 hours annually, the production capacity becomes to 123kW, which is the most realistic values of annual power generation by the Project.

(5) In case of EFB and Surplus Fiber and Kernel Shell

Amounts of Emission Reduction as well as Total Heating Value by all the Biomass are described as follows;

Table 3-6: The Heating Value by mixed combustion of surplus Fiber and Kernel Shell

	Produced amount t/h	Heat value MJ/kg	Generated amount of heat GJ	Yield
EFB (moisture of 10%)	2.3 (1)	(15.0)	(15.0)	23% (moisture of 10%)
The amount of heating input			15GJ	4.17MWth=4.17MJ/sec

When Efficiency of Biomass Boiler is 0.8, and Power Generation Efficiency is 0.2, the production capacity of Power Generation will be 667kW. And when operating hours is estimated as 7,446hours annually, the production capacity becomes to 425kW.

The above mentioned Heating Values shall be considered as an average value, and actual one shall be differed depending upon the variety, quality of the EFBs and seasonal conditions. In this study, the range of fluctuation reaches up to ± 15% as stated in Chapter 2. The fluctuation has impact on the production capacity of Power Generation, and therefore the production efficiency should be set at around 80% for designing the Project in order to envisage the unexpected changes.

3.2.4 **Expected Power Generation Capacity**

The expected Power Generation Values by different configuration of Biomass and Methane Gas are shown in the following table. These unit rates are derived considering the different conditions of POM Wastes such as Actual disposing amount of FFB at the surveyed POMs, Seasonal changes, Months and Days, in order to figure out most realistic amount for Power Generation by the proposed Project.

Table 3-7: Expected Power Generation Values by various configuration

Combinations of biomass	Total produced amount of heat	Total generated amount of electricity (within operating hours)		annual amount	
All of biomass (fiber, shell, EFB and Methane)	45.2GJ≒12.6MJ/sec	2,016kW	(A)	855kW	
Fiber and shell	27.9GJ≒7.8MJ/sec	930kW	Private power generation purpose (B)	526kW	B/A=46%
EFB with moisture of 10% & methane	17.3GJ≒4.8MJ/sec	768kW	Unused (C)	493kW	C/A 38%
EFB	15GJ≒4.2MJ/sec	667kW	Unused (D)	425kW	D/A 33%
POME Methane	2.3GJ=0.64MJ/sec	192kW	Unused (E)	123kW	E/A10%

According to the table shown herein above, it is found that 62% of fiber and shell is used for the Power Generation for their own use at the most of POMs, and the rest 40% of those Fiber and Kernel are used for different purposes. EFBs and Methane Gases are not used at all for the purpose of Power Generation. Potential Heating Value of Methane Gases accounts for approximately 10% of the total potential generation value, while the EFBs, if once the material is dried as 10% moisture contents, accounts approximately 38 % of the total potential generation values.

Based on the figures as estimated in the Table 3-7, the Potential Power Generation Value by firing EFB with 10% moisture contents and Methane will be 1,275kW at the POM with 30 t/h processing capacity of FFB. The most of the POMs owned by PT. PNs are 30 t/h of FFB Processing Capacity.

Table 3-8: Power Generation Potential at the POM with 30 t/h FFB Processing Capacity

Combinations of biomass	Specific unit	POM (within operating hours)	SPC (annual)
All of biomass (fiber, shell, EFB and Methane)	2,016kW	(6,048kW)	(3,860kW)
*Fiber and shell	930kW	2,790kW	N/A
EFB with moisture of 10% & methane	768kW	N/A	1,479kW
**EFB	667kW	N/A	1,275kW
POME Methane	192kW	N/A	N/A

* If POM utilizes all the Biomass Wastes such as Fiber, Kernel Shell, EFB and Methane for Power Generation purposes, potential Power Generation Value accounts 2,790kW, of which 1,500kW is required for internal use and 1,000kW is the surplus.

** When the proposed Power Generation Systems use only EFB for Power Generation purposes, the Potential Power Generation Values accounts approximately 1,275kW.

3.2.5 **Expected Performance and Outputs of the Project at EFB 10t/h**

As the results of this analysis, the expected Performance and Outputs derived from this Project are summarized as shown in the following table.

Table 3-9: The Performance and Outputs from the Project

Basis of Project Performance and Income

No.	Item	Basis	Year Conversion	Case 1	Case 2	Remarks
1	FFBinput t/h	10t/h		30t/h	60t/h	
2	wetEFB t/h	2.3				Moisture60%
3	Moisture35%のEFB t/h	1.42				
4	Methane avoidance t-CH4/h	0.0872				0.0616t-CH4/t-EFB
5	CO2equivalent① t−CO2/h	1.83	8,701	26,102	52,204	x21
6	dryEFB t/h	1.0				Moisture10%
7	Low Heating Value MJ/kg-EFB(dry)	15.0				
8	Generated Heat GJ/h	15.0				
9	Input Heat GJ/h	15.0				
10	Power Generation Efficency %	16				
11	Power Output kW	667	425	1,275	2,553	POM opetarting hours4,752hr
						Power olant operationg hours7,446hr
12	Actual Power Output in plant kW			1,200	2,500	
13	Power to Grid kW			900	2,200	
14	Annual generating hours hr/y	7,446				Sumatora Grid average emmision rate 0.7kg-CO2/kWh
15	CO2 Emmision② t-CO2/y			4,691	11,467	
16	CO2 Emmision total①＋② t-CO2/y			30,793	63,671	
17	CER Income③ kyen/y			61,586	127,341	@2,000yen/t-CO2
18	Power Income④ kyen/y			49,322	120,566	@7.36yen/kWh
19	Project Income③+④ kyen/y			110,908	247,907	

1. EFB shall be supplied from only the nearest POM.
2. Source of Methane avoidance from EFB 0.0616t-CH4/t-EFB : UNFCCC PDD ref.no.0386
3. Power selling price 1,051IDR/kWh source:Report from JCI(Japan Consulting Institute) report 2007. (0.70yen/100IDR March,2,2009TTB)
4. Source of Sumatora grid average CO2 emmision rate 0.791kg-CO2/kWh is NEDO CDM repor in 2003. Value of 0.7 kg-CO2/kWh consider transmission loss.

3.2.6 **Pelletization, carbonization and gasification of EFB**

This Study tries to explore the possibility of generating power by firing the Biomass Wastes at the POMs and Methane Gas from the POME Lagoon. However, there is some Alternative Technologies to be adopted for such purposes.

(1) **Drying and Pelletization of EFB**

In this Study, the EFB is proposed to be fed into the boiler after drying. Alternatively, it also can be used as fuel for Power Generation after drying and pelletization of EFB on sites. These products may be sellable to unidentified users in the domestic Markets as well as for the purpose of Power Generation something like this Project. Drying Technology may be useful for this Project but the Pelletization Technology will not be applied in order to avoid additional costs to the Project.

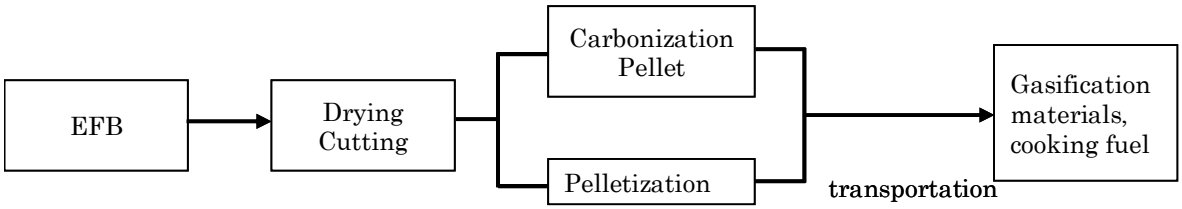


Fig. 3-6: Advance Processing of EFB

(2) Carbonization and Gasification of EFB

As an advanced step of the Drying and Pelletization of EFB, Carbonization and Gasification may be considered. However, mutuality of technology and adoptability to Indonesia market shall be carefully examined as well as the cost implication to the Project viability.

Although several technologies for drying and pelletization are developed and commercially applied, but Carbonization and Gasification technologies are still at the stages of experimental and not the stage of commercial operation. Through the Questionnaire Survey conducted during the Study periods, several negative opinions against this topic have been observed from various stakeholders including POMs, and many of them say that the application of these technologies is premature in such developing countries as Indonesia.

3.2.7 **Technical Issues to be solved**

(1) Higher Moisture Content

The EFB is discharged containing moisture of 60% and decomposes in a day after dumping. As mentioned at the previous clause, in order to convert the biomass into a fertilizer, it is dumped in the palm plantation or fed into boiler without a drying process, however, it is difficult to catch a fire because the EFB is of 60% of moisture contents. And as for composting, it is just lined in rows along the road and it takes several years until it decomposes as fertilizer, and Methane gas is generated during that periods. On this point, back pressure steam which is generated from turbine in the POM Systems might be applied to reduce moisture content of EFB. According to the results of several literature surveys on moisture of the biomass as well as heating value, there is some correlations in between, and LHV 15MJ/kg may be generated when the EFB with 10% of moisture content is fed. In this study, the biomass is set at 10t/h. The weight of which is discharged from POM is 2.3t when moisture content is 60%, and the weight

of moisture is 1.38t. When EFB contains 10% of moisture, and the dried one is x, the removed moisture amount is 1,280 kg, according to the formula ; 0.1=x/(0.92+x) ∴x≒0.1

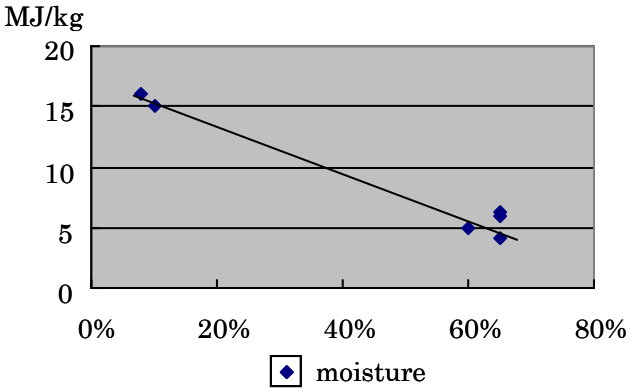


Fig. 3-7: Correlation of Moisture Content and Heating Value on EFB

In case of the POM with treatment capability of 30t/h, the tripled moisture amount of 3,840kg is able to be removed within an hour through the processes of the following Drying Systems.

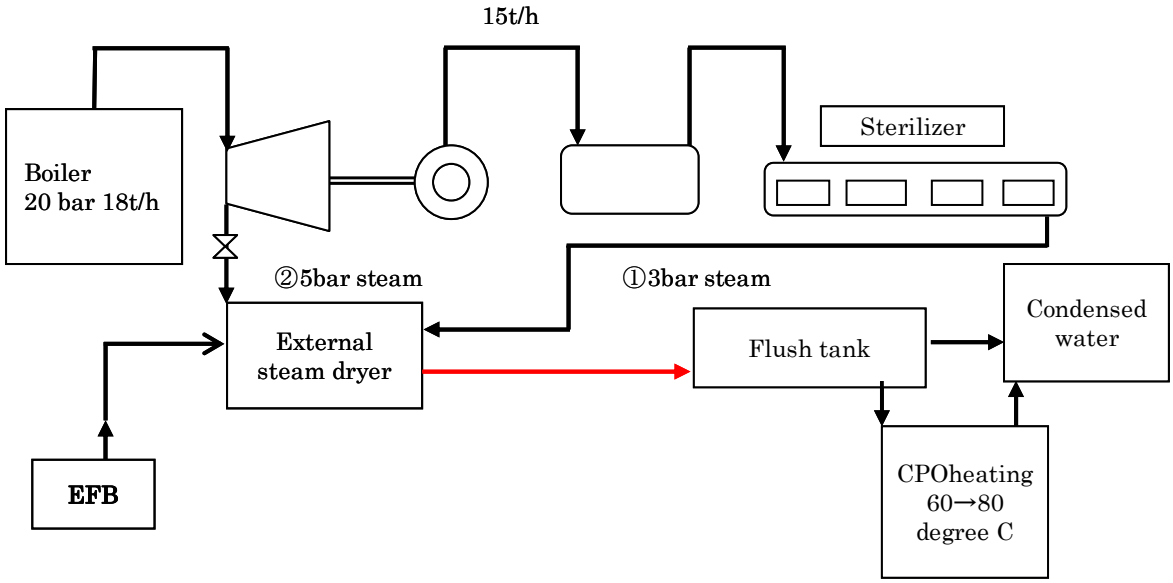


Fig. 3-8: Proposed Drying Procedure

The required heat value for evaporation of 1 kg-moisture is 5MJ/kg, taking the efficiency of dry system into account. In this case, 3,840kg - moisture, the required heat is 19,200 MJ, which is supplied from back pressure tank. When enthalpy of steam ratio for 3 bar is 2100kJ/kg, the

required steam amount is Qr=19,200MJ/h÷2,100kJ/kg=9,142kg/h≒9.5t/h

Although the steam amount supplied from ① is 15t/h>9.5t/h based on the half amount of EFB treatment amount, this is not available for Drying Procedure because the steam has already been sterilized and condensed at the same temperature. If the steam would be able to be extracted from boiler ② directly after decompression, it would be usable for the systems as well.

According to Table 3-3, the heat value for combustion of EFB per 1 kg is 15GJ, and in the POM that processes 30t/h of FFB, 45GJ/h shall be used. And for the heat amount required for drying of the EFB, it constitutes the value equivalent to some 43% of the heating amount, which is worth for investigation. In order to achieve such purpose, certain drying processes must be established in advance. Those systems may be consists of EFB Crusher, Shredder and Press Machines. They are to be discussed in other section.

(2) Methane from Lagoon

In order to capture the Methane Gases, Anaerobic Fermentation Tank Method and Covered Lagoon Method are available. The Tank Fermentation Method has already been introduced in livestock manure disposing projects. The Anaerobic Fermentation Tank Method however requires rather large Capital Investments and Maintenance Costs compare to the other method. This method, therefore, have not been introduced to the POM Systems yet.

The Lagoon Method has been introduced and widely used in the Southeast Asia instead of the tank method. It is the common Methane Capturing Method by putting high-polymer plastic cover on Lagoons in order to heat up by sunshine, and to accelerate the fermentation of the Methane within the Lagoon.

3.3 Selection of the Optimum Systems for utilization of biomass waste

3.3.1 Purposes of the POM Wastes-fired Power Generation and Gas Capturing Project

There will be three (3) major objectives to introduce the proposed POM Wastes-fired Power Generation and Gas Capturing Project.

(1) To help support the Rural Electrification Program which have been initiated by the Government of Indonesia through the extension of DME Program,
(2) To improve the Environmental Conditions within the POMs, at the surrounding communities and to contribute for mitigating the Climate Change at global levels by capturing the methane gas,
(3) To help support the financial sustainability of POMs by providing additional Revenues through the realization of "Waste-to-Energy" concept; the sales of Electric Power to National Grid and/or Off-grid Electricity Districts and the Carbon Credit gained by the Certification of Emission Reduction of GHGs to be issued by the United Nations.

3.3.2 Evaluation Criteria for Selection of the Technology for the proposed Project

In the processes of selecting the optimum technology to the Project, the following Evaluation Criteria was developed and applied.

Table 3-10: Evaluation Criteria for Optimum Technology

		Dry &Direct Firing	Dry & Pelletization	Carbonization/ Gasification
Technical Aspects	Maturity	○	△	△
	Adoptability	○	△	×
	Easy O&M	○	△	△
	Environmental Sustainability	○	○	△
Financial Aspect	Cost Performance	○	○	×
Overall Evaluation		○	△	×

Legends: ○ Most suitable
△ Suitable on certain conditions
× Not recommendable

As the results of Technical and Financial Evaluation, the Study Team finally selected the

technology of Dry and Direct Firing Method for the proposed POM Wastes-fired Power Generation and Gas Capturing Project.

3.3.3 **Technical Outlines of the Selected Power Generation Systems**

As stated in Chapter 3.2.3, the Study Team has selected "Dry and Direct Firing Method" for this Project. If this Project shall be implemented as a PoA verified Project, it is required to implement each Activities of Program under the unified standard form. Thus, the proposed POM Wastes-fired Power Generation and Gas Capturing Project shall be implemented along with the following project components;

(1) Drying and Firing of EFB together with extra Fiber and Kernel in the Biomass Boiler

It is necessary to reduce the Moisture Content of EFBs to the level of less than 20% on site, before firing them in the Biomass Boiler. For Drying Processes, surplus steam from Biomass Boiler, Steam Turbine or Sterilizer is used for that purpose. The dried EFBs together with extra Fiber and Kernel available within the POM, will be fired in the Biomass Boiler of the Power Generation Systems.

For drying up the EFBs, a pair of new Biomass Boiler is recommended in order to avoid to tough with the existing POM Systems. Thus, the proposed POM Wastes-fired Power Generation and Gas Capturing Systems shall be operational completely independent from the existing POM Operations.

The EFBs which are supplied from the existing POM Operator, shall have moisture contents of 60% and they shall be processed by the Crusher and smashed by Shredder as well as Screw Press within the premises of the Project Site. The smashed EFBs contain 40% of moisture, and its Low Heating Value (LHV) is 8 MJ/kg. When the supplied amount of EFB is 6.9t/h (moisture of 60%: water of 4.14t, dried content 2.76t), and moisture 40%, the moisture is 1.84t against 2.76t of the dried content. And when the moisture is 10%, it is 0.31t against 2.76t of the dried contents, therefore 1.53t/h (1.84-0.31) of moisture must be removed in order to reduce the moisture from 40% to 10%. Converting in annual hours of 7,446 hours, 1.53t/h * 4,752h/7,446h=0.98t/h, which must be reduced against operating hours of 7,446 hours at the proposed scheme. The amount of heat which is required to remove 1kg of moisture is settled at 5MJ/kg, taking the efficiency of EFB drying system into consideration.

The following figure shows the flow diagram of the proposed Power Generation Systems

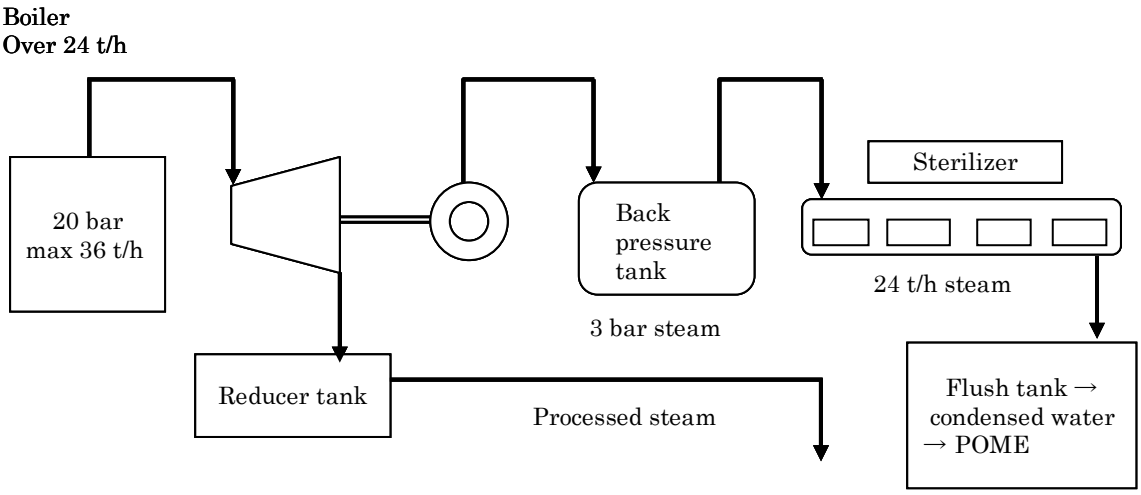


Fig. 3-9: Flow Diagram of the proposed POM Wastes-fired Power Generation and Gas Capturing Systems

(2) Capture Methane Gas from the Covered Lagoon Systems and Flaring

The Methane Gases captured from the POME Lagoon shall be fired either in the Biomass Boiler installed within the Power Generation Systems or at the alongside of the POME Lagoon. Captured Methane Gas has, however, lower Heating Value for Power Generation and lower piping lines to transport the Gases from Lagoon to Power Generation Plant, this Study recommends for flaring the Gases alongside the POME Lagoon and not utilized as an energy source for the Power Generation Systems.

3.3.4 Integration of the proposed Power Generation Systems into the Existing POM Systems

The proposed POM Wastes-fired Power Generation and Gas Capturing Systems shall be properly integrated into the existing POM Systems. Special attention shall be drawn to the points that the Operations of POM are fluctuated depending upon the supply of FFB which varies seasonally while the Operations of the Power Generation Project is required to be consistent throughout the year around. In order to absolve the gap, certain amount of dried EFB shall be kept at the yards of stockpile. Inter-relation of the proposed Power Generation and Gas Capturing Systems and the Existing POM Systems may be illustrated as follows;

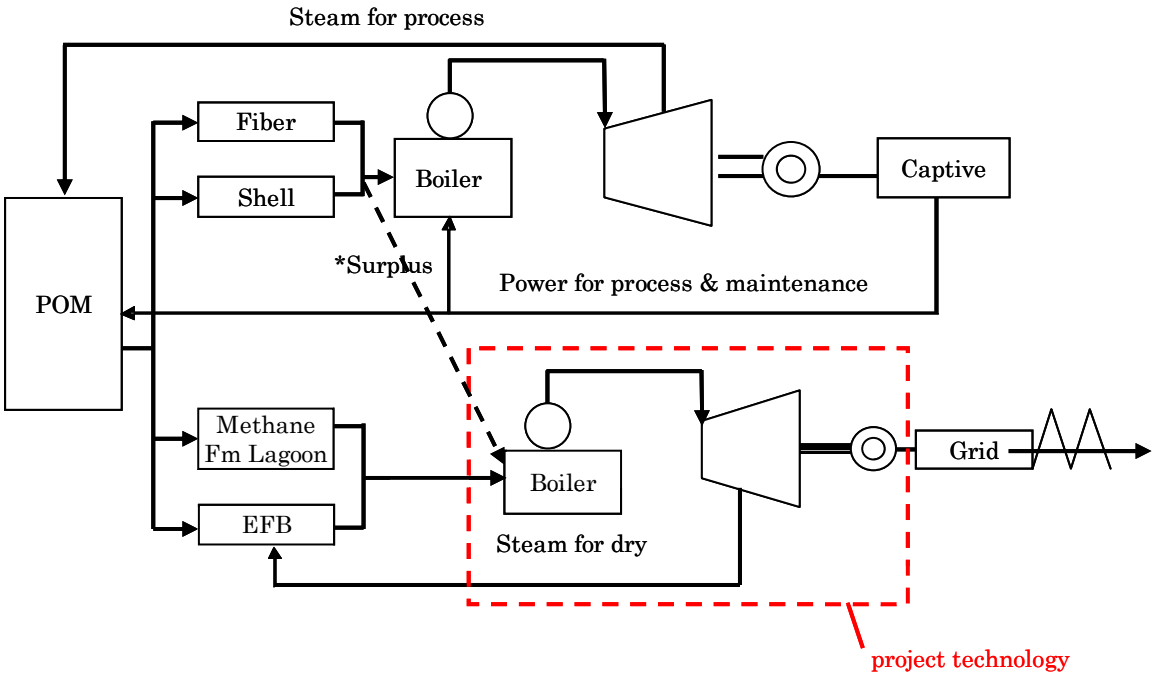


Fig. 3-10: Integration of the proposed Power Generation and Gas Capturing Systems and the Existing POM Systems

3.3.5 Expected Amount of Emission Reduction by Capturing Methane Gas

Power Generation Activities under the Existing POM Operations are not eligible for Certified Emission Reduction (CER) by the United Nations, because the Activities has been conducted before CDM schemes was established. Therefore, the Emission Reduction Activities created by this Project will be the subject under this analysis. According to the Table 3- , 2.3 t/h of EFB is discharged per 10t/h, which substitutes to the discharged amount of 6.9 t/h (moisture 60%) at the FFB Processing Capacity of 30t/h. When the default value of methane generated amount of the biomass is 0.0616t-CH4/t-EFB(moisture35%), the Methane Gases derived from carbon dioxide gas which is generated through annual operating hours of 4,752 in POMs is 4,752h *4.26t/h(moisture35%)* 0.0616 t-CH4/t-EFB * 21 = 26,102(t/y) ……..(I)

According to the Table 3-8, the production of electricity of 900kW * 7,446 hours = 6,701,400kWh, is gained during annual 7,446 hours of Operation. When Emission factor is 0.7kg-CO2/kWh, 4,691t/y of carbon dioxide gas is released……..……(II)

(I) + (II) = 30,793t/y (the Table 3-9 describes the amount of Potential Power Generation of 900kW this is the difference on calculation method on the equipments).

As leakage, Methane and Nitrous oxide are released at combustion in the Boiler. Although it is difficult to make precise calculation for the revenues from the CER as Carbon Credit, approximately 60 million yen is expected to be earned through the sale of CER as the Carbon Credit, on the conditions that the Project creates 30 kt-Co^2 and it can be sold at the rate of 2,000 JPY/t-Co^2.

When only Methane is taken up, the generated amount is 64.3 Nm^3-CH_4* 3 = 202.7N m^3-CH_4 according to the Table 3-5.

Annual amount = 4,752 h* 202.7Nm^3-CH_4/h = 963,230 Nm^3-CH_4 = 655t-CH_4,
When converted into CO2 13,750t/y …….……..…….(III)

Under this Study, it is proposed that Methane shall be captured by covering lagoons. However, covering five lagoons is not a practical and not feasible. Methane capturing rate was set as 50% by covering the first Lagoon out of four (4) Lagoons, and the expected amount of Capturing will be half of (III); approximately seven thousand tons.

Meantime, in implementing a PoA Project, the unified methodologies must be applied. However, distance between the POM Plants and Lagoon is sometime differed POM by POM and taking into the consideration of Capital Investment for the piping facilities for the Methane Gases to the Biomass Boiler to be installed at the Project Site, and necessary modification to the Biomass Boiler for mixed combustion of Methane Gases with the Biomass Wastes, the Study Team opted to flair the Methane Gases at the site of POME Lagoon. This solution may still contribute to create the CER and Carbon Credits by reduction of GHG. The expected Performance and Outputs by the Capturing Methane Gases are shown in the following Table.

Table 3-11: The Performance and Outputs from the Capturing Methane Gases

Basis of Project Performance and Income				
No.	Items	Case 1	Case 2	Remarks
1	The treated amount of FFB	30t/h	60t/h	
2	The generated amounf of POME t/h	15	30	moisture content of 60%
3	The specific unit of the generated methane m3-CH4/m3-POME	12.86	12.86	source : March 2007 A report compiled by Japan Consulting Institute
4	The generated amount of methane m3-CH4/h	192.9	385.8	
5	Methane weight conversion amount kg-CH4/h	138	276	
6	Annual generated amount t-CH4/y	655	1310	Operating hours of POM 4,752hr
7	Co2 conversion amount (1) t-Co2/h	13,750	27,500	
8	Supplementary ratio (Case1:50%, 2:60%)	6,875	16,500	
9	Income from the sales of CER (5) thousand yen/year	13,750	33,000	@ two thousand yen/t-Co2
10				
11	Residence period in anaerobic pond	50		
12	The amount of storage m3			
13	The number of lagoons	4	7	
14	The amount of storage per a lagoon m3	4050		
15	area m2	2,025	2,300	
16	The number of lagoons to be covered	1	2	
17	Cost			
18	Maintenance of pond	2,000	5,000	Upper part of ponds shall be harden
19	Constructing works including installation of props	8,500	20,000	
20	Cover made from plastic	8,500	18,000	
21	Devices for flare disposal of methane	300	600	Including monitoring
22	Total	19,300	43,600	

3.3.6 **Outline Technical Specifications of the Project**

Outline Technical Specifications of the proposed POM Wastes-fired Power Generation and Gas Capturing Project are shown in the following Table.

Table 3-12: Outline Specifications of the Major Equipments

	content	remarks
Generator	1,200kW（800~900kW at grid, 300~400kW is for runnnig）	Efficiency 0.9
Boiler	*Maximum pressure 40bar, The temperature of overheating steam 300~400 degree C, The amount of evaporation 7t/h (3t/h of which are supplied to dryer), Automatic fuel feeding, Automatic ash discharging, Heat input 10MJ/sec, with electrostatic precipitator	Efficiency 0.8
Turbine	Back pressure turbine, back pressure is less than 5bar	
Dryer	The required amount of steam 3bar, Drying steam 6t/h,	From back pressure tank
EFB Shredder	6～8t/h 75kW	Cutting
EFB pressing	8～10t/h 90kW	moisture reduction more than 10%

The Equipments for the POM Systems are used to be order-made and no spare part is kept by the manufacturers.

*Heat input: 3t/h of dried EFB with moisture content of 10% is produced within the operating hours of 4,752. When it is converted into 8400 hours annually, the dried biomass is 1.7t/h.

LHV=15MJ/kg ∴ the amount of heat input is 25.5 GJ. When efficiency of boiler is 0.8, 32GJ of heat input is required. Meanwhile, though the amount of heat for 4MP * 300 degree C * 7t/h 21.7 GJ, when enthalpy is 3,100 MJ/kg, which means the shortage of 1.3 GJ of heating amount, it is almost balanced when taking the sensible heat into consideration.

3.3.7 **Rough Cost Estimate for the Major Equipments and Installations**

The following Table illustrates the Rough Cost Estimate for the Major Equipments and Installations for the proposed Project. There is two separate figures for the Systems; 30t/h FFB Processing Capacity and 60 t/h FFB Processing Capacity. In case of the POMs owned by the PT.PNs, 30 t/h FFB Processing Capacity is the common standard, while those POMs owned by the Private Sector is 60t/h or more in the Processing Capacity of FFB.

Table 3-13: The Cost Estimate for Major Equipments and Installations

Equipments	30t/h	Unit price million yen	60t/h	Unit price million yen
*Turbine generator	Back pressure turbine with 1.2MW With back pressure tank	30	Condensations steam turbine with 3MW With cooling device also	60
Boiler	40bar 7 to 10t/h With economizer With electrostatic precipitator	110	40bar 30t/h With economizer With electrostatic precipitator	163
*Crusher	1 unit	3	2 units	6
*Shredder	1 unit	4	2 units	8
*Press	1 unit	6	2 units	12
*Spare for each unit	1 unit	10	With a motor	24
Dryer	1 unit	85	2 units	140
+Decompression valve	1 unit	2	1 unit	5
Water treatment facility	1 unit	20	Water softener for reusing	40
Piping	1 unit 100 to 400 A	10	~ 600A per a unit	15
Building for power generation	990 m^2	30	1,650 m^2 Fire-extinguishing equipments and others	50
Control Panel & Equipment	1 unit	30	1 unit	40
Transmitting lines	10km	20	10km	20
Others	Warehouse, heavy machinery, fan and others	30	Warehouse, heavy machinery, fan and others	50
Methane Recovery facility	One lagoon is covered for 2,025m^2 with flare facility.	19.3	Two lagoon are covered for total 4,600m^2 with flare facility.	43.6
Total		409.3		676.6

*Quoted on the conditions of Ex Works. If the manufacturing factories are located within FTO, only transportation fee is additionally charged.

3.4 **Outline of PoA and its Applicability to the Project**

In this Chapter, the Concept and Applicability of the Program of Activities (PoA) is intensively discussed and explored applicability of PoA to the proposed Project together with the recommended Structure for the implementation of this Project as a verified PoA Project by the United Nations

3.4.1 **Definition and Outlines of the PoA Concept**

The brief definitions of PoA may be digested as under;

(1) Programme of Activities (PoA) is:

- a voluntary coordinated action,
- by a private or public entity,
- which coordinates and implements any policy/measure or stated goal,
  i.e. incentive schemes and voluntary programs,
- which leads to GHG emission reductions or increase removals by sinks additionally,
- via an unlimited number of CDM program activity,
- and able to registered as a single CDM project activity.

(2) CDM program activity (CPA) is:

- a project activity under a Program of Activities,
- a single, or a set of interrelated measure(s),
- to reduce GHG emissions or result in net removals by sinks, applied
  within a designated area defined in the baseline methodology.

There is several basic key words governing the core activities under the PoA, and they will be summarized as follows.

(3) Coordinating and Managing Entity (CME) is;

The Implementation body of PoA, roles and function of which are summarized as:

A PoA shall be proposed by the coordinating or managing entity which shall be a Project Participants (PP) authorized by all participating host country DNA involved and identified in the modalities of communication as the entity which communicates with the CDM EB, including on matters relating to the distribution of CERs.

Project Participants of the PoA shall make arrangements with the coordinator or managing entity, relating to communications, distribution of CERs and change of Project Participants.

(4) Boundary of PoA;

The physical boundary of a PoA may extend to more than one country provided that each participating non-annex I host Party provides confirmation that the PoA, and thereby all CPAs, assists it in achieving sustainable development.

(5) Baseline and additionality;

All CPAs of a PoA shall apply the same Approved Methodology (AM), The PoA shall demonstrate that GHG reductions or net removals by sinks for each CPA under the PoA are real and measurable, are an accurate reflection of what has occurred within the project boundary, and are uniquely attributable to the PoA.

The PoA shall therefore define at registration, the type of information which is to be provided for each CPA to ensure that leakage, additionality, establishment of the baseline, baseline emissions, eligibility and double counting are unambiguously defined for each CPA within the PoA.

If the Approved Methodology is put on hold or withdrawn, not for the purpose of inclusion in a consolidation, no new CPAs shall be added to the PoA in accordance with the timelines indicated in procedures.

If the methodology is subsequently revised or replaced by inclusion in a consolidated methodology, the PoA shall be revised accordingly and changes validated by a DOE and approved by the CDM EB. Once changes have been approved by the CDM EB, each CPA included in the PoA thereafter has to use the new version of the PoA.

CPAs included prior to the methodology being put on hold, shall apply the new version of the PoA at the time of the renewal of its crediting period.

(6) Project Scale;

In the case of CPAs which individually do not exceed the SSC threshold, SSC methodologies may be used.

(7) Applicable GHG reduction methodology, technology and measure

All CPAs shall be applicable same methodology, same technology and measure in a PoA.

(8) CPA's number

There is no limitation of number of CPA's.

(9) Crediting period

PoA's crediting period is defined as less than 28years, and CPA's is same as to CDM, that is, less than 7years by 3 times, or 10years by 2 times.

With due consideration to the definitions as given herein above, the Outline of the PoA may be illustrated as shown in the following figure.

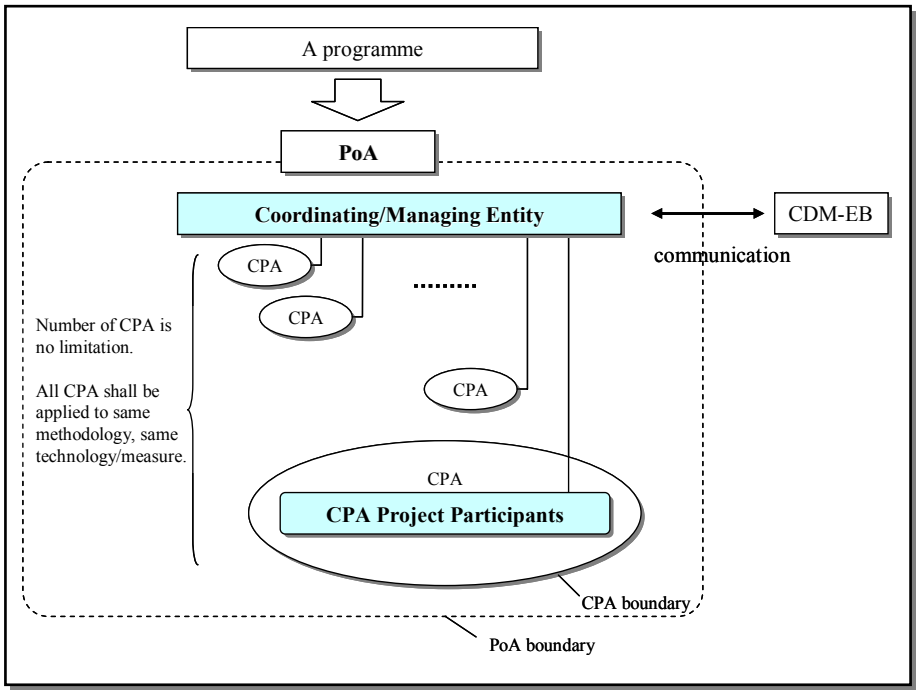


Fig. 3-11: Outline of the PoA

3.4.2 Applicability of the PoA Concept to the Project

The proposed POM Wastes-fired Power Generation and Methane Gas Capturing Project may be applicable for the PoA along with the following points, considering both the Results of Site Survey in the Project Areas and the PoA Rules.

(1) Programme

The proposed Programme is appropriate and may be qualified as a part of the DME

programs in Indonesia. We expect that the proposed PoA contributes towards the development needs for Electrification in the Rural Areas of Sumatra, Indonesia.

(2) Boundary

It is assumed that PoA boundary can be all province of Sumatra island. However, DME programme covers the whole Indonesia, so we have to consider the case that PoA boundary may be extended to the entire Indonesia.

CPA boundary which includes the installation for the proposed Power Generation Systems may be defined within each Project Site.

(3) Coordinating and Managing Entity

It is suggest that the Ministry of State Corporation can be most appropriate body for Coordinating and Managing Entity (CME), because they manage all the PT. PNs at present and it is further expected that they can communicate to the other Government bodies of Indonesia, Japan and UNFCCC including the CDM EB.

(4) Applicable Technology and Methodology

It is assumed that all CPAs install the Biomass Residue (mainly EFB) Combustion Power Generation and Supply Systems to National Power Transmission Grid and Off-grid Electricity Districts in Sumatra. And it is expected that the Biomass Residue Combustion Power Generation Systems may be applicable for AMS-Ⅰ.D and the Supply of the Electricity to National and Local Grids may be applicable for AMS-Ⅲ.E.

(5) CDM additionality

Under the DME Programme, many different Energy Resources are identified such as Solar power, Fuel oil, Hydropower at present. This is reason why the Biomass Power Generation Technology is so expensive and difficult to operate its systems for the people living in a rural area. This is the PoA additionality on this Project grounded by the technical barrier and financial barrier. These barriers may be cleared by the extension of the ODA loan and advanced technology from Japan with an additional profits from selling the CERs.

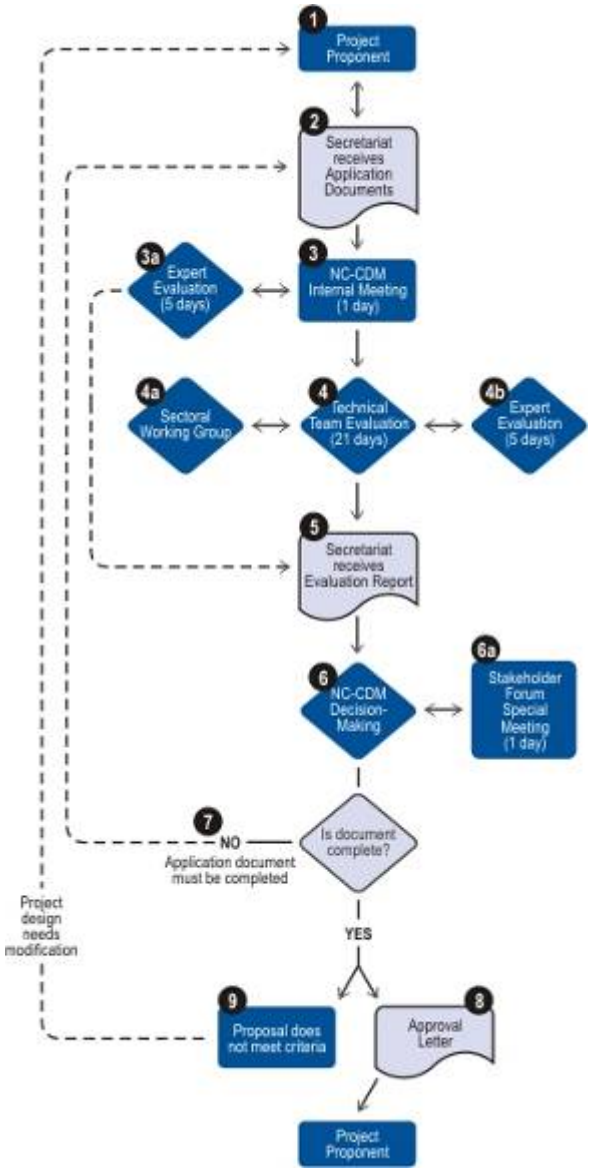
(6) ODA usage

The provision of the public funding for CDM is not allowed by COP7, so this Project is not qualified for the ODA fund directly. However, if the Project Site is located in the developed country (including Japan) and certified that the funding is not ODA funding, the public fund can be used for CDM without certification by host country.

(7) Environmental Impact Assessment (EIA)

EFB Combustion Generation Systems in a degree of 5-10MW is not imposed on in the present EIA regulation in Indonesia. However, this Project may execute spontaneous EIA when the CDM project starts.

(8) National approval[1]



1 Project proponent apply the application form.
2 Secretariat has to make sure the document are complete.
3 Executive Secretary presents the Project Proposal to the National Commission for CDM in Internal Coordination Meeting. The Internal Coordination Meeting last within one day.
3a If required by the National Commission, Executive Secretary will assign Experts to perform Additional Evaluation to Project Proposals as second opinion. Experts should evaluate within 5 days.
4 The National Commission assigns members of Technical Team to evaluate Project Proposals.
4a If required, Technical Team may take the application document to the Technical Team meeting.
4b If required by Technical Team, with the approval from the National commission, Executive Secretary will assign Experts. The whole process of (4), (4a) and (4b) is within 21 days.
5 Technical Team submits the Evaluation Report to the Secretariat to be passed on to the National commission. The Evaluation Report will be posted at the National Commission website.
6 The National Commission makes a decision whether the Project Proposal will be given Approval or Rejection. The National Commission Decision-making Meeting last within one day.
6a If there is any essential difference of opinion between the Stakeholders, the National commission may hold a Special Meeting of Stakeholder Forum. The Stakeholder Forum Special Meeting last within one day.
7 If the National commission cannot give the Approval Letter, according to the note made by Technical Team and Experts, Project Proponent is given 3 months time to make up and resubmit the revised Project Proposal to the Secretariat. The Secretariat will process the revised documents with the same procedures for new Project Proposal. However, Technical Team or Experts will re-evaluate only part of the proposal with the new additional data. The process of returning Project Proposal by Technical Team or Expert Group to be revised by Project Proponent may only be done once for every Proposal.
8 Secretariate submits National Commission Approval to Project Proponent.
9 If the Proposed Project does not meet the criteria, it may be re-submitted for National Approval after modifying the project design.

Fig. 3-12 : National Approval Transaction

[1] http://dna-cdm.menlh.go.id/en/approval/

(9) CDM Criteria[2]

CDM Criteria is provided in terms of Environment, Economy, Social and Technology. This Project may satisfy all the Conditions required under this clause.

Environment

The scope of evaluation is the area having direct ecological impacts from the project.

- Criteria: Environmental sustainability by practicing natural resource cnservation or diversification
  - Indicator: Maintain sustainability of local ecological functions
  - Indicator: Not exceeding the threshold of existing national, as well as local, environmental standards (not causing air, water and/or soil pollution)
  - Indicator: Maintaining genetic, species, and ecosystem biodiversity and not permitting any genetic pollution
  - Indicator: Complying with existing land use planning
- Criteria: Local community health and safety
  - Indicator: Not imposing any health risk
  - Indicator : Complying with occupational health and safety regulation
  - Indicator: There is a documented procedure of adequate actions to be taken in order to prevent and manage possible accidents

Fig. 3-13:CDM Criteria-Environment

Economy

The scope of evaluation is administrative border of regency. If the impacts are cross boundary, the scope of evaluation includes all impacted regencies.

- Criteria: Local community welfare
  - Indicator: Not lowering local community's income
  - Indicator: There are adequate measures to overcome the possible impact of lowered income of community members
  - Indicator: Not lowering local public services
  - Indicator: An agreement among conflicting parties is reached, conforming to existing regulation, dealing with any lay-off problems

Fig. 3-14: CDM Criteria-Economy

[2] http://dna-cdm.menlh.go.id/en/susdev/

Social
The scope of evaluation is administrative border of regency. If the impacts are cross boundary, the scope of evaluation includes all impacted regencies..

- Criteria: Local community participation in the project
  - Indicator: Local community has been consulted
  - Indicator: Comments and complaints from local communities are taken into consideration and responded to
  - Indicator: Local community social integrity
  - Indicator: Not triggering any conflicts among local communities

Fig. 3-15 : CDM Criteria-Social

Technology
The scope of evaluation is national border.

- Criteria: Technology transfer
  - Indicator: Not causing dependencies on foreign parties in knowledge and appliance operation (transfer of know-how)
  - Indicator: Not using experimental or obsolete technologies
  - Indicator: Enhancing the capacity and utilisation of local technology

Fig. 3-16 : CDM Criteria-Technology

According to the results of careful study, the proposed Power Generation Project is most likely to clear these figures.

3.4.3 Proposed Structure to implement the Project as a validated PoA Project

As stated in the Chapter 3.5.2 herein above, the boundary of this Project covers entire Provinces of Sumatra Island with the designated functions as the Coordinating and Managing Entity (CME) by the Ministry of State Corporation. The Ministry of State Corporation will be at the same time functioned as the Implementation Agency of this Project.

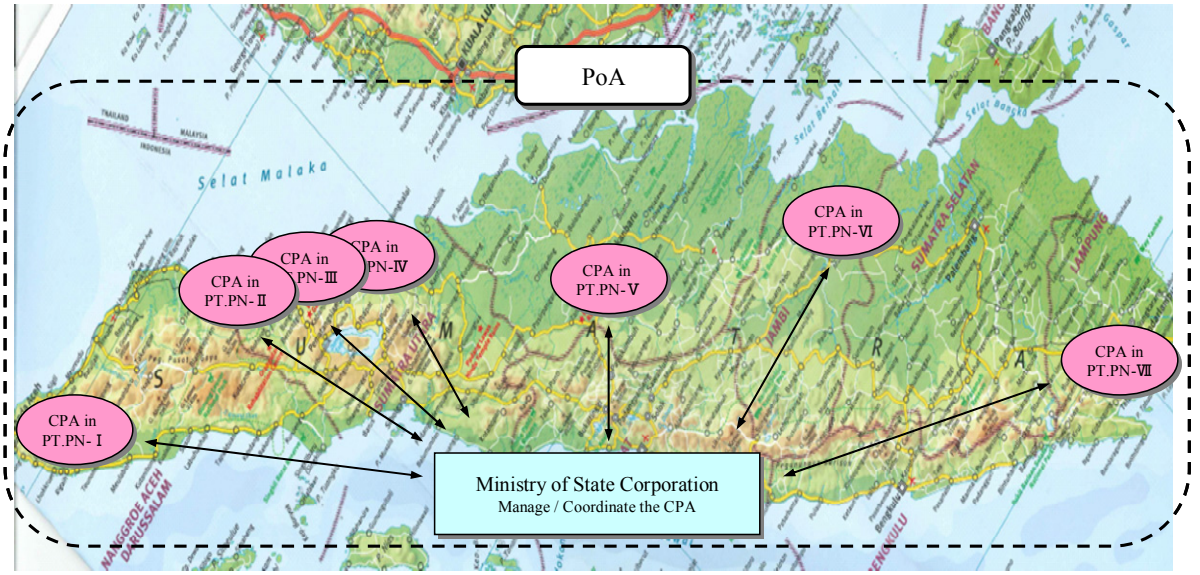


Fig. 3-17 : Concept of PoA under DME

Chapter 4 : **Schemes foe the Project Implementation**

4.1 **Project Implementation for the POMs owned by PT. PNs and POMs owned by the Private Sector**

In Sumatra, there is large number of Palm Oil Mills (POMs) owned by the Private Sector and PT. Perkebunan Nusantara or PT. PN, the State Owned Corporation under the administrative control by the Ministry of State Corporation. At present, total 61 numbers of POM are being operational under Seven (7) PT.PNs in Sumatra. Besides these POMs owned by PT. PNs, thousands of POM are owned and operated by the Private Sector in Sumatra. From the point of view on financing Capital Expenditure for the proposed Power Generation and Supply Scheme, these PKS may be classified for two different categories; POMs owned by PT.PNs are eligible for ODA Soft Loan directly and other category is not eligible directly but may be indirectly.

4.1.1 **Project Implementation for the POMs owned by PT. PNs**

Considering the magnitude of initial investment for the proposed scheme, it is recommendable to deploy a Soft Loan with lower capital cost in order to make the Project financially viable. For those POMs owned by PT.PNs may have an access to such Soft Loan as that provided by Japan International Cooperation Agency (JICA) of Japan. Since there is tremendous requirement for a large numbers of Projects in different PT. PNs and regions, it is recommended to make several numbers of POM into one package suitable to the scale of Soft Loan provided by JICA. The proposed flow diagram for the Project Implementation may be illustrated as follows;

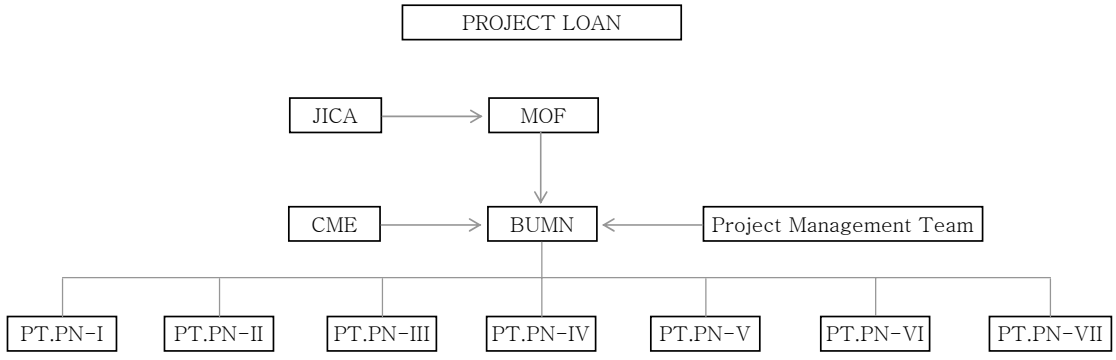


Fig. 4-1: Proposed Project Implementation Structure for the POMs owned by PT. PN

4.2 Project Implementation for the POMs owned by the Private Sector

For those POMs owned and operated by the Private Sector may be financed through the mechanism of Two-steps Loan from JICA via a conduit organization in Indonesia. Thus, every effort for exploring a suitable institution to conduit the Soft Loan to the POMs owned by the Private Sector was conducted during the survey periods.

After intensive discussions with the Ministry of Finance and Bappenas, Bank Mandiri, the largest state owned bank is considered to be the conduit organization best suit for this Project. Interest of Bank Mandiri in this Project was also confirmed by subsequent interviews made by the survey team. The proposed Power Generation and CDM scheme shall be implemented by the mechanism of Special Purpose Company (SPC) in order to establish an independent operation from that of Palm Oil Mill and to get a loan from the conduit organization as a Project Finance. The proposed flow diagram for the Project Implementation by the Two-steps Loan may be illustrated as follows;

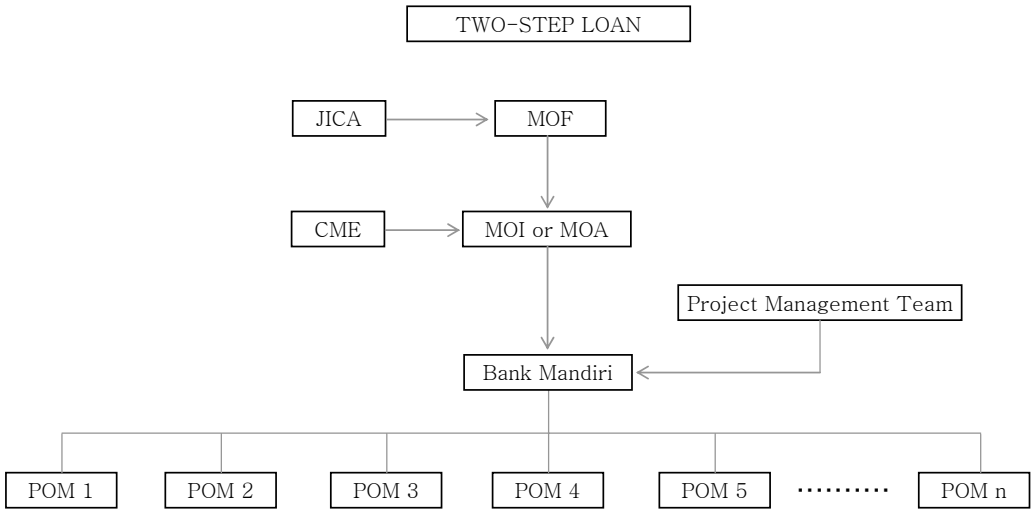


Fig. 4-2 : Proposed Project Implementation Structure for the POMs owned by the Private Sector

4.3 Economic and Financial Viability of the Project

This Study intends to analyze the Economic and Financial Viability of the Proposed Projects that provide the Electric Power to various Off-grid Electric Districts in Sumatra. However, more emphasis has been deployed for the analysis of Financial Viability considering the nature of the Project that shall be developed with the facility of a Project Finance. Meantime, “Off-grid” means the Electricity District which is not connected with Sumatra Electricity Grid, as stated in

the Chapter 2. This Biomass Wastes-fired Power Generation Systems shall be developed at Twenty-two (22) POMs in Sumatra simultaneously and expected Revenues are the Revenue from the sale of extra Electricity to the Provincial PLN Offices whose administrate the Off-grid power distribution networks and Revenue from the Sale of Carbon Credit derived from this venture. Thus, this financial viability analysis was conducted for Twenty-two (22) Biomass Wastes-fired Power Generation Project as one package that shall be implemented by PT. PNs under the administrative monitoring by the Ministry of State Corporation.

4.3.1 Pre-conditions for the Financial Viability Analysis

The Financial Viability Analysis has been conducted based on the following pre-conditions.

- All the Plants, Equipments and other Components shall be procured in the Republic of Indonesia, except for a few component,
- Inflation factors in relation to this Capital Investment are eliminated in this analysis,
  Selling Price of Electric Power to the Provincial Office of National Electricity Corporation (PLN) shall be determined based on the Unit Price for inter-connection under the medium voltage transmission which shall be governed by the Ministerial Decree No. 2 of 2006, that was issued by the Ministry of Energy and Mineral Resources, the Republic of Indonesia,
- Sale of Carbon Credit will be realized after One (1) year from the commencement of Operation of the Power Generation Systems,

Capital Cost for the Project shall be based on the costs imposed by a Soft Loan to be provided under the Official Development Assistance program by the Government of Japan or similar facility.

4.3.2 Total required costs for the Project

○ Composition of the Project Costs

The Capital Expenditures required for the development of Power Generation facilities have been estimated along with the following payment categories;

(a)Dehydration Facility for EFBs,
(b)Power Generator,
(c)Methane Gas Capturing and Piping Facility,
(d)Engineering Services,

(e)General Administration Costs,

(f)Contingency.

○ Currency and Foreign Exchange Rates

The Investment costs have been separately estimated in the Foreign and Local Currencies based on the following exchange rates;

One (1) U.S. Dollars = 100 Japanese Yen = 12,000 Indonesian Rupees

○ General Administration Costs and Contingency

General Administration Costs cover all the Costs by the Implementation Agency for the administration of the Project during the preparation and construction of the Project, and Five (5) percent of the Investment Costs identified under the pay items (a), (b) and (c) hereinabove was allocated. In the meantime, the Contingency shall be responded to risks of the Project during the periods of Planning and Construction, and Five (5) percent of the Construction Costs were allocated based on the experiences in the similar projects in the Republic of Indonesia.

○ The Breakdown of the Project Costs

The total project costs for 30 tons/hour and 60 tons/hour are broken down in the following tables.

Table 4-1: Break Down of the Project Cost (FFB Process Capacity: 30 tons/hour)

		Foreign Currency		Local Currency		Total	
		Mill. Yen	Bill Rupee	Mill. Yen	Bill. Rupee	Mill. Yen	Bill. Rupee
1	Dehydration of EFB & Boiler	100	0	0	15.3	100 (127)	15.3
2	Collection of Methane Gas & Piping	0	0	0	5.2	(43)	5.2
3	Generator(1,200kW) Transmission Line	30	0	0	10.8	30 (90)	10.8
4	Engineering Fees	10	0	0	0	10	0
5	General Administration	0	0	0	3.8	(32)	3.8
6	Contingency(5%)	0	0	0	2	(24)	2
7	Total	140	0	0	37.9	456	

Table 4-2: Break Down of the Project Cost (FFB Process Capacity: 60 tons/hour)

		Foreign Currency		Local Currency		Total	
		Mill. Yen	Bill Rupee	Mill. Yen	Bill. Rupee	Mill. Yen	Bill. Rupee
1	Dehydration of EFB & Boiler	100	0	0	33.9	100 (283)	33.9
2	Collection of Methane Gas & Piping	0	0	0	8.4	(70)	8.4
3	Generator (3MW) & Transmission	60	0	0	14.4	60 (120)	14.4
4	Engineering Fees	10	0	0	0	10	0
5	General Administration	0	0	0	3.8	(32)	3.8
6	Contingency	0	0	0	4.3	(35)	4.3
7	Total	170	0	0	64.8	710	

○ Financing plan for the Project Investment

In the analysis of the Financial Viability on this Project, it was opted that the major part of the Capital Expenditure will be financed by the Project Loan to be provided by the Japan International Cooperation Agency (JICA) and the financing conditions under the Project Loan may be summarized as follows;

Table 4-3: Borrowing condition of the Project Loan

Pay items to be financed	Loan coverage	Interest Rate	Repayment (Grace) Period	Borrowing Conditions
All the pay items except Land Acquisition, General Admi. and Tax	Total Investment Costs and Operational Costs	Approx.1.4% Per Annum	30Years, with 10 years Grace period	Un-tied for the Procurement of Plant/Equipment and Consultancy Services.

4.3.3 **Results of the Financial Feasibility Analysis (Analysis of FIRR)**

Under this study, the Financial Viability of the Project was evaluated on the basis of the Revenue and Cost on the Project for 15 years from the commencement of the Operation of the Project applying the method of Financial Internal Rate of Return (FIRR). In the evaluation of the Financial Viability, results of FIRR shall be compared with the opportunity cost which may arise from the Capital Cost to be applied for this Project.

○ Project Cash-In Flow

In-flow of Cash under this Project consists of (1) Equity and Borrowings for the Initial Investment, (2) Sale of Electric Power, (3) Sale of Carbon Credit, and (4) Saving from the Fuel and Operational Costs at the existing High Speed Diesel (HSD) Generation Systems in the Off-grid Electric District.

○ Equity and Borrowing for the Capital Investment

Among the total costs required for the development of the such Capital Outlays as Plants, Equipments, Buildings and Operational Costs in it first year, it was assumed that Ten (10) percent of the total sums may be paid up by PT. PNs as the Equity, and the rest of the Capital Expenditures shall be covered by the Project Loan to be provided by JICA. Anticipated Capital Cost for discounting the revenues may be summarized as follows;

Table 4-4: Details of the Capital Cost and WACC

Financing Method	Loans		Equity	Total/Weighted Average
	ODA Loan	NEDO's Advance		
Ratio between Loan and Equity	75%	Appro.15%	10%	100%
Capital Cost	1.4%/Year	Zero	15%/Year	1.51%/Year

Weighted Average Cost of Capital (WACC) is calculated as 1.51% per year, based on the composition of the Loans and Equity as stated hereinabove.

○ Sale of the Electric Power

For the calculation of Sale of Electric Power, Unit Rate of 1.051 Ind. Rupee or 7.36 Japanese Yen per Kilowatt Hour shall be applied according to Decree No. 002 of 2006 issued by the Ministry of Energy and Mineral Resources, the Government of Indonesia which being the Eighty (80) percent of the average production cost of electricity in the region.

○ Sale of Carbon Credit

For the calculation of Sale of Carbon Credit, Unit Rate of Japanese Yen 2,000 per one ton of CO2 shall be applied.

○ Project Cash-out Flow

Cash-Out Flow of this Project consists of the following four pay items.

・Engineering and Construction Costs

The Engineering and Construction Costs for this Project were shown in the Table under Article 4.3.2 in this Chapter, and these expenses shall be paid out within one year from the commencement of the Project.

Table 4-5: Engineering and Construction Costs

Projects	Engineering Costs	Construction Costs	Total
POM with FFB Process Capacity 30 tons/hour	Jp¥ 10Mill	Jp¥ 446Mill	Jp¥456 Mill
POM with FFB Process Capacity 60 tons/hour	Jp¥ 10Mill	Jp¥ 700Mill	Jp¥710 Mill

・Operational Costs

The Operational Costs for this Project was projected as Five (5) percent on the Construction Costs, based on actual occurrence of the same expenditure on the similar projects in Indonesia.

・Depreciation Costs

Such Major Initial Investment Costs as the Boiler, Generator and auxiliary equipments shall be depreciated up to Ninety (90) percent of its costs at the equal amount every year within 15 years time.

・Taxes

Any Tax applicable in Indonesia for the procurement of Engineering Services, Construction of the Building, Installation of Plants and Equipments and other activities shall be inclusive of the costs estimated in each pay items, and the Income Tax derived from this Project is deemed to be Thirty (30) percent on the Incomes before Tax.

○ Results of the Financial Feasibility Analysis

The results of the Financial Feasibility for the Two (2) cases assessed at the Financial Internal Rate of Return on the incomes before Taxes, are summarized as follows. In all the cases, the Projects are financially viable at the given conditions as stated hereinbefore.

Table 4-6: FIRRs on 2 Base Cases

Projects	FIRR (Before Tax)	FIRR (After Tax)
(1) POM with FFB Process Capacity 30 tons/hour	9.3 %	3.9 %
(2) POM with FFB Process Capacity 60 tons/hour	29.3 %	21.7%

The detailed breakdown of Financial Internal Rate of Return, Payment Schedule and Cash Flow Statement are shown in the Appendix 4.

○ Sensitivity Analysis on the Financial Internal Rate of Return

The Sensitivity Analysis has been conducted for these Two (2) cases with different assumption, since the viability of two cases is differed. In the case of (1), FIRR before Tax shows 9.3% while FIRR after Tax is rather low as 3.9% which are not attractive as the investment by the Business Entity although the POMs are owned and operated by the State Owned Corporation. Thus the Sensitivity Analysis was conducted what parameters can improve higher FIRR, while what level of risks on the Project can sustain its viability in the case of (2). The results of the Sensitivity Analysis are shown as follows.

(1) Case One: The POM having 30 tons of FFB Processing Capacity per hour.

○ Increasing the Annual Operation Hours.

In the Base Case Study, Annual Operating Hour was set 7446 hours considering the idle times for the Maintenances and Overhauls. However, It is possible to increase the Annual Operating Hour to the level of 8400 hours out of annual hours of 8,760 (24 hours for 365 days) in a Year, because the proposed systems are equipped with two units of the Boiler in order to envisage such Maintenances and Overhauls. In this case, FIRR before Tax reached to 11.2% and FIRR after Tax to 5.4%.

○ Increasing the Unit Sales Rate of CER.

In the Base Case Study, Unit Sales Rate of CER was set at Japanese Yen 2,000 per CO2 ton. Should this Unit Rate which is currently at lowest level due to economic recession world-wide, hike up to the level of 3,000 Japanese Yen per CO2 ton, the FIRR will be improved to 17.7% before the Tax and 10.5% after the Tax which are the level good for the investment.

(2) Case Two: The POM having 60 tons of FFB Processing Capacity per hour.

○ Overrun of the Project Cost

Should the Initial Investment Costs increase for Fifteen (15) percent against that of Base Case, FIRR drops from 29.3 % to 28.5 % at the stage of "before Tax", and it drops from 21.7 % to 21.5 % at the stage of "After Tax" respectively. This means that the cost overruns on the Project does not have significant influence to viability of the Project.

○ Change in the Selling Unit Rates of CER and Operating Hours.

Should the Selling Unit Rates of CER and Operating Hours drops by Fifteen (15) percent respectively, the FIRR before Tax drops from 29.3% to 23.7%, and the FIRR after Tax drops from 21.7 % to 17.6% respectively.

4.4 Proposed Implementation Schedule of the Project

4.4.1 Construction at the Project Sites

The major part of the Project may be undertaken by local construction companies with adequately qualified in terms of Technology and Financial capabilities. They shall undertake the following Scope of Works and responsibility for overall quality of the works that are required on this Project.

○ Installation of Crusher, Shredder, Press Machines and Drying Devices for treatment of EFB

In order to conduct Pre-firing processes, these equipments play important roles in the Systems. Alternative study shall be conducted on the performances between the set of Crusher, Shredder and Press Machines and the Drying Devices. A Warehouse for stockpile of the treated EFB shall be provided within the yard of the POMs.

○ Installation of Boiler and Turbine Generator after interior replacement of mills

The models of Biomass Boiler which has proven performance records and Steam Turbine and Generator may be procured as core plants for the Power Generation Systems. And those equipments can be procured from the well-qualified supplier from Japan or other South-east Asian Country.

○ Power Transmission lines to the Grid and the Power Stabilizer

Connection to the Electricity Grids adjacent to POMs, and procurement and installation of a Power Stabilizer are required.

○ Access Road for Construction Materials

Should there be no Access Road for the transportation of Construction Materials that are required for the Project, necessary costs shall be prepared within the budget of the Project.

It is considered to have a five meters wide macadamized road which runs between POMs and major roads.

4.4.2 **Trial operation**

As an Independent Electricity Producer, the Project is required uninterrupted operation, once commenced its operation and around 8,400 hours of operation in a year is ideal target based on the track records in the similar Project. Therefore, the discussions with PLN's provincial offices are important for mutual understanding and agreement on the conditions to be performed by the Project. Trial Operation of the Systems shall be conducted prior to the official handing over of the Project by the Contractor to the Implementation Agency.

4.4.3 **Personnel**

Operators for the boiler, turbine and generator, dryer and electricity transmission and distribution systems must be stationed for a sound system operation and maintenance at the Project Site. In order to operate the systems around the clock, approx. 10 personnel for three shift works is necessary.

4.4.4 **Training program for operators**

The training program for operators shall be carried out along with construction at the sites.

The actual training program shall be undertaken by the Contractor or Supplier of the Plants and Equipments for the Project.

4.4.5 **Construction schedule**

○ Project Preparation Study

The Project Preparation Study which is formerly known as Special Assistance for Project Formation (SAPROF) is required before the physical development is undertaken, and the schedule is as the table below.

No	Process of Project Preparation Study		1	2	3	4	5	6	7	8	9	10	11	12
1	Domestic survey	Preparations of field survey												
2	Field survey Survey on POA candidacies	Ministry of State Corporation Candidacies for Public POM s SPC candidacies												
	PLN Independent power producer	Purchasing terms on biomass generated power Policies on electricity The same as noted												
	Confirmation of intention Environmental impact assessment	BAPPENAS BAPEDAL												
	JICA	Survey on the required conditions in applying for ODA Financial flow												
3	Domestic survey	Drafting												
4	Field survey	Confirmation of draft contents Agreement												
5	Domestic survey	Final report Presentation to JICA on the report												
6	Coordination at field	Presentation at domestic level on the report												
7	Coordination at national level	Final agreement												

Fig. 4-3: Project Preparation Study implementation schedule

If viability is confirmed by the Project Preparation Study, official request by the host nation must be prerequisite. The Construction Schedule is planned as 2). (Full-scale Study and Constructing Schedule shall be examined closely by prior consultation)

The project scale by a case is estimated to be approximately no more than 4 hundred thousand yen. Therefore, it aims to expand from the first year of the project 2 to 10 cases in three years, which totals 4 to 5 billion yen of the project scale.

○ Construction schedule

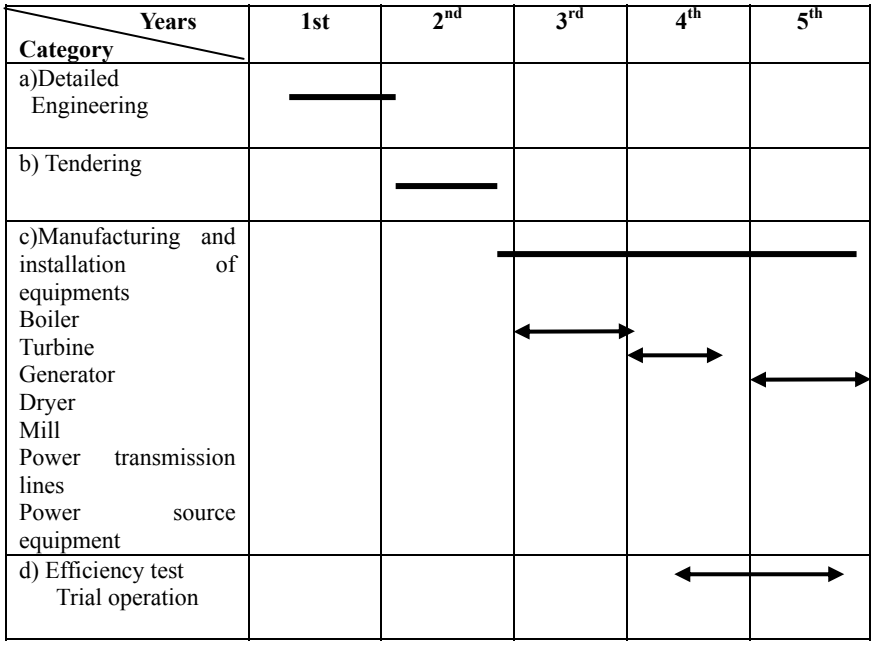


Fig. 4-4: Construction Schedule

As described in the report, some programs can be established into the one with the aim of electricity generation by using the captured methane from the lagoons of POME, or of the destruction of methane by flaring. Considering that common programs available for various POMs must be applied for the Program of Activity, it might infringe on the condition of maintainig the present equipments. And therefore, any Project improving the existing Plants and Equipment are excluded from the initial discussions.

Chapter 5 : **Recommendations**

This Study is designed to collect data and information on the present conditions of Rural Electrification and to explore the possibility to realize "Waste to Energy" concept by utilizing Biomass Wastes in the Palm Oil Mills (POMs) in Sumatra. Through the processes of this Study, Interviews with various authorities concerned and Financial Viability Analysis have been conducted. As the result of this Study, the proposed concept of Biomass Wastes-fired Power Generation Systems and CDM Project is assumed to be Financially Viable, if it is developed with a Soft Project Loan from the Financial Institution such as Japan International Cooperation Agency (JICA). However, the Soft Loan is applicable only for those POMs owned by PT. PNs which are under the administrative jurisdiction of the Ministry of State Corporation, the Government of Indonesia.

There is another possibility to realize the same concept for the POMs owned by the Private Sector which is much larger in its number. The Study Team recommends implementation of this scheme by the deployment of a Two-steps Loan through the Conduit Organization such as Bank Mandiri, one of the prominent state banks in Indonesia. However, it was difficult for the Study Team to gather sufficient data and information during rather limited study periods, thus the Preliminary Feasibility Study for this scheme is yet to be conducted.

According to the Financial Viability Analysis under the given pre-conditions, the proposed scheme performs 9.3% in the Financial Internal Rate of Return (FIRR) before Tax in case of FFB process capacity of thirty (30) tons per hour, and 29.3% of IRR before Tax in case of 60 tons per hour. The demands for Rural Electrification are quite large in the surveyed areas and there is sufficient numbers of POM sites to be developed, it is recommendable to implement simultaneously several numbers of investments as one package. The Project will therefore require qualified project management team attached to the Implementation Agency to monitor the quality and progress of various Projects in different region in Sumatra.

This concept is also suitable for the Program of Activity (PoA) to be applied to the United Nations for the Certified Emission Reduction (CER) under the Kyoto Protocol. In implementing the PoA, a Coordination and Management Entity (CME) shall be appointed to monitor and coordinate with various stakeholders along with the chains of activities required under the Clean Development Mechanism. For such roles and activities, it is most

recommendable to establish a unit designated for these requirements within the Ministry of State Corporation. A professional team of the Project Management may be attached to BUMN to help support the activities of BUMN and CME. Considering these activities, the proposed Project Implementation Structure may be illustrated as follows;

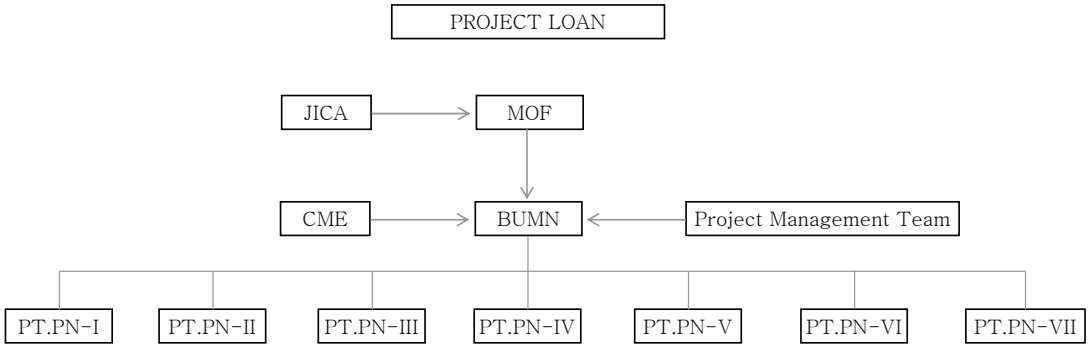


Fig. 5-1: The Proposed Structure of Project Implementation with a PoA Concept

Although results of this Preliminary Feasibility Study show positive indications, it is however strongly recommended to conduct a full scale Feasibility Study and Environmental Impact Assessment for this scheme, utilizing a facility of the Technical Assistance from the Government of Japan. A full scale Feasibility Study and Environmental Impact Assessment may be the initial step to be taken in order to lead this vital Project to a reality.

APPENDIX 1

Itinerary for the Field Survey

Appendix 1: Itinerary for the Field Survey

Itinerary for the Field Survey

Date	Day	From	By	To	Activities
Dec. 14, 2008	Sun	Tokyo	CX501/719 via Hong Kong	Jakarta	Proceeding to Jakarta, Indonesia
Dec. 15, 2008	Mon			Jakarta	JICA Indonesia Office, BAPPENAS, Coordinating Ministry for Economic Affairs, Ministry of Agriculture
Dec. 16, 2006	Tue			Jakarta	Ministry of State Owned Corp., Ministry of Mining & Energy, Ministry of Environment
Dec. 17, 2008	Wed	Jakarta	GA178	Pekan Baru	Riau Provincial Government, Riau Province Development Bank
Dec. 18, 2008	Thu	Pekan Baru	SJ040	Medan	Site Survey to a Privately-owned Palm Oil Mill
Dec. 19, 2008	Fri			Medan	Bank Manderi Medan Branch, North Sumatra Provincial Government
Dec. 20, 2008	Sat	Medan	GA183	Jakarta	Site Survey to Palm Oil Mills owned by PT. PN-II & IV
Dec. 21, 2008	Sun				Data & Information gathering
Dec. 22, 2009	Mon			Jakarta	JICA Expert in Ministry of Mining & Energy, Coordinating Ministry for Economic Affairs, Ministry of Industry, Bank Mandiri
Dec. 23, 2008	Tue			Jakarta	JICA Indonesia Office, JICA Expert in Ministry of Agriculture, Ministry of Agriculture
Dec. 24, 2008	Wed	Jakarta	CX718/508 via Hong Kong	Tokyo	Take off Jakarta Arrival at Tokyo

APPENDIX 2

Technical Data

Appendix 2: Technical Data Sheets

General Description of PT Sinar Agro Raya (Private oil mill)

Site	20 km north of Pekanbaru, Riau Province
Type	The oil mill without plantation, which purchased all amount of EFB from the union. The area owned by union members is 2ha~100ha.
Treated amount	60t/h～30t/h average 45t/h that of dry season from Jan to Jul at most 700t/d, while rainy season, at lowest, 400t/d average 450t/d Though operation is 24 d/m and 11h/d, the mill is flexibly run.
Employees	60(officially) 30(present) (due to the decrease of Palm harvest, setting in the rainy season)
Treatment methods of biomass	(1) Fiber & Kernel : fuel for independent power generation (2) EFB : boiler fuel and decomposition after dumped in the forest (3) POME : poured into 6 lagoons accordingly, some of which is used for irrigation and the rest is discharged into a river
Spec	(1) A boiler (manufactured in 2004:20bar * 36t/h), actual amount of operation is 24t/h pressure 17kg/c ㎡, fixed bed, no economizer (2) Generator (manufactured in 2004) 1400KVA * 2, all amount of the generated electricity is used in the mill Power generation is covered by a generator in the rainy season when EFB supply is smaller Spare: two diesel generators of 500KVA (3) Saturated back pressure of 3kg/ c ㎡ is almost provided into a sterilizer. (4) Steam is generated on the oil extracting stage, and the flow is described as the following figure. The amount of generated steam is almost stable.
Others	The cooling pond of POME is heated above 100 degree C through saturated water in steam tank. The rest of oil is no more than 1%, which is collected by skimmers.

General Description of PKS Adolina (PT PN IV Public Oil Mill)

Site	Medan, Northern Sumatera Province
Type	**One of the 15 mills which is under the umbrella of PT PNIV and controls 8800ha, including 6500ha of private plantation. An old oil mill which has been established in 1942, and equipments of which has been replaced in 1962.
Treated amount	Treatment amount is at most in the dry season from January to July, while the rainy season at lowest. Year average is 30t/h. Operating hours is 30 days / month and 24 hours / day (only in July) in the peak, while 25days / month and 16 hours / day in the off season. Maintaining this, the mill is run flexibly by adjusting personnel.
Employees	The work shift system by two groups of 41 personnel. (The harvesting amount of Palm decreases due to the rainy season) The shortage of work forces is covered by extra work.
Treatment methods of biomass	(1) Fiber & Kernel : fuel for independent power generation, 700kWof power generation is available. (2) EFB : composted in plantations (3) POME : the digested liquid of lagoons is irrigated into the forests which are located three km away from the mill, the rest is discharged in a river.
Spec	(1) Two boilers, fixed bed and with economizer Operation : manufactured in 1995:23bar * 20 t/h actual amount of use is 18 t/h, 19 bar 260 degree C (overheated steam) Spare : manufactured in 1990:24bar * 18t/h 260 degree C (overheated steam) when suspended (2) Generator 700kW * 3, and one of which is operated now. It covers 90% of the required electricity. Electricity is generated by a generator in the rainy season. Spare : Two diesel generators of 500 KVA (3) The back pressure of turbine is 5 to 6 bar, 170 degree C. After it is fed into sterilizer, maintain it for 90 min. (the pressure seems to be a little bit higher) (4) Steam is generated on the oil extracting stage, and the flow is described as the following figure. The amount of generated steam is almost stable.
Others	According to an experimental conducted by the domestic public palm oil research center, methane has not been generated from the methane fermentation tank for POME. (It is just an experimental that POME was fed into drum can, but failed.)

General Description of PKS Marbaw (PT PN II Public Oil Mill)

Site	Medan, Northern Sumatera Province
Type	Scale is the same as the public mills, Adolina. 70% of EFB is purchased from the private plantation of about 6,000 ha, and 30% is from the adjacent. One of the six oil mills which are under the umbrella of PTPN II and has been established in 1960 with history. **
Treated amount	30t/h (treatment capacity 50t/h) According to the monthly data, the amount is volatile. Operating hours: 16 hours / day, 25 days / month
Employees	Unknown
Treatment method of Biomass	(1) Fiber & Kernel : fuel for independent power generation, 460 kW of power generation is available. The surplus power generation is also available, however, it must be purchased from PLN (2) EFB : composted in plantations (3) POME : digested liquid of adjacent lagoons is irrigated into the plantation, the rest is discharged as BOD 100 into a river In order to promote digestion, POME is fed into boiler after cooling it from 80 to 60 degree C through cooling tower
Spec	(1) Two boilers, fixed bed, no economizer 20bar * 20t/h, actual operated amount is 18bar * 16t/h (2) Three generators : 800kW Two units are for common use, 450kW, 800kW A unit of diesel for spare (3) The back pressure of turbine is 3 bar. After it is supplied to sterilizer, maintain it for 90 min. (4) Steam is generated on the oil extracting stage, and the flow is described as the following figure. The amount of generated steam is almost stable. (5) Process stages are common in every public oil mills.
Others	The domestic public palm oil research center has conducted experiment on methane fermentation tank of POME. It is the round funnel-shaped one with the height of three meters, which is bigger than the previous mentioned public oil mills. It is under trial manufacturing.

APPENDIX 3

Sites Photographs

Appendix 3: Site Photographs

Site Photographs which have been taken at PKS Adolina（affiliates of PTPN Ⅳ in Medan）in North Sumatra

FFB on sterilizing process

CPO milling process

EFB

Lagoon

Biomass boiler

Steam turbine and Generator

APPENDIX 4

Financial Analysis

Appendix 4: Financial Analysis Sheets

＜算出前提条件　ケース1　FFB処理能力30トン/時間 ベースケース＞

1. 初期投資額（百万円）： 475

＜初期投資額（資金調達）内訳＞

（1）出資金

	出資額（百万円）	
PT.PN	48	
NEDO	75	2011－2012年のCER額の50%を前払い（61,586x2年x50%）
合計	123	

（2）借入金

○具体的な借入予定先名も含め下記表を記載せよ（海外から借入の場合、US$1=100円　で計算）

	借入金（百万円）	返済期間（年）	金利（%）	通貨の種類	備考（金利の根拠等）
Aプロジェクトロー	362,000	30	1.40%	円	JICA融資条件30年10年据え置き半年賦計算例

2. 建設期間 1 年

3. プロジェクト期間（建設期間含む） 16 年

4. 減価償却 残存薄価（%） 10.00%

償却年数（年間） 15

5. 売上高

（1）事業収入

事業収入として、①余剰電力をPLNに売電および②CDMの販売収入がある。

①売電収入

10MW未満のバイオマス発電の購入単価はスマトラグリッドの平均発電原価の80%である。スマトラグリッドの電源は水力と石炭火力であり、発電原価は9.2円／kWh程度と推定される。

売電量900kWx7,446hrx9.2x0.8=49,322千円／年

②CDM販売収入

バイオマス発電とメタン回収合計で30,793t-CO2／年x2,000円／t-CO2=61,586千円／年

廃水地ラグーンからのメタン回収で6,875t－CO2/年x2000円t－CO2＝13,750円/年

①＋②より

合計収入：49,322 + 61,586 + 13,700= 124,608 千円/年

（2）クレジット収入（Pay on deliverly 型を選択する場合のみ記入）

本プロジェクトでは、Pay on delivery型を選択しない。

6. コスト（売上原価＋販管費＋オペレーション＋減価償却費 等）

本プロジェクト実施にあたるコストとして、維持管理費は初期投資の5%の24,250千円／年としている。

7. 法人税等実行税率とその根拠

32.00%（インドネシア国の税率）

＊下表を参照のこと。

2001年法人税比較】

国・地域	法人税率（%）
チリ	15
香港	16
台湾	25
シンガポール	25.5
マレーシア	28
インドネシア	30
タイ	30
英国	30
韓国	30.8
フィリピン	32
ニュージーランド	33
オーストラリア	34
米国	40
日本	42

（'01年2月12日ビジネスタイムスより）

FFB処理能力30トン/時間　ベースケース

《収支一覧表

（単位：千円）

事業年度		建設期間(1年)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
（*：記入不要欄、網掛け部分は記入）		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
損益計算書																	
1．売上高合計			124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608	124,608
売上高（売電事業）			49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322
売上高（CER販売）			75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286	75,286
2．コスト			55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,870
建設・開業費	485,000																
原材料費			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
運転管理費			24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250
3．減価償却費	475,000		31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,620
営業利益（*）			68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,738
4．支払利息（*）			5,068	5,068	5,068	5,068	5,068	5,068	4,561	4,054	3,548	3,041	2,534	1,773	1,329	886	443
5．繰延資産償却費(*)			2,000	2,000	2,000	2,000	2,000	–	–	–	–	–	–	–	–	–	–
税引前当期利益（*）			61,620	61,620	61,620	61,620	61,620	63,620	64,127	64,634	65,140	65,647	66,154	66,915	67,359	67,802	57,708
6．法人税等（*）	32.00%		19,718	19,718	19,718	19,718	19,718	20,358	20,521	20,683	20,845	21,007	21,169	21,413	21,555	21,697	18,467
当期利益（*）			41,902	41,902	41,902	41,902	41,902	43,262	43,606	43,951	44,295	44,640	44,985	45,502	45,804	46,105	39,241
キャッシュフロー計算書																	
税引前当期利益			61,620	61,620	61,620	61,620	61,620	63,620	64,127	64,634	65,140	65,647	66,154	66,915	67,359	67,802	57,708
償却費（設備）			33,670	33,670	33,670	33,670	33,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,620
キャッシュインフロー合計			95,290	95,290	95,290	95,290	95,290	95,290	95,797	96,304	96,810	97,317	97,824	98,585	99,029	99,472	89,328
法人税等支払			19,718	19,718	19,718	19,718	19,718	20,358	20,521	20,683	20,845	21,007	21,169	21,413	21,555	21,697	18,467
借入金返済			0	0	0	0	0	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200
キャッシュアウトフロー合計			19,718	19,718	19,718	19,718	19,718	56,558	56,721	56,883	57,045	57,207	57,369	57,613	57,755	57,897	54,667
キャッシュフロー			75,572	75,572	75,572	75,572	75,572	38,732	39,076	39,421	39,765	40,110	40,455	40,972	41,274	41,575	34,661
貸借対照表																	
流動資産（余剰資金）			75,572	151,143	226,715	302,286	377,858	416,590	455,666	495,087	534,852	574,962	615,417	656,389	697,663	739,238	773,900
固定資産(償却資産)	475,000		443,330	411,660	379,990	348,320	316,650	284,980	253,310	221,640	189,970	158,300	126,630	94,960	63,290	31,620	–
繰延資産	10,000		8,000	6,000	4,000	2,000	0	0	0	0	0	0	0	0	0	0	0
資産合計（資産の部）	485,000		526,902	568,803	610,705	652,606	694,508	701,570	708,976	716,727	724,822	733,262	742,047	751,349	760,953	770,858	773,900
借入金（当初借入）	362,000		362,000	362,000	362,000	362,000	362,000	325,800	289,600	253,400	217,200	181,000	144,800	108,600	72,400	36,200	0
不足資金借入金（追加借入）			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
負債合計			362,000	362,000	362,000	362,000	362,000	325,800	289,600	253,400	217,200	181,000	144,800	108,600	72,400	36,200	–
資本金	123,000		123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000	123,000
（上記資本金のうち、クレジット購入分額）	75,000		75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000	75,000
剰余金	0		41,902	83,803	125,705	167,606	209,508	252,770	296,376	340,327	384,622	429,262	474,247	519,749	565,553	611,658	650,900
資本合計	123,000		164,902	206,803	248,705	290,606	332,508	375,770	419,376	463,327	507,622	552,262	597,247	642,749	688,553	734,658	773,900
負債・資本合計（負債及び資本の部）	485,000		526,902	568,803	610,705	652,606	694,508	701,570	708,976	716,727	724,822	733,262	742,047	751,349	760,953	770,858	773,900
借入金																	
A	（借入金残高：記入）	362,000,000	362,000	362,000	362,000	362,000	362,000	325,800	289,600	253,400	217,200	181,000	144,800	108,600	72,400	36,200	0
国際協力銀行	（元利合計返済金額：記入）			5,068	10,136	15,204	20,272	61,540	102,301	142,556	182,303	223,389	263,498	302,630	340,784	377,961	414,161
投資金融	（元金分返済額）		0	0	0	0	0	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200
	（支払利息：金利のみ記入）	1.40%	5,068	5,068	5,068	5,068	5,068	5,068	4,561	4,054	3,548	4,886	3,909	2,932	1,954	977	0
合計	（借入金残高：記入）		362,000	362,000	362,000	362,000	362,000	325,800	289,600	253,400	217,200	181,000	144,800	108,600	72,400	36,200	0
	（元利合計返済金額：記入）		0	5,068	10,136	15,204	20,272	61,540	102,301	142,556	182,303	223,389	263,498	302,630	340,784	377,961	414,161
	（元金分返済額）		0	0	0	0	0	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200	36,200
	（支払利息：金利のみ記入）		5,068	5,068	5,068	5,068	5,068	5,068	4,561	4,054	3,548	4,886	3,909	2,932	1,954	977	0
採算計算																	
税引後キャッシュフロー			75,572	75,572	75,572	75,572	75,572	74,932	75,276	75,621	75,965	76,310	76,655	77,172	77,474	77,775	70,861
税引後キャッシュフローの累計 ［S］			75,572	151,143	226,715	302,286	377,858	452,790	528,066	603,687	679,652	755,962	832,617	909,789	987,263	1,065,038	1,135,900
［S］－ 投下資本	977		−399,428	−323,857	−248,285	−172,714	−97,142	−22,210	53,066	128,687	204,652	280,962	357,617	434,789	512,263	590,038	660,900
内部利益率 ［IRR］（利息除外、税金繰込）							−18.7%					0.4%					5.8%
（IRR計算データ）		−475,000	48,970	48,970	48,970	48,970	48,970	48,330	48,167	48,005	47,843	47,681	47,519	47,275	47,133	46,991	50,271
内部利益率 ［IRR］（利息除外、税引前）							−9.9%					7.3%					11.7%
（IRR計算データ）		−475,000	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,688	68,738

設定項目					
償却率	14.2%	残存薄価	10%	% ←	15 年償却
繰延資産償却年数	5	年			
初期投資額	475,000				

＜算出前提条件　ケース1　FFB処理能力30トン/時間　　CER単価　￥3,000/トン＞

1．初期投資額（百万円）： 475

＜初期投資額（資金調達）内訳＞

（1）出資金

	出資額（百万円）	
PT.PN	48	
NEDO	113	2011－2012年のCER額の50%を前払い（113,004x2年x50%）
合計	161	

（2）借入金

○具体的な借入予定先名も含め下記表を記載せよ（海外から借入の場合、US$1=100円　で計算）

	借入金（百万円）	返済期間（年）	金利（%）	通貨の種類	備考（金利の根拠等）
Aプロジェクトロー	324,000	30	1.40%	円	JICA融資条件30年10年据え置き半年賦計算例

2．建設期間 1 年

3．プロジェクト期間（建設期間含む） 16 年

4．減価償却 残存薄価（%） 0.00%

償却年数（年間） 15

5．売上高

（1）事業収入

事業収入として、①余剰電力をPLNに売電および②CDMの販売収入がある。

①売電収入

10MW未満のバイオマス発電の購入単価はスマトラグリッドの平均発電原価の80%である。スマトラグリッドの電源は水力と石炭火力であり、発電原価は9.2円／kWh程度と推定される。

売電量900kWx7,446hrx9.2x0.8=49,322千円／年

②CDM販売収入

バイオマス発電とメタン回収合計で30,793t-CO2/年x3,000円/t-CO2=92,379千円/年

廃水地ラグーンからのメタン回収で6,875t－CO2/年x3,000円/t-CO2=20,625千円/年

①＋②より

合計収入：49,322 + 92,379 + 20,625= 162,326 千円/年

（2）クレジット収入（Pay on deliverly 型を選択する場合のみ記入）

本プロジェクトでは、Pay on delivery型を選択しない。

6．コスト（売上原価＋販管費＋オペレーション＋減価償却費 等）

本プロジェクト実施にあたるコストとして、維持管理費は初期投資の5%の24,250千円／年としている。

7．法人税等実行税率とその根拠

32.00%（インドネシア国の税率）

＊下表を参照のこと。

2001年法人税比較】

国・地域	法人税率（%）
チリ	15
香港	16
台湾	25
シンガポール	25.5
マレーシア	28
インドネシア	30
タイ	30
英国	30
韓国	30.8
フィリピン	32
ニュージーランド	33
オーストラリア	34
米国	40
日本	42

（'01年2月12日ビジネスタイムスより）

FFB処理能力30トン/時間　CER単価￥3,000/トン

《収支一覧表

（単位：千円）

事業年度		建設期間(1年)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
（*：記入不要欄、網掛け部分は記入）		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
損益計算書																	
1．売上高合計			162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326	162,326
売上高（売電事業）			49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322	49,322
売上高（CER販売）			113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004	113,004
2．コスト			55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	38,140
建設・開業費		485,000															
原材料費			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
運転管理費			24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250
3．減価償却費		475,000	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	13,890
営業利益（*）			74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	74,736	110,296
4．支払利息（*）			4,536	4,536	4,536	4,536	4,536	4,082	3,629	3,175	2,722	2,268	1,814	1,361	907	454	0
5．繰延資産償却費(*)			2,000	2,000	2,000	2,000	2,000	–	–	–	–	–	–	–	–	–	–
税引前当期利益（*）			68,200	68,200	99,870	68,200	68,200	70,654	71,107	71,561	72,014	72,468	72,922	73,375	73,829	74,282	88,501
6．法人税等（*）		32.00%	21,824	21,824	31,958	21,824	21,824	22,609	22,754	22,899	23,045	23,190	23,335	23,335	23,625	23,770	28,320
当期利益（*）			46,376	46,376	67,912	46,376	46,376	48,044	48,353	48,661	48,970	49,278	49,587	50,040	50,204	50,512	60,181
キャッシュフロー計算書																	
税引前当期利益			68,200	68,200	99,870	68,200	68,200	70,654	71,107	71,561	72,014	72,468	72,922	73,375	73,829	74,282	88,501
償却費（設備）			33,670	33,670	33,670	33,670	33,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	13,890
キャッシュインフロー合計			101,870	101,870	133,540	101,870	101,870	102,324	102,777	103,231	103,684	104,138	104,592	105,045	105,499	105,952	102,391
法人税等支払			21,824	21,824	31,958	21,824	21,824	22,609	22,754	22,899	23,045	23,190	23,335	23,335	23,625	23,770	28,320
借入金返済			0	0	0	0	0	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400
キャッシュアウトフロー合計			21,824	21,824	31,958	21,824	21,824	55,009	55,154	55,299	55,445	55,590	55,735	55,735	56,025	56,170	60,720
キャッシュフロー			80,046	80,046	101,582	80,046	80,046	47,314	47,623	47,931	48,240	48,548	48,857	49,310	49,474	49,782	41,671
貸借対照表																	
流動資産（余剰資金）			80,046	160,092	261,674	341,720	421,766	469,080	516,703	564,634	612,874	661,422	710,279	759,589	809,063	858,845	900,516
固定資産(償却資産)		475,000	443,330	411,660	379,990	348,320	316,650	284,980	253,310	221,640	189,970	158,300	126,630	94,960	63,290	31,620	17,730
繰延資産		10,000	8,000	6,000	4,000	2,000	0	0	0	0	0	0	0	0	0	0	0
資産合計（資産の部）		485,000	531,376	577,752	645,664	692,040	738,416	754,060	770,013	786,274	802,844	819,722	836,909	854,549	872,353	890,465	918,246
借入金（当初借入）		324,000	324,000	324,000	324,000	324,000	324,000	291,600	259,200	226,800	194,400	162,000	129,600	97,200	64,800	32,400	0
不足資金借入金（追加借入）			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
負債合計		324,000	324,000	324,000	324,000	324,000	324,000	291,600	259,200	226,800	194,400	162,000	129,600	97,200	64,800	32,400	–
資本金		161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000	161,000
（上記資本金のうち、クレジット購入分額）		113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000	113,000
剰余金		0	46,376	92,752	160,664	207,040	253,416	301,460	349,813	398,474	447,444	496,722	546,309	596,349	646,553	697,065	757,246
資本合計		161,000	207,376	253,752	321,664	368,040	414,416	462,460	510,813	559,474	608,444	657,722	707,309	757,349	807,553	858,065	918,246
負債・資本合計（負債及び資本の部）		485,000	531,376	577,752	645,664	692,040	738,416	754,060	770,013	786,274	802,844	819,722	836,909	854,549	872,353	890,465	918,246
借入金																	
A	（借入金残高：記入）	324,000,000	324,000	324,000	324,000	324,000	324,000	291,600	259,200	226,800	194,400	162,000	129,600	97,200	64,800	32,400	0
国際協力銀行	（元利合計返済金額：記入）		4,536	9,072	13,608	18,144	22,680	59,616	96,098	132,127	167,702	204,988	241,297	276,629	310,983	344,360	376,760
投資金融	（元金分返済額）		0	0	0	0	0	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400
	（支払利息：金利のみ記入）	1.40%	4,536	4,536	4,536	4,536	4,536	4,536	4,082	3,629	3,175	4,886	3,909	2,932	1,954	977	0
合計	（借入金残高：記入）		324,000	324,000	359,000	359,000	359,000	326,600	294,200	261,800	229,400	197,000	164,600	132,200	99,800	67,400	35,000
	（元利合計返済金額：記入）		4,536	9,072	13,608	18,144	22,680	59,616	96,098	132,127	167,702	204,988	241,297	276,629	310,983	344,360	376,760
	（元金分返済額）		0	0	0	0	0	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400	32,400
	（支払利息：金利のみ記入）		4,536	4,536	4,536	4,536	4,536	4,536	4,082	3,629	3,175	4,886	3,909	2,932	1,954	977	0
採算計算																	
税引後キャッシュフロー			80,046	80,046	101,582	80,046	80,046	79,714	80,023	80,331	80,640	80,948	81,257	81,710	81,874	82,182	74,071
税引後キャッシュフローの累計 ［S］			80,046	160,092	261,674	341,720	421,766	501,480	581,503	661,834	742,474	823,422	904,679	986,389	1,068,263	1,150,445	1,224,516
［S］－ 投下資本			−394,954	−314,908	−213,326	−133,280	−53,234	26,480	106,503	186,834	267,474	348,422	429,679	511,389	593,263	675,445	749,516
内部利益率 ［IRR］（利息除外、税金繊込）							−4.5%					11.7%					15.5%
（IRR計算データ）		−475,000	84,582	84,582	74,448	84,582	84,582	83,797	83,652	83,507	83,361	83,216	83,071	83,071	82,781	82,636	95,866
内部利益率 ［IRR］（利息除外、税引前）							3.9%					18.2%					21.2%
（IRR計算データ）		−475,000	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	106,406	124,186

設定項目		
償却率	100.0%	残存薄価
繰延資産償却年数	5	年
初期投資額	475,000	

0% % ← 15 年償却

＜算出前提条件　ケース1　FFB処理能力30トン/時間　　年間稼動8400時間＞

1．初期投資額（百万円）：　485

＜初期投資額（資金調達）内訳＞

（1）出資金

	出資額（百万円）	
PT.PN	48	
NEDO	84	2011－2012年のCER額の50%を前払い（84，989x2年x50%）
合計	132	

（2）借入金

○具体的な借入予定先名も含め下記表を記載せよ（海外から借入の場合、US$1=100円　で計算）

	借入金（百万円）	返済期間（年）	金利（%）	通貨の種類	備考（金利の根拠等）
Aプロジェクトロー	353	30	1.40%	円	JICA融資条件30年10年据え置き半年賦計算例

2．建設期間　1 年

3．プロジェクト期間（建設期間含む）　16 年

4．減価償却　残存薄価（%）　0.00%

償却年数（年間）　15

5．売上高

（1）事業収入

事業収入として、①余剰電力をPLNに売電および②CDMの販売収入がある。

①売電収入

１0MW未満のバイオマス発電の購入単価はスマトラグリッドの平均発電原価の80%である。スマトラグリッドの電源は水力と石炭火力であり、発電原価は9.2円／kWh程度と推定される。

売電量900kWx8,400hrx9.2x0.8=55,642千円／年

②CDM販売収入

バイオマス発電とメタン回収合計で30,793t-CO2/年x（8,400/7,446）x2,000円/t-CO2=69,477千円/年

廃水地ラグーンからのメタン回収で6,875t－CO2/年x(8,400/7,446)x2,000円/t-CO2=15,512千円/年

①＋②より

合計収入：55,642 + 69,477 +15,512= 140,631 千円/年

（2）クレジット収入（Pay on deliverly 型を選択する場合のみ記入）

本プロジェクトでは、Pay on delivery型を選択しない。

6．コスト（売上原価＋販管費＋オペレーション＋減価償却費 等）

本プロジェクト実施にあたるコストとして、維持管理費は初期投資の5%の24,250千円／年としている。

7．法人税等実行税率とその根拠

32.00%（インドネシア国の税率）

＊下表を参照のこと。

2001年法人税比較】

国・地域	法人税率（%）
チリ	15
香港	16
台湾	25
シンガポール	25.5
マレーシア	28
インドネシア	30
タイ	30
英国	30
韓国	30.8
フィリピン	32
ニュージーランド	33
オーストラリア	34
米国	40
日本	42

（'01年2月12日ビジネスタイムスより）

FFB処理能力30トン/時間　年間稼動8,400時間

《収支一覧表

（単位：千円）

事業年度		建設期間(1年)	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
（*：記入不要欄、網掛け部分は記入）		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
損益計算書																	
1．売上高合計			140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631	140,631
売上高（売電事業）			55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642	55,642
売上高（CER販売）			84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989	84,989
2．コスト			55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,920	55,870
建設・開業費		485,000															
原材料費			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
運転管理費			24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250	24,250
3．減価償却費		475,000	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,620
営業利益（*）			84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,761
4．支払利息（*）			4,942	4,942	4,942	4,942	4,942	4,448	3,954	3,459	2,965	2,471	1,977	1,483	988	494	0
5．繰延資産償却費(*)			2,000	2,000	2,000	2,000	2,000	–	–	–	–	–	–	–	–	–	–
税引前当期利益（*）			77,769	77,769	77,769	77,769	77,769	80,263	80,757	81,252	81,746	82,240	82,734	83,228	83,723	84,217	88,501
6．法人税等（*）		32.00%	24,886	24,886	24,886	24,886	24,886	25,684	25,842	26,001	26,159	26,317	26,475	26,633	26,791	26,949	28,320
当期利益（*）			52,883	52,883	52,883	52,883	52,883	54,579	54,915	55,251	55,587	55,923	56,259	56,595	56,931	57,267	60,181
キャッシュフロー計算書																	
税引前当期利益			77,769	77,769	77,769	77,769	77,769	80,263	80,757	81,252	81,746	82,240	82,734	83,228	83,723	84,217	88,501
償却費（設備）			33,670	33,670	33,670	33,670	33,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,670	31,620
キャッシュインフロー合計			111,439	111,439	111,439	111,439	111,439	111,933	112,427	112,922	113,416	113,910	114,404	114,898	115,393	115,887	120,121
法人税等支払			24,886	24,886	24,886	24,886	24,886	25,684	25,842	26,001	26,159	26,317	26,475	26,633	26,791	26,949	28,320
借入金返済			0	0	0	0	0	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300
キャッシュアウトフロー合計			24,886	24,886	24,886	24,886	24,886	60,984	61,142	61,301	61,459	61,617	61,775	61,933	62,091	62,249	63,620
キャッシュフロー			86,553	86,553	86,553	86,553	86,553	50,949	51,285	51,621	51,957	52,293	52,629	52,965	53,301	53,637	56,501
貸借対照表																	
流動資産（余剰資金）			86,553	173,106	259,659	346,212	432,765	483,714	534,999	586,620	638,577	690,870	743,499	796,465	849,766	903,403	959,904
固定資産(償却資産)		475,000	443,330	411,660	379,990	348,320	316,650	284,980	253,310	221,640	189,970	158,300	126,630	94,960	63,290	31,620	–
繰延資産		10,000	8,000	6,000	4,000	2,000	0	0	0	0	0	0	0	0	0	0	0
資産合計（資産の部）		485,000	537,883	590,766	559,096	696,532	749,415	768,694	788,309	808,260	828,547	849,170	870,129	891,425	913,056	935,023	959,904
借入金（当初借入）		353,000	353,000	353,000	353,000	353,000	353,000	317,700	282,400	247,100	211,800	176,500	141,200	105,900	70,600	35,300	0
不足資金借入金（追加借入）			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
負債合計			353,000	353,000	353,000	353,000	353,000	317,700	282,400	247,100	211,800	176,500	141,200	105,900	70,600	35,300	–
資本金		132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000	132,000
（上記資本金のうち、クレジット購入分額）		84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000	84,000
剰余金		0	52,883	105,766	158,649	211,532	264,415	318,994	373,909	429,160	484,747	540,670	596,929	653,525	710,456	767,723	827,904
資本合計		132,000	184,883	237,766	290,649	343,532	396,415	450,994	505,909	561,160	616,747	672,670	728,929	785,525	842,456	899,723	959,904
負債・資本合計（負債及び資本の部）		485,000	537,883	590,766	643,649	696,532	749,415	768,694	788,309	808,260	828,547	849,170	870,129	891,425	913,056	935,023	959,904
借入金																	
A	（借入金残高：記入）	353,000	353,000	353,000	353,000	353,000	353,000	317,700	282,400	247,100	211,800	176,500	141,200	105,900	70,600	35,300	0
国際協力銀行	（元利合計返済金額：記入）		4,942	4,942	4,942	4,942	4,942	39,748	39,254	38,759	38,265	37,771	37,277	36,783	36,288	35,794	35,300
投資金融	（元金分返済額）		0	0	0	0	0	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300
	（支払利息：金利のみ記入）	1.40%	4,942	4,942	4,942	4,942	4,942	4,448	3,954	3,459	2,965	2,471	1,977	1,483	988	494	0
合計	（借入金残高：記入）		353,000	353,000	353,000	353,000	353,000	317,700	282,400	247,100	211,800	176,500	141,200	105,900	70,600	35,300	0
	（元利合計返済金額：記入）		4,942	4,942	4,942	4,942	4,942	39,748	39,254	38,759	38,265	37,771	37,277	36,783	36,288	35,794	35,300
	（元金分返済額）		0	0	0	0	0	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300	35,300
	（支払利息：金利のみ記入）		4,942	4,942	4,942	4,942	4,942	4,448	3,954	3,459	2,965	2,471	1,977	1,483	988	494	0
採算計算																	
税引後キャッシュフロー			86,553	86,553	86,553	86,553	86,553	86,249	86,585	86,921	87,257	87,593	87,929	88,265	88,601	88,937	91,801
税引後キャッシュフローの累計 ［S］			86,553	173,106	259,659	346,212	432,765	519,014	605,599	692,520	779,777	867,370	955,299	1,043,565	1,132,166	1,221,103	1,312,904
［S］－ 投下資本			−398,447	−311,894	−225,341	−138,788	−52,235	34,014	120,599	207,520	294,777	382,370	470,299	558,565	647,166	736,103	827,904
内部利益率 ［IRR］（利息除外、税金繰込）							−13.7%					4.3%					9.0%
（IRR計算データ）		−475,000	59,825	59,825	59,825	59,825	59,825	59,027	58,869	58,710	58,552	58,394	58,236	58,078	57,920	57,762	56,441
内部利益率 ［IRR］（利息除外、税引前）							−3.7%					12.2%					15.9%
（IRR計算データ）		−475,000	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,711	84,761

設定項目						
償却率	100.0%	残存薄価	0%	% ←	15	年償却
繰延資産償却年数	5	年				
初期投資額	485,000					

＜算出前提条件　ケース2 FFB処理能力60トン/時間　ベースケース＞

1. 初期投資額（百万円）： 754

＜初期投資額（資金調達）内訳＞

（1）出資金

	出資額（百万円）	
PT. PN	75	初期投資額の10%
NEDO	160	2011－2012年のCER金額の50%を前払い（127,341x2年x50%）
合計	235	

（2）借入金

○具体的な借入予定先名も含め下記表を記載せよ（海外から借入の場合、US$1=110円　で計算）

	借入金（百万円）	返済期間（年）	金利（%）	通貨の種類	備考（金利の根拠等）
JICAプロジェクト	529	10	1.40%	円	JBIC融資条件10年5年据え置き半年賦計算例
ファイナンス					

2. 建設期間 1 年

3. プロジェクト期間（建設期間含む） 16 年

4. 減価償却 残存薄価（%） 0.00%

償却年数（年間） 15

5. 売上高

（1）事業収入

事業収入として、①余剰電力をPLNに売電および②CDMの販売収入がある。

①売電収入

10MW未満のバイオマス発電の購入単価はスマトラグリッドの平均発電原価の80%である。スマトラグリッドの電源は水力と石炭火力であり、発電原価は9.2円／kWh程度と推定される。

売電量2,200kWx7,446hrx9．2x0.8=120,566千円／年

②CDM販売収入

バイオマス発電とメタン回収合計で63,671t-CO2/年x2,000円/t-CO2=127,341千円/年
廃水地ラグーンからのメタン回収で16,500t-CO2/年x2,000円/t-CO2＝33,000千円/年

①＋②より

合計収入：120,566　+ 127,341+ 33,000 = 280,907 千円/年

（2）クレジット収入（Pay on deliverly 型を選択する場合のみ記入）

本プロジェクトでは、Pay on delivery型を選択しない。

6. コスト（売上原価＋販管費＋オペレーション＋減価償却費 等）

本プロジェクト実施にあたるコストとして、維持管理費は初期投資の5%の38,200千円／年としている。

7. 法人税等実行税率とその根拠

32.00%（インドネシア国の税率）

＊下表を参照のこと。

2001年法人税比較】

国・地域	法人税率（%）
チリ	15
香港	16
台湾	25
シンガポール	25.5
マレーシア	28
インドネシア	30
タイ	30
英国	30
韓国	30.8
フィリピン	32
ニュージーランド	33
オーストラリア	34
米国	40
日本	42

（'01年2月12日ビジネスタイムスより）

FFB処理能力60トン/時間 ベースケース

《収支一覧表

（単位：千円）

事業年度		建設期間	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
（*：記入不要欄、網掛け部分は記入）		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
損益計算書																	
1. 売上高合計			280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907
売上高（売電事業）			120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566
売上高（CER販売）			160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341
2. コスト			38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200
建設・開業費		764,000															
原材料費		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
維持管理費		38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200	38,200
3. 減価償却費		754,000	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,263
営業利益（*）			192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,440	192,444
4. 支払利息（*）			7,406	7,406	7,406	7,406	7,406	6,665	5,925	5,184	4,444	3,703	2,962	2,222	1,481	741	0
5. 繰延資産償却費(*)		10,000	2,000	2,000	2,000	2,000	2,000	–	–	–	–	–	–	–	–	–	–
税引前当期利益（*）			183,034	183,034	183,034	183,034	183,034	185,775	186,515	187,256	187,996	188,737	189,478	190,218	190,959	191,699	192,444
6. 法人税等（*）		32.00%	58,571	58,571	58,571	58,571	58,571	59,448	59,685	59,922	60,159	60,396	60,633	60,870	61,107	61,344	61,582
当期利益（*）			124,463	124,463	124,463	124,463	124,463	126,327	126,830	127,334	127,838	128,341	128,845	129,348	129,852	130,356	130,862
キャッシュフロー計算書																	
税引前当期利益			183,034	183,034	183,034	183,034	183,034	185,775	186,515	187,256	187,996	188,737	189,478	190,218	190,959	191,699	192,444
償却費（設備）			52,267	52,267	52,267	52,267	52,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,263
キャッシュインフロー合計			235,301	235,301	235,301	235,301	235,301	236,042	236,782	237,523	238,263	239,004	239,745	240,485	241,226	241,966	242,707
法人税等支払			58,571	58,571	58,571	58,571	58,571	59,448	59,685	59,922	60,159	60,396	60,633	60,870	61,107	61,344	61,582
借入金返済			0	0	0	0	0	52,200	52,200	52,200	52,200	52,200	52,200	52,200	52,200	52,200	52,200
キャッシュアウトフロー合計			58,571	58,571	58,571	58,571	58,571	111,648	111,885	112,122	112,359	112,596	112,833	113,070	113,307	113,544	113,782
キャッシュフロー			176,730	176,730	176,730	176,730	176,730	124,394	124,897	125,401	125,905	126,408	126,912	127,415	127,919	128,423	128,925
貸借対照表																	
流動資産（余剰資金）			176,730	353,460	530,190	706,920	883,650	1,008,044	1,132,941	1,258,342	1,384,247	1,510,655	1,637,567	1,764,982	1,892,901	2,021,324	2,150,249
固定資産(償却資産)		754,000	703,733	653,467	603,200	552,933	502,666	452,399	402,132	351,865	301,598	251,331	201,064	150,797	100,530	50,263	0
繰延資産		10,000	8,000	6,000	4,000	2,000	0	0	0	0	0	0	0	0	0	0	0
資産合計（資産の部）		764,000	888,463	1,012,927	1,137,390	1,261,853	1,386,317	1,460,443	1,535,074	1,610,208	1,685,845	1,761,986	1,838,631	1,915,779	1,993,431	2,071,587	2,150,249
借入金（当初借入）		529,000	529,000	529,000	529,000	529,000	529,000	476,100	423,200	370,300	317,400	264,500	211,600	158,700	105,800	52,900	0
不足資金借入金（追加借入）																	
負債合計		529,000	529,000	529,000	529,000	529,000	529,000	476,100	423,200	370,300	317,400	264,500	211,600	158,700	105,800	52,900	0
資本金		235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000	235,000
（上記資本金のうち、クレジット購入分額）		160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000
剰余金			124,463	248,927	373,390	497,853	622,317	748,643	875,474	1,002,808	1,130,645	1,258,986	1,387,831	1,517,179	1,647,031	1,777,387	1,908,249
資本合計		235,000	359,463	483,927	608,390	732,853	857,317	983,643	1,110,474	1,237,808	1,365,645	1,493,986	1,622,831	1,752,179	1,882,031	2,012,387	2,143,249
負債・資本合計（負債及び資本の部）		764,000	888,463	1,012,927	1,137,390	1,261,853	1,386,317	1,459,743	1,533,674	1,608,108	1,683,045	1,758,486	1,834,431	1,910,879	1,987,831	2,065,287	2,143,249
借入金																	
国際協力機構	（借入金残高：記入）	529,000	529,000	529,000	529,000	529,000	529,000	476,100	423,200	370,300	317,400	264,500	211,600	158,700	105,800	52,900	0
投資金融	（元利合計返済金額：記入）		7,406	7,406	7,406	7,406	7,406	59,565	58,825	58,084	57,344	56,603	55,862	55,122	54,381	53,641	52,900
	（元金分返済額）		0	0	0	0	0	52,900	52,900	52,900	52,900	52,900	52,900	52,900	52,900	52,900	52,900
	（支払利息：金利のみ記入）	1.40%	7,406	7,406	7,406	7,406	7,406	6,665	5,925	5,184	4,444	3,703	2,962	2,222	1,481	741	0
合計	（借入金残高：記入）		529,000	529,000	529,000	529,000	529,000	476,100	423,200	370,300	317,400	264,500	211,600	158,700	105,800	52,900	0
	（元利合計返済金額：記入）		7,406	7,406	7,406	7,406	7,406	59,565	58,825	58,084	57,344	56,603	55,862	55,122	54,381	53,641	52,900
	（元金分返済額）		0	0	0	0	0	52,900	52,900	52,900	52,900	52,900	52,900	52,900	52,900	52,900	52,900
	（支払利息：金利のみ記入）		7,406	7,406	7,406	7,406	7,406	6,665	5,925	5,184	4,444	3,703	2,962	2,222	1,481	741	0
採算計算																	
税引後キャッシュフロー			176,730	176,730	176,730	176,730	176,730	176,594	177,097	177,601	178,105	178,608	179,112	179,615	180,119	180,623	181,125
税引後キャッシュフローの累計 [S]			176,730	353,460	530,190	706,920	883,650	1,060,244	1,237,341	1,414,942	1,593,047	1,771,655	1,950,767	2,130,382	2,310,501	2,491,124	2,672,249
[S] − 投下資本			−577,270	−400,540	−223,810	−47,080	129,650	306,244	483,341	660,942	839,047	1,017,655	1,196,767	1,376,382	1,556,501	1,737,124	1,918,249
内部利益率 [IRR]（利息除外、税金繰込）							7.0%					20.6%					23.3%
(IRR計算データ)		−754,000	184,136	184,136	184,136	184,136	184,136	183,259	183,022	182,785	182,548	182,311	182,074	181,837	181,600	181,363	181,125
内部利益率 [IRR]（利息除外、税引前）							18.3%					29.8%					31.7%
(IRR計算データ)		−754,000	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707	242,707

設定項目					
償却率	100.0%	残存薄価	0%	% ←	15 年償却
繰延資産償却年数	5	年			
初期投資額	754,000				

＜算出前提条件　ケース2 FFB処理能力60トン/時間　初期投資額が15%上昇＞

1. 初期投資額（百万円）: 867

＜初期投資額（資金調達）内訳＞

（1）出資金

	出資額（百万円）	
PT. PN	87	初期投資額の10%
NEDO	160	2011－2012年のCER金額の50%を前払い（127,341x2年x50%）
合計	247	

（2）借入金

○具体的な借入予定先名も含め下記表を記載せよ（海外から借入の場合、US$1=110円　で計算）

	借入金（百万円）	返済期間（年）	金利（%）	通貨の種類	備考（金利の根拠等）
JICAプロジェクト	630	10	1.40%	円	JBIC融資条件10年5年据え置き半年賦計算例
ファイナンス					

2. 建設期間 1 年

3. プロジェクト期間（建設期間含む） 16 年

4. 減価償却

残存薄価（%） 0.00%

償却年数（年間） 15

5. 売上高

（1）事業収入

事業収入として、①余剰電力をPLNに売電および②CDMの販売収入がある。

①売電収入

10MW未満のバイオマス発電の購入単価はスマトラグリッドの平均発電原価の80%である。スマトラグリッドの電源は水力と石炭火力であり、発電原価は9.2円／kWh程度と推定される。

売電量2,200kWx7,446hrx9．2x0.8=120,566千円／年

②CDM販売収入

バイオマス発電とメタン回収合計で63,671t-CO2/年x2,000円/t-CO2=127,341千円/年

廃水地ラグーンからのメタン回収で16,500t-CO2/年x2,000円/t-CO2＝33,000千円/年

①＋②より

合計収入：120,566　+ 127,341+ 33,000 = 280,907 千円/年

（2）クレジット収入（Pay on deliverly 型を選択する場合のみ記入）

本プロジェクトでは、Pay on delivery型を選択しない。

6. コスト（売上原価＋販管費＋オペレーション＋減価償却費 等）

初期投資額（￥754百万円が15%上昇したと仮定）を￥867百万円とする

本プロジェクト実施にあたるコストとして、維持管理費は初期投資の5%の43,350千円／年としている。

7. 法人税等実行税率とその根拠

32.00%（インドネシア国の税率）

＊下表を参照のこと。

2001年法人税比較】

国・地域	法人税率（%）
チリ	15
香港	16
台湾	25
シンガポール	25.5
マレーシア	28
インドネシア	30
タイ	30
英国	30
韓国	30.8
フィリピン	32
ニュージーランド	33
オーストラリア	34
米国	40
日本	42

（'01年2月12日ビジネスタイムスより）

FFB処理能力60トン/時間 初期投資額が15%上昇

《収支一覧表

（単位：千円）

事業年度	建設期間	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
（＊：記入不要欄、網掛け部分は記入）	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
損益計算書																
1. 売上高合計		280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907	280,907
売上高（売電事業）		120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566	120,566
売上高（CER販売）		160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341	160,341
2. コスト		43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350
建設・開業費	877,000															
原材料費	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
維持管理費	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350	43,350
3. 減価償却費	867,000	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800
営業利益（＊）		179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757	179,757
4. 支払利息（＊）		8,820	8,820	8,820	8,820	8,820	7,938	7,056	6,174	5,292	4,410	3,528	2,646	1,764	882	0
5. 繰延資産償却費(＊)	10,000	2,000	2,000	2,000	2,000	2,000	–	–	–	–	–	–	–	–	–	–
税引前当期利益（＊）		168,937	168,937	168,937	168,937	168,937	171,819	172,701	173,583	174,465	175,347	176,229	177,111	177,993	178,875	179,757
6. 法人税等（＊）	32.00%	54,060	54,060	54,060	54,060	54,060	54,982	55,264	55,547	55,829	56,111	56,393	56,676	56,958	57,240	57,522
当期利益（＊）		114,877	114,877	114,877	114,877	114,877	116,837	117,437	118,036	118,636	119,236	119,836	120,435	121,035	121,635	122,235
キャッシュフロー計算書																
税引前当期利益		168,937	168,937	168,937	168,937	168,937	171,819	172,701	173,583	174,465	175,347	176,229	177,111	177,993	178,875	179,757
償却費（設備）		59,800	59,800	59,800	59,800	59,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800	57,800
キャッシュインフロー合計		228,737	228,737	228,737	228,737	228,737	229,619	230,501	231,383	232,265	233,147	234,029	234,911	235,793	236,675	237,557
法人税等支払		54,060	54,060	54,060	54,060	54,060	54,982	55,264	55,547	55,829	56,111	56,393	56,676	56,958	57,240	57,522
借入金返済		0	0	0	0	0	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000
キャッシュアウトフロー合計		54,060	54,060	54,060	54,060	54,060	117,982	118,264	118,547	118,829	119,111	119,393	119,676	119,958	120,240	120,522
キャッシュフロー		174,677	174,677	174,677	174,677	174,677	111,637	112,237	112,836	113,436	114,036	114,636	115,235	115,835	116,435	117,035
貸借対照表																
流動資産（余剰資金）		174,677	349,354	524,031	698,709	873,386	985,023	1,097,259	1,210,096	1,323,532	1,437,568	1,552,204	1,667,439	1,783,274	1,899,709	2,016,744
固定資産(償却資産)	867,000	809,200	751,400	693,600	635,800	578,000	520,200	462,400	404,600	346,800	289,000	231,200	173,400	115,600	57,800	0
繰延資産	10,000	8,000	6,000	4,000	2,000	0	0	0	0	0	0	0	0	0	0	0
資産合計（資産の部）	877,000	991,877	1,106,754	1,221,631	1,336,509	1,451,386	1,505,223	1,559,659	1,614,696	1,670,332	1,726,568	1,783,404	1,840,839	1,898,874	1,957,509	2,016,744
借入金（当初借入）	630,000	630,000	630,000	630,000	630,000	630,000	567,000	504,000	441,000	378,000	315,000	252,000	189,000	126,000	63,000	0
不足資金借入金（追加借入）																
負債合計	630,000	630,000	630,000	630,000	630,000	630,000	567,000	504,000	441,000	378,000	315,000	252,000	189,000	126,000	63,000	63,000
資本金	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000	247,000
（上記資本金のうち、クレジット購入分額）	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000	160,000
剰余金		114,877	229,754	344,631	459,509	574,386	691,223	808,659	926,696	1,045,332	1,164,568	1,284,404	1,404,839	1,525,874	1,647,509	1,769,744
資本合計	247,000	361,877	476,754	591,631	706,509	821,386	938,223	1,055,659	1,173,696	1,292,332	1,411,568	1,531,404	1,651,839	1,772,874	1,894,509	2,016,744
負債・資本合計（負債及び資本の部）	877,000	991,877	1,106,754	1,221,631	1,336,509	1,451,386	1,505,223	1,559,659	1,614,696	1,670,332	1,726,568	1,783,404	1,840,839	1,898,874	1,957,509	2,079,744

借入金																	
国際協力機構	（借入金残高：記入）	630,000	630,000	630,000	630,000	630,000	630,000	567,000	504,000	441,000	378,000	315,000	252,000	189,000	126,000	63,000	63,000
投資金融	（元利合計返済金額：記入）		8,820	8,820	8,820	8,820	8,820	70,938	70,056	69,174	68,292	67,410	66,528	65,646	64,764	63,882	0
	（元金分返済額）		0	0	0	0	0	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	0
	（支払利息：金利のみ記入）	1.40%	8,820	8,820	8,820	8,820	8,820	7,938	7,056	6,174	5,292	4,410	3,528	2,646	1,764	882	0
合計	（借入金残高：記入）		630,000	630,000	630,000	630,000	630,000	567,000	504,000	441,000	378,000	315,000	252,000	189,000	126,000	63,000	0
	（元利合計返済金額：記入）		8,820	8,820	8,820	8,820	8,820	70,938	70,056	69,174	68,292	67,410	66,528	65,646	64,764	63,882	63,000
	（元金分返済額）		0	0	0	0	0	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000	63,000
	（支払利息：金利のみ記入）		8,820	8,820	8,820	8,820	8,820	7,938	7,056	6,174	5,292	4,410	3,528	2,646	1,764	882	0

採算計算																
税引後キャッシュフロー		174,677	174,677	174,677	174,677	174,677	174,637	175,237	175,836	176,436	177,036	177,636	178,235	178,835	179,435	180,035
税引後キャッシュフローの累計 [S]		174,677	349,354	524,031	698,709	873,386	1,048,023	1,223,259	1,399,096	1,575,532	1,752,568	1,930,204	2,108,439	2,287,274	2,466,709	2,646,744
[S] − 投下資本		−692,323	−517,646	−342,969	−168,291	6,386	181,023	356,259	532,096	708,532	885,568	1,063,204	1,241,439	1,420,274	1,599,709	1,779,744
内部利益率 [IRR]（利息除外、税金繰込）						1.9%					16.5%					19.7%
（IRR計算データ）	−867,000	183,497	183,497	183,497	183,497	183,497	182,575	182,293	182,010	181,728	181,446	181,164	180,881	180,599	180,317	180,035
内部利益率 [IRR]（利息除外、税引前）						11.5%					24.3%					26.6%
（IRR計算データ）	−867,000	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557	237,557

設定項目					
償却率	100.0%	残存薄価	0%	% ←	15 年償却
繰延資産償却年数	5	年			
初期投資額	867,000				

＜算出前提条件　ケース2 FFB処理能力60トン/時間　操業率15%ダウン＞

1. 初期投資額（百万円）: 754

＜初期投資額（資金調達）内訳＞

（1）出資金

	出資額（百万円）	
PT. PN	76	初期投資額の10%
NEDO	136	2011－2012年のCER金額の50%を前払い（136,291x2年x50%）
合計	212	

（2）借入金

○具体的な借入予定先名も含め下記表を記載せよ（海外から借入の場合、US$1=110円　で計算）

	借入金（百万円）	返済期間（年）	金利（%）	通貨の種類	備考（金利の根拠等）
JICAプロジェクト	552	10	1.40%	円	JBIC融資条件10年5年据え置き半年賦計算例
ファイナンス					

2. 建設期間 1 年

3. プロジェクト期間（建設期間含む） 16 年

4. 減価償却 残存薄価（%） 0.00%

償却年数（年間） 15

5. 売上高

（1）事業収入

事業収入として、①余剰電力をPLNに売電および②CDMの販売収入がある。

①売電収入

10MW未満のバイオマス発電の購入単価はスマトラグリッドの平均発電原価の80%である。スマトラグリッドの電源は水力と石炭火力であり、発電原価は9.2円／kWh程度と推定される。

売電量2,200kWx7,446hrx9.2x0.8x0.85=102,481千円／年

②CDM販売収入

バイオマス発電とメタン回収合計で63,671t-CO2/年x2,000円/t-CO2x0.85=108,241千円/年

廃水地ラグーンからのメタン回収で16,500t-CO2/年x2,000円/t-CO2x0.85＝28,050千円/年

①＋②より

合計収入：102,481+ 108,2411+ 28,050 = 238,772 千円/年

（2）クレジット収入（Pay on deliverly 型を選択する場合のみ記入）

本プロジェクトでは、Pay on delivery型を選択しない。

6. コスト（売上原価＋販管費＋オペレーション＋減価償却費 等）

初期投資額は754百万円とする

本プロジェクト実施にあたるコストとして、維持管理費は初期投資の5%の37,700千円／年としている。

7. 法人税等実行税率とその根拠

32.00%（インドネシア国の税率）

＊下表を参照のこと。

2001年法人税比較】

国・地域	法人税率（%）
チリ	15
香港	16
台湾	25
シンガポール	25.5
マレーシア	28
インドネシア	30
タイ	30
英国	30
韓国	30.8
フィリピン	32
ニュージーランド	33
オーストラリア	34
米国	40
日本	42

（'01年2月12日ビジネスタイムスより）

FFB処理能力60トン/時間 操業率15%ダウン

《収支一覧表

（単位：千円）

事業年度		建設期間	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
（*：記入不要欄、網掛け部分は記入）		0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
損益計算書																	
1．売上高合計			237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772	237,772
売上高（売電事業）			102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481	102,481
売上高（CER販売）			135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291	135,291
2．コスト			37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700
建設・開業費		754,000															
原材料費		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
維持管理費		37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700	37,700
3．減価償却費		754,000	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267
営業利益（*）			149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805	149,805
4．支払利息（*）			7,728	7,728	7,728	7,728	7,728	6,955	6,182	5,410	4,637	3,864	3,091	2,318	1,546	773	0
5．繰延資産償却費（*）		10,000	2,000	2,000	2,000	2,000	2,000	–	–	–	–	–	–	–	–	–	–
税引前当期利益（*）			140,077	140,077	140,077	140,077	140,077	142,850	143,623	144,396	145,169	145,941	146,714	147,487	148,260	149,033	149,805
6．法人税等（*）		32.00%	44,825	44,825	44,825	44,825	44,825	45,712	45,959	46,207	46,454	46,701	46,949	47,196	47,443	47,690	47,938
当期利益（*）			95,253	95,253	95,253	95,253	95,253	97,138	97,664	98,189	98,715	99,240	99,766	100,291	100,817	101,342	101,868
キャッシュフロー計算書																	
税引前当期利益			140,077	140,077	140,077	140,077	140,077	142,850	143,623	144,396	145,169	145,941	146,714	147,487	148,260	149,033	149,805
償却費（設備）			52,267	52,267	52,267	52,267	52,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267	50,267
キャッシュインフロー合計			192,344	192,344	192,344	192,344	192,344	193,117	193,890	194,662	195,435	196,208	196,981	197,754	198,526	199,299	200,072
法人税等支払			44,825	44,825	44,825	44,825	44,825	45,712	45,959	46,207	46,454	46,701	46,949	47,196	47,443	47,690	47,938
借入金返済			0	0	0	0	0	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200
キャッシュアウトフロー合計			44,825	44,825	44,825	44,825	44,825	100,912	101,159	101,407	101,654	101,901	102,149	102,396	102,643	102,890	103,138
キャッシュフロー			147,519	147,519	147,519	147,519	147,519	92,205	92,730	93,256	93,781	94,307	94,832	95,358	95,883	96,409	96,934
貸借対照表																	
流動資産（余剰資金）			147,519	295,039	442,558	590,077	737,596	829,801	922,531	1,015,787	1,109,568	1,203,875	1,298,707	1,394,065	1,489,948	1,586,357	1,683,292
固定資産(償却資産)		754,000	703,733	653,467	603,200	552,933	502,667	452,400	402,133	351,867	301,600	251,333	201,067	150,800	100,533	50,267	0
繰延資産		10,000	8,000	6,000	4,000	2,000	0	0	0	0	0	0	0	0	0	0	0
資産合計（資産の部）		764,000	859,253	954,505	1,049,758	1,145,010	1,240,263	1,282,201	1,324,665	1,367,654	1,411,168	1,455,208	1,499,774	1,544,865	1,590,482	1,636,624	1,683,292
借入金（当初借入）		552,000	552,000	552,000	552,000	552,000	552,000	496,800	441,600	386,400	331,200	276,000	220,800	165,600	110,400	55,200	0
不足資金借入金（追加借入）																	
負債合計		552,000	552,000	552,000	552,000	552,000	552,000	496,800	441,600	386,400	331,200	276,000	220,800	165,600	110,400	55,200	–
資本金		212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000	212,000
（上記資本金のうち、クレジット購入分額）		136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000	136,000
剰余金			95,253	190,505	285,758	381,010	476,263	573,401	671,065	769,254	867,968	967,208	1,066,974	1,167,265	1,268,082	1,369,424	1,471,292
資本合計		212,000	307,253	402,505	497,758	593,010	688,263	785,401	883,065	981,254	1,079,968	1,179,208	1,278,974	1,379,265	1,480,082	1,581,424	1,683,292
負債・資本合計（負債及び資本の部）		764,000	859,253	954,505	1,049,758	1,145,010	1,240,263	1,282,201	1,324,665	1,367,654	1,411,168	1,455,208	1,499,774	1,544,865	1,590,482	1,636,624	1,683,292
借入金																	
国際協力機構 投資金融	（借入金残高：記入）	552,000	552,000	552,000	552,000	552,000	552,000	496,800	441,600	386,400	331,200	276,000	220,800	165,600	110,400	55,200	0
	（元利合計返済金額：記入）		7,728	7,728	7,728	7,728	7,728	62,155	61,382	60,610	59,837	59,064	58,291	57,518	56,746	55,973	0
	（元金分返済額）		0	0	0	0	0	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200	0
	（支払利息：金利のみ記入）	1.40%	7,728	7,728	7,728	7,728	7,728	6,955	6,182	5,410	4,637	3,864	3,091	2,318	1,546	773	0
合計	（借入金残高：記入）		552,000	552,000	552,000	552,000	552,000	496,800	441,600	386,400	331,200	276,000	220,800	165,600	110,400	55,200	0
	（元利合計返済金額：記入）		7,728	7,728	7,728	7,728	7,728	62,155	61,382	60,610	59,837	59,064	58,291	57,518	56,746	55,973	55,200
	（元金分返済額）		0	0	0	0	0	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200	55,200
	（支払利息：金利のみ記入）		7,728	7,728	7,728	7,728	7,728	6,955	6,182	5,410	4,637	3,864	3,091	2,318	1,546	773	0
採算計算																	
税引後キャッシュフロー			147,519	147,519	147,519	147,519	147,519	147,405	147,930	148,456	148,981	149,507	150,032	150,558	151,083	151,609	152,134
税引後キャッシュフローの累計 ［S］			147,519	295,039	442,558	590,077	737,596	885,001	1,032,931	1,181,387	1,330,368	1,479,875	1,629,907	1,780,465	1,931,548	2,083,157	2,235,292
［S］－ 投下資本			−606,481	−458,961	−311,442	−163,923	−16,404	131,001	278,931	427,387	576,368	725,875	875,907	1,026,465	1,177,548	1,329,157	1,481,292
内部利益率 ［IRR］（利息除外、税金繰込）							1.0%					15.8%					19.0%
（IRR計算データ）		−754,000	155,247	155,247	155,247	155,247	155,247	154,360	154,113	153,865	153,618	153,371	153,123	152,876	152,629	152,382	152,134
内部利益率 ［IRR］（利息除外、税引前）							10.2%					23.3%					25.7%
（IRR計算データ）		−754,000	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072	200,072

設定項目					
償却率	100.0%	残存薄価	0%	% ←	15 年償却
繰延資産償却年数		5	年		
初期投資額		754,000			

APPENDIX 5

Recommended Terms of Reference

Appendix 5: Recommended Terms of Reference

Recommended Terms of Reference
for
the Project Preparation Study
on
the POM Wastes-fired Power Generation and POA Project
for
the Rural Electrification in Sumatra, Indonesia

1. Project Digest

(1) Project Title:

The Project Formulation Study on POM Wastes-fired Power Generation and PoA Project for the Rural Electrification in Sumatra, the Republic of Indonesia.

(2) Location:

Entire Provinces in Sumatra Island, the Republic of Indonesia

(3) Implementing Agency:

The Ministry of State Corporation (BUMN)

The Ministry of State Corporation (BUMN) shall be responsible for the whole course of the Study and will coordinate and cooperate with related Government Agencies and PT. Perkebunan Nusantara I~VII in proceeding on this Project and will set up a Steering Committee as follows.

Structure of the Steering Committee:

Chairman:

- The Ministry of State Corporation (BUMN)

Secretary:

- Office of the Deputy Minister for Agro Industry, Forestry, Paper, Printing and Publishing.

Members:

- Coordinating Ministry for Economic Affairs
- National Development Planning Board (BAPPENAS)
- Ministry of Finance (MOF)
- Ministry of Energy and Mineral Resources (MEMR)
- National Electricity Company (PT. PLN)
- Agencies for the assessment and application of technology (BPPT)
- Ministry of Agriculture (MOA)
- Ministry of Industry (MOI)-
- Ministry of Environment (MOE)
- PT. Perkebunan Nusantara I
- PT. Perkebunan Nusantara II
- PT. Perkebunan Nusantara III
- PT. Perkebunan Nusantara IV
- PT. Perkebunan Nusantara V
- PT. Perkebunan Nusantara VI
- PT. Perkebunan Nusantara VII

(4) Rationale of the Project

1) Needs for Rural Electrification

The Electrification Rate of Indonesia is said to be approx. 60%, which is lower than the neighboring countries. Especially in the isolated rural area, such as mountainous remote area and islands, it is presumed that considerable amount of non-electrified indigent villages still remain in large number. Indonesian Government has, with the assistance of developed countries, promoted the electrification of such rural area starting from 1970's, in the manner of not only enriching power distribution network but also introduction of diesel power generator, micro hydro power station and solar energy generation including such Off-grid Electric Districts. The Electrification Rates by Region in Indonesia are shown as follows;

Electrification Rate at the End of Fiscal 1995

Region	Rate of Electrified Villages (%)	Rate of Electrified Households (%)	Area per Village (km^2)
Jawa-Bali	89.0	53.0	6.5
Sumatera	54.0	32.0	29.1
Sulawesi	76.0	35.0	38.9
Kalimantan	32.0	36.0	90.2
East Indonesia	35.0	20.0	117.6
Average	62.0	44.0	28.5

Source: Ministry of Cooperatives and Small Enterprises

In addition, in order to fulfill the government's responsibility " to guarantee the safety of domestic power supply", prescribed in the Presidential Decree No.5 in 2006 as Energy-Independent Village (DME) Program, for the mountainous remote area and isolated islands which suffer from the shortage of power supply, the Government has planned to secure power to be necessary for lighting, cooking and industrial /productive activities, utilizing up-to-date technology, such as, solar energy, wind-generated electricity etc..

In order to materialize this program, Coordinating Ministry for Economic Affairs has launched the initiative of DME together with other line 6 Ministries. Under the program, the villages that 60% of the demand for power can be managed by the renewable energy (Biomass fuel, geothermal energy, wind, micro hydro power and biomass from waste) are chosen as candidates and electrification work shall be carried out for them. Many Off-grid area in Sumatra where are always suffering the brownouts from shortage of power supply, and so far no significant counter measures have been taken by the Government. These areas however are rich in Biomass Resources from the Palm Oil Plantations such as Fiber, Kernel Shell, Empty Fruit Bunches (FEBs), and Methane Gases from Palm Oil Mill Effluent (POME). Thus, there is a great potential at the POMs for utilization of EFBs for Power Generation and creating the Carbon Credit that will be derived by capturing

the Methane Gases from the POME, and eventually to contribute the DME program throughout the entire provinces in Sumatra Island.

2) Purpose of the Project

Purposes of the proposed Palm Oil Mill (POM) Wastes-fired Power Generation and Gas Capturing Project which shall be implemented as a Program of Activity (PoA) Project, will be consists of three (3) major Objectives that may be summarized as under.

a. To help support the Rural Electrification Program which have been initiated by the Government of Indonesia through the extension of Energy-independent Village Program,

b. To improve the Environmental Conditions within the POMs, at the surrounding communities and to contribute for mitigating the Climate Changes at global levels by capturing the Green House Effect Gases (GHGs), and

c. To help support the financial sustainability of POMs by providing additional Revenues through the realization of "Waste-to-Energy" concept; the sales of Electric Power to National Grid and/or Off-grid Electricity Districts and the Carbon Credit gained by the Certification of Emission Reduction of GHGs to be issued by the United Nations.

3) Need for the Project Preparation Study

The Preliminary Feasibility Study has been conducted by Engineering and Consulting Firms Association (ECFA), Japan in March 2009. Through this Study, the Optimum Technology for the proposed Systems, Applicability of PoA Concept to the Scheme, Implementation and Monitoring Structures and Financial Viability have been fairly analyzed.

However, dept of the Site Investigation and Cost Estimate were rather limited due to time constraints given to the study team. In addition, the Environment Impact

Assessment (EIA) Study and the Detailed System Design and Detailed Engineering Study are yet to be conducted. Thus, the Project needs a full-scale Preparation Study in order to meet these requirements prior to the implementation of the Project.

2. Terms of Reference for the Project Preparation Study

(1) Objectives of the Study

The main objective of the Project Preparation Study is to ascertain the outputs of the Preliminary Feasibility Study for the proposed Palm Oil Mill Wastes-fired Power Generation and Methane Gas Capturing Project in Sumatra. Preliminary Feasibility Study has been conducted by ECFA in March 2009, which aimed at the dissemination of the Rural Electrification through the implementation of the Project Areas of the proposed Project Preparation Study covers the entire regions of Sumatra Island.

(2) Scope of the Study

1) Overview of Rural Electrification in Indonesia

a) Gathering and Analyzing of Background Data/Information

- Economic situation
- Energy situation in Indonesia such as energy consumption, energy resources, and energy policies
- Current state of electrification including electrification policies and plan, related laws, acts
- Rural electrification plans by PLN
- Related organizations, their activities and their awareness in regard to electrification

b) Confirmation of Rural Electrification Policy

- Review and confirmation of rural electrification policy

- Rural electrification capacity including human resource development
- Finance for rural electrification
- Establishment of coordination mechanism among central and local organizations

2) Dissemination for Rural Electrification with the development of POM Wastes-fired Power Generation and Methane Gases Capturing Project.

a) Gathering of Basic Data/Information

- Analyzing and sorting out the POMs shall be done for prioritized implementation.

b) Selection of Target POMs

The POMs that shall be implemented as the Priority Project, will be properly selected keeping in mind that the POMs are located adjacent to Off-grid Electricity Districts in the Project Area.

3) Verification of the Preliminary Feasibility Study done earlier

a. Justification of the Technology adopted for the Project

b. Confirmation of the Heating Values and other Performance Outputs calculated in the earlier studies.

c. Development of Preliminary Design and Cost Estimate

e. Confirmation of Economic and Financial Viabilities

f. Confirmation of Implementation Agency and other Stakeholders together with the proposed Implementation and Monitoring Structures

4) Assistance in the Environmental Impact Assessment Study done by the recipient Government

a. Impact after the commencement of Operations
(Air Quality, Water Quality, Noise and Vibration, Bad Smell, etc)

b. Impact during the Construction Period
(Dust, Exhaust Gases, Noise and Vibration, Water Quality, etc)

c. Impact to Natural Environment (Protected Districts, Protected

Geography and Hydrology, Protected Animals, Fauna and Flora, etc)

d. Impact to the Society (Land Acquisition, Relocation of Habitants, Cultural Heritages and Landscape, Minority Races etc.

5) Preparation of Project Design Document (PPD)

a. Identification of candidate sites
b. Site conditions survey
c. Supply area survey (number of consumers, distribution of consumers, potential demand, industrial and economic conditions, and road condition)
d. Evaluation of development potential (optimal scale of development, estimated construction cost, economic viability and effects)
e. Facility design (rough equipment specifications for the model plants, preparation of basic drawings and estimation)
f. Funding scheme (construction and operation fund procurement method)
g. Work control (deal with changes of the design and schedule, etc.)
h Operation and maintenance (civil engineering structures, electrical installations and transmission/distribution facilities)
i. Power plant management (financial management and profit management)
j. Electrification plan (decision on type of generating source, development priority, development timing, funding scheme and creation of secondary effects)
k. Selection of methodologies ,project boundary ,baseline scenario, calculation of GHG reduction, additionality ,project period and monitoring method etc
l. Prelimininary plant design and cost estimation
m. Steak-folders meeting

(5) Study Period

The working period is estimated as 6 months.

3. Staff/Personnel Participating in Project Implementation

The estimated number of the Experts for the study is as follows:

- 1 (one) senior engineer as the team leader fully in charge and well experienced in such nature of work
- 1 (one) biomass power engineer
- 1 (one) electrical engineer (distribution and consumer)
- 1 (one) CDM expert
- 1 (one) economist
- 1 (one) legal expert

4. Assistance Requested

(1) Counterparts

It is preferable that an equivalent number of counter-parts from local officials can work with the foreign experts.

(2) Reporting and Printing

The following Reports shall be prepared in English and Japanese.

a. Inception Report 10 copies

b. Interim Report 10 copies

c. Draft Final Report and Summary 20 copies

The Government of Indonesia will provide JICA with the comments on the Draft Final Report within one month after its reception.

d. Final Report and Summary 20 copies

インドネシア・スマトラにおける地方電化のためのパームオイル工場廃棄物
発電システムとＣＤＭプロジェクトに関する予備事業性調査

要　約

1. 調査の目的と重要性

インドネシア共和国は1990年代末期に1997年のタイの経済危機を発端とする深刻な経済不振に見舞われた。また、2000 年に石油輸出国から石油輸入国になったこともインドネシア経済に深刻な影響を与えた。このような状況は、インドネシア政府をして石油製品、電力およびその他のユーティリティへの補助金を削減せしめることとなり、化石燃料から水力、太陽光、風力、地熱、バイオマスのような再生可能なエネルギーへのエネルギー資源の多様化を奨励することとなった。2004 年には、政府は国家電力マスタープラン（ RUKN ）を策定し、全国電化率を設定した。しかし、このマスタープランの実際の実施は国家電力公社PLNの地方事務所に委ねられており、彼らは州政府と緊密な協力を得て、プログラムを実施すべきであるが、州政府およびPLN地方事務所の計画立案作業の能力不足と電力供給能力の不足により期待したほど進捗していない。

2006年に、インドネシア政府は再生可能エネルギーを活用した民間部門による電力供給ビジネスを奨励するエネルギー鉱物資源省令2006年002号を公布した。この省令はＰＬＮに対し再生可能エネルギーにより発電された電力の購入を義務付け、また購入価格の決定方法を定めている。この省令に加え、政府は離島や遠隔山岳地帯のすべての住民の生活水準を向上させるため、安定した電力供給を保証する“エネルギー独立村プログラム（ＤＭＥ）”の概念を導入した。

全国で政府主導によるＤＭＥプログラムの導入が開始されたが、スマトラ島の農村地帯ではこのプログラムがうまく機能しておらず、改善すべき点が残されている。一方、スマトラ島には豊富なバイオマス資源があり、パームオイル工場のバイオマス廃棄物はスマトラ配電に接続されていない地域での電力供給に利用できるもっとも潜在能力のある資源のひとつである。

これらの要素を勘案して、このプロジェクトではスマトラにおける電力配電網に接続されていない地域の地方電化による貧困の減少と地域開発の促進のためのパームオイル搾油工場（POM）の廃棄物発電の実現性を探索することを目的とした。“廃棄物からエネルギーへの転換”を標榜する本プロジェクトにおいて、POMでの空花房(Empty Fruit Bunch ,EFB）の燃焼やパームオイル搾油工場廃水（Palm Oil Mill Effluent ,POME）からのメタンガスの回収は、同工場内および周辺地域での衛生面および環境面での改善にも繋がる。このメタンガス回収は、京都議定書制度下の国連の認定を得た温室効果ガス(Greenhouse Gas, GHG)削減クレジット(Certified Emission Reduction, CER)として、この新事業である廃棄物発電の追加的な収入となる。

2.　調査結果の概要

本調査は、インドネシア国の社会経済状況の実態調査、電力分野における既存および将来の開発計画、“エネルギー独立村”計画の進捗、電力分野およびパームオイル産業における技術と人材の評価、プロジェクト実施地域内の POM の実態調査、新事業の経済財務分析その他の調査を含み、その調査結果は以下のように整理・要約される

(1)　パームオイル工場廃棄物のバイオマス発電における代替燃料としての意義

インドネシア国は世界最大のパームオイル生産国であり、スマトラ諸州には世界でも有数のバイオマス発電の中心となる可能性がある。空花房（Empty　Fruit Bunch ,EFB）は、搾油前の油やし房実（Fresh Fruit Bunch,　FFB）の重量に対し 23%を占める残渣で、わずかに農場に肥料として戻される分を除き、これまでパーム搾油工場（Palm Oil Mill,　POM）の廃棄物として活用されることなく処分されて来た。一方、気候変動に影響を与える温室効果ガスのひとつであるメタンガスは、パーム搾油工場廃水(Palm Oil Mill Effluent , POME)から回収されずに放置されてきた。本調査は、これらの廃棄物を回収活用し“廃棄物からエネルギーへの転換”のコンセプトに基づき発電資源として利用することを提起するものである。本調査期間内に実施された現地調査によれば、スマトラ島には 7 社の国営農場会社（PT.Pekebunan Nusantasas , PT.PNs）が経営する 61 のパーム搾油工場と数百にのぼる民間企業により運営されるパーム搾油工場がある。それゆえ、スマトラ島には夥しい量の潜在的な発電用資源が賦存していると言える。これらの資源を活用して発電を行い、特にスマトラ配電網でカバーされていない地域に対して供給することは、インドネシア国政府の主導で鋭意推進されている「独立エネルギー村」計画の一部として利用されることとなり、検討に値する。

(2)　関係機関および地域コミュニテイによる計画遂行の意向の確認

本調査団は、大統領府経済担当調整省、財務省、国家開発企画庁、国営企業省、農業省、エネルギー鉱山資源省、工業省、国営農場会社、州政府、国営マンディリ銀行との一連のインタビュー及び意見交換を通じて、本調査により提案された開発コンセプトは実施機関と目される国営企業省及びいくつかの国営農場会社はもとより全ての関係機関に受容され、これらの関係者はこの計画の実施に関心があることを確認した。また、有力な国営銀行のひとつであるマンディリ銀行はこのプロジェクトに対しツーステップローンが供与された場合、導管機能の役割を果たすことに関心を表明した。また、地域コミュニテイにとっても、文書による検証を得たわけではないが、本プロジェクトの目的が地方電化の促進と農村地域での貧困減少に資することであることに鑑み、本プロジェクトを魅力的な計画とみなしていることが窺がわれた。

(3)　バイオマス発電システムとして最も適合しかつ最適な技術の選択

プロジェクト対象地域における入手可能な技術や人的資源への細心な評価結果を基に、本調査団は現地調査の結果得られたPOMからのメタンガス回収とEFBを利用する発電と電力供給のいくつかの代替案を比較検討した。その結果についての詳細な説明は本報告書3章に示されている。

(4)　公営セクターと民間セクターの両方で所有されるプロジェクトの実施モデル

本調査団は、国営企業が保有するパーム搾油工場に対するプロジェクトだけでなく、民間セクターが所有かつ運営しているパーム搾油工場についても適切なプロジェクト実施体制の構築を試みた。この事業モデルを確立するにあたり重要な課題となる事項は、「だれがプロジェクト実施の責任機関となるか」、及び「だれが供与されたソフトローンの導管機能を果たすか」にある。財務省、国家開発企画庁のアドバイスに基づき、本調査団は最大の国営銀行であるマンディリ銀行に接触した結果、彼らはこのプロジェクトのために供与されるソフトローンの導管機関になることに強い関心を示した。しかしながら、プロジェクトの実施機関については、いくつかの実施省庁が関心を示したが時間の制約もあり、特定の省庁を本プロジェクトの実施機関として絞り込むまでには至らなかった。

(5)　プログラムCDMプロジェクトとしての財務的企業化可能性の分析

いくつかの財務評価上のパラメータを仮定して財務的企業化可能性分析を実施した。財務的企業化可能性分析に当たり設定した主要な前提条件は以下の2点である。

①　主要な２大収益源として、PLNへの電力販売と温室効果ガス削減クレジット(京都議定書のCertified of Emission Reduction, CER)を設定、及び

②　初期投資を補うために日本政府からのソフトローンが供与される。

財務的企業化可能性分析の結果、油やし花房（ＦＦＢ）の処理能力が時間あたり30トンの場合、税引き前内部収益率は11.7%であり、同処理能力が時間あたり60トンの場合は 31.7%であった。いくつかの財務評価上のパラメータを変動させたシナリオに基づく感度分析も実施された。

(6)　プロジェクト実施のための工程表（ロードマップ）

今回の予備事業化調査では肯定的な指標が得られたが、本格的な企業化調査と環境影響調査を日本政府関連機関から供与される技術支援スキームを活用し実施することが推奨される。上記技術支援スキームへの申請や本格的な企業化調査と環境影響調査のための行程表（ロードマップ）は本報告書の第４章に示した。