Scoping Study
Clean Technology Opportunities and Barriers in Indonesian Palm Oil Mill and Rice Mill Industries

FINAL REPORT

Prepared by:

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A. Introduction

1. Background

Indonesia has been enjoying high and increasing economic growth since it started to recover from the financial crisis of the late 1990s. At the same time, however, Indonesia has become the world's third largest emitter of carbon (after the USA and China). Moreover, the strong economic recovery has not solved the persistent poverty. In fact, unemployment rate has risen to double digits—from 6.1% in 2000 to 10.3% in 2006—and poverty incidence continues to increase—from 16.0% in 2005 to 17.8% in 2006. Over 70 million Indonesians (about one-third of the country's total population) live without access to electricity. The overarching goal, therefore, of the Indonesian government should be to continue to attain high economic growth while reducing poverty and mitigating its impacts on the environment.

No doubt, the industry and power sectors, among other sectors, have contributed to this positive economic performance. The manufacturing and construction industries alone combined to contribute 34% of GDP in 2005. The power sector, along with the entire energy sector, of course fuels the growth of the Indonesian economy. These two sectors, however, are also contributing to the rapidly increasing carbon emissions and environmental pollution (waste, water, and air)—clearly a negative side effect of growth and industrialization. The industrial sector relies on fossil fuels and, along with the household sector, dominate final energy consumption. The power sector, on the other hand, continues its dependence on coal to increase capacity and satisfy rapidly expanding electricity demand. Already, coal accounts for close to 70% of Indonesia's power generation mix. Yet it should be possible to ensure the two sectors' contributions to the growing Indonesian economy through the use of proven clean and sustainable energy technologies.

To be sure, the Government of Indonesia (GOI) has taken steps to arrest these growing environmental impacts. For example, the Presidential Regulation on National Energy Policy in 2006 aims to increase the share of geothermal and other renewables to 5% by 2025 and reduce energy intensity by 1% per year. Though maybe modest compared to national potentials, it cannot be denied that this is still a step in the right direction. However, while already modest, the attainment of these goals is hampered by technical, financial, and institutional barriers.

2. Objectives

The International Finance Corporation (IFC) intends to take a closer look at the barriers and opportunities for sustainable energy finance and clean technology applications in Indonesian industry and energy sectors. It has, therefore, commissioned a study that finally aims:

1. To understand, both quantitatively and qualitatively, financing barriers that impede the development of sustainable energy in Indonesia; and
2. To have a basis for making concrete decisions regarding the type of sustainable energy-related advisory work, as well as investment interventions, which IFC may undertake in Indonesia and maximize opportunities for replicability and substantially improve the access to finance.

IFC has instituted sustainable energy finance programs in Russia, China, the Philippines, and other countries, and now plans to do the same in Indonesia.

Specifically, the study will:

1. Assess attitudes of manufacturing companies that wish to improve their environmental and economic performance and identify barriers to their doing so;

2. Identify and assess the capabilities of consulting companies or individual consultants that wish to deliver Sustainable Energy and Cleaner Production (SE/CP) services to companies;
3. Assess government policies and regulations aimed at increasing awareness and promoting sustainable energy and cleaner production or which act as barriers to investment;
4. Identify international companies that wish to market and supply SE/CP equipment and technologies to Indonesia;
5. Identify international buyers (importers) requiring energy efficiency or environmental compliance from Indonesian suppliers (exporters);
6. Identify important technical, commercial, financing, institutional, and other hurdles and constraints to the implementation of SE/CP projects;
7. Identify key players in the promotion of Distributed Generation in Indonesia, in relation to both project development (developers, technical consultants, contractors, technology providers, equipment manufacturers) and financing (banks, parastatal institutions, etc.).

The study will be undertaken in two phases. The present scoping study represents Phase 1 of the study. It covers two important industries in Indonesia, which have been prioritized in consultation and agreement with IFC after evaluation of additional data and information provided by the World Bank and IFC. Phase 1 study focused on two specific areas: the barriers to adoption of technologies by selected companies and the range of modern technologies available in each sector. Phase 2 will expand the coverage of the study to additional key Indonesian industries, including possibly the power sector, focusing on distributed generation options. The final scope and sectoral coverage of Phase 2 will be discussed and agreed upon with IFC after the completion of Phase 1 study.

Both Phase 1 and Phase 2 studies will investigate barriers and opportunities to sustainable energy investments in the prioritized sectors. For the manufacturing industries, the study on sustainable energy investments is oriented towards cleaner production and clean technologies, which refer to business activities and technology applications that have the common characteristic of providing environmental (mainly through energy efficiency improvements) as well as financial (cost savings) benefits. The scoping study is focused on private sector-led sustainable energy investment opportunities and in promoting market-led outcomes.

3. Scope

The following six criteria were used in selecting the priority industries for Phase 1:

- 1.Contribution to export value added
- 2.Contribution to sectoral gross value added
- 3.Number of firms
- 4.Potential for clean technology
- 5.Data availability
- 6.Potential for getting loans from IFC for the adoption of clean technologies

The first three criteria were based on a study made by the World Bank office in Indonesia comparing the macroeconomic performance and contributions and energy intensities of Indonesian industries, with particular emphasis on the food and beverage sectors. The fourth criterion was based on prior expert knowledge of candidate industries. The fifth and sixth criteria were based on a quick pre-assessment of the candidate industries and initial discussion with key stakeholders.

After careful discussions with IFC, it was agreed that Phase 1 of the Scoping Study focus on the palm oil mill and rice mill sectors.

The palm oil mill sector easily satisfied all these criteria. The rice mill sector was not a strong candidate in terms of the first two criteria but came out very strongly in terms of the last four criteria.

The potential for the adoption of clean technologies focused on these two industrial processess. However, it was necessary to go back upstream and further downstream, that is, study the production of the basic agricultural crops processed by these industries—oil palm and rice paddy (rough rice)—as well as sale and export of the final products of the industries—crude palm oil and milled rice—to gain better understanding of the target industries.

4. Methodology

The study was conducted primarily through interviews with key stakeholders in Indonesia's energy and environment sectors, including policy makers and NGOs, and the target indusries, including key players and industry associations. The interviews were conducted during the two technical missions in which the offices in Jakarta of the identified stakeholders and plants or factories of the selected players in the palm oil and rice mill sectors were visited.

Table 1: Stakeholders interviewed and plants visited

Date	Person and designation	Organization/Company Affiliation
3 Dec 2008	Yuber Hadiyanto *Finance Director*	GAWI Plantation
3 Dec 2008	Thomas Suseno *Director*	PT. Gawi Makmur Kalimantan
5 Dec 2008	Ir Humuntar Lumban Gaol *Chairman*	Indonesian Ricemillers Association
5 Dec 2008	Henry Artono	Indonesian Ricemillers Association
12 Jan	Thomas Suseno *Director*	PT. Gawi Makmur Kalimantan
12 Jan	Yuber Hadiyanto *Finance Director*	GAWI Plantation
13 Jan	Dr Masnellyarti Hilman Deputy Minister	Ministry of Environment
13 Jan	Dr Sri Tantri Arundhati *Asst Deputy for Standardization Technology and Cleaner Production*	Ministry of Environment
13 Jan	Laksmi Dhewanthi *Asst Deputy Minister for Incentive and Environment Fund*	Ministry of Environment
13 Jan	Andriah Feby Misna	Directorate of New Renewable Energy and Energy Utilization
13 Jan	Dr Ir Ego Syahrial *Head of R&D Division for Exploration Technology*	Research and Development Agency for Energy and Mineral Resources Research and Development Centre for oil and Gas Technology
14 Jan	Ganda *President Commisioner*	PT. Ganda Enviro Energi
14 Jan	Andy Indigo *Director*	PT. Ganda Enviro Energi
14 Jan	Harino T. Kusumo *President Director*	PT. Primanusa Palma Energi
14 Jan	Charles Gouwanda	PT. Jatisari Srirejeki

Date	Person and designation	Organization/Company Affiliation
14 Jan	Dr Zaenal Soedjais *Ketua Umum*	Indonesian Fertilizer Council Oganic Farming Society of Indonesia PT. Greenland Niaga Indonesia
14 Jan	Mohamach Abdoula *Business Development Director*	PT. Vietindo Jaya
14 Jan	Mrs. Astrida Daulay *President Director*	PT. Vietindo Jaya
15 Jan	Haryanto Dinata *Plant Director*	PT. Alam Makmur Sembada
15 Jan	Suherman Dinata *President Director*	PT. Alam Makmur Sembada
15 Jan	Muljo Rahardjo *Director*	Lyman Group
16 Jan	Derom Bangun *Executive Chairman*	Indonesian Palm Oil Association
16 Jan	Dra. Rismawarni Marshal *Executive Director*	Indonesian Cleaner Production Centre
16 Jan	Adi Sulaksono *Technical Staff*	Indonesian Cleaner Production Centre
16 Jan	Dra. Titiresmi, M.Si.	Institute for Environmental Technology
16 Jan	Rolliyah	Ministry of Environment Republic of Indonesia
21 Jan	Ho Chew An *General Manager*	PT Austindo Nusantara Jaya Agri
21 Jan	Andi Esfandiari *Finance Director*	PT Austindo Nusantara Jaya Agri
23 Jan	Dr Lolo M. Panggabean *Director of RE and EE*	YBUL
23 Jan	Suroso Sastrosuwito *RE and CDM Program Manager*	YBUL
23 Jan	Novrida Masli *Climate Change Specialist*	YBUL

Structured questionnaires were sent to selected palm oil and rice mills, including those visited, prior to the interviews. Unfortunately only two questionnaires were returned for the palm oil mill sector and one incomplete questionnaire for the rice mill sector. However, the interviews confirmed the responses to the questionnaire. Both the information collected in the questionnaire and during the interviews served as basis for preparing case studies on appropriate clean technologies for the two industries.

It was also necessary to supplement the interviews with secondary research, including review of related literature and gathering of published secondary data. In fact, the financial and policy aspects of the study relied to a large extent on secondary information rather than the few interviews that could be made given the time and resources available for the study.[1] However, these secondary sources were close to primary sources as they were authored by direct stakeholders in the target sectors, as against secondary sources authored by observers or researchers. The resource and technology opportunities in the palm oil and rice mill sectors have been also explored in the literature through similar investigations

1 For instance, the sections on barries on clearn energy relied heavily on two recent studies commissioned by USAID—one including Indonesia as one of the six target Asian countries and the other focused on Indonesia alone.

in the sector, including in Indonesia and other countries, particularly Thailand and Malaysia, which are important players in the international market for crude palm oil and rice. The interviews and plant site visits confirmed the technological opportunites, as well as reveal or confirm policy and financial barriers. The resource and technology opportunities (and barriers for that matter) made several references to the experience of the consultants in the same sectors in Thailand and Malaysia.

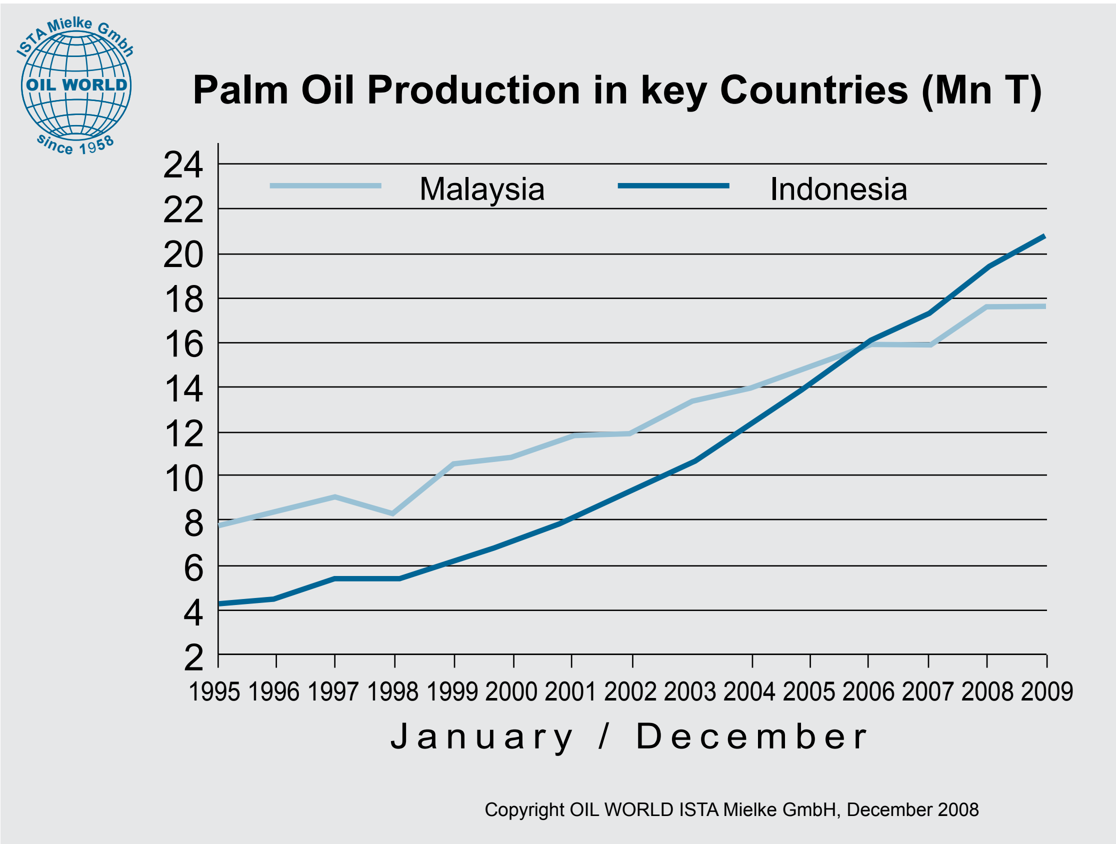
The study culminated in a Dissemination Workshop on 14 April 2009, organized by the IFC. The additional knowledge shared and recommendations made during the workshop have been incorporated in this final report.

B. The Opportunities

1. Palm oil mill industry and clean technology

1.a Industry background and market opportunities

Since 2006, Indonesia has overtaken Malaysia as the largest producer of palm oil in the world. That year Indonesia produced 16.050 million tons of crude palm oil (CPO), slightly higher than Malaysia's 15.881 million tons (Figure 1). In fact, Indonesia's CPO production has been growing much faster than Malaysia's. Between 1995 and 2006, Indonesia's CPO production was growing at 12.3% per year compared to Malaysia's 6.7%. Younger plantations and continuing land conversion to oil palm plantations have boosted Indonesian palm oil production and driven the country to this current status. The combined palm oil production of Indonesia and Malaysia accounts for 86% of world palm oil output.



As of 2004, some 320 palm oil mills (POMs) with a total processing capacity of 13,520 tons of fresh fruit bunches (FFB) per hour had been operating in Indonesia (Table 2). In 2005, there were more than 340 POMs processing 13.8 million tons of CPO.[2] Most POMs are located in North Sumatra and Riau, and a significant number are also located

2 Asian Development Bank (ADB) 2006. "Final Report on Technical Assistance for the Gas Generation from Waste," 29 September.

in South Sumatra, Aceh, Jambi, and in East and South Kalimantan. The typical capacities of POMs in Indonesia are 30, 45, 60, and 90 tons per hour (tph) of FFB per palm oil mill.

Indonesia exports between 73%and 78% of its palm oil production as crude or processed palm oil[3] and generates export revenues in excess of US$ 1 billion annually.[4] The major destinations for Indonesia CPO exports are India (48% of crude palm oil exports in 2007), the Netherlands (10%), Malaysia (5%), Germany (5%), and China (4%). On the other hand, the major destinations for processed palm oil exports are China (21% of processed palm oil exports in 2007), Pakistan (9%), India (8%), Bangladesh (7%), and Netherlands (5%).

For the long term, the Food and Agriculture Organization of the United Nations (FAO) is predicting that global production of palm oil will increase by 60% from 33.3 million tons in 2005 to around 54.2 million tons in 2030, or by about 2% per year. Indonesia is expected to remain as the top producer because of abundant supply of suitable land for oil palm and relatively cheap labor. Total CPO demand projections indicate that Indonesia's oil palm plantation base may continue to increase and reach around 15 million hectares by 2020.[5]

1.b Palm oil mill clean technology opportunities

Cleaner production measures in palm oil mills (POMs) maybe grouped into three categories:[6]

(A) Good housekeeping

(B) In-house re-use or recycling

(C) Equipment or process modification including energy efficiency improvements and energy conservation

The specific measures, including clean technologies, under each category are enumerated below:

3 In fact, processed palm oil accounts for between 55% and 60% of total palm oil exports.
4 ADB 2006.
5 BisInfocus 2006. "Prospek Perkebunan & Industri Minyak Sawit Di Indonesia 2006-2020," PT Bisinfocus Data Pratama.
6 Chavalparit, Orathai 2006. "Clean Technology for the Palm Oil Industry in Thailand," PhD Thesis, September.

Box 1: Clean technology options in Palm Oil Mills

(A) Good housekeeping

1. Process fresh fruit bunch within 24 hours after harvesting to avoid excessive production of free fatty acids by the natural enzymes present in the fruit.
2. Collect wastewater from loading ramp in order to recover oil and prevent oil contamination of land and surface water.
3. Apply good practice in solid waste handling such as solid waste separation and application of certain fractions as soil cover material or reuse/ recycling in the palm oil plantation area as soon as possible to reduce dust and bad smell in the mill area.
4. Separate fresh fruit bunch into 2 categories: ripe and unripe fruit to control optimal conditions for sterilization, since time for sterilization of ripe fruit is shorter than for unripe fruit.
5. Apply good maintenance practice.
6. Improve combustion control: Control excess air/ fuel ratio at 0.4 in burner to reduce energy (fuel) consumption. Maintain 9-12% oxygen in flue gas outlet

(B) On-site reuse/ recycling

1. Reuse fiber and shell as fuel in boiler.
2. Recycle sludge from vibrating screen to digestion tank.
3. Recycle sterilized condensate to screw press and vibrating screen to reduce hot water use and to improve the recovery of oil from wastewater.
4. Recycle hot water from vacuum tank for cleaning decanter and separator.
5. Recycle steam condensate (temp. 100oC) from kernel drying tank for reuse as boiler feed water to reduce water use and energy for heating water.
6. Recovery of biogas from palm oil mill effluent (POME) for generating steam and /or electricity and hot water, or for use as substitute for diesel as transport fuel.
7. Recycle wastewater after anaerobic treatment for irrigation in oil palm plantation area.
8. Recycle sludge from wastewater treatment plant for soil conditioning and fertilizing.
9. Mix effluent from biogas plant with shredded empty fruit branches (EFBs) and recycle as fertilizer.
10. Recycle EFBs as solid fuel or compost fertilizer.
11. Mix shredded EFBs with POME to produce biogas or compost fertilizer.
12. Mix EFBs with shell and fiber and re-use as fuel in boiler.
13. Recovery of ash from boiler and mix with wastewater for use as fertilizer.

(C) Process modification

1. Employ an automatic autoclave for optimal sterilization conditions.
2. Collect remaining unripe palm fruit to re-sterilize manually in order to reduce oil loss.
3. Install 2nd bunch stripper to enhance fruit separation from bunch stalk to reduce oil loss from EFB.
4. Install buffer tank to separate the sludge from the crude oil before flow to the settling tank to enhance oil separation, and remove sand from sludge.

Source: Chavalparit 2006; Authors

Beyond on-site reuse and recycling, POM residues can be re-used and recycled in an "industrial ecology" approach. In simplest terms, this approach would give market or commercial value to the POM residues that can be used or processed by other firms besides the POMs. For example, in Indonesia, the fibers and shells can be collected, briquetted, and sold to independent power producers (IPPs, Green IPPs) or nearby industries for use as fuel in generating electricity. The EFBs can be dried and shredded or chipped and sold for making furniture cushion. The palm oil mill could rely solely on the biogas generated from POME for its electricity requirements.

Palm oil mills are processing palm oil from fresh fruit bunches harvested from oil palm trees by first cutting the frond below the fresh fruit bunch and then cutting loose the fruit bunch. Approximately 20% of the weight of the FFBs going into the palm oil mill comes out as palm oil. The remaining 80% is biomass residue: ~20% empty fruit bunches; ~22% fiber; ~7.5% shells; decanter cake ~2%. The remaining biomass residues go out with the wastewater at ~0.45 m3/ton of FFB (depending on the water management, boiler water treatment among others).

Residues from palm oil processing could be used to produce a lot of energy. The energy content of the different residues is listed in Table 2.

Table 2: Energy Content of Palm Oil Mill Residues

Energy Supply and Demand at 45 tons of FFB/hour

Fuel supply / residue production	kWh/ton FFB	kWh/h
Fine shell energy output (LHV 4.3 kWh/kg)	8.82	397
Dry shell energy output ((LHV 4.22 kWh/kg))	35.28	1,588
Wet shell energy output (LHV 3.75 kWh/kg)	240.45	10,820
Fiber energy output (LHV 3.44 kWh/kg)	777.00	34,965
EFB energy output (LHV 1.67 kWh/kg)	250.14	11,257
Biogas fuel energy in WW	93.60	4,212
Total fuel production in kWh	**1,405**	**63,238**

Energy Demand	kWh/ton FFB	kWh/h
Steam demand for processing 3 bar 134°C	318	14,296
Electricity demand for processing	13.33	600

The figures above are from a Thai palm oil mill before they optimized the energy supply and consumption.

Naturally some of the biomass residues are used as fuel for processing of the palm oil. But even though the energy conversion efficiencies are kept extremely low it is still not possible to use all of the residues.

1.c Energy from POME

Table 3 describes a number of energy conversion options for POME.

Table 3: Overview of POME Usage Options

"Waste" product	Technology	Energy use	Residue use
POME	Mixed with EFB's		Compost fertilizer
POME			Liquid fertilizer
POME	Biogas from POME	Fuel for gas engine, Fuel for steam boiler, Fuel for mill trucks	WW used as fertilizer
POME	Biogas from POME	Fuel for gas engine, Fuel for steam boiler, Fuel for mill trucks	WW mixed with EFB's and used as fertilizer
POME + EFB	Biogas from POME mixed with EFB's	Fuel for gas engine, Fuel for steam boiler, Fuel for mill trucks	WW used as fertilizer

At full capacity, a 60-ton FFB/hour mill will generate around 27 – 30 m3/hr of wastewater (POME). Chemical oxygen demand (COD) and biological oxygen demand (BOD) will depend on the efficiency of the decanters at the mill, with the more efficient decanters yielding higher oil output and less polluted wastewater. The COD value can vary between 40,000 mg/L and 60,000 mg/L. Depending on the biogas technology, it is possible to convert from 65 to 90% of the COD to biogas. Standard figure is 65%, but when using hydrolysis and two-stage biogas plants, full scale experiments have shown COD reductions above 90%.

A 60-ton FFB/hour mill with a COD value of 40,000 mg/L will generate methane (CH_4) at 200 m3/hr from a 325 m3/hr biogas plant (biogas has a methane content of around 65%). The methane produced (200 m3/hr) corresponds to approximately 200 liters of diesel oil/hr.

The methane could be used in a gas engine for electricity generation and can produce around 800 kW of electricity. An additional 800 kW of thermal energy is available for hot water used in oil clarification, threshing and pressing. The biogas (with H_2S removed) could be injected into the air intake of existing diesel engines (dual fuel operation) and substitute a substantial amount of diesel oil used for electricity generation. During operation of the boiler, surplus gas could be used in the boiler to supply steam for electricity and processing of the palm oil.

Cleaned and compressed methane could be used to substitute diesel oil for trucks either by modifying the cylinder head of the diesel engine and turning the diesel engines into gas engines, or by injecting the methane into the air manifold of the diesel engine (dual fuel principle). It is recommended that a lubrication oil supplier be consulted to ensure that the right engine oil for the gas engines or dual fuel engines is used.

A simplified mass and energy balance with specific focus on the biogas utilization options seen from an energy point of view is presented in Figure 1.

Figure 1: Simplified Mass and Energy Balance for Scenario 1

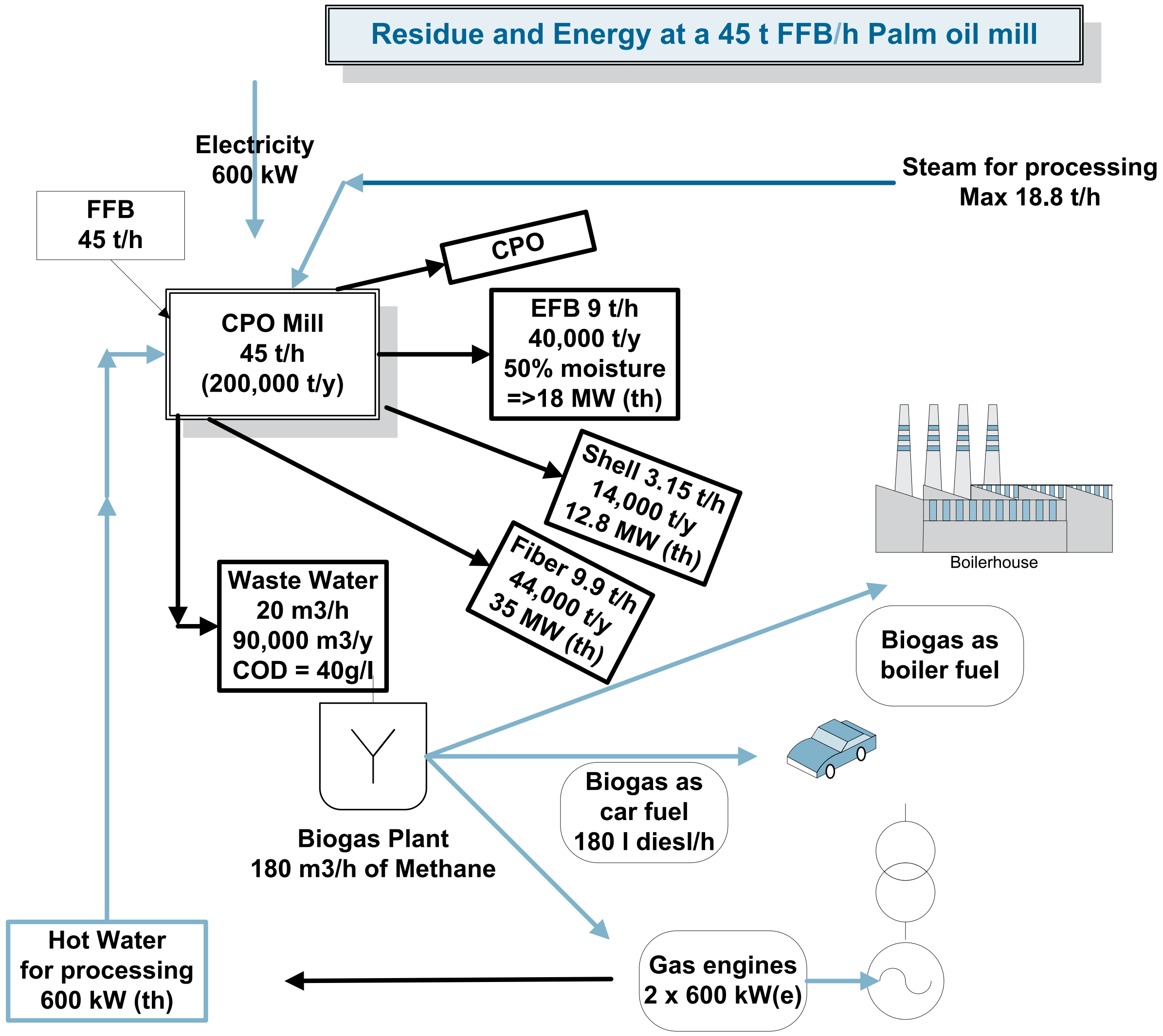


Table 4. Fertilizer comparison after and before biogas treatment (Values from Danish experience)

	Digested Manure	Cow manure	Pig Manure
Dry matter % (TS)	4.8	7.5	5.0
Total-N, kg/ton	4.4	3.9	4.0
Ammonium-N, kg/ton	3.5	2.4	2.9
Phosphorus, kg/ton	1.0	0.9	1.1
Potassium, kg/ton	2.3	3.5	2.3
pH	7.6	6.9	7.1
Ammonium share	81	61	74

From the Danish experience it is seen that the biogas plant converts dry matter to biogas, increases the expensive ammonium and nitrogen in the effluent, maintains phosphorus and slightly reduces the potassium (Table 4). It is believed that the potassium is settled in the biogas plant. The Total Solids (TS) in POME is expected to be around 3%, thus the fertilizer figures might be slightly less than seen in the table above.

It is recommended to have the POME analyzed before utilization to determine its proper dosing.

Table 5 shows the fertilizer content of POME after biogas treatment.

Table 5. Type of treated POME and their composition

	Ppm				
Type of Effluent	BOD	N	P	K	Mg
ANAEROBIC EFFLUENT					
Digested in stirred tank	1,300	900	120	1,800	300
Digested in pond/ditches/lagoon					
-supernatant	450	450	70	1,200	280
-supernatant – 10% slurry	191	320	42	1,495	258
Digested in tank – bottom slurry	1,000-3,000	3,552	1,180	2,387	1,509
AEROBIC EFFLUENT					
Aerobic pond – supernatant	100	52	12	2,300	539
– bottom slurry	1,000-3,000	2,670	461	2,378	1,004
Dried sludge cake	-	45,000	12,000	15,000	12,000

(American Palm Oil Council)

Some projects in Malaysia applying for CDM involve producing compost fertilizer by soaking shredded or chipped EFBs in POME. Some mills are soaking EFBs in POME and then spreading the soaked EFBs evenly in the plantations. This brings the fertilizer and trace elements back into the plantation, helps keep the soil moist during the dry season, and adds fiber where aerobic micro-organisms can grow and help to keep the soil healthy. But if overdone, there is a risk that the soil environment becomes anaerobic causing choking of the palm trees.

Treating POME in a biogas plant before using as fertilizer will produce about 3.3 m3 of CH4 (equivalent to ~3.3 liters of diesel oil) from each ton of FFB processed.

The feasibility of a biogas production plant and a gas engine generator system for substitution of diesel generated electricity is very high. With a diesel price of 0.57 USD/liter the FIRR on the project will be slightly above 50%. In other words the biogas plant and the gas engine investments would, after covering the operation service and maintenance costs generate a surplus big enough to pay the investment back in 2 years.

If the gas is converted to vehicle fuel the same feasibility or slightly lower feasibility can be expected. The value of the biogas for this example is the same as for the example with substitution of diesel generated electricity. The investment costs for conversion of biogas to vehicle fuel and conversion of diesel trucks to gas is expected to be higher.

None of the feasibility calculation includes the value of CER's from a CDM project. It is believed that it is easier to have a CDM project approved with the conversion of the biogas to vehicle fuel.

Biogas CER Calculation/assessment for a 45 t/h mill				
	MWh/yr	m3 CH4/yr	ton CH4/yr	CER/yr
Produced/Consumed biogas	16,178	1,617,800	1,100	23,102
Substituted el. CER	5,533			2,822
total CER/year				25,924

If the above calculation is converted into an annual income from sale of the CER's at 10 USD/CER the FIRR would be around 65 %. If a debt equity ratio of 70/30 is used, the IRR on the equity would be around 220 %. (Better than most other infrastructure projects.)

1.d Energy from Biomass Residues:

Table 6 lists some usage options for POM biomass residues.

Table 6: Overview of Biomass Residue usage options:

"Waste" product	Technology	Energy use	Residue use
EFBs	Fuel for low pressure steam boiler 4-6 bar	Produce steam for processing	Ash to be mixed with WW as Fertilizer
EFBs	Dried, chipped or shredded	Sold as fuel	Ash to be used as fertilizer
EFBs	Dried, shredded		Sold as furniture cushion
EFBs	Biogas from EFBs mixed with POME	Fuel for gas engine, Fuel for steam boiler, Fuel for mill trucks	WW used as fertilizer
EFBs			EFB's mixed with POME or Biogas WW and used as compost fertilizer
EFBs	Chipped or shredded		Used as compost fertilizer
EFBs + Shell + Fiber	Fuel for high pressure steam boiler, mixed with shell and fiber	Steam and electricity generation for processing, sale of surplus electricity	Ash to be mixed with WW as Fertilizer
Shells + Fiber	Used in existing 25 bar boiler	Produce steam and electricity for processing	Ash mixed with POME or Biogas WW fertilizer
Fiber	Used in optimized existing 25 bar boiler	Produce steam and electricity for processing	Ash mixed with POME or Biogas WW fertilizer
Shells		Sold as fuel to IPP or other markets	Ash to be used as fertilizer
Fiber		Sold as fuel to IPP or other markets	Ash to be used as fertilizer

LHV means Lower Heating Value and tells about the energy converted during combustion, with the water vapor generated by the combustion, and the water vapor in the combustion air, still being vapor.

HHV means higher heating value, where the vapor from the combustion and the combustion air has been condensed. HHV is thus LHV + energy for evaporation of the amount of water vapor found in the flue gas.

Table 7 lists the LHV of some biomass residues from POMs.

Table 7: Lower Heating Values of POM Biomass Residues

Item	Moisture%	LHV	Units	kWh/kg
Lower Heating Value Fiber	28.00	12,715	kJ/kg	3.53
Lower Heating Value shells (average)	21.60	14,657	kJ/kg	4.07
Lower Heating Value clay bath shells	22.65	14,427	kJ/kg	4.01
Lower Heating Value Dry Shells	16.03	15,876	kJ/kg	4.41
Lower Heating Value Fine shells	16.03	15,876	kJ/kg	4.41
Lower Heating Value EFB	64.00	4,503	kJ/kg	1.25
Lower Heating Value of Fresh Fronds	69.20	4,503	KJ/kg	1.25

Source: Data from Malaysia J&J, June 2005

The LHV can be calculated from the moisture content according to the formulas below:

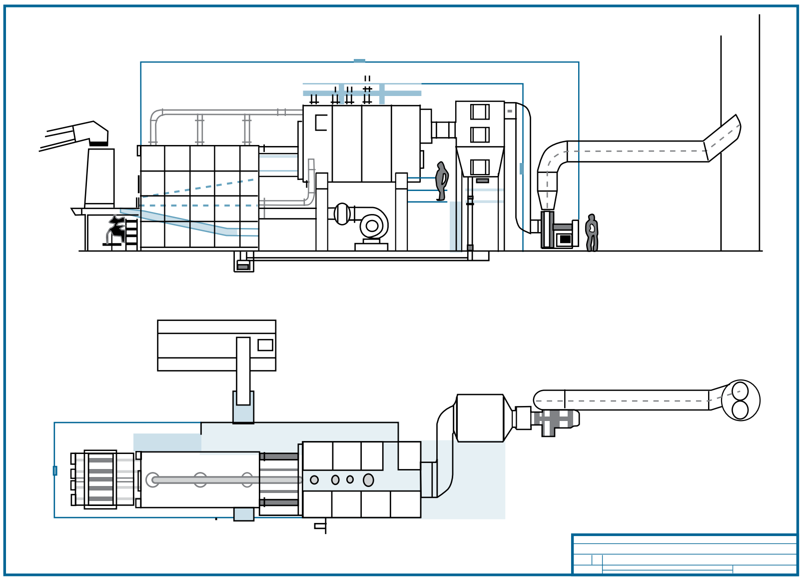
LHVfiber [kJ/kg] = 18631 [kJ/kg] – 211.3 [kJ/kg] * moisture [%]

LHVshells [kJ/kg] = 19385 [kJ/kg] – 218.9 [kJ/kg] * moisture [%]

LHVEFB [kJ/kg] = 16957 [kJ/kg] – 194.6 [kJ/kg] * moisture [%]

EFBs are often considered as the "black sheep" in the Palm Oil Industry. Many mills incinerate EFBs because it will generate clinker ash and cause fouling problems if burnt in the boiler. Combustion of biomass with high potassium content at high temperature results in the formation of clinker ash, and sticky fly ash when it is burnt at high temperature. The deformation temperature for EFB ash is actually as high as1,080°C. (Gulf).

Around 20% of the FFB input comes out as EFBs; if the EFBs are sun-dried to a moisture content of around 20%, the LHV would be ~13,000 kJ/kg (3.6 kWh/kg). Each ton of FFB would generate 200 kg of EFB fuel equivalent to ~ 726 kWh. The thermal energy needed for processing is 0.4 ton steam/ton of FFB or ~350 kWh/ton of FFB (A low pressure steam boiler with a total efficiency of 50% could generate all the steam needed for processing using the sun dried EFBs as fuel). Biogas from the POME could be used to produce all the electricity needed for processing.



Low pressure fire tube steam boiler with water cooled step grate in a pre-combustion furnace.

Combustion of biomass with up to 65 % moisture content.

Controlled combustion temperature with fully automatic combustion control (removes the risk for ash deformation, and boiler fouling).

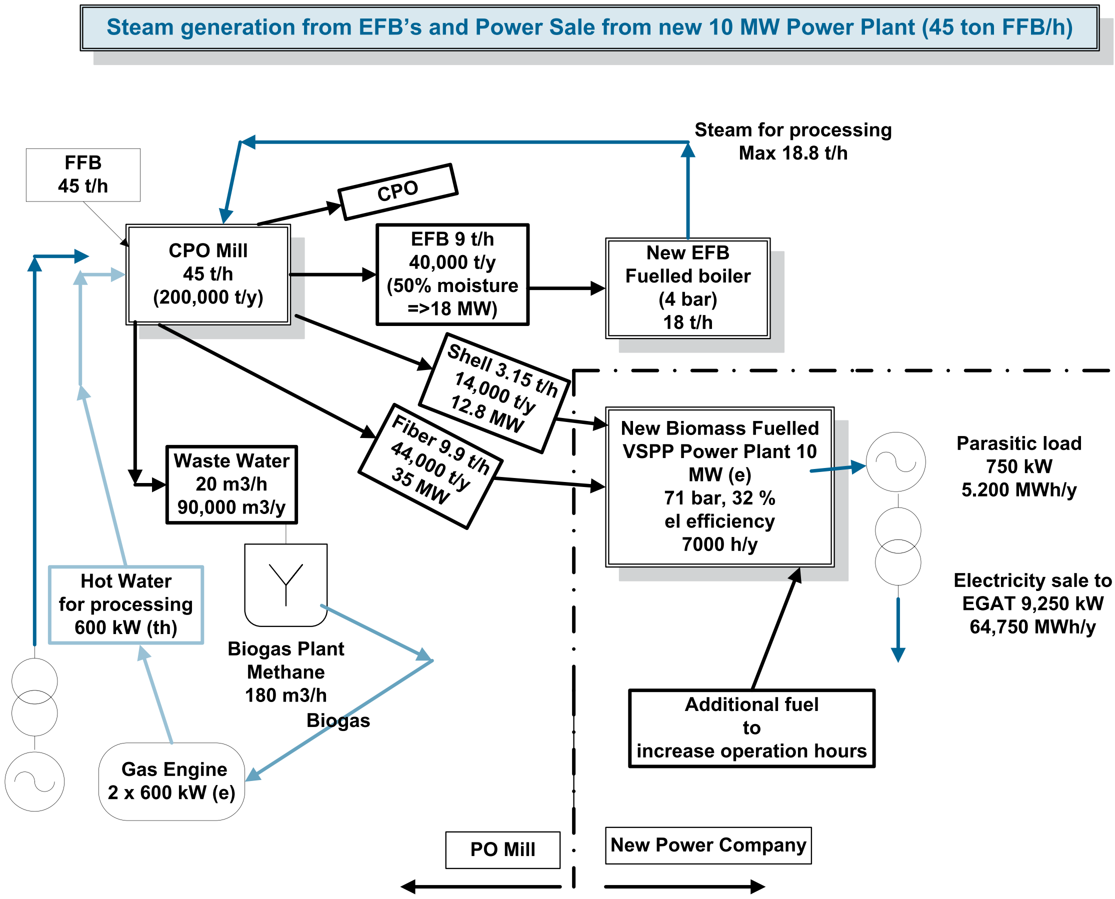
With a setup where the electricity for processing comes from biogas and the thermal energy is covered by EFBs, there would be ~220 kg fiber/ton of FFB and ~70 kg of shells/ton of FFB. A total of ~1 MWh of good quality surplus fuel per ton of FFB is available.

A 60-ton FFB/hr mill with an annual FFB input of 300,000 tons would thus have a fuel surplus of 300,000 MWh, which could generate 100,000 MWh of electricity in a high pressure (70 bar) power plant with condensing steam turbine (fuel for a 15 MW power plant).

A simplified mass and energy balance with specific focus on the utilization of excess biomass, after the energy demand for processing has been covered by biogas generated electricity and EFB generated steam, is shown below. The scenario has been chosen from an optimized energy point of view. Biogas and fertilizer considerations would be the same as in the biogas scenario described earlier.

The feasibility for the biogas part will be the same as in the previous scenario.

Figure 2. Simplified Mass and Energy Balance for Scenario 2.



No significant savings would be expected by installing a new EFB-fueled boiler for steam generation. A CDM project is possible if the EFBs were previously not utilized or dumped in an open landfill. Income from sale of CERs would be realized by turning a new EFB-fueled steam boiler into a CDM project. Using a CER generation of 0.92 CER/ton of EFB and a CER price of 10 USD/CER, the project would generate a FIRR of 8%, if the sales price of the CERs was 15 USD/CER the FIRR would be 22%.

1.e Technology suppliers

Several potential technology suppliers have been identified who could support Indonesian Palm Oil Mills with regards to the production of biogas. A summary of the technology suppliers identified, as well as their contact information (email or telephone) are provided in Table 8.

Table 8: Overview of potential technology suppliers for biogas production and utilization:

Name of supplier	Email/phone
Biomass Technology Group BV (BTG)	office@btgworld.com; consultancy@btgworld.com; knoef@btgworld.com
COGENCO	info@cogenco.com
ENER-G	chp@energ.co.uk
GE's Jenbacher Gas Engines	harry.steenhuis@ge.com
GUASCOR Group	grupoguascor@gr.guascor.com; guascorid@idguascor.com; guascor@guascor.com
Eurotech West A/S	www.eurotec.dk
	mail@eurotec.dk
Inbiogas	info@inbiogas.com
Merapi solutions (PT Niarta JasaNet)	info@merapi.co.id
MTU Onsite Energy	henry.tio@mtu-online.co.id; dun@centrin.net.id; epj@epj.co.id
PT Spektra Matrika Indah	Tel: (62-21)-7653180
Camda Generator Work CO., Ltd	power810@gmail.com
PT. Barata	info@barata.co.id; baratain@indosat.net.id;
Schmack Biogas AG	info@schmack-biogas.com; veronika.bergmaier@schmack-biogas.com
TEDOM	tedom@tedom.cz; l.nedvedicky@chp.tedom.cz; p.dolezal@chp.tedom.cz; kamat@anamaenergies.com

A number of potential suppliers for technologies allowing steam or electricity production using solid biomass (oil palm residues) have also been identified. These are presented in Table 9.

Table 9: Overview of potential technology suppliers for steam / electricity production using solid biomass waste of Palm Oil Mills:

Name of supplier	Email/phone
Aalborg Industries	E-mail: aal@aalborg-industries.com
Aalborg Sunrod Indonesia	Tel: (62-21)-4610569
ACCIONA Energía	e-mail: contact@acciona.es
Ankur (India)	ascent@ankurscientific.com; info@ankurscientific.com
Babcock & Wilcox Volund A/S	bwv@volund.dk
Bangkok Industrial Boiler	woot@vpe.co.th
Belyea	powergeneration@belyeapower.com; info@belyeapower.com
BHEL	khram@bheltry.co.in
Biomass Technology Group BV (BTG)	office@btgworld.com; consultancy@btgworld.com; knoef@btgworld.com
Industrial Power technology PTE LTD	info@ipttech.net
Cheema Boilers Limited (CBL)	info@cheemaboilers.com
COMPTE.R	info@compte-r.com
ENER-G	chp@energ.co.uk

Name of supplier	Email/phone
ENCO	enco@po.jaring.my
EPATO	mbox@erato.bg
ERATIC, S.A.	eratic@eratic.es
Euro Therm A/S	info@eurotherm.dk
Factory Sales & Engineering, Inc	salesinq@fsela.com
FireCAD Technologies	info@firecad.net
Hansa Intertech co., Ltd. (Hansa Boilers)	hit@hansa-boiler.com
Industrial Boilers Ltd.	mumbai@indboilers.com
INTEC Engineering GmbH	info@intec-energy.de
LIPI Bandung	N/A
L.Sole S.A.	info@lsole.com
Merapi solutions (PT Niarta JasaNet)	info@merapi.co.id
MTU Onsite Energy	henry.tio@mtu-online.co.id; dun@centrin.net.id; epj@epj.co.id
PT Gikoko Kogyo Indonesia	gikoko@gikoko.co.id; gikoko@aol.com
PT PAL/ABB	Tel. : (62-031)-3292275
PT. Barata	info@barata.co.id
PT. Boma Bisma Indra (different from above??)	info@sasbbi.com
PT. Indonesia Power	Phone: 62-21-5267666
Schmid	pas@holzfeuerung.ch Mail: pf@holzfeuerung.ch
Stork Indonesia	storkjkt@cbn.net.id
Thermax (India)	ngupta@truemail.co.th; pramodh@thermaxindonesia.co.id
Vickers Hoskins (M) Sdn Bhd	vhm@vhmblr.po.my
Vulcano Sadeca S.A.	sadeca@vulcanosadeca.es
Wärtsilä	Tel. +62 21 893 7654 Tel. +62 21 5793 0515

In addition, other suppliers have been identified who could provide technologies for the treatment of the biomass waste before their utilization for combustion. These suppliers are briefly described in Table 10.

Table 10: Overview of technology suppliers for treatment of biomass waste

Name of supplier	Email/phone
Babcock & Wilcox Volund A/S	bwv@volund.dk
Biomass Technology Group BV (BTG)	office@btgworld.com; consultancy@btgworld.com; knoef@btgworld.com
Diavach Ltd	office@diavach-bg.com
EPATO	mbox@erato.bg
Euro Therm A/S	info@eurotherm.dk
Factory Sales & Engineering, Inc	salesinq@fsela.com
Henan Jingxin Machinery Co,Ltd	shwpcd@263.net; hn@shwpcd.com
L.Sole S.A.	info@lsole.com
Merapi solutions (PT Niarta JasaNet)	info@merapi.co.id

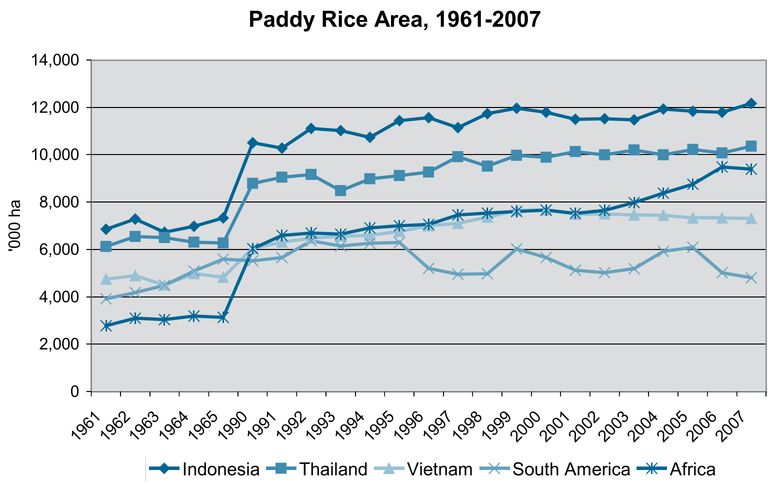
2. Rice mill industry and clean technology

2.a Industry background and market opportunities

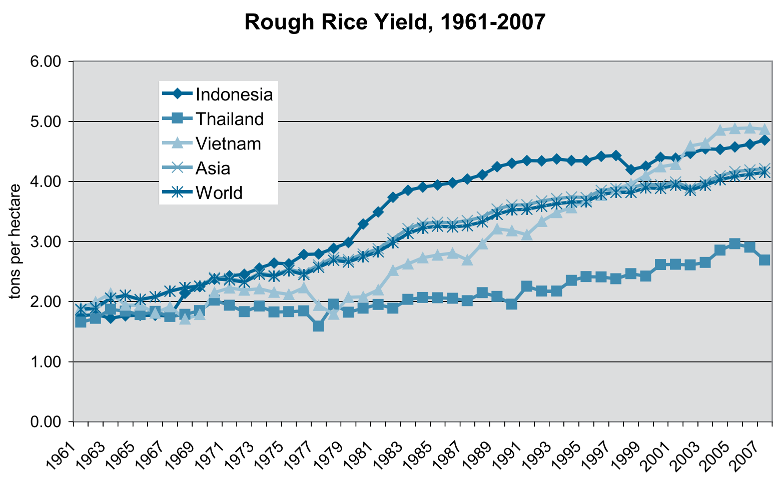
Indonesia is one of the world's leading rice producers with paddy production in 2007 of more than 57 million tons, which was about 9% of the world total. According to official statistics, paddy rice production was expected to reach close to 60 million tons in 2008. The provinces in the major island of Java, particularly West Java, Central Java, and East Java, accounted for 54% of paddy production in 2008. It was followed by Sumatra (23%) and Sulawesi (11%).

Indonesia has also exhibited one of the highest growths in paddy rice production at 3.43% per year from 1961-2007, as against the world average of 2.43%. This can be attributed to a large and growing area dedicated to rice production and at the same time increasing yield in tons per hectare. Except as against China and India, Indonesia has the largest paddy rice area in Asia; which has grown from under seven million hectares in 1961 to more than 12 million hectares in 2007. It could expand further and become even larger than the combined paddy rice areas of South America and Africa. The expansion in paddy rice area has been accompanied by an even higher growth in rice yield that is in fact even higher than world and Asia's average. From below world and Asia's average in 1961, Indonesia's rice yield has grown to 4.69 tons per hectare compared to the world average of 4.15 tons per hectare and Asia's average of 4.21 tons per hectare. Indonesia's rice yield has been higher than those of Thailand and Vietnam, the top two rice exporting countries. Both trends—growth in paddy rice area and rice yield—are expected to continue in the future.

Source: FAO Statistics Division 2008 in IRRI, http://beta/irri.org/statistics



Source: FAO Statistics Division 2008 in IRRI, http://beta/irri.org/statistics



Source: FAO in IRRI, http://beta/irri.org/statistics

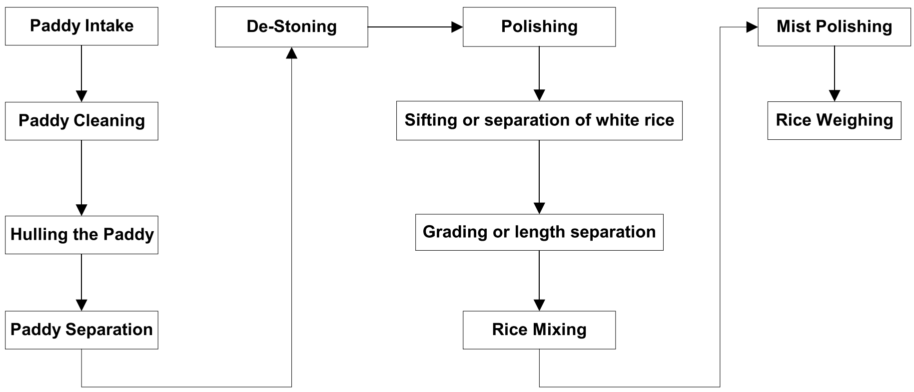
The rice export market has been dominated by Thailand and Vietnam, particularly since the late 1980s, when the two countries have been cornering more than half of the export market. Thailand's rice exports, however, has been slowing down, and its share has been eaten by other rice exporters.

Only less than 5% of paddy rice produced worldwide is exported as milled rice. However, this share has grown from less than 3% in the last two decades and is expected to grow further, as growth in exports continue to exceed that of production.

Indonesia is actually one of the largest rice importers because of huge domestic demand. However, with rice production growing and almost equalling that of Thailand and Vietnam combined, larger area being dedicated to rice than most exporting countries, and rice yield increasing and higher than world and regional averages, Indonesia could very well enjoy huge rice surplus and thus enter the growing export market. Price is also another incentive. Although the short-term shows a decreasing trend, rice export price is expected to increase in the long-term.

2.b Rice mill clean technology opportunities

After threshing and drying, milling is a crucial post-harvest activity in the production of rice. The basic objective of rice milling is to remove the least amount of husks/hulls and bran layers, and produce an edible, white rice kernel that is sufficiently milled and free of impurities.



Source: International Rice Research Institute (IRRI)

For rice milling, the main environmental issues are as follows:

- Water used for soaking the paddy, especially for parboiled rice production, if not properly treated could result in water pollution and odor nuisance to local community
- Effluent produced during cleaning of equipment may cause water pollution through insufficient treatment of effluent
- Air pollution both on site and in the surrounding locality may result from release of dust to the atmosphere from handling or processing of the paddy or its by-products (in fact, this is a major environmental concern for rice mills)
- High internal and external noise levels that may generate health hazard to employees and nuisance to the local community
- Disposal of solid wastes, particularly unused rice husk and bran, as well as other wastes generated from the cleaning process
- Raw materials and by-products may be subject to pest infestation and contamination (Birds contaminated with avian flu can leave their droppings in the rice mill)

- Pollution risks to water and soil from spillage and leakage of fuels that maybe stored on site
- High risks of fire

To address and mitigate the above-mentioned environmental concerns, the following cleaner production measures are particularly relevant for rice mills:

- Good and adequately maintained drainage to facilitate run-off and minimize the likelihood of flooding
- Regular inspection of bulk storage tanks to minimize the risk of surface water pollution
- Installation of interceptor traps for solids, oil and fuel to reduce the control release of contaminated water via the surface drains
- Separation of milling areas from all other areas of operation
- Water proofing of mill floor and all other floors
- Walls are designed to prevent accumulation of dust and entry of rodents, birds, or pests
- Adequate ventilation to prevent dust pollution and reduce heat
- Prevention of build up of dusts on machinery and ledges, and in the building
- Design of chimney and vents of sufficient height and appropriate technology to avoid causing local nuisance of dust and smoke emissions
- Measures to control noise levels at the site boundary
- For parboiling mills, locating the steam-generating units away from storage and immediate work areas
- Locating the soaking tanks close to the drying area
- Locating the steaming tanks close to the soaking tanks and using non-corrosive metal
- Insulating the steam conduit pipes and making sure they are free from leaks
- Treatment of effluents and wastewater
- Re-use of rice husk as fuel for paddy drying, steam generator, or gasifier
- Sale of rice husk or high crystalline silica produced from controlled burning of rice husk
- Use of more efficient variable-speed drive motors for controlling combustion of rice husk

2.c Rice mill residue usage options

Around 20% of the paddy is husk; rice husk in turn contains 16 to 22% ash, and 90-96% of the ash is composed of silica (silicon dioxide, $SiO2$). Rice husk has traditionally been used as an ingredient in ruminant and poultry feeds worldwide. In the modern rice milling industry today, rice husk is commonly used as fuel source for grain drying and parboiling. The husk is burned in a simple steam boiler where the steam is then used for drying of paddy, or the hot flue gas from combustion of rice husk is used to heat up air used for paddy drying. The energy content, in terms of Lower Heating Value (LHV), of rice husk is around 14,204 kJ/kg which is equal to 3.95 kWh/kg. The moisture content is normally <10%.

Most of the rice milled in Indonesia today is milled at small rice mills scattered all over the country for the country's own consumption. The husk is sometimes used as food for chickens together with broken rice. Sometimes the husk is collected and burned, with the ash used for cleaning utensils. Broken rice is used for animal fodder.

Incomplete combustion of rice husk generates ash with very high carbon content. This can be briquetted and used as fuel for cooking in biomass stoves.

Rice that is to be sold for export or to be sold under specific brand names must meet certain criteria for moisture, protein content, variety of rice, amount of broken rice and other requirements. This kind of rice is produced on large rice mills. Large rice mills try to keep the mill in operation as many hours as possible during the year, even during the rainy season. Rice delivered during the rainy season must be dried according to the quality criteria. Large rice mills use the rice husk as fuel for paddy drying. The rice husk is burned in a furnace and the hot flue gas is used to heat up the air used for paddy drying.

Ash from these paddy drying furnaces should be analyzed for carbon and silica content. If the carbon content is high, the ash could be converted into charcoal briquettes used as fuel for cooking.

Table 11 gives the various potential uses of rice mill residues.

Table 11: Rice Mill Residue Usage Options

RESIDUE	TECHNOLOGY	ENERGY USE	RESIDUE USE
Rice husk	Fuel for paddy drying	Hot air for paddy drying	Mix in cement kiln
Rice husk	Fuel for high pressure steam generation	Cogeneration: steam for paddy drying, for parboiling of rice noodles, electricity for milling and other processing	Mixing with cement/sale as high crystalline silica
Rice husk	Fuel for high pressure steam generation	Condensing steam turbine, electricity generation for sale to public grid	Mixing with cement/sale as high crystalline silica
Rice husk	High temperature combustion > 850 Deg C	Heat recycling for paddy drying/no heat use	Sale as very high quality crystalline Silica
Rice husk	Fuel for gasifier	Cogeneration: Hot water for paddy drying, electricity for milling and grid sale	Charcoal part might be briquetted
High Carbon Ash	Briquetted	Cooking fuel	Cleaning utensils
Rice husk	Briquetted	Sold as fuel	
Rice husk	Bulk	Sold as fuel	

Rice husk as biomass fuel

Rice husk is the only rice mill residue that is considered relevant when it comes to renewable energy. It is estimated that 175 MWe could be generated from rice husk, which is equivalent to 15% of the total electricity that could be generated from biomass wastes in Indonesia. As can be expected, the bulk of this capacity would come from Java. Significant additional capacities could come from Sumatra, Sulawesi, and Kalimantan.

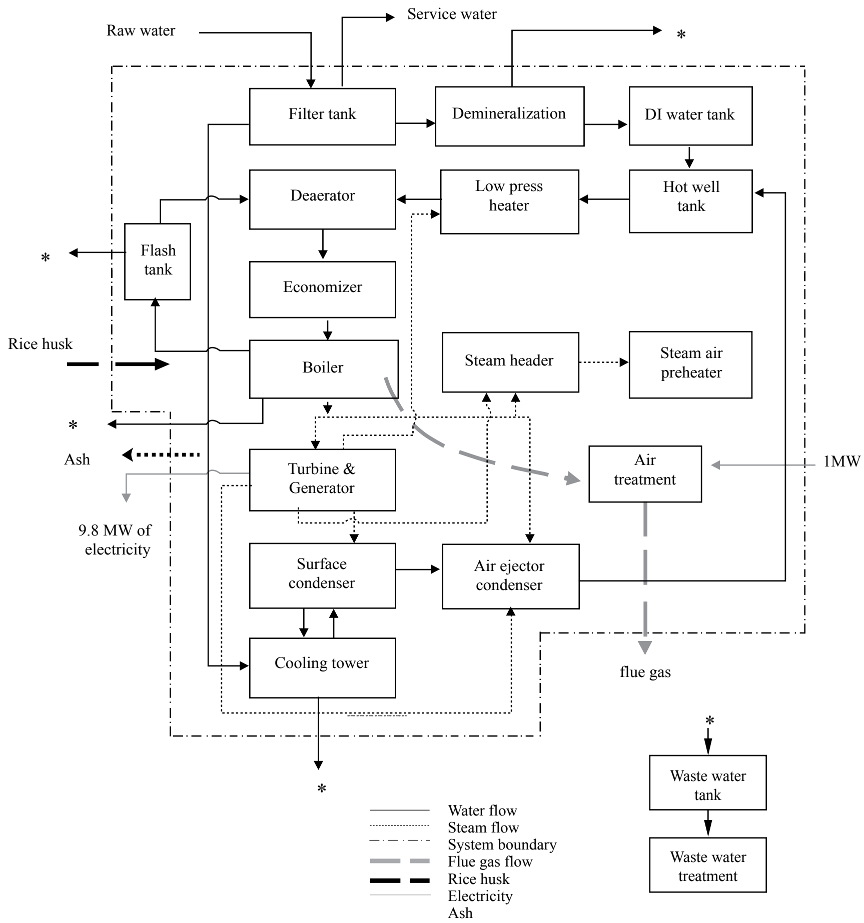
Box 2: Rice husk in Thailand

In Thailand, the husk is commonly used as fuel for power generation and as fuel in cement kilns. When used in cement kilns the crystalline silica helps to improve the quality of the cement.

One of the biggest alcohol producers in Southeast Asia, Thai Alcohol is using rice husk and biogas as fuel for processing of the alcohol. The plant is not connected to the public grid. In 2005, the plant was paying USD50 per ton of rice husk.

On the central plain of Thailand, North and North-East of Bangkok, a number of rice husk-fired power plants have emerged during the last 10 years. Due to the energy policy and electricity payment schemes, most of the plants are just below 10 MW. Most of the power plants are equipped with a bagging unit for bagging and exporting white ash; this business generates almost as much money as the electricity sale.

These power plants use 40 bar water tube steam boilers and 8-10 MW steam turbines with possibility to extract steam for paddy drying. The electrical efficiency (fuel to electricity) is around 18%.



Silica from rice husk

A by-product from rice mills where the rice husk is used as fuel for drying is the ash. This ash contains a high degree of silica which has many different uses and can be sold to increase the income in the local community.

There is a growing demand for fine amorphous silica[7] in the production of special cement and concrete mixes; high performance concrete; and high strength, low permeability concrete for use in bridges, marine environments, nuclear power plants, etc. This market is currently filled by silica fumes or micro-silica imported from Norway, China and Burma. Due to limited supply of silica fumes in India and the high demand, the price of silica fume has risen to as much as USD500 per ton in India.

Rice husk as building materials

Low carbon, white husk ash suitable for use in manufacturing building materials, more particularly refractory building materials, are prepared by first removing volatile constituents by heating the husks to a relatively low temperature below the ignition point of the husks. Rice husks are usually used but wheat, oats or barley husks can also be used. Fixed

7 Rice husk is burned in controlled temperatures below 700°C. The ash generated is amorphous in nature. The transformation of this amorphous state to crystalline state takes place when the ash is exposed to high temperatures above 850°C.

carbon is then oxidized in the presence of a reagent by heating the husks to a second temperature above the separation temperature but below the crystallization temperature of the SiO_2 in the husks. This is followed by heat treatment at a third temperature above the crystallization temperature of the SiO_2 to produce a uniform SiO_2 crystal structure.

Rice husk briquettes

Rice husk is a rather bulky material, but also a good fuel with a Lower Heating Value of almost 4 kWh/kg. Storage and handling could be made easier if the rice husk is briquetted. Briquetted rice husk could be used to substitute kerosene for cooking. The price of kerosene in Indonesia is around Rp2,500 per liter (USD0.23 /liter). Assuming a LHV of kerosene of around 8 kWh/liter, the price of briquetted rice husk should be around Rp1,250 per 8 kWh (Rp625 /kg) or USD0.06 /kg to compete with kerosene.

2.d Technology suppliers

Potential technology suppliers for conversion of rice husk to energy were identified. The companies identified are presented in Table 12.

Table 12: Overview of Potential Technology Suppliers for Rice Husk Preparation Prior to its Utilization for Energy Purposes

Name of Supplier	Email/Phone
Babcock & Wilcox Volund A/S	bwv@volund.dk
Biomass Technology Group BV (BTG)	office@btgworld.com; consultancy@btgworld.com; knoef@btgworld.com
Diavach Ltd	office@diavach-bg.com
EPATO	mbox@erato.bg
Euro Therm A/S	info@eurotherm.dk
Factory Sales & Engineering, Inc	salesinq@fsela.com
Henan Jingxin Machinery Co,Ltd	shwpcd@263.net; hn@shwpcd.com
L.Sole S.A.	info@lsole.com
Merapi solutions (PT Niarta JasaNet)	info@merapi.co.id
Industrial Power technology PTE LTD	info@ipttech.net
PT. Super Andalas Steel	Tel: 061-523.049

The treated rice husk can be used for electricity or steam generation using boilers and furnaces. Potential suppliers of boilers and furnaces are listed in Table 13.

Table 13: Potential Suppliers of Boilers and Furnaces

Name of Supplier	Email/Phone
Aalborg Industries	aal@aalborg-industries.com
Aalborg Sunrod Indonesia	Tel: (62-21)-4610569
ACCIONA Energía	contact@acciona.es
Ankur (India)	ascent@ankurscientific.com; info@ankurscientific.com
Babcock & Wilcox Volund A/S	bwv@volund.dk
Bangkok Industrial Boiler	woot@vpe.co.th
Belyea	powergeneration@belyeapower.com; info@belyeapower.com
BHEL	khram@bheltry.co.in
Biomass Technology Group BV (BTG)	office@btgworld.com; consultancy@btgworld.com; knoef@btgworld.com

Name of Supplier	Email/Phone
Camda Generator Work Co., LTD.	sf@china-kangda.com
Cheema Boilers Limited (CBL)	info@cheemaboilers.com
COMPTE.R	info@compte-r.com
ENER-G	chp@energ.co.uk
ENCO	enco@po.jaring.my
EPATO	mbox@erato.bg
ERATIC, S.A.	eratic@eratic.es
Euro Therm A/S	info@eurotherm.dk
Factory Sales & Engineering, Inc	salesinq@fsela.com
FireCAD Technologies	info@firecad.net
GE's Jenbacher Gas Engines	extranetaccount@ps.ge.com
GUASCOR Group	grupoguascor@gr.guascor.com
Hansa Intertech co., Ltd. (Hansa Boilers)	hit@hansa-boiler.com
Industrial Power technology PTE LTD	info@ipttech.net
Industrial Boilers Ltd.	mumbai@indboilers.com
INTEC Engineering GmbH	info@intec-energy.de
KALTIMEX ENERGY	kaltimex@kaltimex.co.id
LIPI Bandung	N/A
L.Sole S.A.	info@lsole.com
Merapi solutions (PT Niarta JasaNet)	info@merapi.co.id
MTU Onsite Energy	henry.tio@mtu-online.co.id; dun@centrin.net.id; epj@epj.co.id
PT. Barata	info@barata.co.id
PT. Gikoko Kogyo Indonesia	gikoko@gikoko.co.id; gikoko@aol.com
PT. IMECO INTER SARANA	imeco@imeco.co.id; powersup@imeco.co.id
PT. Indonesia Power	Phone: 62-21-5267666
PT. NARAMA MANDIRI	naramamandiri@cbn.net.id
PT PAL/ABB	Tel. : (62-031)-3292275
PT. SUMBERDAYA SEWATAMA	sales.jakarta@sewatama.com
PT. Super Andalas Steel	Tel: 061-523.049
Schmid	pas@holzfeuerung.ch; pf@holzfeuerung.ch
Stork Indonesia	storkjkt@cbn.net.id
Thermax (India)	ngupta@truemail.co.th; pramodh@thermaxindonesia.co.id
Vickers Hoskins (M) Sdn Bhd	vhm@vhmblr.po.my
Vulcano Sadeca S.A.	sadeca@vulcanosadeca.es
Wärtsilä	Tel.1: +62 21 893 7654 Tel.2: +62 21 5793 0515

For smaller mills, the rice husk can be fed into a gasification process. Potential suppliers have also been identified for this type of technology, presented in Table 14.

Table 14 Potential Suppliers of Gasifiers

Name of Supplier	Email/Phone
Ankur (India)	ascent@ankurscientific.com; info@ankurscientific.com
Babcock & Wilcox Volund A/S	bwv@volund.dk
Biomass Technology Group BV (BTG)	office@btgworld.com; consultancy@btgworld.com; knoef@btgworld.com
ENER-G	chp@energ.co.uk; chris.hayton@energ.co.uk
ENCO	enco@po.jaring.my
ERATIC, S.A.	eratic@eratic.es
GUASCOR Group	grupoguascor@gr.guascor.com; guascorid@idguascor.com; guascor@guascor.com
PT. Boma Bisma Indra	info@sasbbi.com
PT IMSF	Tel: (62-21)-4604047, 4892450, 4893960
SATAKE INTERNATIONAL BANGKOK CO., LTD	taruih@gmail.com
Thermax (India)	ngupta@truemail.co.th; pramodh@thermaxindonesia.co.id; pghelani@thermaxindia.com

3. Policy and Institutions

The development and utilization or application of clean technologies in Indonesia has been driven by environment and energy policy frameworks.

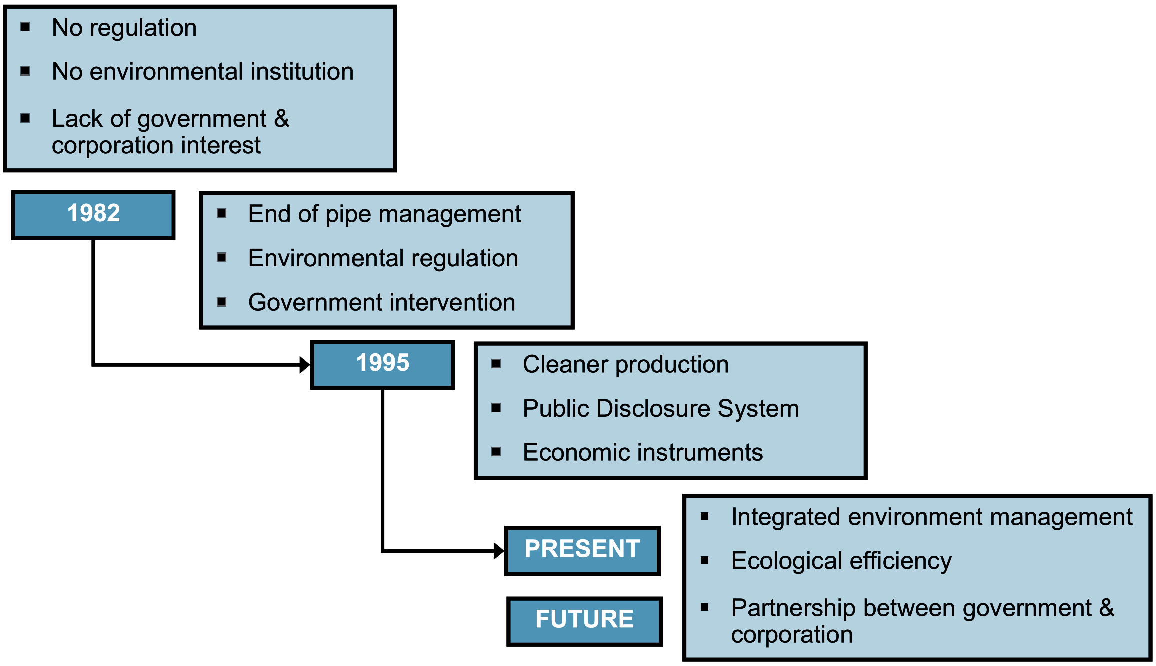
3.a Cleaner Production

The industrial sector has been responsible for a "significant percentage" of all environmental damage and pollution in Indonesia. Like most countries, the policy frameworks in Indonesia to address these environmental problems have shifted from the end-of-pipe approach and strong government intervention to cleaner production and market-based actions.The first measures by the government of Indonesia to address pollution problems in the 1980s were through the introduction of regulations and control. While this command and control approach had been successful in raising awareness on environmental management issues, it resulted in a perception that environmental management meant high costs for both capital investments and operations & maintenance (cost centre). Hence, these mandatory measures did not succeed particularly well in responding to the environmental problems.

For this reason, in the mid 1990s, the Ministry of Environment (KLH) started to apply mixed policies and instruments which integrate between the mandatory approach, partnerships and voluntary programs, and market-based & economic instruments. In particular in 1995, the Government of Indonesia announced a National Commitment on the Implementation of Cleaner Production. "This stated that the Government of Indonesia is committed to implementing Cleaner Production as the most effective means of protecting our environment and promoting sustainable development in Indonesia."[8] The positive response to this paradigm shift came towards the end of 1990s when several industries became aware of the savings that could be achieved through cleaner production measures, both in terms of reduced waste management costs and in terms of decreased need for raw materials and other inputs.

8 BAPEDAL 1998. "Cleaner Production Action Plans," p. 6.

Figure 3: The evolution of environment policy in Indonesia—shifting from end-of-pipe to cleaner production



Source: Adapted from Dhewanthi (2007) and Roosita (2004).

The Indonesia Cleaner Production Center defines Cleaner Production (CP) as "the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase eco-efficiency and reduce the risks for human and the environment."

Cleaner Production has been a conceptual bridge connecting industrialization and sustainability.[9] Cleaner production has allowed industrial production to find a place in the vision of sustainability "by recasting negative images of polluting industrial processes into positive images of technologies that are materials-conserving, energy-efficient, non-polluting and low-waste, and that produce ecologically friendly products which are responsibly managed throughout their lifecycle."[10]

One concrete output of the national Cleaner Production policy was the establishment of Indonesia Cleaner Production Center (ICPC) in 2003, under the auspices of the Ministry of Environment. Both ICPC and the Ministry of Environment have been involved in the promotion of and capacity building for Cleaner Production.

The Indonesia Cleaner Production Center (ICPC) will include such services as:

- Collect information concerning CP (policies, implementation, progress status, industries that have already applied CP measures etc.) so that it functions as an information center for domestic consumers as well as for foreign investors in order to further the transfer of clean technology.
- Become the axis between industries interested in applying CP measures and stakeholders for CP analysis in order to decrease the dependency on foreign experts.
- Act as a forum for stakeholders to exchange information and policies

9 Geiser, Ken 2001. ""Cleaner Production perspectives 2: integrating CP into sustainability strategies," UNEP Industry and Environment, January-June, p. 33.
10 Ibid.

- Promote the application of CP throughout all industrial sectors and thus, through the use of the forum, facilitate the dialog between the different interested parties (government, industry, academics, NGOs etc.);
- Provide incentives for industries to apply CP concept and establish benchmarking
- Propose pilot projects[11]
- Catalyse institutional growth

The Ministry of Environment itself has directly conducted CP-related activities, including:

- Promotion of CP through the conduction of seminar and the production of training material, brochures and a website.
- Advise on the application of CP measures for the textile, leather, palm oil, electroplating, rubber, tapioka, sugar industries and the development of hotel and urban communities.
- Compose technical guideline for the implementation of Chemical Management and Good Housekeeping
- Establishing a pilot project implementing CP in the textile industry, palm oil and small environmental industries.
- Consulting and technological guidance for more than 500 industries, such as: automobile, agricultural, electroplating, textile, sugar industries.
- Practise of CP, Good-Housekeeping, Chemical Management and Life Cycle Analysis
- Participation in international forums, e.g. UNEP High Level Seminar for CP; Pollution Prevention Roundtable, USA; Asia Pacific Roundtable for CP (APRCP); Asia Productivity Organization (APO), Eco-Industrial Estate Asia (EIEAsia), etc.

Other ministries and line agencies have been involved in CP. These include Ministry of Agriculture, Ministry of Tourism, Ministry of Transportation, Ministry of Trade and Industry, and of course the Ministry of Energy and Mineral Resources.

The current basis for government intervention in clean and environment technology is Act 23/1997 by which "government shall develop and implement type of instruments (preemptive, preventive, and proactive) to enhance environment management in Indonesia." The Ministry of Environment (MOE) is naturally the main agency spearheading this government mandate.

MOE implements the following incentive schemes to encourage industries to adopt "cleaner"[12] technologies:

- Soft Loan Programs
- Import Duty Exemption Program
- Debt-for-Nature Swap
- GEF (multilateral fund)
- ODS Phase-out Trust Fund
- Subsidy/grant for composting program
- Special Allocated Fund for Environmental Management by Local Government

The Environmental Soft Loan Program (ESL)

The Environmental Soft Loan (ESL) Programme may be called as the "flagship program" of the Ministry of Environment in supporting investments in clean and environment technologies. It was in fact an offshoot of the Cleaner Production policy.

11 The palm oil industry was among the priority industries targeted for implementing cleaner production. In fact, a pilot study had been conducted for the industry. In this pilot project, liquid and solid wastes from two palm oil mills were recycled to produce organic fertilizer.

12 The Ministry of Environment prefers to use "cleaner" over "clean" technologies.

The ESL Programme includes four credit schemes supporting environmental investments:

- Pollution Abatement Equipment (PAE) supported by JBIC
- Industrial Efficiency and Pollution Control (IEPC1) by KfW
- Industrial Efficiency and Pollution Control Phase 2 (IEPC2) by KfW
- Debt for Nature Swap (DNS)

The JBIC-PAE started in 1992 with an offer from the government of Japan of a soft loan to assist industries primarily in managing their pollution loads (through end-of-pipe technologies). Following the success of the PAE loan scheme, a similar lending program was provided in 1997 by a grant amounting to IDR53 billion from the government of Germany through its financial aid agency, KfW. The Industrial Efficiency and Pollution Control (IEPC) soft loan program "promotes and speeds up the process of changing environmental management processes towards the principles of pollution prevention particularly in SMEs."[13] Both original PAE and IEPC funds have been fully exhausted but the programs continue to use the repayments as revolving fund. During this period, there was also a shift in the technologies supported by these schemes, from end-of-pipe to cleaner production. Clean technologies accounted for 89% of investment under JBIC-PAE and 86% under KfW-IEPC1. In 2005, the government of Indonesia received a EUR9 million grant from KfW to start the Phase 2 of IEPC.

The Debt-for-Nature Swap scheme provides financial assistance particularly to micro and small enterprises that have marginal or outreach financial access to banks in order to invest in environmentally friendly technologies.

The ESL Programme does not target particular industries but each scheme targets specific types of enterprises in terms of scale, as shown below. The various schemes can also finance any of the following investments:

- Pollution prevention equipment, including:
  - Cleaner production equipment, energy efficiency and changing technology
  - Non-ozone depleting substances (ODS) equipment
- Recycling industries, referring to all equipment to save natural resources and reduce wastes
- End of Pipe technologies, including:
  - Wastewater treatment plants
  - Air pollution control equipment
  - Solid waste treatment plants
- Environment analysis equipment, including
  - Emission analysis equipment for auto repairs
  - Laboratory equipment
- Raw and additive materials or substitution of bleaching agent
- Environmental certification (e.g. ISO14000 series)
- Consulting services

The Program for Pollution Control, Evaluation, and Rating (PROPER)

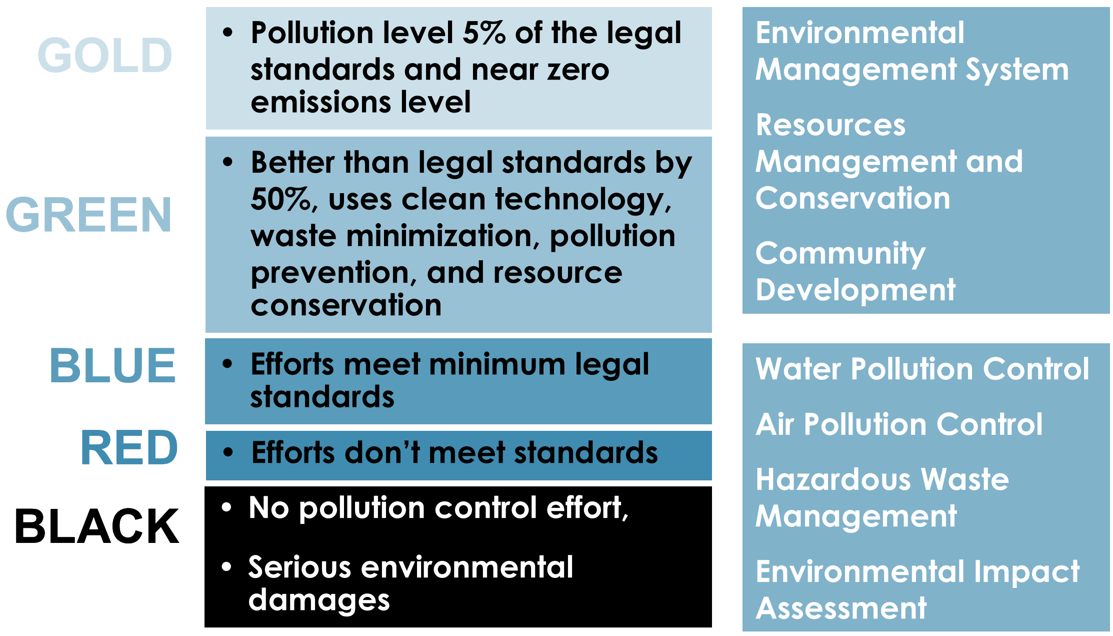
Indonesia is a pioneer country in applying information disclosure[14] for the environmental management of industries. The Program for Pollution Control, Evaluation, and Rating, better known as PROPER, is based on public disclosure of facilities' environmental performance and is "the first major public disclosure program in the developing world."[15] The program was launched in June 1995 and targeted major industrial water polluters. The program controled, assessed and classified or graded the pollution levels of industrial factories or plants using a five-color scale. "Black" plants were the ones without efforts for pollution control, which therefore cause serious damage to the environment. "Red" was for enterprises that implement some pollution control activities but did not achieve the standards and had insufficient

13 Dhewanthi 2007.
14 "Information disclosure is of special interest because it is both a pre-requisite for other instruments and an instrument in its own right." (Lopez, Sterner and Afsah 2004, p. 4)
15 Lopez, Sterner and Afsah 2004.

reporting. The enterprises meeting the national standards and had reasonably frequent reporting would be ranked "Blue". "Green" was intended for the "proactive" companies and was awarded if pollution was significantly below legally required standards and the firm conducted good equipment maintenance, reporting, and environmental work. "Gold" or "Yellow" would reward firms that meet international standards of environmental excellence, which in addition to the Green requirements implied the use of clean production technology, waste minimization, and pollution prevention activities.

PROPER was stopped by the financial crisis in 1998 but is now being revived and on a larger scale than before. One study finds that "there was indeed a strong, positive response to the scheme, in particular among firms with poor environmental compliance records; these firms cut their emissions intensity by approximately a third. The response was immediate, and firms pursued further reductions in the following months."[16]

Figure 4: PROPER—Environmental performance rating for industries



Source: Adapted from various sources.

3.b Clean Energy

The Ministry of Energy and Mineral Resources (MEMR) issued the "Green Energy Policy" in December 2003 to encourage the development and utilization of renewable energy and to improve efficiency of energy utilization This policy provides the reference for renewable energy development and energy conservation in Indonesia.

Under the Green Energy Policy, renewable energy in Indonesia has been classified into three types: (i) already developed commercially (biomass, geothermal, and hydro energy); (ii) already developed but still limited in use (solar, wind); and (iii) still at the research stage (ocean energy). The Green Energy Policy defines action steps consisting of formulation of more specific policies and programs, including policies for: (i) investment and funding; (ii) incentives; (iii) energy pricing; (iv) human resources; (v) information dissemination; (vi) standardization and certification; (vii) research and development; and (viii) institutional development.

16 Lopez, Sterner and Afsah 2004, p. 3.

Following the Green Energy Policy, the Blueprint on Energy was published by MEMR and set forth roadmaps for energy development (solar, geothermal, and nuclear) and a number of programs such as phasing out subsidies in the energy sector, introduction of new incentives, and introduction of a carbon tax. It has become the basis for several laws enacted for the energy sector, including the National Energy Policy Law of 2006.

The President issued Presidential Regulation (Perpres) No. 5/2006 on National Energy Policy (Kebijakan Energi Nasional or KEN) to set national targets for the optimal energy mix in 2025, i.e.: (i) less than 20 percent from oil; (ii) more than 30 percent from gas; (iii) more than 33 percent from coal; (iv) more than 5 percent from biofuels; (v) more than 5 percent from geothermal; (vi) more than 5 percent from other renewable sources, especially biomass, micro-hydro, solar and wind; and (vii) more than 2 percent from liquefied coal. In addition, a national target was established to reduce energy elasticity to less than 1.

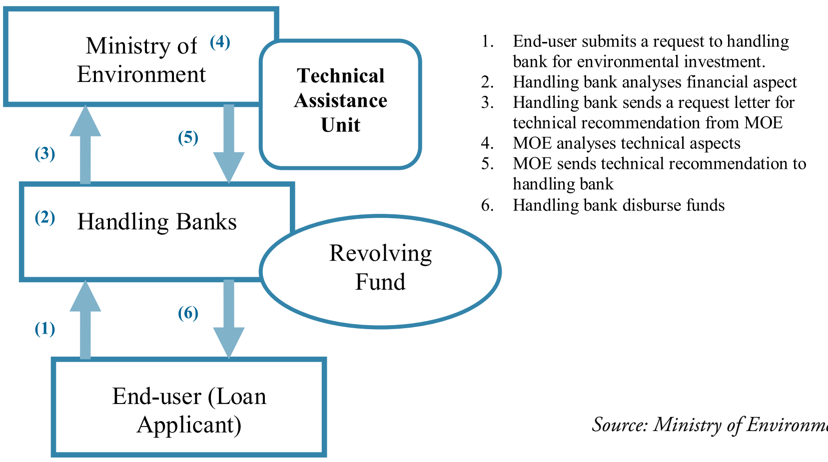
4. Finance

4.a Local commercial banks

The local financial sector in Indonesia comprises basically of banks and non-bank financial institutions (NBFIs). Banks dominate the local financial landscape as they account for about 80% of the assets of the financial system.

Local commercial banks, both private and state-owned, have been cooperating with the Government of Indonesia through the Ministry of Environment and Ministry of Finance in implementing a number of economic incentives or instruments, particularly environmental credit schemes, since beginning of 1990s. One of the economic measures implemented since 1992 is a programme of revolving environmental soft loans. The programme, is a joint effort between the government of Indonesia Bank Indonesia (the Central Bank) and channeling banks. This programme so called JBIC PAE started with the offer of a soft loan from the government of Japan to assist industries primarily in managing their pollution loads (end-of-pipe). Following the success of the JBIC-PAE loan scheme, the government of Germany provided a grant to the government of Indonesia through KfW for the first Industrial Efficiency and Pollution Control soft loan programme (IEPC1-KfW). This financial cooperation programme promotes and speeds up the process of changing environmental management processes towards principles of pollution prevention particularly in SMEs. In year 2005 the government of Indonesia received a soft loan from the government of Germany to continue this approach under IEPC-KfW phase 2. The above soft loan schemes still continue to run although the original donor funds for PAE and IEPC1 have already been fully exhausted. The funds that are now being managed by the banks are those revolving through repayments.

Figure 5: Current role of banks in environmental financing



Source: Ministry of Environment

Table 15: The Environmental Soft Loan Programme

	PAE	IEPC1	IEPC2	DNS
Target groups	All scale	SMEs	SMEs	MSEs
Donor	JBIC	KfW	KfW	KfW
Participating and conduit, or "handling" banks	PT. Bank BNI (Persero), PT Bank Mandiri (Persero), PT Bank Central Asia, PT Bank International Indonesia, PT Bank Danamon, PT Bank Lippo	PT BPD Bali PT BPD Jawa Tengah PT Bank Jabar Bank Nagari (BPD Sumatera Barat) PT BNI (Persero)	**Bank Pelaksana** Bank Negara Indonesia (BNI) Bank Ekspor Indonesia (BEI) **Bank Penyalur** Bank BNI Bank Jateng Bank BPD Kaltim Bank Kalbar Bank Niaga	Bank Syariah Mandiri
Type of credit (financial assistance)	Investment, up to 5 b Rupiah	Investment, up to 500 m Rupiah	Investment (75%) and working capital (25%)	Investment (60%) and working capital (40%)
Interest rate	Central Bank rate	9-14% pa	Min 2% below market	Syariat (=10-13% pa)
Term (years)	3-20	3-10	3-10	3-7
Grace period (years)	0-3	0-3	0-1	0-1
Technical assistance	None	Regional consultant	Technical Assistance Unit (TAU)	TAU

Sources: Adapted from various sources.

"Banks gradually started to see that environmental investments can be interesting and financially rewarding."[17] Cleaner production equipment accounted for 89% of investments under PAE-JBIC and 86% under IEPC1-KfW. This shows that cleaner production equipment has become an interesting object for financing by banks and for companies to get funding for.

4.b Non-bank financial institutions

NBFIs remain a small part of the local financial system but they can be a good source of financing for SMEs. A recent World Bank study explores the potential of NBFIs.[18]

"A well-developed NBFI system can play a major role in achieving Indonesia's development goals and can enhance the stability of the country's financial system. NBFIs have the potential to unlock long-term domestic resources for investment in sectors critical to growth, such as infrastructure, and increase access to low-cost financial services."[19]

"By providing additional and alternative financial services, NBFIs improve general system-wide access to finance. They also help to facilitate longer-term investments and financing, which is often a challenge in the early stages of bank-oriented financial sector development. The growth of contractual/collective savings institutions such as insurance companies, pension funds, and mutual funds widens the range of products available for people and companies with

17 Dewanthi 2007, p. 6.
18 World Bank 2006. Unlocking Indonesia's Domestic Financial Resources: the Role of Non-bank Financial Institutions, World Bank, Jakarta.
19 Ibid, p. xiii.

resources to invest. These institutions also provide competition for bank deposits, thereby mobilizing long-term funds necessary for the development of equity and corporate debt markets, municipal bond markets, infrastructure finance, mortgage bond markets, leasing, factoring and venture capital.

Collective savings institutions also allow for better risk management, while helping to reduce the potential for systemic risk through the aggregation of resources, allocation of risk to those more willing to bear it, and application of portfolio management techniques that spread risk across diversified parts of the financial system."[20]

The same study points out: "Indonesia needs strong NBFIs for at least three reasons: (i) they can play a critical role in mobilizing and allocating domestic resources for financing development – an urgent priority; (ii) they can reduce the vulnerability of the financial sector to future shocks; and (iii) they can help meet other articulated Government objectives."[21]

NBFIs may be compared to a "spare tires"[22] that is a must especially if you're in for a long trip. Indonesia must still travel long to economic prosperity and thus needs those spare tires. "It urgently needs to develop (NBFIs) if it is to reduce the vulnerability of its still bank-dominated financial system to future shocks, which will almost inevitably occur. It needs NBFIs and capital markets that can pick up the slack and act as shock absorbers – strong institutional investors such as pension funds and insurance firms; well developed capital markets – both equity and fixed income; and well-functioning other NBFIs such as leasing and venture capital firms that can support a variety of industries."[23]

"NBFIs broadly provide a set of products that can be used by the society to manage individual and corporate risks better."[24]

4.c Banking policy

The Central Bank of Indonesia (BI) and the Ministry of Environment have signed an MOU envisaged to improve the banking role in protecting the environment. In fact, the BI has been encouraging the banking sector to be concerned with environmental issues in their financing activities through regulations. Among other regulations, these environmental regulations for the banking sector include:

- Bank Indonesia regulation no. 21/9/UKU/1989 dated 25 March 1989 on "Investment Credit and Equity Participation";
- Banking Law or Act no. 23 of 1999, amended through Act. No. 3 of 2004;
- Bank Indonesia's latest regulation PBI no. 7/2/PBI/2005 dated 20 January 2005, on the "Assessment of Quality of Productive Assets Owned by Commercial Banks" (recorded in the State Gazette no. 12 of 2005), with its implementing regulation Bank Indonesia Circular no. 7/3/DPNP dated 31 January 2005. It stipulates that productive-asset assessment by a bank to its client should refer to and comply with the Ministry of Environment's guideline. It also implies that banks need to adjust their methodologies concerning the collectibility or quality of their credit provision by adding covenants on environmental considerations geared towards assessing the business sustainability of the debtors.
- National ordinance relating to these legal bases are Law no. 23 of 1997 and the Government Regulation no. 27 of 1997 on the Environmental Impact Analysis (AMDAL).

20 Ibid, p. 3.
21 World Bank 2006, p. 4.
22 World Bank 2006, p. 7.
23 World Bank 2006, p. 7.
24 World Bank, 2006, p. 7.

4.d CDM and the carbon market

Growing concerns of climate change was remarkably highlighted through the adoption of the United Framework on Climate Change Convention (UNFCCC) in the Earth Summit 1992, Rio de Janeiro, and discussion on climate change issues have undergone important milestones ever since. Under a major milestone - the Kyoto Protocol of the United Nations Framework Convention on Climate Change (UNFCCC), 1997 - developed countries listed in Annex B (hereinafter called the "Annex B countries"), have committed to reduce their greenhouse gas (GHG) emissions with an aim to stabilize the concentration of GHG in the atmosphere to a level that does not cause harm to the living beings.

CDM is one of the flexibility mechanisms of the Kyoto Protocol, designed to facilitate Annex B countries to fulfill their commitments for reducing GHG emissions, and at the same time to assist non Annex-B countries, which are mostly developing countries, in achieving sustainable development. It is a means for developed countries (Annex B countries) to achieve part of their target under the Kyoto Protocol by purchasing Certified Emission Reductions (CERs) from GHG reduction projects in developing countries. CDM is the only flexibility mechanism that involves developing countries. Under the Kyoto Protocol, developing countries have no obligation to constrain their GHG emissions, but may, on a voluntary basis, contribute to global emission reductions by hosting CDM projects.

The clean development mechanism (CDM) is a means for developed countries to achieve part of their GHG (green house gas) emission reduction target under the Kyoto Protocol by purchasing Certified Emission Reductions (CERs) from GHG reduction projects in developing countries. A prerequisite for a CDM project is that it must contribute to sustainable development in the host country. The most direct way to achieve this other objective of CDM is by offering or serving as additional sources of technology and finance for clean technology projects.

CDM is a project-based mechanism where the emission reductions are generated through specific projects and it is intended to promote the investment in projects in developing countries. A prerequisite for a CDM project is that it must contribute to sustainable development in the host country. CDM projects must be validated, the projects must be registered, their emissions reductions generated must be verified, and then the verified emission reductions must be certified. Only the certified emission reductions can be used by Annex B countries to comply with their emission reduction commitments.

The CDM project cycle consists of several steps as follows:

Step 1: Project Development by the Project Proponent: In the beginning, the project proponent (PP) identifies the project idea and conducts an initial evaluation of the eligibility and feasibility of developing the project. This evaluation will involve development of a Project Design Document (PDD) consisting of description of the baseline, baseline and project emission calculations, emission reduction calculations, and monitoring and verification protocol. The PDD is a formal requirement of the CDM Executive Board (CDM EB) and the format is also given by the CDM EB. The determination of baseline is developed based on the approved baseline methodology by the CDM EB. In the absence of an approved methodology, the PP may propose a new baseline methodology for evaluation and consideration by the CDM EB.

Step 2: Validation and Registration: PP seeks validation by a Designated Operation Entity (DOE) –an entity accredited by CDM EB to conduct CDM project validation. Validated projects will be then registered under CDM project registry.

Step 3: Project Monitoring: The emission performance of the project is monitored throughout the crediting lifetime of the project using the monitoring methodology and monitoring plan (Monitoring and verification protocol, MVP) described in the project PDD. This is conducted on the basis of data collected on emission reductions, environmental and social impacts, and other operational information. MVP reports are submitted to DOE for verification as a basis for the issuance of CER.

Step 4: Verification, Certification and Issuance: Once the emission reductions verified by DOE, the emission reductions can be certified and the CER is issued to appropriate parties.

A variety of projects are eligible under the CDM. The following list classifies the eligible CDM projects according to sectors and technologies, as well as specific activities:[25]

- Renewable energy technologies;
- Energy efficiency improvements (supply side and/or demand side);
- Fuel switching;
- Combined heat and power;
- Capture and destruction of methane emissions (e.g. from landfill sites, oil, gas and coal mining);
- Emissions reduction from industrial processes;
- Capture and destruction of GHGs other than methane (i.e. N2O, HFCs, PFCs, and SF6);
- Emission reductions in the transport sector;
- Emission reductions in the agricultural sector;
- Afforestation and reforestation (also called sink projects);
- Modernisation of existing industrial units/equipment using less GHG-intensive practices/technologies (retrofitting);
- Expansion of existing plants using less GHG intensive practices/technologies (Brownfield projects);
- New construction using less GHG intensive practices/technologies (Greenfield projects).

CDM projects are also categorized as large-scale and small-scale. Small-scale projects are: (1) renewable energy projects with a maximum output capacity equivalent to up to 15 MW; (2) energy efficiency improvement project activities which reduce energy consumption, on the supply and/or demand side, by up to the equivalent of 60 GWh per year; or (3) other project activities that both reduce anthropogenic emissions by sources and directly emit less than 60 kilotonnes of carbon dioxide equivalent annually.

As of 1 March 2009, some 1,423 CDM projects had been registered at the CDM Executive Board. To this date, a total of 261,756,264 tCO2eq have been issued. But the expected annual average CERs from these registered projects amount to 264,170,818 tCO2eq. 23 projects have been registered from Indonesia, and 195,490 tCO2eq have been issued as CERs. But the expected average annual CERs from the 23 projects are 3,256,883.

The table below lists the 22 registered CDM projects on which some information could be gathered. As shown, the projects are almost equally divided between small- and large-scale CDM projects. Most are renewable energy projects using biomass or biogas. Some of these renewable energy projects and others are recycling and utilizing wastes, thus avoiding or recovering methane, which is a more powerful greenhouse gas than carbon dioxide.[26]

Although the additional revenue from the sale of CERs under the CDM can increase the financial feasibility of projects there are transaction costs that place small-scale projects at a disadvantage. Transaction costs in Indonesia are estimated to be between USD 50,000 up to USD 300,000 depending on the complexity of the project (such as the selection of the baseline methodology and additionality compliance) and the availability of local expertise to help develop the project. The challenge for small scale renewable energy projects in pursuing CDM revenue lies in the capability of the project owner to pay the transaction costs in advance and the capacity of the project to produce sufficient revenues from CDM to justify the transaction costs.[27]

25 UNEP 2005. Baseline Methodologies for Clean Development Mechanism Projects.
26 Methane has 21 times global warming potential than carbon dioxide.
27 IRG, 2007. From *Ideas to Action: Clean Energy Solutions for Asia to Address Climate Change*, report prepared for USAID's Eco-Asia Clean Development and Climate Program.

Table 16: Registered CDM Projects in Indonesia

Name of Project	Other parties involved	Type of project	Scale	Average annual ERs (tCO2eq/yr)	Total ERs by 2012 (tCO2eq)
1. Methane Recovery in Wastewater Treatment, Project AIN07-W-04, Sumatera Utara, Indonesia	The Netherlands	Biogas	small-scale	39,218	155,260
2. Listrindo Kencana Biomass Power Plant	Japan	Biomass	small-scale	57,784	231,136
3. Methane Recovery in Wastewater Treatment, Project AIN07-W-01, Sumatera Utara (North Sumatera), Indonesia	The Netherlands	Biogas	small-scale	33,390	147,518
4. Gianyar Waste Recovery Project	Switzerland	Methane avoidance	small-scale	7,671	25,791
5. Emission reductions through partial substitution of fossil fuel with alternative fuels in the 2 cement plants of PT Holcim Indonesia Tbk	Switzerland	Biomass	large	516,706	2,171,145
6. Gas turbine co-generation project in Indonesia	Japan	Energy efficiency	small-scale	20,516	79,786
7. Pontianak - GHG emission reduction through improved MSW management – LFG Capture, Flaring and Electricity Generation	The Netherlands	Methane recovery & utilization	large	49,098	223,753

Name of Project	Other parties involved	Type of project	Scale	Average annual ERs (tCO2eq/yr)	Total ERs by 2012 (tCO2eq)
8. 4MW Biomass Power Plants Using Waste Wood Chips & Sawdust in Central Java Province, Indonesia	Japan	Biomass	small-scale	14,139	65,145
9. MEN-Tangerang 13.6MW Natural Gas Co-generation Project	Japan	Fuel switch	large	42,622	163,967
10. Tambun LPG Associated Gas Recovery and Utilization Project	UK	Waste gas/heat utilization	large	390,893	2,429,689
11. Amurang Biomass Cogeneration Project	"Switzerland	Biomass	small-scale	30,263	151,315
12. Nagamas Biomass Cogeneration Project in Indonesia	UK"	Biomass	small-scale	77,471	395,633
13. PT. BUDI ACID JAYA Tapioca Starch Production Facilities Effluent Methane Extraction And On-site Power Generation Project in Lampung Province, Republic of Indonesia	Japan	Biogas	large	271,436	1,401,800
14. PT Navigat Organic Energy Indonesia Integrated Solid Waste Management (GALFAD) Project in Bali, Indonesia	Japan	Methane recovery & utilization	large	123,423	591,440
15. Darajat Unit III Geothermal Project	Japan	Other renewable energies	large	652,173	3,967,385
16. Lampung Bekri Biogas Project	UK	Biogas	small-scale	18,826	112,956

Name of Project	Other parties involved	Type of project	Scale	Average annual ERs (tCO2eq/yr)	Total ERs by 2012 (tCO2eq)
17. Indocement Blended Cement Project	"Switzerland	Cement	large	469,750	3,329,166
18. Indocement Alternative Fuels Project	UK"	Cement	large	146,434	1,025,038
19. Methane Capture and Combustion from Swine Manure Treatment Project at PT Indotirta Suaka Bulan Farm in Indonesia	"The Netherlands	Biogas	large	167,024	1,070,000
20. MNA Biomass 9.7 MWe Condensing Steam Turbine Project	Finland"	Biomass	small-scale	45,936	293,373
21. MSS Biomass 9.7 MWe Condensing Steam Turbine Project		Biomass	small-scale	56,116	360,078
22. CDM SOLAR COOKER PROJECT Aceh 1	Japan	Other renewable energies	small-scale	3,500	24,500

Source: IGES CDM Project Database as of February 2009, URL: http://www.iges.or.jp/en/cdm/report_cdm.htm

The clean development mechanism (CDM) has promoted further cleaner production applications in the POMs because the carbon revenue serves as an economic incentive and offer additional income to offset additional costs necessary to implement clean technology applications.

Based on the observation of 32 POM-related projects in the Indonesian CDM pipeline as of October 23, 2008,[28] seven clean technology applications in the palm oil mill industry have the potential to earn certified emission reduction (CER) revenues:

1. Bio-diesel fuel production from palm oil waste
2. Biomass power plant from palm oil waste
3. Biomass cogeneration
4. Methane recovery from wastewater treatment
5. Composting from solid and wastewater treatment
6. Biogas extraction for heat generation
7. Biogas extraction from POME treatment plan for bio-hydrogen production

28 UNFCCC 2008. The information contained in the CDM section is taken from various PDDs of CDM projects available in UNFCCC website.

The CDM status and GHG emission reduction estimation of those projects are shown below.

Table 12: POM projects currently in CDM Pipeline (per Oct 23, 2008)

ID	Title	Province / State/ Region	CDM Status	1st crediting period ktCO2e/yr	Credit start	2012 ktCO2
CDM2077	1. Bahari Co-Composting Project	Aceh	At Validation	44	1-Oct-08	189
CDM2755	2. Patisari Co-Composting Project	Aceh	At Validation	53	1-Sep-08	228
CDM3030	3. Methane Recovery in Wastewater Treatment, Project AIN07-W-05, Sumatera Utara	North Sumatra	At Validation	29	1-Nov-08	122
CDM3783	4. AIN08-W-07, Methane Recovery in Wastewater Treatment, Sumatera Utara, Indonesia, Version 1	North Sumatra	At Validation	10	1-Mar-09	40
CDM3794	5. AIN08-W-06, Methane Recovery in Wastewater Treatment, Sumatera Utara	North Sumatra	At Validation	18	1-May-08	82
CDM3800	6. AIN08-W-03, Methane Recovery in Wastewater Treatment, Sumatera Utara,	North Sumatra	At Validation	22	1-May-09	82
CDM3466	7. Nubika Jaya Biogas Extraction for Bio-Hydrogen Production	North Sumatra	At Validation	42	30-Sep-08	177
CDM0582	8. MNA Biomass 9.7 MWe Condensing Steam Turbine Project	North Sumatra	Registered	46	1-Aug-06	251
CDM1807	9. PTMM Biomass to Electricity Project 24.0 MW(e)	North Sumatra	At Validation	104	1-May-08	485
CDM4257	10. ID08-WWP-10, Methane Recovery in Wastewater Treatment, West Sumatera	West Sumatra	At Validation	15	1-Aug-09	68
CDM2672	11. PAA Biogas Extraction Project for Heat Generation	Riau	Under review	42	18-Apr-08	199
CDM2080	12. Gandaerah Hendana Co-Composting Project	Riau	At Validation	50	1-Oct-08	214

ID	Title	Province / State/ Region	CDM Status	1st crediting period ktCO2e/yr	Credit start	2012 ktCO2
CDM2662	13. Rohul Sawit Industri Co-Composting Project	Riau	At Validation	49	1-Oct-08	209
CDM2685	14. Fetty Mina Co-Composting Project	Riau	At Validation	47	1-Jan-08	234
CDM2836	15. Organic Waste Composting at Nilo Palm Oil Mill	Riau	At Validation	236	1-Jan-08	973
CDM0583	16. MSS Biomass 9.7 MWe Condensing Steam Turbine Project	Riau	Registered	56	1-Aug-06	251
CDM1641	17. Nagamas Biomass Cogeneration Project in Indonesia	Riau	Registered	77	23-Nov-07	395
CDM1808	18. PTIP Biomass to Electricity Project (7 MW)	Riau	At Validation	41	1-Apr-08	194
CDM2088	19. Mandau Biomass Power Plant	Riau	At Validation	33	1-Apr-08	156
CDM3425	20. Pelita Agung Agrindustri Biomass Cogeneration Plant	Riau	At Validation	181	1-May-08	843
CDM2640	21. Organic Waste Composting at CKT Palm Oil Mill	Jambi	At Validation	65	30-Oct-08	271
CDM1623	22. Listrindo Kencana Biomass Power Plant	Bangka-Belitung	Reg. request	50	25-Aug-08	215
CDM0035	23. Bio-Diesel Fuel Production Project in Indonesia	South Sumatra	At validation	5.5	1-Apr-07	31
CDM2702	24. Methane Recovery in Wastewater Treatment, Project AIN07-W-01, Sumatera Utara (North Sumatera)	South Sumatra	Reg. request	33	1-Aug-08	147
CDM2983	25. Methane recovery in wastewater treatment, Project AIN07-W-04, Sumatera Utara	South Sumatra	At Validation	42	2-Jul-08	190
CDM3960	26. Co-composting of EFB and POME at PT. Kriya Swarna Pubian in Lampung	Lampung	At Validation	29	1-Jan-09	116
CDM3382	27. Harapan Biogas Project	West Kalimantan	At Validation	41	1-Sep-08	180

ID	Title	Province / State/ Region	CDM Status	1st crediting period ktCO2e/yr	Credit start	2012 ktCO2
CDM2596	28. Organic Waste Composting at PTS Palm Oil Mill	West Kalimantan	At Validation	93	30-Oct-08	389
CDM2653	29. Karya Makmur Bahagia Co-composting Project	Central Kalimantan	At Validation	45	1-Sep-08	196
CDM2663	30. Windu Nabatindo Lestari Co-Composting Project	Central Kalimantan	At Validation	49	1-Sep-08	213
CDM2885	31. Organic Waste Composting at Terra Indo Fertilizers JV	East Kalimantan	At Validation	202	1-Oct-08	858
CDM2886	32. Organic Waste Composting at Terra-GMP Composting Plant	East Kalimantan	At Validation	297	1-Oct-08	1262

Source: UNEP RISOE 2008.

A 2005/2006 technical assistance project by the ADB estimated the potential for GHG emissions reductions in Indonesian palm oil mills at 6.5 million tons of CO2eq per year of which 3.3 million tons is from POME methane sequestration. At the CER price of USD7 per tCO2, the "potential CER revenues from the sustained implementation of the waste to energy projects in the POM are estimated at 45 million USD/yr."[29]

On the other hand, the utilization of rice husk as renewable energy to generate heat and/or electricity has the potential to be proposed as a CDM project, especially if:

- The fuel which would have been used to generate heat/and/or electricity in the area is diesel or coal, which have high carbon content/unit energy
- In case of electricity generation, the size of the power generation for rice husk-fired power plant is equal to or more than 5 MW. Less than 5 MW may not be suitable to be proposed as CDM project due to lower CER potential and may not bring valuable return from the CDM transaction costs incurred (cost for development of PDD, validation, registration, and verification). A 5 MW rice-husk power generation may generate CER of 28,000 tonnes of CO2e/year, assuming that the baseline of the project activity is diesel power generation with the efficiency (power output to energy input) of 30%, and CO2 emission factor of 74100 kg/TJ.[30] Theoretically on ideal basis, based on data on paddy production in the year 2008 which is given in Chapter 1, and the rice husk LHV of 14,204 kJ/kg, the estimated potential of CER which would be generated by rice husks as renewable energy in Indonesia is about 12 million tonnes.

5. Environmental and social benefits

Renewable energy technologies and options, like those mentioned earlier, contribute to reducing environmental emissions at the global and national level as well as air pollution in cities and rural areas. In addition, renewable energy sources and their attendant technologies have other important and proven benefits:[31]

29 ADB 2006, p. xix.
30 IPCC 2006.
31 Adopted from Ministry of Environment (Germany) 2004. *Conference Issue Paper*, International Renewable Energy Conference, Bonn, p. 8-9.

- Reduction of foreign exchange burden because of less reliance on energy imports;
- Reduction of human-induced climate impacts caused by the use of fossil fuels;
- Reduction of negative health impacts and physical damage from airborne emissions;
- Increase in access to modern energy services for large parts of unserved rural population in the developing world, as renewable energy technologies are the most cost-effective and competitive supply options for many remote areas;
- Increase in local economic development by creating employment, introducing new capital and innovation, developing new sources of revenue for households and local communities;
- Reduction in the depletion rate of natural resources and help in revitalizing local economies in agriculture and forestry because of improved technologies for using biomass resources;
- Creation of highly qualified employment in small and medium-sized enterprises by stimulating the development of new products and services that cater to rural energy needs; and
- Creation of the potential for decentralized use, technological innovation, and opportunities for wider participation of people in decision-making about energy options.

The specific benefits depend on the type of technology options and the conditions or circumstances within which the renewable energy potential is being harnessed. The renewable energy technology options discussed for the palm oil mills would have the following environmental, social and economic benefits:

- Methane emissions reductions from POME and aerobic digestion of EFBs from capturing methane and using it as biogas or as compost fertlizer
- CO2 emissions reductions from replacement of diesel oil in the vehicles, biomass residues in the boiler, and fossil fuels in power plants by biogas from POME, or blend of POME and EFBs
- CO2 emissions reductions from replacement of fossil-based electricity from the grid by electricity generated from power plants fueled by biomass residues of the POMs
- Reduction in particulate emissions from uncontrolled gathering or accumulation of fibers and shells by transporting them for use as feedstock to biomass power plants
- Reduction in other air pollutants from uncontrolled gathering or accumulation of excess EFBs and other solid wastes[32]
- Increased productivity of plantations through better use of fertilizer value of POM "wastes" and residues, e.g. mixing of biogas effluent and EFBs, production of compost from EFBs, collection of ash from boilers and mixing them with waste water (or biogas effluent)
- Cost savings from replacing even a small part of procured and expensive commercial fertilizers
- Electrification of nearby communities from excess renewable electricity generated by POMs
- Electricity supply made available to rural enterprises
- Employment and livelihood opportunities arising from construction activities, operation of biomass-fired power plants, collection and transport of biomass residues from POMs, and growth and proliferation of rural enterprises as a result of available energy supply
- Other social benefits of available electricity supply and ensuing increased penetration of energy in rural areas where POMs operate are shown below in terms of their direct and indirect contribution to the achievements of the MDG:

Similarly, the renewable energy technology options described earlier, particularly using rice husk residues as fuel, have the following environmental and socio-economic benefits:

- Reduction in particulate and possibly other air pollutant emissions and avoidance of methane emissions from exposed, dumped, or unused rice husk
- Reduction in CO2 and air pollutant emission by substituting fossil fuels directly with rice husk or briquetted as biomass for producing steam or electricity

32 In the same way that air pollutants are actually emitted at open dumpsites.

- Reduction in CO_2 and air pollutant emissions by substituting "dirtier" wood fuels with charcoal briquettes derived from rice husk ash as cooking fuel
- Additional revenue from selling rice husk ash for use in cement kilns or as high crystalline silica for use in the steel and cement industries
- Rural electrification benefits of producing electricity from rice husk-fired gasifiers or high-pressure steam generators
- Socioeconomic benefits of creating a market for rice husks (and possibly rice husk briquettes), including collection, transport, and supply
- Socio-economic benefits of access to clean electricity supply, including health, nutrition, livelihood, education, and gender

C. The Barriers

The Scoping Study identified renewable energy options for both the palm oil mill and rice mill sectors as solutions or *opportunities* for addressing both the industries' waste management problem (cleaner production) and need for efficent and environment-friendly energy supply (clean energy).

Regardless of context, renewable energy development and use face common barriers that are generally classified into financial and economical, technical and marketing, legal and institutional, political and social, and awareness and information.[33] The specific barriers under each of these major categories of barriers are shown below. The table also shows the generally applicable and workable measures to overcome those barriers.

Table 13: Common barriers for adoption and market penetration of renewable energy

Barrier	Overcoming
Financial and Economical • High production cost • High investment cost • High financial cost • High project development cost • Expensive grid connection equipment • Low feasibility of project • Little opportunity in financing smaal scale investment	• Reduce O&M cost • Reduce cost • Reduce interest rates loan • Standardized contract PPA • Long term & large contract • Feed in tariff • Increase community share and PPP
Technical and Market • Low generation capacity • Low generation efficiency • Technology not mature commercially • Low availability in market • Infrastructure not available • Secure fuel source supply • Secure fuel price supply • Logistic of fuel not existing • High standard grid connection • Standard of equipment used in RE power plant	• Increase capacity factor • Increase efficiency • RDD (Research, development and demonstration) • Technology transfer • Distributed generation • Improve dispatchability • Set cap for fuel price • Zoning power plant • Improve grid connection standard • Issue specification book
Legal and Institutional • Complicated permisology procedures • Restrictions on the use of residues • Restrictions on transportaion of residues • Limitation on the emissions from production • Restrictions on site access	• Referring of concession to DIW and PPA • Select suitable technology • Improve procedure of Tax on emission • Separate phase of construction and power plant

33 Thailand PRET Project 2006. *Renewable Energy Barriers and Incentives Catalogue*.

Barrier	Overcoming
Political and Social • Subsidy in conventional • Tax on fuel • Tax on energy production • Protection of favor of specific technologies/fuels • Unclear related policy • Communities acceptance	 • Reduce subsidy • Reduce tax on fuel • Tax exemption from the Board of Investment • Create right understanding • Renewable Portfolio Standard clarification • Community participation initially
Awareness and Information • Lack of knowledge about technical possibilites • Lack of knowledge about O&M • Lack of information about financial possibilites • Lack of experience on infrastructure management • Neglect of benefit on environment impact of RE • Lack of current cost information	 • technical training • O&M training • Promote of financial scheme • Special propose vehicle • CDM preparation • Dissemination of information

Source: Thailand PRET Project 2006, Renewable Energy Barriers and Incentives Catalogue.

Many of these barriers could be found in the Indonesian renewable energy market. The Scoping Study finds some barriers more important and more relevant to the target industries.

1. Industry and technology

Both the few interviews with the palm oil and rice mills and the two returned palm oil mill questionnaires indicate that a key technological barrier is the lack of knowledge on appropriate technological opportunities and their financial, economic, and environmental impacts or benefits. This situation has led to expectations of low financial returns on technology investments and perceptions of high technology and financial risks. The industry respondents also believe that the Indonesian government has no clear policy on both cleaner production and renewable energy and offer low prices for recovered energy. The result is low investment on clean technologies.

To be sure, the palm oil industry in Indonesia is practicing many of the clean technology measures enumerated earlier, including:

- Good housekeeping
    1. Process fresh fruit bunch within 24 hour after harvesting to avoid excessive production of free fatty acids by the natural enzymes present in the fruit
    2. Apply good practice in solid waste handling such as solid waste separation and application of certain fractions as soil cover material or reuse/ recycling in the palm oil plantation area as soon as possible to reduce dust and bad smell in the mill area
    3. Apply preventive and good maintenance practices
    4. Improve combustion control

- On-site reuse/ recycling
    1. Reuse fiber and shell as fuel in boiler.
    2. Recycle sludge from vibrating screen to digestion tank.
    3. Recycle sterilized condensate to screw press and vibrating screen to reduce hot water use and to improve the recovery of oil from wastewater.
    4. Recycle hot water from vacuum tank for cleaning decanter and separator.
    5. Recycle steam condensate (temp 100 oC) from kernel drying tank for reuse as boiler feed water to reduce water use and energy for heating water.
    6. Recycle wastewater after anaerobic treatment for irrigation in oil palm plantation area
    7. Recycle sludge from wastewater treatment plant for soil conditioning and fertilizing

- Process modification
    1. Employ an automatic autoclave for optimal sterilization conditions.
    2. Collect remaining unripe palm fruit to re-sterilize manually in order to reduce oil loss.
    3. Install 2nd bunch stripper to enhance fruit separation from bunch stalk to reduce oil loss from EFB.
    4. Install buffer tank to separate the sludge from the crude oil before flow to the settling tank to enhance oil separation, and remove sand from sludge.

Moreover, as also shown earlier, a number of industry players are exploring CDM opportunities.

Notwithstanding, the maximum potential of biomass and biogas resources generated by the industry, both as waste management solution and clean energy option is not being exploited.

2. Policy and institutional

The Scoping Study also finds barriers in Cleaner Production and Clean Energy policies.

For one, the implementation process of Cleaner Production has experienced many delays because of the following obstacles:[34]

- a public policy concerning the implementation of CP has not been completed;
- retrieval of technological information concerning CP (best practice and best available technology) is still difficult;
- capacity building and CP experience in the industrial sector, associations, governmental apparatus, consultancy is limited;
- CP suitable for the manufacturing sector has not yet been developed;
- A funding mechanism to facilitate the adoption of CP principles is still lacking;
- lack of incentive to motivate and possibly subsidize activities of companies that have already applied CP.

As regards clean energy, the following barriers stand out:

- **Weak implementation of renewable energy policy, or policy does not provide adequate incentive**. *Ministerial Decree No. 1122/K/30/MEM on Small-Scale Power Purchase Agreement* (PSK), issued in 2002, requires PLN to purchase electricity generated from renewable energy sources by cooperatives, private enterprises, and government companies or non-PLN producers for projects up to 1 MW capacity. This program known as *PSK Tersebar* has set the purchase tariffs at 80% for connection at medium voltage and 60% for connection at low voltage of PLN's announced "Electricity Base Price' (*Harga Pokok Penjualan - HPP*), which is supposed to be its marginal production cost at the location where the plant is to be built. Despite the clear potential of this standard offer approach and its good intentions to produce renewable energy at lower cost than the grid, "only a handful of mostly very small (10-100 kW) hydro facilities have been constructed."[35] This is because PLN has refused to commit to a long-term price based on forecast marginal production cost, a requirement for the long-term financing necessary for renewable power assets. Moreover, the rate at which the purchase prices have been set are contrary to the common and proven approach to place a premium on and guarantee a market for renewable energy electricity.[36] The government subsidies on fossil fuels also makes the calculated marginal production costs of PLN questionable. *Ministerial Regulation No. 2 on Medium Scale Power Generation from Renewable Energy Sources* (PSM), issued in 2006, extends the same price guidelines as PSK for projects from 1 MW to 10 MW but sets a minimum contract period of ten years.

34 ICPC
35 IRG Co. Ltd/USAID 2008, p. 3.
36 This is the so-called *feed-in tariff*, which is thought as responsible responsible for the renewable energy growth that has taken place in Germany, Denmark, and Spain.

- **PLN's monopsonistic position and perceived inefficiency discourages sellers (or at least does not provide incentive to potential sellers)**. PLN remains the sole buyer of distributed electricity. This position, coupled with weak regulation on the utility, gives PLN great market power. In fact, PLN is viewed as the stumbling block to the development of renewable energy in the country.
- **Uneconomical nation-wide electricity tariff.** The Government's political decision to hold electricity tariffs constant since July 2003 and to apply a nation-wide uniform electricity tariff (TDL) continue to hide the true cost of supplying electricity to consumers. This of course leads to inefficiency in the use of energy and over consumption. The current electricity pricing policy is also not good for ensuring adequate electricity supply, as current prices do not give the right signal to investors.

In addition, a recent USAID-commissioned study also identified other key barriers in the energy sector that can hamper the utilization of clean technologies in industries:[37]

- **Lack of fiscal incentives for clean and renewable energy technology**. Despite an explicit policy to increase the share of renewable energy and accommodate connection of renewable energy technology to the grid, no fiscal incentives are provided for the utilization of renewable energy technology in Indonesia. The customs duties of about 10 percent, VAT of about 10 percent, and import income tax of 2.5 percent of the import value are also all applicable to clean and renewable energy technology. In 2006, the MOF issued a regulation exempting import duty on capital goods purchased by IPPs entering into PPA contracts with PLN. However, the promulgation of a new Customs and Excise Law later in the same year has effectively nullified this tax exempt regulation.
- **Lack of policy and regulatory coordination on rural electrification**. A World Bank study[38] has reported that there are many players in the country working on various rural electrifications programs with competing government departments, varying procedures, and diverse financing sources. Unfortunately, there is no effective coordination among the different players. There is also legal and regulatory ambiguity surrounding the responsibility for rural electrification. It is unclear whether the responsibility for rural electrification is given to the MEMR Social Electrification Unit or to the PLN. In fact, as a result PLN disbanded its Rural Electrification Unit.
- **PPA pricing**. Pricing of electricity for purchase by PLN from private producers has been one of the most significant barriers to renewable energy IPP. PLN was required to purchase electricity-based on a tariff formula that used the nationwide uniform tariff (TDL) as a reference. This regulation has made small and renewable PPA non-bankable, as the price did not truly reflect the cost of supply. New reference prices based on local cost of supply were introduced in 2008 to overcome this problem. Its implementation by PLN regional units is yet to be confirmed.
- **Lack of institutional capacity**. Both central government and sub-national governments lack the capacity to formulate and effectively implement policies and regulations. Weak political commitment and lack of budget support have diminished the capacity of government institutions and staff to execute policy and enforce regulations. Training need analyses are rarely conducted and no rigorous training plan was available. Effective training programs depend on collaborations with donor institutions, which program for no longer than a two-year period. Lack of consistency in staff selection and career advancement, together with the bureaucratic communication process, weaken institutional memory and eventually hinder a sustainable implementation of government policies

There seems to be barriers as well in terms of industrial policy. The interviewed stakeholders in the rice mill sector have commonly pointed out the absence of government support on the sector, including paddy (or rough rice) production and post-harvest processing (which includes rice milling).

37 This section derives heavily from IRG 2008. *Indonesia Energy Pre-Assessment*, report prepared for USAID.
38 World Bank 2005. *Electricity for All: Options for Increasing Access in Indonesia*, World Bank, Jakarta.

3. Finance

Access to finance remains a key barrier to SMEs. "Although in the aggregate SME lending is growing rapidly (from a small base), the vast majority of SMEs in Indonesia continue to face constraints in access to credit. Bank lending is heavily collateral based – and with weak land titling and collateral documentation, especially for land, many SMEs find the banking sector hard to access."[39]

It is not without reason why banks *would* not finance SMEs?[40] In terms of administrative lending requirements, SMEs "often povide insufficient or unfeasible collateral and have inadequate financial reports and/or business licenses." Banks continue to perceive SMEs businesses as high risk because of the following:

- SMEs products are regarded as innovative product,
- SMEs need seed capital to develop new products
- SMEs are in developing stage
- SMEs need extensive funding but haven't entered their mature period
- SMEs businesses are seasonal, such as plantation and fisheries.

The banks themselves faced constraints when it comes to sustainable energy or environment finance despite the exposure offered by the enviromental finance program of the Ministry of Environment. These constraints include:

- "limited knowledge in waste management and clean development infrastructures;
- lack of uniformity in implementation by banks;
- rigid conditionalities by foreign partners; and
- sustainable banking is still a new concept in Indonesia."[41]

39 World Bank 2006, p. 5.
40 Dhewanthi, Laksmi 2008. "Waste to Energy: Incentives for MSMEs for Environmental Investment," 18-20 September 2008, Cebu.
41 Bien Subiantoro, Director of Commerical and Syariah Banking of BNI, "Information sharing - Lessons from BNI's Implementing Sustainable and Responsible Investment," National Workshop: The Roles and Benefits of Sustainable Development from Banking Perspectives, Ministry of Environment and Bank Indonesia, 15 December 2005, Batam, Indonesia.

D. Recommendations

1. Industry and technology

The palm oil and rice mill industries in Indonesia can benefit from awareness raising and capacity building particularly on renewable energy and CDM, including latest developments in these two closely inter-related markets.

The recommended capacity building activities should be extended to local service and equipment providers and this should be coupled with a registration scheme to upgrade the quality of local support industries.

During the dissemination workshop for the scoping study held on 14 April 2009 in Jakarta, it was also recommended to include as participants to the proposed capacity building activities plantation cooperatives and other interest groups.

All these recommended capacity building efforts would increase the level of confidence of the target or priority sectors and their stakeholders on renewable energy technologies. In turn, it will increase the level of confidence of the financial sector in the two industries and in lending for clean technologies.

2. Policy

The mission statement proposed by ICPC could very well be the general framework for implementing the national policy on cleaner production:

- Create climate and condition in society condusive to the successful implementation of CP, so that further environmental pollution is halted and production and consumer habits change;
- Develop a national draft framework to adopt CP strategy and change production and consumption patterns;
- Integrate and synchronize the innovational principle of CP in rural, local and national rules and regulations;
- Promote CP as priority strategy in the development program and development policy, thus aiming to alter social attitudes and views toward the environment.
- Promote the obedience of CP measures as an effective instrument to increase competitiveness on the international market through eco-labelling, ISO 14000 etc.

On the other hand, the following selected policy recommendations are made for Indonesia's energy sector:

Revive the planned electricity sector restructuring and rationalize electricity tariffs. A key recommendation for Indonesia's energy sector is an up-to-date review and eventual enactment of the long-delayed electricity law that would institutionalize a multi-buyer (distribution companies or utilities, direct customers), multi-seller (distributed generators) sector structure. This proposed restructuring of Indonesia's electricity sector should provide more opportunities for the spread of distributed or decentralized renewable energy systems. Coupled with increasing concern for the environment, the restructured market will also call for internalizing environmental costs, thus making renewable energy technologies more competitive and giving them higher market value than fossil-based technologies.

The rationalization of electricity tariffs, from wholesale to retails levels, is sine qua non to the establishment of a competitive electricity market and its sustainability. This should start with the gradual removal of price subsidies, while maintaining lifeline rates for the poor. It is not necessary to jump to retail electricity market model where every customer can choose its electricity supplier, but it is necessary to allow competition in electricity generation.

Put in place incentives for Green IPPs. The availability of large energy resources from biomass residues in palm oil and rice mills is not enough to set the stage for Green IPPs, or IPPs investing in renewable energy technologies. Fiscal, market, and other incentives are necessary to encourage entry into this industry, especially to overcome perceptions of high technical and financial risks on renewable energy technologies. To overcome perceptions of high financial risks, the following incentives have been proven effective in other countries:

- Capital subsidies or grants
- Feed-in tariffs (which is a form of price subsidy but should be technology specific)
- Tax and duties exemptions and discounts
- Relaxed lending policies (low interest rates, longer repayment terms, loan guarantees)

Similarly, to overcome perceptions of high technical risks, the following incentives are also used in other countries:

- Priority grid connection
- Net metering
- Research, development and demonstration (RD&D)

In addition, the setting of national renewable portfolio standard and renewable energy targets can overcome perceived market and policy risks.

As PLN would be the major buyer of the electricity produced by Green IPPs and considering its important stake in the sector, it should be involved in stimulating as well as governing the market for Green IPPs.

MEMR to coordinate the policy on rural electrification, while PLN remains as one of its implementing actors. It is appropriate that policy on national rural electrification should proceed from the MEMR, being in principle the central energy planning and policy-making agency of the Indonesian government. MEMR should set the policy directions and targets for increasing electricity access and work with different national and international actors (national and international NGOs, donor organizations, etc.) to achieve these targets. In fact, PLN as a national utility should be one of these actors and has a social responsibility to pursue rural electrificaton, particularly through its IPP program and/or an entity within its organization that takes on this responsibility.[42] World Bank, for example, proposes as one solution for increasing electricity access in Indonesia the establishment of an independent PLN subsidiary that "would be allowed to focus on the needs of the local area, while maintaining the decision-making autonomy necessary to quickly address localized concerns."[43]

Assist and improve image of PLN and increase its role in renewable energy development. PLN has negative image among many sectors in Indonesia, including potential renewable energy project developers. But as a large buyer of renewable electricity and operator of electricity supply network in the restructured electricity market, PLN has an important role in the development of renewable energy market. For one, PLN can identify and prepare renewable energy projects for potential private sector investments. PLN should develop standard contracts and procurement process for small power producers, most of them would be investing in renewable energy technologies.

42 In the Philippines, for example, IPPs are obliged by law to provide priority electrification (and other benefits for that matter) to its host communities. The national utility also has a separate group within its organization that aims to provide electrification in remote and small islands. Both Philippines and Indonnesia are archipelagic countries.

43 World Bank 2005, p. xii. In fact, this model is currently being applied in the Indonesian districts of Batam and Tarakan.

3. Finance

There is no doubt that banks and the financial sector are needed to achieve economic growth and sustain it. It seems that two urgent actions at the sectoral level are needed in Indonesia's financial sector so that it can fulfill this role:

- Banks that currently dominate Indonesia's financial landscape must be restructured or prepared to finance long-term assets. Right now they're not poised to do that.
- The potential of NBFIs as a source of deep and diversified long-term finance must be tapped.

On the other hand, at the level of the financial institutions, the future role of Indonesia's financial sector as a source of sustainable finance requires two fundamental actions at the level of the firm:

- Integrate environmental/Cleaner Production criteria into investment appraisal, credit rating and loan application process
- Develop new financial products linked to environmental performance

There are fundamental reasons why Indonesia's banks "should undertake and stick to environmentally friendly credit policies:

- the right and responsibility of each individual towards environment protection;
- the need for banks to protect themselves in their various forms of financing; and
- bank management can be legally implicated for failures in complying with environment-related policies."[44]

Thus, in order to protect and improve credit quality, it has been suggested that banks should include environment-related covenants in credit agreements, such as conditions precedent, representation and warranties, affirmative covenants, negative covenants, and events of default."[45]

To be sure, the environmental soft loan program of the Ministry of Environment has improved the understanding and awareness of Indonesia's banks on environmental issues or environmental risks of providing funds to any enterprise (see for example the case of Bank Negara Indonesia in Box 3). Therefore, the environmental soft loan programme is not only a sustainable funding scheme, but also consitutes a source of learning and increased awareness and knowledge to build the bank's capacity in this field. Relevant bank staff will continue receiving training in environmental awareness and tools through the capacity building activities included in the programme.

Notwithstanding, the capacity building program should be extended to the entire financial sector. The program should revolve around renewable energy, climate change and CDM, and sustainable development.

44 Sutan Remy Sjahdeni, Remy Sjahdeni and Partners Law Firm, "What Environment means to banks - Legal Perspectives," *National Workshop: The Roles and Benefits of Sustainable Development from Banking Perspectives*, Ministry of Environment and Bank Indonesia, 15 December 2005, Batam, Indonesia.

45 Ibid.

Box 3

Case Study in Sustainable or Environment-friendly Banking: BNI

- Bank Negara Indonesia (BNI), a commercial bank with a public company status, is the first financial institution in Indonesia to sign up to the UNEP Finance Initiative.\1
- BNI's environment risk management system includes an assessment of the environmental awareness of the customer, which affects the setting of interest rates.
- Eco-friendly policies in BNI include training on environment awareness to loan officers, inclusion of environmental factors to the Industry Risk Rating, requirement of debtor's commitment in environmental management, and inclusion of the factors as part of the early warning system.
- BNI has participated in environment credit financing through commercial lending and soft loans lending provisions. To date the bank has worked with KfW in industrial efficiency and pollution control and with JBIC in pollution abatement equipment program.

Notes:

\1 *The UNEP Fnance Initiative (UNEP FI) is a partnership between UNEP and the financial sector worldwide.*

Another recommendation that came out during the Dissemination Workshop in April 2009 is to replicate in Indonesia the experiences of IFC with the Bank of Philippine Islands (BPI) in the Philippines and the Industrial Bank in Chna. BPI partnered with IFC in establishing a Sustainable Energy Finance program that provides loans in the areas of energy efficiency in buildings and manufacturing and renewable energy. IFC provided advisory services on strategic planning, market analysis and development, and engineering reviews; assisted BPI in deal origination and evaluation, and pipeline development; conducted capacity building for BPI team; and provided financial product support. On the other hand, the Industrial Bank teamed up with IFC to launch the first energy efficinecy financing project in China. On top of providing advsory services similar to those in the Philippines, IFC established with Industrial Bank an equally- shared risk facility to overcome perceived market risks in energy efficiency and emisison reduction projects.

In any case, it has been recommended that Indonesian banks start a sustainable energy finance loan program with palm oil and rice mills currently in their portfolio, as partnership has already been established with these clients and whose creditworthiness has been established.

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