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DIVERSIFICATION OF SUGAR AND PALM OIL INDUSTRIES: INDONESIA

Part 1: Survey of Energy and Product Investment Options

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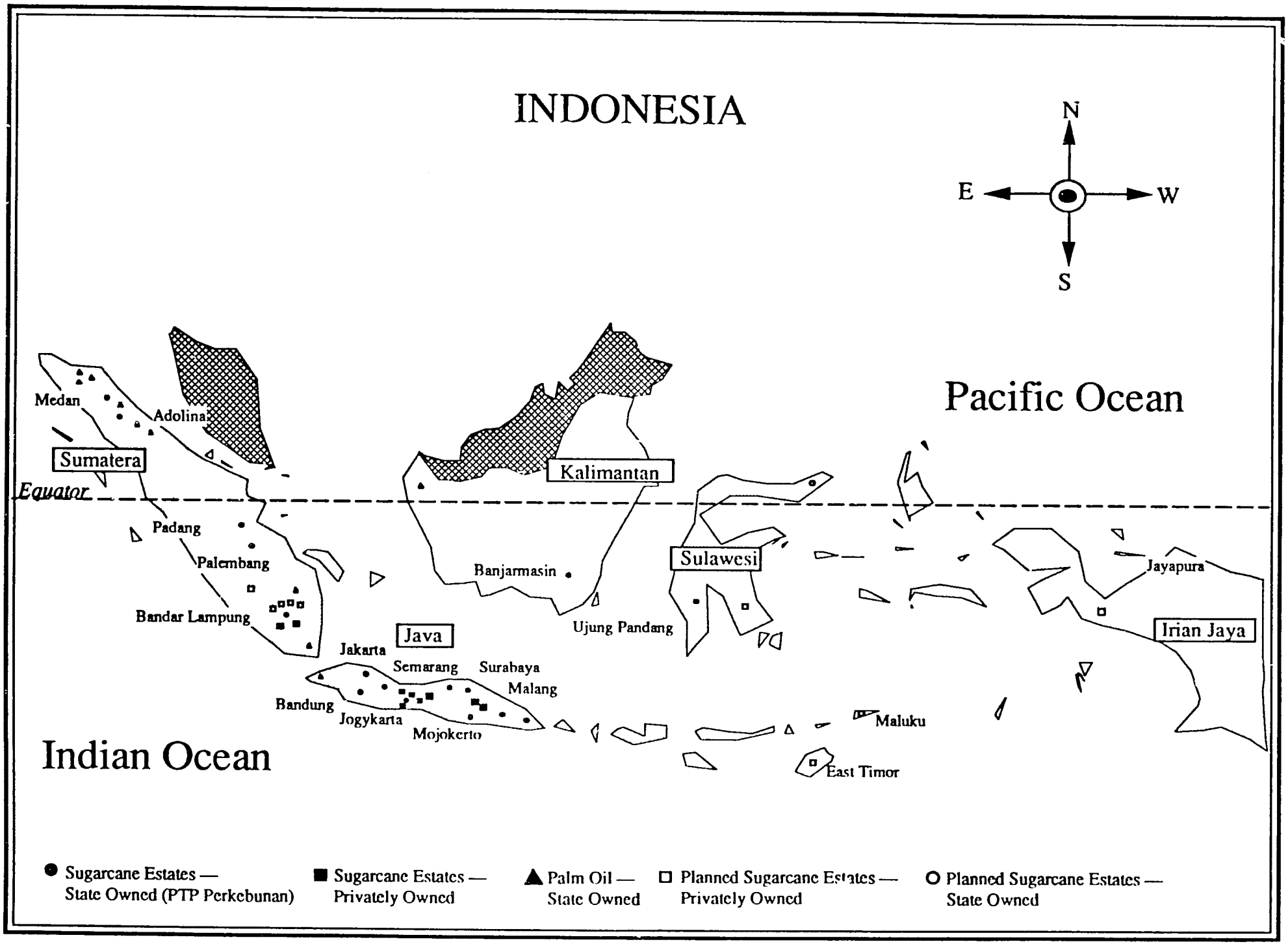
GLOSSARY OF ACRONYMS

ABC	Annualized Benefit Cost (%)
ADO	Automotive Diesel Oil
BOE	Barrel of Oil Equivalent
BOO	Build-Own-Operate
BTU	British Thermal Unit
BULOG	Indonesia State Commodity Agency
CPO	Crude Palm Oil
EFBs	Empty Fruit Bunches (Oil Palm)
EPPS	Energy Policy Pricing Study (World Bank)
FFBs	Fresh Fruit Bunches (Oil Palm)
FOB	Freight on Board
GW and GWh	Gigawatts and Gigawatt-hours (10^9 watts)
kV	Kilovolts
kW and kWh	Kilowatts and Kilowatt-hours (10^3 watts)
LNG	Liquefied Natural Gas
MSG	Monosodium Glutamate
MW and MWh	Megawatts and Megawatt-hours (10^6 watts)
NB	Netback Values (for economic and financial analyses)
PKO	Palm Kernel Oil
PLN	State Electricity Agency
PTP	State Estate Company, prefix for Perkebunan operating companies
Rp	Rupiahs (Indonesia Currency Unit) 1 USD = Rp 1960
T	Metric Tons
TCD	(Metric) Tons of Cane per day, sugar factory processing capacity
TG	Turbo-Generator
USAID	U.S. Agency for International Development
USD	United States Dollars


INDONESIA
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Pacific Ocean
Indian Ocean
Equator
Sumatera
Medan
Adolina
Padang
Palembang
Bandar Lampung
Kalimantan
Banjarmasin
Ujung Pandang
Sulawesi
Java
Jakarta
Semarang
Surabaya
Malang
Bandung
Jogykarta
Mojokerto
Maluku
East Timor
Irian Jaya
Jayapura
Sugarcane Estates — State Owned (PTP Perkebunan)
Sugarcane Estates — Privately Owned
Palm Oil — State Owned
Planned Sugarcane Estates — Privately Owned
Planned Sugarcane Estates — State Owned

Diversification of Sugar and Palm Oil Industries: Indonesia

Part I: Survey of Energy and Product Investment Options

1.0 EXECUTIVE SUMMARY

1.1 Introduction

This report presents the results of a preliminary study of the technical, economic and commercial feasibility of improving the utilization of biomass byproducts from the palm oil and sugar industries of Indonesia. The primary purpose of this study is to explore possibilities for new investment in these industries and for joint ventures between Indonesian organizations and foreign investors. The study was conducted by a team of specialists from the Winrock International Biomass Energy Systems and Technology (BEST) Project, funded by the U.S. Agency for International Development, and KPB Perkebunan.

Promising opportunities for new energy and related byproduct ventures have been discovered in this industry survey, which is Part I of the diversification analysis. The study team recommends that site-specific case studies to investigate electricity production by the sugar industry be conducted in the near future. The nature of the follow-up studies is discussed at the end of the Executive Summary and in the report conclusions. Part 2 of this study will consist of the proposed site specific case studies.

The main study conclusions regarding supply of byproducts from the sugar and palm oil industries and their recommended uses are briefly summarized in the next sections.

1.2 Current Palm Oil Byproducts and Wastes

Indonesia has 500,000 hectares (ha) of mature palm oil estates and 333,000 ha of immature estates. The estates and associated mills produce 1.6 million metric tons (T) of palm oil and nearly 345,000 tons of palm kernel meal used for animal feed. The average palm oil mill processes about 30 tons of fruit bunches per hour. The largest plants have capacities up to about 60 tons per hour. At the largest plant size, a palm estate of about 10,000 ha is required, assuming an average production of 45 tons of FFBs per hectare. The fiber of the palm fruit and shells of the palm nuts are already used as fuel to provide steam and electricity for the mills, which are mainly self-sufficient in energy production. Palm oil production is seasonal with the differential between peak production and the trough at roughly a factor of two.

The major biomass waste byproduct from the palm oil industry is empty fruit bunches (EFBs), the fibrous residue remaining after the palm fruits are separated in the mills. Indonesia now produces about 5 million tons of EFBs (at 60 percent moisture). Currently, EFBs are often incinerated at the plant site, which leaves a disposal problem and causes some air pollution. By 1992, this pollution will need to be curbed in compliance with new environmental regulations. The only beneficial current use of EFBs is the fertilizer value of the ash. At a few places, the EFBs are chopped up and spread on estate grounds without incineration.

Other potentially important palm industry biomass products are on the estate grounds themselves. First, the fronds from the palm trees are trimmed annually, to reduce infestation by rodents. This produces about 10 T/ha of palm fronds (at 50 percent

moisture) per year. These fronds could be used as fuel for power production, especially in the off-season when EFBs are not available. Second, grasses grow between the palm trees in the estates. These grasses have potential as animal feeds--either by grazing livestock in the estates under controlled conditions, or by harvesting and processing the grasses for markets. Last, the wastewater from palm mills contains solids that could be used as animal feeds or as a substrate for fermentation processes.

1.3 New Product and Energy Potential from Palm Wastes

New or improved uses for these palm wastes are described below and analyzed in the report.

Energy Production By far the most important potential use of EFBs under present technology and economic conditions is as a fuel for production of heat and power.

Since EFBs are typically incinerated, it may be possible to upgrade electrical power production at palm plants by installing additional power capacity to utilize this resource. However, EFBs would have to be chopped and dried to approximately 50 percent moisture and made suitable as a fuel for potential co-firing with palm nut shells, which would entail some cost. Also, even if all of the EFBs were used for electrical generation, a 40 tons of cane per day (TCD) plant would produce about one megawatt (MW or million watts) of electricity. Because most palm oil plants are in remote areas, there may not be a market for this amount of electricity. The potential for using EFBs as a power source depends mainly on the market for electricity—either by facilities on the palm oil factory site, local users, or by transmission through the electrical grid.

A possible solution to this problem is to build power plants near existing transmission lines that would be fed EFBs from several surrounding plants. Such an opportunity exists in the Medan area, as discussed in the text, where several palm plants in the neighborhood of PTP's Adolina mill could support a power plant of some 3-5 MW. An important added advantage of power production from EFBs is that the improved combustion technology would substantially reduce the air pollution caused by open incineration.

The team recommends that the feasibility of using palm industry EFBs for electrical generation in areas close to villages, industries and transmission lines be further examined. This study should concentrate on the feasibility of establishing a central power plant in the Medan area that would use EFBs from several neighboring palm oil plants. Such plants could become the basis of biomass-based growth centers, as in the case of sugar mills.

Chemicals. The use of EFBs as a feedstock for production of furfural, a specialty solvent chemical used in plastics and paints, is currently being investigated in collaboration with foreign companies. Furfural is currently produced at few facilities, and is made, interestingly, from bagasse, cane tops and leaves in the Caribbean, and from maize cobs in the U.S. Its production would not compete significantly with such end uses as energy, however, since furfural processes consume only a small portion of the biomass.

Furfural occupies a number of small niche markets in the chemical industry and these are considered difficult to penetrate, especially in comparison to energy markets. With economic growth in Asian markets, however, the opportunity for an efficient, large scale, low cost producer of furfural may be realistic. Consideration of this option should continue through private channels.

Animal Feed. The palm industry produces meal from the palm nuts that is a valuable animal feed. It is possible that EFBs, with a residual oil content of about 10 percent could

be used as feed for ruminate animals. No written or anecdotal reports have been found on this possibility. The condensate from palm wastewater, mentioned above, is another possible source of animal feed. The moisture content of this material, however, is likely to be too high to be an economical source of feed. The fibrous fines which result from palm processing can serve as a feed for cattle and other small ruminants. Also, as noted before, the grasses in the palm estates are usable as animal feed. Each of these feed production strategies bears further research and development, as this is perhaps a high value use of the wastes.

Fertilizer. EFBs have some value as fertilizer applied directly. EFBs are typically incinerated, and the ash is applied to fields to provide potassium and potash. It should be noted, however, that applying excessive biomass back to the soil can cause loss of soil nitrogen as well as increased methane production and release to the atmosphere through processes of decomposition. Research is necessary to quantify these effects and their associated costs and benefits.

Palm oil mill effluents can also undergo microbial decomposition in lagoons or settling ponds, creating nutrient-rich irrigants for plantations. While these practices are exploited to a limited extent in Indonesia, it appears there may be scope for expanded use of these wastes through such low-cost fertilizer techniques.

Pulp. The Indonesian Planters Association for Research and Development has had samples of EFBs analyzed as a potential paper pulping feedstock and the results are reported as favorable. It appears that paper pulp is potentially one of the most important uses of EFBs in the future, especially given current pressures on Indonesia's traditional wood-based pulping feedstocks. However, the technology and economics of this use require more research before commercial prospects can be determined.

Food. As noted, the waste water condensates of palm plants can be used as a substrate for fermentation processes to produce ethanol, alcohols, monosodium glutamate (MSG), vitamins, and other possible food products, the highest value potential use of wastes. However, little is known currently about the value of these solids in either use.

Palm kernel meal contains carbohydrates which can be hydrolyzed to yield sugars which can then be fermented with grain yeast to produce potable alcohol. While the processes involved are well established, this means of producing alcohol must compete with more traditional and accepted fermentation and distillation practices.

1.4 Current Sugar Industry Wastes and Byproducts

Indonesia's growing sugar industry has 67 factories with 184,000 metric tons per day of cane processing capacity. The average size of plants is 3,000 TCD, although the capacity range is 900 TCD to 10,000 TCD. These plants process 26 million tons of cane per year, producing about 2 million tons of sugar and 1 million tons of molasses. Sugar industry growth will be significant over the next three years, with some 60,000 TCD additional capacity now being planned.

Molasses is an important byproduct of the sugar industry. It is widely used as an animal feed supplement, and as a substrate for fermentation processes yielding alcohols, vitamins, monosodium glutamate (MSG), and other food products. Indonesia currently exports about one third of its molasses production at favorable international prices of around USD 60 per ton. Exports are decreasing in order to satisfy growing domestic needs. Since molasses is a valuable product of the sugar industry, rather than a waste product, it is not a subject of this study.

Bagasse represents about 32 percent of the cane processed, or 8.3 million tons per annum at about 50 percent moisture content. Over 90 percent of the bagasse now produced in Indonesia is used in the sugar mills as fuel to produce steam and electricity. For this reason, most of the mills are self-sufficient in energy. However, since bagasse has been a virtually free energy resource with few other uses, these mills have had no incentive to use the energy in bagasse more efficiently. Consequently, the mills use low pressure boilers and low efficiency single cycle turbogenerators, requiring three to four times the amount of bagasse, when compared to efficient sugar factories, to make the necessary steam and electricity. The energy efficiency of the larger mills and many medium sized mills can be substantially increased, with substantial savings of bagasse for surplus electrical production and other possible uses. Bagasse is also used in at least three facilities as a pulping feedstock for paper and board.

As much as 30 percent of the total biomass in cane fields before harvest is in leaves and cane tops. Smallholders, mainly on Java, use a small amount of this material for animal feed, while large estates generally leave it on the ground at harvest. This material could provide a substantial additional source of biomass for the cane industry. There are costs and technical issues associated with gathering, transporting and storing these byproducts, however BEST Project research indicates that cane field residues may be a viable low cost energy source.

1.5 New Product and Energy Potential from Sugar Wastes

Electricity Production. The use of bagasse and, if economically viable, cane trash as a fuel for high efficiency electric power production is the most important diversification option for Perkebunan as well as the private sugar industry.

Indonesia's rapidly growing economy is beginning to encounter electricity shortages. Plans are underway to add some 16,000 MW of new capacity over the next 10 years, mostly from coal and natural gas. However shortages are projected by 1995, mainly in Java and Sumatera, and this will induce plant owners to continue installing diesel generators for their factories.

Biomass energy can make an important contribution to resolving this problem — especially in rural areas, where diesel use is predominant. If 25 percent of the bagasse produced in Indonesia were used for generation of electricity, about 100 MW of year-round capacity could be produced using current technology, and more than 200 more with high efficiency technology. Some 400 MW of year-round potential exists in the sugar industry using bagasse in presently available systems, and an additional 100-200 MW is possible using cane tops and leaves if this proves economic. Together, these biomass sources could provide an additional 500-600 MW, sufficient to fill 15 percent of the projected shortage of 3,000 MW by the late 1990's.

Behind the national figures lie some locally significant effects of biomass-based electricity systems. Potential electricity generation from sugar mills in Lampung province, Sumatera, could exceed 100 MW, about twice the existing diesel capacity of the province. One plant, the large 10,000 TCD private Gunung Madu factory currently has a bagasse "mountain" of some 600,000- 1 million tons, after making efficiency improvements four years ago which resulted in excess bagasse of 800 TCD. This daily excess would support a 13-14 MW power plant. Generation of power from such mills would not only replace existing diesel use but also would provide ample reserves for new industries.

Fiber. At least three plants in Indonesia are pulping bagasse for a variety of paper and board products because of the increasing prices for wood-based pulps. The newest and

largest plant, P.T. Tyiwi near Surabaya is privately owned; the study team was not permitted to see it. There is also a public sector plant, P.T. Leces near Propolinggo. It appears that paper pulp may be an important use of bagasse in the future; however, the economics of this use may not compare with its value as a fuel for electricity, and technical opportunities for improvement require more study.

Bagasse is being used in Thailand and Pakistan to make an extruded fiberboard that is used to make furniture as well as construction materials. These are generally small, low-cost plants, and this potential use should be investigated further.

Animal Feed. Molasses is widely used for animal feed. Bagasse is too low in nutrient value for this purpose, however, the team found reports of pilot plants in Brazil which hydrolyze bagasse to produce a more digestible feed. There are four or five plants in Indonesia that use fresh leaves stripped from the sugar cane in the fields to produce animal feed that is exported. The study team visited two of these plants each of which produces around 40 tons (air dry) of baled cane leaves per day. It is anecdotally reported that there is an optimal level of leaf stripping that improves the yield of the cane, but too much stripping decreases yield. It is unknown what that optimum level is or whether stripping is done accordingly.

Food. The major food use of byproducts is the use of molasses as a substrate for fermentation processes to produce ethanol, alcohols, monosodium glutamate (MSG), vitamins, and other possible products. Ethanol, or potable alcohol, is being produced by a public sector plant, and MSG is produced by a Japanese-operated private sector plant, near Surabaya. The proprietary nature of many of these processes and products precludes their coverage in this report.

Electricity Economics. The study's preliminary economic analysis of electricity production by the sugar industry indicates that highly favorable returns on the order of 20-40 percent per annum can be obtained by *designing large, new sugar mills for electrical production*, or by *including such capabilities in expansions of existing mills*. These returns are possible because the additional cost of improving new power plants is relatively low. For existing mills, it may not be economically feasible to convert to high efficiency systems until the existing equipment needs to be replaced. However, modest efficiency improvements in sugar processing can often result in low power generation normally below the current costs in the PLN system (Indonesia's state-run power utility). These measures are discussed and analyzed in the report.

Excess bagasse production would become a major source of revenue if it could be converted to electricity and sold. In Hawaii, electrical production from sugar mills provides about 12 percent of the state's electricity and has become a major source of profit for the mills. One of the greatest sources of uncertainty in Indonesia, however, is that of government policies for generation and sale of electricity by the private sector and other non-PLN organizations. PLN has announced its willingness to purchase electricity from other producers but terms and conditions are not yet clear. The study examines these issues with regard to sugar industry concerns.

The study team recommends that site specific studies be made of the technical, economic and commercial feasibility of designing new large and medium sugar cane mills to high efficiency standards with electricity export. Further, the team recommends site-specific feasibility studies for factories which are planning overall expansion or replacement of their power facilities. The team learned that one 4,000 TCD public sector plant, P. T. Gempolkrep, is being planned for expansion to 6,000-10,000 TCD in the Mojokerto area for operation in 1994, and four similarly sized plants are being planned by the private

sector in Lampung, southern Sumatera. Each of these plants could generate about 30 MW of electricity, using high pressure equipment, exporting 20 MW. Investigations of similar opportunities in Thailand showed returns on investment in the 30-40 percent range, even where the mills sell some bagasse to fiberboard factories. In addition to the focus on new or expanding mills, the team recommends that a follow-up team look at several existing mills and investigate ways of making such mills net electricity exporters.

New power facilities could establish the basis for biomass-based growth centers in which industries producing such products as animal feeds, vitamins, MSG, alcohols, fiberboard and other products would be located on the grounds of sugar factories. The factories would provide these industries with reliable low cost energy supplies.

Last, the study recommends that Perkebunan actively solicit investments by the private sector in furfural, vitamins, fiberboard, alcohols and other products noted above. The BEST project could be able to assist Perkebunan in this task by assisting in making contacts with private sector firms. Continued support for research in the sugar and palm industries and their byproducts is essential to full utilization of these valuable resources.

1.6 Recommendations

The summaries above point to a number of recommended actions for diversification of Indonesia's sugar and palm oil industries, concentrating on power options. These are listed in the table below.

Table 1. List of Study Recommendations

Recommendations for the Palm Oil Industry
1. Examine the feasibility of using EFBs for small-scale electrical generation; focus on combustion feasibility, combining wastes from several mills, and development in areas close to villages, industries and transmission lines.
2. Continue pre-investment analysis for furfural from EFBs.
3. Research and develop animal feed production strategies.
4. Investigate the technology and economics of EFB use as potential paper pulping feedstock.
Recommendations for the Sugar Industry
1. Conduct targeted case studies of the technical, economic and commercial feasibility of designing new mills to high efficiency standards with electricity export; investigate factories planning expansion or replacement of their power facilities.
2. Examine power markets and investment potential for sugar industry power plants, especially in light of new national private power policy.
3. Continue research and market studies for use of bagasse as feedstock for domestic paper and board production.
4. Continue to solicit sound joint venture investments in high value food products (e.g., potable alcohol, MSG) based on molasses.

2.0 INTRODUCTION

2.1 Background to the Study

Perkebunan, the Indonesian holding company for state-owned sugar and palm oil production companies, has embarked on a program of diversification of its agro-industries. In this, it has retained private advisory services on foreign investor interest and, in May 1990, it requested technical assistance from the Jakarta Mission of the U.S. Agency for International Development (USAID/Jakarta) and the USAID Biomass Energy Systems and Technology (BEST) Project managed by Winrock International in Washington, D.C. Despite its state ownership, *Perkebunan's objective is to enter into joint ventures with foreign private investors in new enterprises* based on Perkebunan agricultural estate resources and processing facilities.

The main focus of this study is biomass energy development based on processing wastes from the sugar and palm oil industries. While a variety of new agro-industrial and biomass-based product options are technically possible, any new activity by Perkebunan will require new process energy and electric power. Energy production by the sugar industry is a proven and profitable commercial strategy in the U.S. and a number of countries, and in the oil palm industry broad-based energy research suggests energy development as a potential strategy as well.

At the same time, rapid economic growth in Indonesia is creating enormous pressure on the power sector. In order to avoid shortfalls in electricity, the Government of Indonesia is seeking to implement a policy of private sector development of new power facilities. Similar to Perkebunan's strategy to engage foreign private investment in its diversification, the purpose of this policy is to stimulate accelerated development of needed sources of energy and to lessen public debt accumulation by state bodies by engaging private investment in the energy sector. This strategy is strongly endorsed by USAID.

The study was conducted by a team of specialists fielded by Winrock International and Perkebunan in September-October, 1990. The team sought to identify opportunities for waste-to-energy projects within the sugar and palm oil industries. Such projects would use processing wastes -- bagasse from the sugar industry, fruit bunches and other wastes from the palm oil industry -- to generate steam and/or electricity for use by these industries and associated by-product industries which may be based on sugar cane and palm oil. Improved energy production would displace the use of fuel oil and the purchase of electricity, increasing Perkebunan's profits and energy reliability, and providing incentives for additional value-added product diversification. Energy production in these industries may also permit the sale of electricity outside the sugar or palm oil complex, such as to adjacent communities, light industries or the electrical grid network, thus providing a new source of revenue to the rural sector.

This preliminary industry survey, Part I, is designed to determine the basic commercial plausibility of sugar or palm oil energy projects. Part II of this study will be a series of case studies of electric power investment potential at a number of promising sugar factories.

2.2 Economic Trends

The 1970's marked a period of strong growth for the Indonesian economy. GDP growth averaged 7.5 percent per annum, with rapid growth continuing through 1981. In 1982, however, the slowdown of the global economy and the fall in the price of oil caused a sharp reduction in the Indonesian GDP, which fell to 2.3 percent. Since 1982, Indonesia

has undergone a period of strong growth, which reached 4-5 percent in 1987-89 and 7.0 percent in 1990. This growth is projected to continue in the near future.

The return to rapid growth has been largely attributed to economic reform measures which have been undertaken by the Indonesian government. The reforms focus on growth in non-oil exports as a major engine of economic expansion. This policy has proven to be effective. Indonesia's reformers have chosen a market-oriented strategy to promote greater competition and efficiency. Although manufactured exports have grown substantially over the past three years, Indonesia remains primarily an exporter of raw, unprocessed commodities. As such, the country is vulnerable to any major slowdowns in the world economy.

Repelita V, the fifth official five-year development plan, began April 1, 1989. Its major economic targets include real growth in agriculture and oil, but especially in the non-oil industrial sector. New investment is expected to total Rp. 239.1 trillion (approximately USD 128 billion) over the five-year period, with the private sector contributing 55 percent of those needs. The development of the mining and energy sectors remains a high priority for the government.

2.2.1 Investment Climate

Indonesia is pursuing an aggressive investment policy encouraging both domestic and foreign investment. It has removed foreign exchange controls and the rupiah is freely convertible. It is unlikely that the government will pursue a policy that would include devaluation of the currency, protecting the value of domestic investments.

Investment in Indonesia is coordinated through the Investment Coordinating Board (Badan Koordinasi Penenaman Modal—BKPM), which is also responsible for investment policy. Reportedly it has made an effort to streamline application procedures and to speed up response times for investors. Considerable information concerning taxation, guarantees, banking, export procedures, and related business concerns is available from a variety of sources.[1]

According to the BKPM, foreign investment approvals in 1988 were USD 4,407 million. This figure is 53 percent above the previous peak of USD 2,282 million in 1983. Domestic investment approvals were much higher at USD 8,681 million. This record setting figure was 12 percent above the highest ever level of USD 7,747 million reached in 1983. In 1990, investment in Indonesia totalled USD 80 billion.

2.3 Energy Sector Trends

The oil and mineral industries have played a critical role in Indonesia's economic expansion over the past 25 years. Before the fall in oil prices in the late 1980's, oil accounted for over half of Indonesia's exports, and a comparable amount of foreign exchange earnings and government revenues. Between 1986 and 1989, the proportion of exports contributed by oil dropped from 51 to 39 percent.

There is an increasing awareness of the importance of resource conservation in Indonesia. With economic expansion and the government's aggressive pursuit of manufacturing

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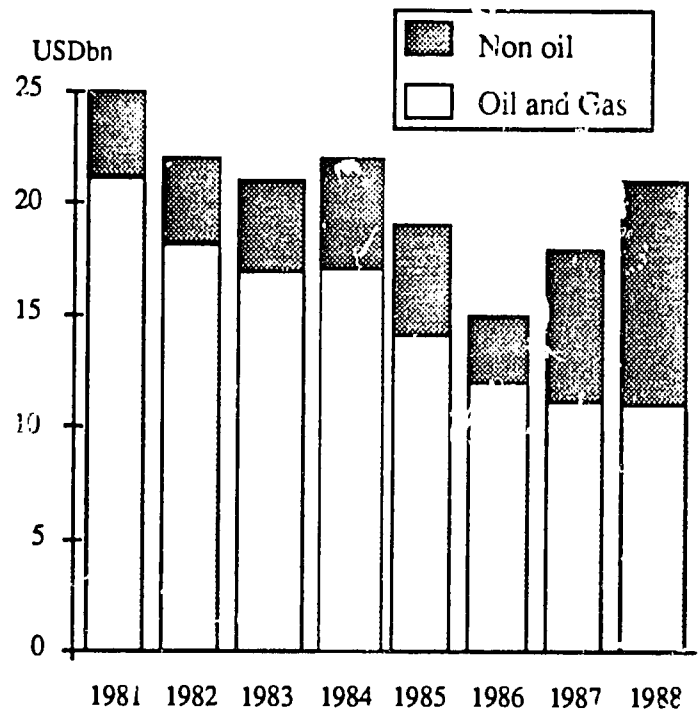
[1] E.g., U.S. Department of Commerce, U.S. Overseas Private Investment Corporation (OPIC), ExIm Bank are good sources of investment and trade information. Additionally see Doing Business in Indonesia, Price Waterhouse Correspondent Office, Jakarta, 1990.

industries and non-oil exports has come a rapid increase in domestic oil demand. Quantities available for export are expected to decrease steadily in the absence of major new discoveries, and Indonesia should become a net oil importer around the year 2000.

The oil economy has also led the way in Indonesia's policies promoting foreign participation in the economy. Since 1967, 144 contracts have been signed between the state-owned oil company, Pertamina, and foreign contractors, many of which are active today. The government has instituted incentives to encourage more rapid exploration and development, and has also encouraged greater use of natural gas for liquefied natural gas (LNG) exports and for domestic electric power development.

In addition to oil, coal development is beginning to increase from a low level of some three million tons annually; coal is being developed both for export and for electric power production. These energy sector trends signal an overall pragmatic approach to growth and foreign investment.

Figure 1
Changes in Oil Prices and Indonesia Exports



	1981	1982	1983	1984	1985	1986	1987	1988
Oil Price	38.50	36.00	33.75	30.00	29.00	22.50	18.50	18.00

[Avg. world price, USD/Barrel (1988 Dollars)]

From: Price Waterhouse, Doing Business in Indonesia, Jakarta, 1990, p. 13.

2.4 Private Electric Power Policy

Indonesia has instituted a private power policy in recent years, based largely on Law 15/1985, which is designed to facilitate and expedite private sector participation in electricity production. The purpose of this policy is to lessen the accumulation of state debt from continued expansion of the PLN power system. USAID has supported this policy strongly, most recently by providing a resident advisor and related technical assistance to help develop the policies, regulations, and contracting procedures needed for implementation of new private power investments.

As of January 1991, the government had received at least 24 expressions of interest from private companies to finance and build power plants. Few of these detailed concrete project proposals, most have been general expressions of interest. These have been largely stimulated by public invitations by the government to industrialists in the local press. To this date, however, no specific policy statement, regulations, or price guidelines have been issued by the government.

The lack of a formal set of regulations for private power is seen as an important stumbling block to the development of this market. Therefore, priority efforts of USAID's private power technical assistance are to help formalize these procedures. Other areas which remain without adequate guidance are environmental issues; power purchase and implementation agreements; taxes and duties; and investment guarantees. It is intended that these issues will be addressed in early and mid-1991.

Private power policy is based in the Directorate General for Electricity and New Energy (DGENE), in the Ministry of Mines and Energy. DGENE's Director General serves as Chairman of the Private Power Team, established by decree number 0666 K/702/M.PE/1990. Vice Chairmen of this team are the Director for Development of Electrification, DGENE, and the President of the State Electricity Company, PLN. Other members of the team are from the Investment Coordinating Board (BKPM), the Agency for the Assessment and Application of Technology (BPPT), and the Ministry of Finance. This team is viewed as a group of senior decision makers in the Indonesian Government.

The Paiton project in East Java, east of Surabaya, has been the focal point for private power activities for the past year. The large scale of this 1,200 MW coal-fired project with an estimated capital cost of USD 1.2-1.5 billion, has tended to dominate private power policy discussion. In addition, the project involves partial PLN ownership. As currently envisioned, it will be implemented under a build-own-operate (BOO) arrangement, but many contractual arrangements are yet undecided.

Despite a somewhat confusing initiation of this high profile energy sector policy, it appears clear that private power will become a major business in Indonesia. Because of its diverse primary energy resources, and because of the varying electric power demand characteristics in different areas of the country, Indonesia is suited for application of all types of commercially proven power technologies at a variety of scales. Projects dependent on this evolving policy will need to maintain current information on the private power situation.

3.0 PALM OIL DIVERSIFICATION

3.1 Industry Background

The oil palm was first introduced to Indonesia in 1864 and descendents of these original plantings can still be seen in the botanical garden in Bogor. Palm oil originally developed in the northern part of Sumatera and then expanded to other regions of the country. The plant was successful in achieving high yields and slowly became an important crop for domestic use as well as for export markets. With the drive to expand non-oil exports, palm oil has been one of the principal agricultural commodities promoted. Over the twenty year period ending in 1988, palm oil production increased by over 350 percent. Today, palm oil represents the second most important agricultural export from Indonesia, exceeded only by rubber.

The area under palm oil is expected to continue to show rapid expansion. During 1989, over 110,000 ha was planted for a 13 percent increase in the total palm oil area. By 1993, the area under palm is expected to reach 1,200,000 ha. This rapid growth has taken place in all enterprise categories, but the growth has been especially strong in the locally owned private estate category (see Table 2, below). Palm oil has been designated by the government as the primary crop for developing the private sector during the current five year plan (*Repelita V*).[2]

Most of the government palm oil plantations (PTP's) pre-1980 were located in North Sumatera. In the last decade ten of the other 25 provinces including the eastern-most province of Irian Jaya have been rapidly developing new estates. Perkebunan operates 52 of the 83 palm oil mills in Indonesia. (See Annex 1 for a location, capacity and ownership list of palm oil mills.)

Table 2. Palm Oil Land Areas by Type of Enterprise, 1988.

Enterprise	Mature area	Immature area	Total area
		Hectares	
Government estates	288,095	69,902	357,997
Private estates:			
Joint venture	56,564	12,564	69,162
Locally owned	77,382	129,688	207,070
Small holders	21,816	36,473	58,289
Nucleus small holders	58,632	84,193	142,825
Total area	502,489	332,854	835,343

Indonesia's palm oil development is expanding somewhat more rapidly than total world growth in palm oil production (see Table 3). Over the four year period, 1984 to 1988, palm oil production increased by 39 percent in Indonesia compared to a 26 percent increase

2 The overall development of palm oil estates has been facilitated by the Ministry of Agriculture. The government unit for state owned corporations (Badan Usaha Milik Negara) has been in charge of coordination of government estate development. Other estate development, especially small holders, has been coordinated through the Directorate for Estate Crops in the Ministry of Agriculture.

for the world as a whole. During this same period, Indonesia's market share of the total world supply increased by nearly two percentage points.

Table 3. Indonesia Palm Oil and Palm Kernel Production Compared to World Total 1984 to 1988 (tons 000)

Year	World production		Indonesia	
	Palm oil	Palm kernel	Palm oil	Palm kernel
1984	6,942	2,415	1,121.1 (16.2%)*	293.3 (12.1%)
1985	7,587	2,628	1,297.9 (17.1%)	259.8 (9.9%)
1986	8,279	2,783	1,357.4 (16.4%)	274.9 (9.9%)
1987	8,733	2,840	1,406.0 (16.1%)	311.0 (11.0%)
1988	8,774	2,957	1,562.3 (17.8%)	345.0 (11.7%)

* Figures in parentheses indicate Indonesia production as a proportion of world production.

Prices of crude palm oil (CPO) for domestic use are regulated by the government through the Ministry of Trade. The objective of regulated prices is to insulate domestic producers from international prices which, like the prices of other agricultural commodities, tend to vary significantly over brief periods of time. This policy has given stability to domestic products produced from CPO, particularly cooking oil.

There are two principal reasons why the international palm oil prices exhibit a high level of variation. On the supply side, changes in rainfall in producing countries may cause yield and production variations from one year to another. On the demand side, changing trade policies in consuming nations along with production variations in substitute crops (e.g., soybean oil) can lead to significant changes in quantities of palm oil needed from one year to another. Table 4 shows the recent history and variability of prices for the various palm oil products for the export market.

Table 4. Average export prices of palm oil products from government estates (- USD/lb -)

Commodity	1987	1988	1989
Crude palm oil	0.2821	0.3792	0.3009
Palm kernel oil	0.3767	0.4747	0.3832
Palm kernel pellet	0.0548	0.0765	0.0788
RBD palm oil	0.2835	----	0.3062
RBD palm stearine	0.2805	0.3827	0.2687
Crude palm stearine	----	0.3795	----

The price for CPO received ex-factory is a composite of the controlled domestic price and the varying international price. With about 60 percent of current production being exported, there is still great price variation caused by changes in the international prices.

With increasing levels of demand for cooking oil in the domestic market, the relative proportion of exports is expected to decrease. This will have a stabilizing effect on domestic prices for CPO (See Table 5).

Table 5. Palm Oil, Palm Kernel and Palm Kernel Oil Utilization (T)

Year	Domestic consumption		Export		
	Palm oil	Palm Kernel	Palm oil	Palm Kernel Nuts	Palm Kernel Oil
1984	993,200	230,100	127,900	9,160	0
1985	779,900	237,300	518,000	22,500	0
1986	852,903	0	504,497	3,937	42
1987	935,120	0	470,880	0	83,302
1988	901,210	0	661,097	0	121,724

3.2 Palm Oil Processing

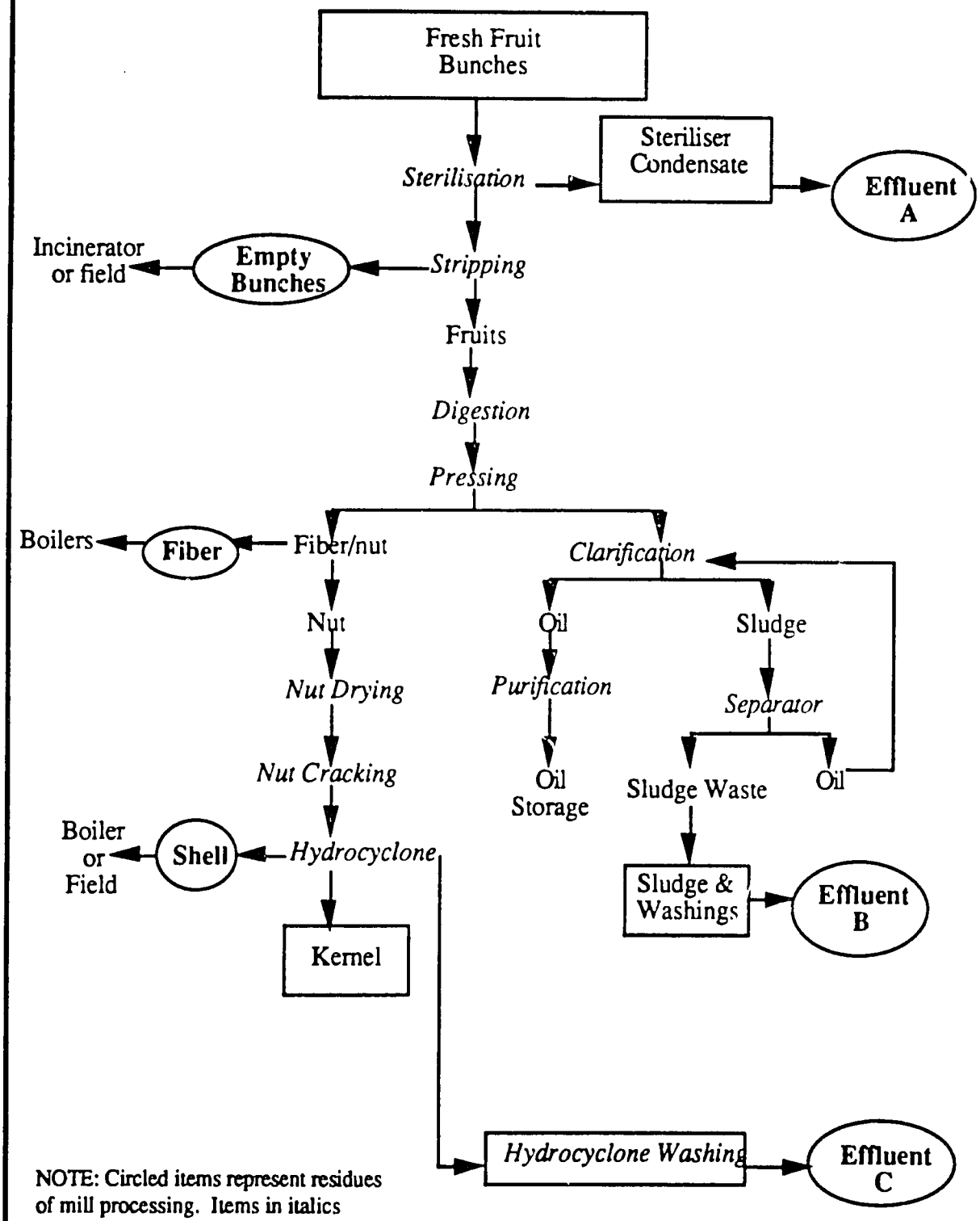
Palm oil is harvested as fresh fruit bunches (FFB) throughout the year. The normally expected range of production varies from 12 to 15 tons of FFBs per hectare, depending on genetic characteristics and cultivation practices. Per hectare, a stand of 136 oil palms will produce, on average, 2,689 kg of palm oil and 363 kg of palm kernel oil, the principal commercial products, and waste products. The plantation will also produce palm fronds. (A complete material balance for palm plantations and mills is shown in Annex 2.)

The FFBs are brought by trucks or other transport to palm oil mills. These vary in size, energy characteristics and some practices. Palm oil mills process the FFBs to extract the crude palm oil (CPO). The byproducts of this process include the palm kernel, empty fruit bunches (EFBs), and the fiber from the exterior fruit. The palm kernel is then crushed to produce palm kernel oil (PKO) with empty shells being a byproduct of this process. Palm oil and palm kernel oil are the main economic products along with palm kernel meal. Figure 2 shows the basic processing steps and material flows for palm processing.

Palm oil wastes thus include the stripped fruit bunches, which are typically incinerated with no heat recovery or field disposal, pressed palm fruit fiber and palm kernel shells, which are typically fed to factory boilers for process energy, and several streams of palm oil mill effluent/sludge, which are disposed in rivers and on land.

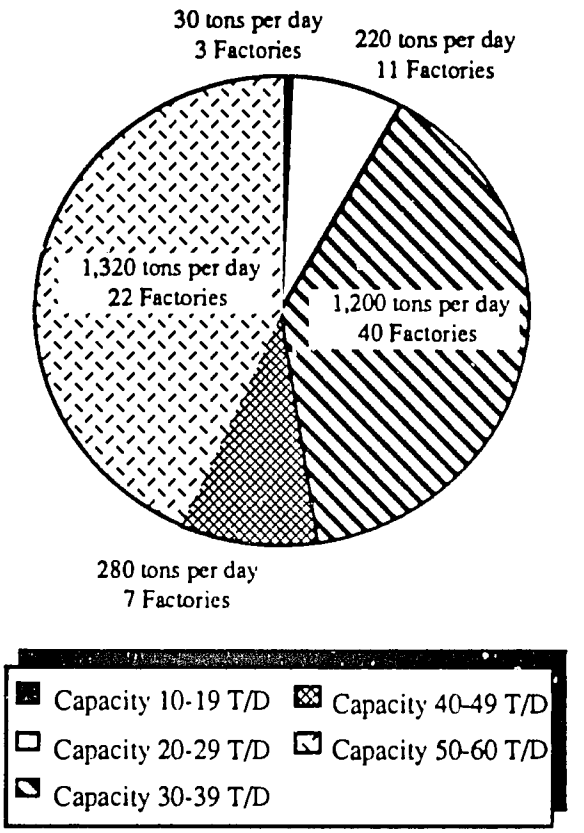
In terms of steam and electricity, practically all mills use the palm fruit fiber and kernel shell from palm oil manufacture for process heat. In some cases mills also produce electricity and mechanical power, but practically all are known to use diesel generators for supplemental power; cogeneration appears to be growing in practice. Many mills are in areas not served by the PLN electrical grid; thus to the extent that excess power potential exists there may be ready markets for Perkebunan-supplied energy. As with the sugar industry, energy potential may be large. Figure 3 shows the capacity of palm mills ranked by scale and total processing capacity.

Figure 2
Palm Oil Process and
Waste Flowchart



NOTE: Circled items represent residues of mill processing. Items in italics require energy inputs.

Figure 3
Capacity of Palm Oil Mills by Scale
Total Capacity (metric tons per day)



The most commonly used boiler type is a low pressure water tube boiler. If the mill and boiler operate 20 hours per day, the solid fuel from the fiber and shell is sufficient for the boiler consumption needed for processing the FFBs. However, if the mill is operated for less than 20 hours a day, the factory will usually experience an insufficient supply of fuel to keep the boiler operating. Thus, energy needs are often supplemented with diesel generator sets or publicly supplied electricity sources.

While the fiber and shells are currently being used entirely as a fuel for the boilers, the other main waste product, EFBs are usually burned in incinerators at the palm oil mills. Another means of disposing of this waste is to return the EFBs to the estate fields as a source for organic matter. The more generally used practice of burning the EFBs creates an air pollution problem from the formation of CO and NO_x gases. This practice will likely be decreased as environmental regulations come into effect, although the ashes which are rich in K_2O can be used as fertilizer. By 1993 the palm oil crop in Indonesia will produce 3

million tons of dry empty bunches, the majority of which will be produced in the provinces of North Sumatera and Riau. Because of the large volume being produced, it is important to find an attractive economic use for the EFBs. Present use of palm oil wastes is shown in Table 6.

Table 6. Utilization of Palm Oil Waste Products

Waste product	Used	Unused	Total
		T millions -	
Palm oil:			
Empty fruit bunches	0	3.0	3.0
Fiber	1.3	0	1.3
Shells	0.2*	0.2*	0.4
Palm tree fronds	0.0	6.0	6.0
Total	1.5	9.2	10.7

* = Estimated

3.3 Improved Use of Palm Wastes

New product development under consideration in the palm oil industry includes the use of fruit bunches as a pulp and chemical feedstock, use of fruit fiber wastes and kernel meal as animal feedstuffs, and greater energy production. The following sections review these diversification options.

3.3.1 Energy Production Potential

There has been considerable research in use of palm oils as a diesel substitute and in anaerobic digestion of effluents for production of methane gas; neither of these has evolved into commercial practice. As noted previously, better opportunities are likely to exist in improved mill energy efficiency and possible surplus production of power.

Palm oil mills are generally smaller than sugar mills, processing up to 1,000 TCD of FFBs (compared to over 10,000 TCD in some sugar mills). Presently, the practice of burning the fiber and shells in the palm oil mill is done inefficiently in most mills, barely generating sufficient steam and power for the milling process. It has been calculated that the EFBs, left over generally to be incinerated and/or returned to the soil, contain sufficient energy to power the entire oil processing plant (e.g., margarine) which often accompanies a palm oil mill. For example, the EFBs from a 40 T/hour (FFB) oil palm mill could generate over one MW of electricity.

The caloric value of palm oil wastes depends on the level of moisture in the particular waste. The general values, shown below, are comparable to biomass fuels being used in power systems throughout industrialized economies. The full energy balance for a 136 tree oil palm stand on one hectare is depicted in Annex 2.

The use of EFBs as a fuel requires adjustments to be made in the boiler burner, along with other changes such as the use of dryers and a hammermill or "monomuncher," which would be used to cut and compress the EFBs. Early studies on the use of EFBs as an additional solid fuel for boiler consumption indicated the net energy gains from burning the

EFBs would not be very high after deducting the energy used to prepare the EFBs. However, it is felt that these studies need updating to take account of new developments in biomass fuel processing.

Waste Product	Dry matter weight (%)	Caloric value (BTU/lb)
Fiber	50 - 80	3,000
Shell	40	4,200
EFB	40	3,400

The increased cost of biomass power systems which could accommodate EFBs would allow a tradeoff in reduced incinerator investment. The incinerators used to burn off the EFBs themselves require a relatively large capital investment. A mill capacity of 30 tons FFB per hour generally requires two incinerators with an approximate total cost of USD 200,000. Maintenance is also required because the incinerator can easily break up through overheating.

Total Indonesia power production potential from use of waste EFBs is in the range of 200-300 MW. One of the critical considerations for efficient energy production, achieving sufficient economies of scale, suggests looking first at locations where several palm mills could provide waste EFBs to a centralized power station and where electricity markets are in deficit. Because most palm oil plants are in remote areas where power demands are weak, realizing this potential would require the existence of power consuming facilities on the palm oil factory site, local users, or transmission lines to the larger power grid.

One such centralized plant opportunity exists in the Medan area, where several palm plants in the neighborhood of PTP's Adolina mill could support a power plant of some 3-5 MW. An important added advantage of power production from EFBs is that the improved combustion technology would substantially reduce the air pollution caused by open incineration.

3.3.2 Furfural

One potential end use for the empty fruit bunches is the manufacture of furfural and furfural alcohols. Using a weak acid hydrolysis process, the 20-22 percent of the EFB dry matter that is pentose sugar can be separated from the cellulose and fermented. One kilogram of pentose can produce 0.64 kilograms of furfural. Thus, one metric ton of (wet) EFBs can produce 128-140 kilograms of furfural. In theory, the 1.2 million tons of EFBs produced annually in Indonesia can produce more than 150,000 tons per year of furfural, more than the present world production of about 123,000 tons per year.

Furfural occupies a number of small niche markets in the chemical industry and these are considered difficult to penetrate. With economic growth in Asian markets, however, the opportunity for an efficient, large scale, low cost producer of furfural may be realistic. It should be recognized, however, that large scale new production of furfural could result in prices lower than current prices of USD 1.50 - 1.85 per kilogram.

Major feedstocks for furfural production worldwide include corn cobs, bagasse, and oat bran. These materials generally store poorly (pentose deteriorates, reducing yields) so that access to excess and fresh raw materials is crucial to the success of the business, a factor favoring production in Indonesia.

On the marketing side, furfural and its associated byproducts, furfural alcohols and tetrahydrofuran, a solvent, sell for just 15 percent or more than the furfural itself. Both domestic and external markets may be of interest to potential producers in Indonesia.

On the domestic side, the major potential end uses include the following. The last use is of particular interest, given the growing forest products industry in Indonesia.

* Solvent for lubricating oils;
* Phenolic resins for foundry use; and
* Additives for plywood glues (from byproduct).

Outside the country, the major export markets are Japan, Korea, and Taiwan. In addition, Hong Kong might prove to be a small market, especially for plywood glues. Potential end uses in the export markets include all of the above plus solvents for butadiene extraction and general solvent uses for the tetrahydrofurans. It is not known at this time what other regional competition might exist for these export markets. However, potential competitors in the furfural market include India, Australia, Malaysia, Thailand and China. As in the Western Hemisphere, furfurals are market limited, not production limited, and significant overcapacity could easily occur given the abundance of feedstocks.

About 60 percent of the total world production of furfural originates in the United States. Given the relatively small market for the product and its derivatives, any proposal to expand furfural production should be evaluated carefully, in full knowledge of the implications for prices. It is possible that one or two plants could be built in Indonesia, collecting EFBs from several palm oil mills. However, if the experience in the Western Hemisphere is any guide, production is not likely to occur continuously, given the thin and erratic nature of the market.

3.3.3 Animal Feeds

Ruminate animals such as dairy and beef cattle require two types of feeds, namely roughage (high fiber - low protein) and concentrates (high protein and low fiber). Both types of feeds are in high demand in Indonesia, but roughage is in particular demand on Java, where the availability of grazing land is extremely limited. The production of cattle feeds represents another important potential use for the waste products of palm oil mills.

Another possible raw material source for feeds are the fiber and EFBs from the processing of oil palm. EFBs would appear to be an attractive cattle feed, composed of carbohydrates, protein, fat, vitamins, and minerals. However, because they contain high levels of lignocellulose, the EFBs and fiber cannot be used directly and must be hydrolyzed to break down the lignocellulosic bonds. There is little known commercial experience for processing EFBs into a digestible feed.

Various liquid effluents from the processing of palm oil may also have potential as constituents in the production of animal feed. Effluent solids contain nitrogen and phosphorus which are critical elements for metabolism and growth of cells. The fibrous fines can also be used as a feed for cattle and small ruminants.

3.3.4 Pulp

With an expanding population and increases in incomes, the demand for paper in Indonesia is increasing rapidly. From 1981 to 1986, total consumption of paper increased by 34 percent; still, Indonesian use of paper is likely to grow considerably (See Table 7). During the same period, importation of pulp for the paper industry increased from 86,000 to

255,000 tons. As the major raw material, there is an increasing need and growing domestic market for paper pulp. For comparison, paper consumption in other ASEAN countries is shown in Table 7.

Table 7. Paper Consumption per Capita (kg) in ASEAN Countries, 1981-1985

Country	1981	1982	1983	1984	1985	Average
Indonesia	3.66	4.20	4.00	3.92	4.25	4.01
Malaysia	30.29	25.42	27.46	31.24	26.00	28.08
Philippines	8.09	7.20	7.64	7.64	7.36	7.59
Singapore	125.41	115.95	120.83	100.01	87.00	111.64
Thailand	9.89	12.74	12.09	12.48	12.25	11.89

Source: ASEAN Pulp and Paper Industry Club (APPIC)

At the present time, modest research is being conducted on the use of EFBs as a pulping feedstock. Sterilized EFBs containing 72% moisture, 20% crude fiber, and 8% ash are currently being used on a laboratory scale to produce pulp for fine paper manufacture. The pulp is produced using a chemical sulfate process. In the present study, little information could be obtained about these options.

3.3.5 Other

Vitamins, Proteins and Industrial Chemicals.
Palm oil wastes can be used to produce several other products, including vitamins, proteins and human foods through the fermentation of the sugars in carbohydrates, or using various processes such as enzymatic hydrolysis to decompose cellulose. Within this group of products, vitamin B_{12} is said to be particularly promising. These products require practical testing to verify the economic returns.

4.0 SUGAR INDUSTRY DIVERSIFICATION

4.1 Industry Background and Policies

Sugar has long been identified as a basic agricultural commodity in Indonesia and, along with cane production, has been the object of various governmental policies and controls. The main goal of these policies has been to regain sugar self sufficiency which Indonesia enjoyed prior to independence. The results have been mixed: Indonesia presently produces about 90 percent of its total consumption, and has maintained this level for several years despite industry growth.

On Java, cane cultivation is in increasingly severe land use competition with food crops, in particular rice. Given the priority placed on maintaining Indonesia's current status of rice self sufficiency, it is generally agreed that further expansion of sugarcane production will take place off Java. This approach has been incorporated into Indonesia's overall strategy for agricultural development of the outer islands. However, the capacity to utilize land areas off Java is limited by capital and manpower constraints. Under these conditions, private enterprise is being requested to take a more active role in developing the sugar industry on the outer islands of Indonesia.

The distribution and marketing of sugar has been controlled by BULOG (State Commodity Agency and Logistics Board) since 1982. This government body has the mandate to maintain adequate supplies of sugar at prices which are considered reasonable and stable. The sugar price policy in Indonesia has attempted to maintain a competitive balance between sugar and other commodities, particularly rice. Production side incentives of sugar price regulation are implemented by setting ex-factory prices for sugar through annual governmental decrees (see Table 11). This includes setting price incentives to maintain the level of farmer and sugar factory incomes and, as noted, encouraging the development by the private sector of new sugar factories on the outer islands. Retail prices for plantation white sugar are controlled by the government as well.

Private sugar producers have responded by seeking more autonomy in the marketplace. Measures which have recently been requested by private producers include:

* The opportunity for direct sales of 50 percent of the sugar production on Sumatera and 75 percent of sugar production from factories in eastern Indonesia.

* Permission to sell 30 percent of their production at FOB price to BULOG whenever the world market price is higher than domestic prices.

An important obstacle holding up the development of new plantations is the general lack of infrastructure in the areas available for expansion of sugarcane production. In this respect, government assistance is expected to be forthcoming.

The Indonesian Sugar Council, Dewan Gula, formed by government decree in 1982, is another partner providing institutional support for the sugar industry. The Council includes representation by all major directorates and government bodies related to agriculture and maintains linkages to the Indonesian Sugar Research Institute. (The organizational structure of the Dewan Gula is shown in Annex 6.) Other policies and programs aimed at increasing sugar production include the implementation of the Tebu Rakyat Intensifikasi, or small sugarcane farmers intensification program, rehabilitation of sugar factories on Java, erection of new sugar factories on the outer islands, strengthening of the government estate enterprises, and improving the marketing and pricing operations of BULOG.

The estimated current cost for establishing a sugarcane estate and sugar factory with a capacity of 4,000 TCD is about Rp 140 billion. Although available feasibility studies would not indicate high returns to the investment, private investors have shown continued interest in the possibilities of developing sugar plantations and factories on the outer islands.

4.2 Sugar Production Statistics

Recent production statistics show a relatively constant level of sugar production. The area under sugarcane has increased steadily over the past five years, but the industry has not realized corresponding increases in sugar production. This results from slightly lower cane production per hectare and cane sugar content (Table 8). Given constantly increasing population and an increasing level of per capita consumption of sugar, the potential for achieving self sufficiency in sugar production in Indonesia would not appear to be positive in the next few years. In fact, the projected sugar balance sheet for the period 1990 to 1993 indicates maintaining sugar imports equivalent to about 15 percent of total consumption (see Table 9). The apparent sharp increase in imports for 1990 indicates a change in government policy with respect to stock maintenance, moving from a stock position of between 800,000 to 900,000 tons to a goal of 1,500,000 tons of sugar.

At the present time, there are 67 sugar factories in Indonesia with crushing capacities ranging from 1,000 to 10,000 metric tons of cane per day (TCD). The trend is toward larger sugar factories, with six planned at 6,000-10,000 TCD, and three at the 4,000-6,000 TCD scale (see Figure 4). The total crushing capacity of sugar factories in Indonesia is 181,000 TCD, with 134,000 TCD or 74 percent on Java and 47,000 TCD on the outer islands (see Annex 4). Indonesian sugar companies harvested nearly 27 million tons in 1989, and sugar production was over 2 million tons.

The milling season in Indonesia is from January to October on Sumatera, and April to December on Java, Kalimantan and Sulawesi. The duration of the milling season ranges from 30 to 200 days. Most of the factories in Indonesia are using a double sulphitation process to produce white crystal sugar, except for 10 sugar factories which are using the double carbonation process.

Table 8. Cane Area and Sugar Production, 1985-1989

Year	Cultivated Area (ha)	Cane per ha (T)	Sugar Content (%)	Rende-ment (T/ha)	Cane Production (T)	Total Sugar Production (T)
1985	277,709	76.3	8.14	6.21	21,194,963	1,725,386
1986	316,033	79.5	8.05	6.40	25,127,096	2,022,387
1987	337,531	77.0	8.20	6.32	26,000,751	2,132,036
1988	329,467	76.6	7.60	5.82	25,234,864	1,917,422
1989	340,035	78.8	0.64	6.02	26,811,513	2,047,375

Source : Indonesian Sugar Council (Dewan Gula)

Figure 4 Capacity of Sugar Mills by Scale

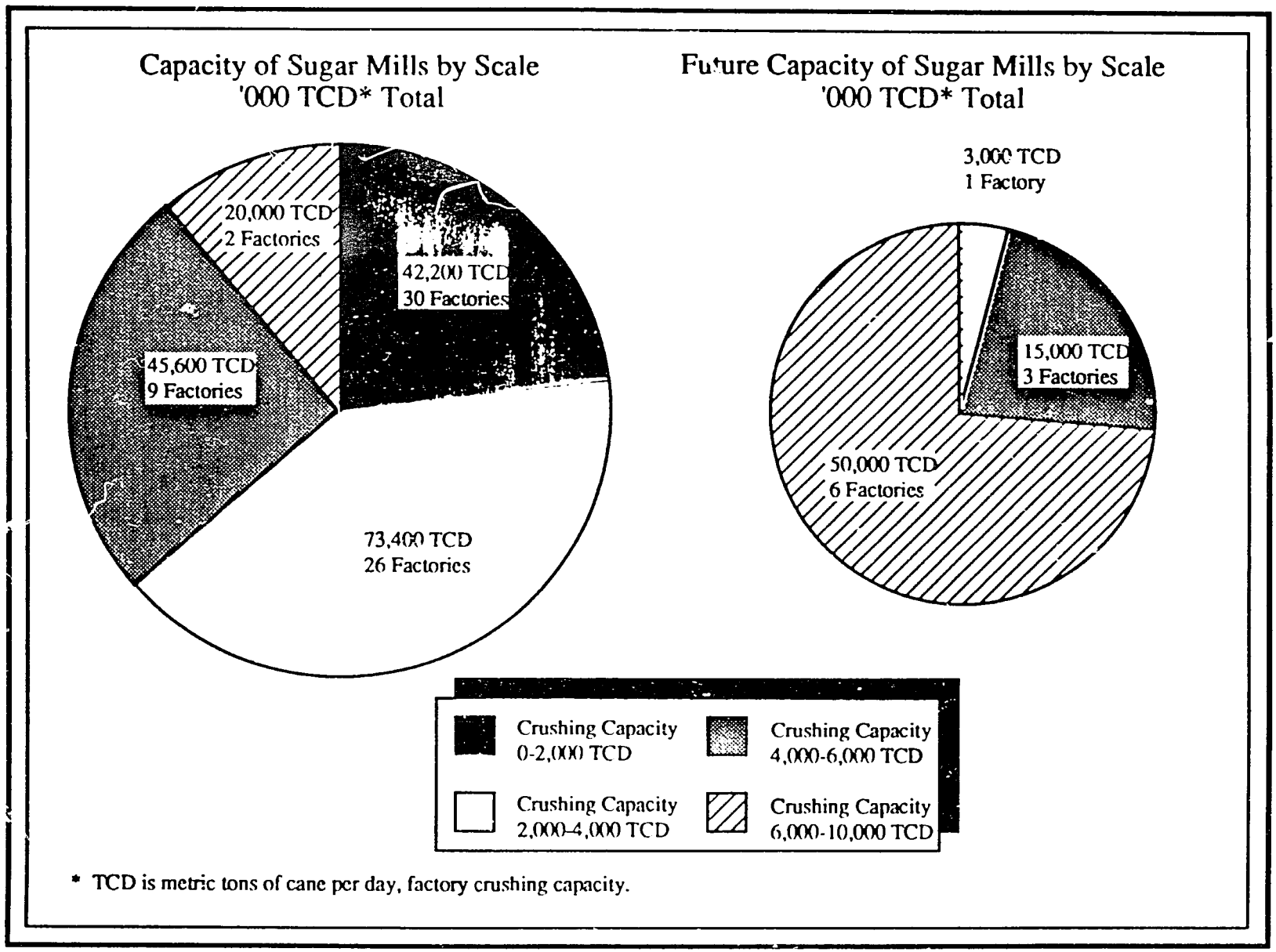


Table 9. Sugar Balance Sheet, 1989-1993

Item	1989 actual	1990	1991	1992	1993
1. Production	2,047,238	2,215,360	2,283,300	2,342,640	2,373,600
2. Import	282,922	636,040	240,289	281,893	355,914
3. Beg. stock	848,168	898,328	1,378,528	1,436,069	1,495,912
4. Total Avail.	3,178,328	3,749,728	3,902,117	4,060,602	4,225,426
5. Consumption	2,280,000	2,371,200	2,466,048	2,564,690	2,667,278
6. Ending stock	898,328	1,378,528	1,436,069	1,495,912	1,558,148
7. Population	177.8	181.4	185.0	188.7	192.5
8. Consmp. pc (Kg)	12.82	13.07	13.33	13.59	13.86

Assumption: Consumption Growth = 4.25 % per year Source: Indonesian Sugar Council

One of the important byproducts of the sugar industry is molasses. Total molasses production in Indonesia is presently over 1.1 million tons (Table 10). In the past, a high proportion of molasses production has been exported. But with increasing domestic demand, exports are expected to be negligible within five years.

Another important joint product or waste product from sugar production is cane bagasse. With bagasse totalling approximately 32 percent of total sugar cane production, over 8 million tons of bagasse are currently being produced in Indonesians cane mills. About 90 percent of this bagasse production is being used as fuel for sugar factory boilers. Some of the remaining bagasse is used as pulp feedstock in paper production. The rest is presently going unused for any purpose.

Table 10. Production and Use of Molasses, 1985-1989 (T)

Year	Production	Export	Industrial Use	Other*
1985	869,995	577,022	224,009	68,964
1986	918,992	714,712	268,988	-64,708
1987	1,105,560	624,780	3 24,187	156,593
1988	1,029,206	540,211	483,211	784
1989	1,148,862	385,070	623,196	140,596

Source : Dewan Gula * Beverage and other food products

Table 11. Government Regulated Sugar Prices in Indonesia, 1981-1990

Minister of Finance Decree		Factory Production Price	Price ex-Factory (Wholesale)
Date	Number		
		- Rp. per quintal -	
1-4-1981	SR.43/MK.011/81	35,000	42,930
2-7-1993	Kep.447/KMK.011/83	35,000	40,600
1-5-1984	346/KMK.011/84	40,000	50,447
28-3-1985	294/KMK.011/84	42,500	52,903
26-5-1987	342/KMK.011/87	46,750	57,965
27-5-1988	571/KMK.013/88	51,425	64,061
31-7-1989	837/KMK.013/89	60,000	74,300
1-4-1990	391/KMK.013/90	65,000	-------

* Price reflects factory production price plus regulated charges for packaging and various taxes.

Present plans for expansion of sugar factories would provide an increase of 32,000 TCD, for an increase of nearly 20 percent in factory capacity. A list of the currently projected investments in sugar factories on the outer islands is given in Annex 2.

4.3 Non-Energy Diversification

There is an expanding quantity of waste products resulting from the processing of sugarcane which are, to varying degrees, going unused or could be used more efficiently. These waste products—bagasse, cane tops and leaves, and, to a certain extent, molasses—have the potential for significantly increasing the overall returns to the industry when utilized in new commercial enterprises.

Sugar processing presently produces approximately 8 million tons of bagasse. At the present time, about 90 percent of the bagasse is being used as fuel in the sugar mills itself. However, there is considerable scope for increasing the efficiency of this energy production which would free up a sizable proportion of the bagasse for other uses or for energy production. Annex 5 details the variety of products that are now produced from the sugarcane plant and its wastes. The remainder of this section surveys the non-energy product options for cane wastes, while the following two sections analyze electricity production in detail.

4.3.1 Cane Trash

Table 12 shows estimates of the total quantities of sugar industry waste products and their use. While bagasse figures are fairly reliable, quantities of cane tops and leaves are estimates based on average values for sugar industries where these have been measured. Cane tops and leaves, or trash, represent perhaps the largest and cheapest untapped biomass resource base in sugar producing countries, but also perhaps, the most uncertain. The BEST Project and a number of select sugar industries have studied the costs, fuel values and energy balances of cane trash collection for use as an off-season boiler fuel. The results indicate that large-scale collection schemes can deliver biomass fuels at one-half to two-thirds of the cost of oil (at USD 18/bbl), while causing little or no negative

agronomic effects. The BEST project continues to sponsor research into the agronomic and commercial prospects for trash collection.

Still other enterprises have made use of cane tops and leaves as a feedstock for furfural (combined with bagasse, Central Romana, Dominican Republic) and as cattle feed supplements. In Indonesia, an indeterminate quantity of the cane tops and leaves are now being used for animal feed. Generally, the cane tops and leaves being produced on Java are fed to cattle, while most of the production off Java is going to waste.

Table 12. Utilization of Sugarcane Waste Products

Waste product	Used	Unused	Total
		- T millions -	
Sugar:			
Bagasse	7.0	1.1	8.1
Cane tops	0.1*	3.4*	3.5
Cane leaves	4.0*	4.0*	8.0
Total	11.3	8.2	19.5

* = Estimated

4.4 Pulp

Paper pulp production from bagasse is an established, but limited, commercial practice in a number of countries. Early attempts to process cane bagasse fibers into pulps suitable for paper products date to the nineteenth century; however, it was not until the early 1900's that pulp production from bagasse became an economically viable enterprise.[3] In most cases where bagasse is used it is generally because of the high cost of obtaining wood based pulps and, still, it is often mixed with these.

In Indonesia today, three of the 41 pulp and paper manufacturers in the country use bagasse as one of their principal raw materials. Two of these are private, as is most of the industry, and one is state-owned; all three are in East Java, all are large-scale, fairly modern complexes, and all make a variety of products, including boards (see Table A3.5, Annex 3). Little information could be obtained on the operations of these companies. However, the study team determined that a number of sugar factories with proximity to these plants either sell their surplus bagasse for a low price (approximately USD 5 per ton, ex-factory -- Gempolkrep), or exchange their surplus bagasse for diesel oil, which is used as a supplementary boiler fuel (PT Tri Gunabina, Kebon Agung factory). The value of the diesel oil exchange transactions could not be learned.

While these cases represent a limited use of the Indonesia sugar industry's excess bagasse, it is clear that the potential for expansion exists at these relatively low values for bagasse and that the potential may be significant. The demand for paper in Indonesia is increasing rapidly as discussed in Section 3 and shown by the market projections in Annex 3. Furthermore, the study team learned of a number of planned private pulp, paper and board plants which are basing their operation partially on bagasse feedstocks. As in other cases, the availability of low cost excess bagasse and small transport distances from sugar factory

3 See By-products of the Cane Sugar Industry, by J. Maurice Paturau, Elsevier Scientific Publishing Company, Amsterdam, 1982.

to pulp plant appear to be necessary conditions. These conditions would tend to limit the pulp development potential of bagasse.

With increased boiler efficiency and sugar factory energy balance improvements, additional quantities of bagasse could be made available for pulp production. However as the analyses in Sections 6 and 7 indicate, it may be far more attractive to plan electric power investments around bagasse availability. These analyses employ a range of values for bagasse approximating its value as a pulp feedstock.

4.5 Animal Feeds

Cane tops are already used as fodder for cattle on Java. As a normal practice, family members of the cane cutters collect the tops during the harvest season using it as fodder for their own cattle. During the off season, the dry cane leaves can also be collected without any harm to the growing plant. However, this practice is usually discouraged because of the problems of preventing the collection of green leaves which has a detrimental effect on cane growth.

In addition to this informal collection on Java, a factory is operating in North Sumatera to process cane tops and leaves. With an installed capacity of 150 tons of input per day, this Japanese joint venture factory is presently processing an average of 100 tons of cane tops and leaves from a nearby sugarcane plantation. The basic product is a compressed bale of cut tops and leaves dried to a moisture level of about 15 percent. (See Annex 6 for a list of the processing steps.) These bales are shipped to Japan and used as cattle forage.

With the harvest season lasting five to seven months, this implies the need to strip leaves and tops from growing sugarcane in order to have year round supplies. Though it is apparently not harmful to the plant growth to strip away the dry leaves, this is hard to control. A conservative estimate of the quantity of cane tops and leaves available for producing cattle feed would be about 200,000 tons (Table 9). This assumes all of the cane tops and leaves on Java are already used, and would imply that the opportunities for commercial production of cattle feed are off Java.

4.6 Particle Board

One of the important uses for excess bagasse is in structural materials. The team learned that two plants in Indonesia produce some particle board from bagasse, but little else could be learned about these operations. There are at least five plants in Thailand and several in Pakistan that use bagasse for these materials. The fiber board produced in the Thailand plants is a high density material which is high quality and durable, suitable for furniture and shelving.

There are two major material costs for producing particle board. The first is the raw material and the second is energy, both mechanical and heat. All but one of the Thai plants are located adjacent to sugar mills. In one case, the sugar mill owns the fiber board plant as well. Where the bagasse sales were handled through market exchanges, sugar mills generally received Rp 3,500 - 7,500 per tons. In a few cases, the prices range as high as Rp 8,500. With transportation of the bagasse costing the particle board manufacturers at least Rp 3,000 per tons, the apparent value of the bagasse as a raw material for these products will exceed Rp. 6,500 per tons. The upper limit on possible prices for bagasse will depend on what other materials are available. It is possible that given Indonesia's rich forest resources, bagasse can not command too high a price in this end use.

While the volumes of bagasse that might potentially be absorbed in the fiber board industry are significant, they are relatively small in comparison with the potential output of excess bagasse. Thus, it is reasonable to expect that a fiber board plant, located adjacent to a sugar mill could rely on that mill for its heat and power needs. These types of closed product and energy systems are viewed as having the greatest promise for the sugar industry and need to be investigated further.

4.7 Other

Alcohol

Alcohol is a product which can be produced from a variety of the waste products of sugar production. While molasses is the most obvious alcohol feedstock, using simple fermentation process, the market for Indonesia molasses is sufficiently high to preclude its consideration for ethanol or fuel alcohol. The market for other alcohols needs further investigation in Indonesia.

Vitamins, Proteins and Industrial Chemicals

Molasses is the most important byproduct from sugar production. It is already used to produce MSG, ethanol and, acetic acid, with the remaining molasses exported to Japan, Taiwan, and South Korea. However, as a substrate for fermentation processes, several other chemicals can also be produced such as ethyl acetate, butyl acetate, acetonnese, and buthano (2-ethyl hexanol). Since Indonesia is in the process of industrializing with an increasing demand for industrial chemicals, it is reasonable to expect the country to consider their manufacture within Indonesia, substituting for some which are presently being imported.

5.0 ENERGY USE AND POTENTIAL IN INDONESIAN SUGAR FACTORIES

Sugar mills use large amounts of energy to extract and refine sucrose crystal from cane. Using current technology, it takes about five barrels of oil equivalent to obtain one metric ton of plantation white sugar. Since most mills use bagasse to provide both steam and electrical energy for the mill, this energy requirement translates to 2.6 tons of bagasse for each ton of white sugar produced.

At the present time, Indonesia's sugar mills produce about 8 million tons of bagasse annually. About 1.1 million tons is produced in excess of the sugar factories' normal requirements.[4] This bagasse is typically held over for starting up the boiler in the following season, and in some cases is sold to pulp and paper mills.

Cane processing efficiency varies widely from one mill to another. Energy use depends largely on the type and age of equipment used, but also on factors such as processing practices, consistency of cane supply, and final products from the mill (i.e., raw versus refined sugar). To understand how bagasse could be made available for uses outside the mill, it is important to review the major uses of energy in those mills

5.1 Steam and Energy Balance

The composition of whole sugar cane varies greatly from one country to another and can be affected by such variables as rainfall, fertilizer, harvest techniques, and cane cultivar, among others. The composition of cane in Indonesia is roughly as follows:

Item	Percent of Whole Cane
Sucrose	10-17
Water	65-75
Reduction sugar	0.5-1.5
Inorganic matter	0.5-15
Organic acids	0.15
Other substances	0.5-1.5
Fiber	11-19

In the sugar factory, the cane is milled and pressed so that the cane juice is separated from cane, leaving the fibrous residue bagasse. The juice is further clarified while the bagasse is conveyed to the boiler for fuel. The water content of the bagasse passing through the last mill is high, usually from 46-50 percent. The bagasse contains some sugar and other materials, in addition to fiber as follows:

Water	46-50%
Fiber content	48-51.0%
Brix (including pol or soluble sugar 1-3%)	4.5%

For example, a sugar mill which processes 4,000 metric tons of cane per day (TCD) where the cane has a 30 percent bagasse content will produce .3 percent x 4,000 tons or 1,200 tons bagasse per day. Thus the total production of bagasse is equivalent to 2,300 barrels of

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4 About 15% of this total is produced at one mill, the Gunung Madu mill In Lampung province which produces more than 150,000 T/yr of surplus bagasse.

oil in energy terms. Of this total energy production from bagasse, about 95 percent goes to the turbogenerators or to the mechanical drive turbines. Only about five percent goes to the evaporators via a pressure reducing valve. Saving energy in the mill then becomes a question of improving combustion efficiency and making better use of the energy that is exhausted through existing turbogenerators.

5.2 Areas for Reducing Energy Use in Sugar Mills

In spite of the tremendous heating and grinding demands of the milling process, several mills studied by Winrock teams have been able to reduce energy use substantially. These reductions have in turn led to availability of significant volumes of excess bagasse for other uses, including generation of electric power in the mill itself.

Without making significant modifications to the mills or to the processing of the cane, there are often several areas in which energy use can be reduced. Some of these modifications involve modest investments. The possible modifications include the following:

* Installing pre-evaporators to conserve steam;
* Using continuous vacuum for low grade sugar extraction;
* Flue gas drying of excess bagasse to increase combustion efficiency;
* Baling of surplus bagasse to improve its storability and use beyond the grinding season;
* Installing air preheaters and economizers on the boilers; and
* Closing pressure reducing valves to force additional steam through the turbogenerators and using the evaporators as "sinks" for the steam.

Other alternatives generally involve the use of higher temperatures and pressures in the boiler and turbogenerator units. The volumes of energy that can be produced from such investments are outlined in the following section.

Typical reductions in bagasse use may range from 10-20 percent, permitting the sugar mills to export power or sell the bagasse to paper and pulp mills. The mill studied in Section 5.3.2 Option One shows how up to 1 MW can be exported from existing equipment simply by making better use of existing energy flows. In the simplest case, such conservation measures consist of forcing additional steam through the turbogenerators. Greater amounts of energy can be conserved by installing additional equipment including deaerating feedwater heaters which absorb turbogenerator exhaust.

5.3 Sugar Industry Generation Options

This section outlines the types of investments that are necessary to export electricity from Indonesia's sugar mills. The BEST team briefly visited four sugar factories in September 1990. No direct measurement of process variables was possible on this mission. Certain process variables which are critical to estimating export capability, such as quantities of surplus bagasse, boiler flue gas excess air and temperatures, evaporator supply juice densities, and bagasse ash and moisture variability were not routinely measured or were not available from all of the mills. This is not unusual for sugar factory operations since their main concern is the efficient processing of cane and sugar, not the generation of electric energy for export.

Predicting the export electric power and energy for a sugar factory requires a detailed analysis of factory operations. Heat balances must be conducted to determine export levels with sufficient precision to substantiate investment decisions. The predictions contained herein were made without benefit of such detailed analyses.

There are, however, a series of typical export electric energy options available to most sugar factories of the types and sizes in Indonesia. These are described below. The Indonesian mills visited generally reported more time out of crop than has been the case in some other countries. Given the relatively large number of hours that the mills must fire the boilers with bagasse in the absence of cane, it is not surprising that some mills run out of cane and turn to fuel oil from time to time.

5.3.1 Processing Changes For Electricity Export

Sugar factories in Indonesia are designed to produce that amount of steam and electric energy needed from bagasse fuel to operate the factory. During off seasons, electric energy is purchased from PLN or is generated using diesel engines at various levels to support off season maintenance activities. The capacities of the interconnections for the factories are generally limited to 1,000 - 3,000 kW.

Several of the factories reported burning fuel oil to support operations. However, with appropriate energy management steps, sufficient surplus bagasse can be stored for start up of the boilers each season and for steam production during brief periods where the process is interrupted.

Most Indonesian sugar factories are essentially "balanced" or even slightly in surplus with regard to bagasse.[5] That is, they produce more bagasse than is consumed for boiler fuel. The amount of surplus bagasse is generally estimated by observation of the quantity of bagasse stored in huge open air piles. Too little surplus bagasse raises the threat of burning oil to support the process. Too much bagasse can create a major disposal problem.

In general, cane sugar factories control surplus bagasse by the design and operation of their energy producing and consuming devices in the factory. There are a number of ways surplus bagasse can be controlled by modifying one or more of the following variables:

1. Boiler heat recovery systems;
2. Process evaporators;
3. Dilution of cane juices;
4. Venting of process steam; and
5. Steam cycle design.

Where bagasse is treated as a valuable resource, either for fuel or for byproduct usage, all of the above areas offer potential for increasing the quantity of surplus bagasse. Conversely, where bagasse creates a disposal problem, these same areas permit a considerable degree of operational control over surplus bagasse quantities. Control of these parameters can vary the quantity of surplus bagasse from zero to 30 percent or more of total bagasse produced.

The Indonesia sugar factories visited do not have condensing turbogenerators and therefore lack the ability to generate significant quantities of surplus electric power as a means to control surplus bagasse quantities. Further, the process equipment is designed for high production rates with minimal interruptions at relatively low initial cost.

The various options presented herein require relatively minor changes in the mill's process equipment or operation. Options 1 and 2 use existing factory equipment while the third option, which entails installing a new boiler and turbogenerator, requires substantial

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5 This excludes the Gunung Madu Mill which produces 800-1,000 TCD of surplus bagasse.

changes in the setup of the mill but not in its operation. The generation options which the team identified for Indonesia are listed below. Costs are summarized in Table 13.

5.3.2 Generation/Export Option 1

There are no process equipment changes required in this system. The factories which go forward with this option should have adequate steam and power generation capabilities to produce an export of 1,000 kW periodically or continuously, and to do so without resorting to burning fuel oil. The changes in operation that are required to obtain the 1 MW of export electricity are relatively simple.

It is necessary to "force" the existing evaporators to absorb the additional 10 - 20 T/Hr of turbogenerator exhaust steam during periods of export. Alternatively, exhaust steam or first evaporator vapors may be vented, or vacuum pans switched from vapors to exhaust steam, depending on the size and condition of the evaporator system. Since this option is considered to be used only during processing and generally to assist in meeting peak demands, this option is suggested solely for near term implementation. This option does, however, represent a low cost means to assist in controlling surplus bagasse, provides some additional revenues, and provides a small amount of peaking capacity to PLN.

As a part of an industrial complex, the energy from this option can replace diesel generation at the sugar factory. This option could be accomplished in the nearest term since it requires only the installation of electrical protective devices, which would require approximately six months. Investment costs are shown in Table 13. The costs and performance figures are not based on any particular mills in Indonesia but are considered to be applicable to mills in the 4000-6000 TCD crushing capacity range.

5.3.3 Generation/Export Option 2

This option requires that live and exhaust steam systems and the respective condensate system for one boiler and one turbogenerator be isolated from the rest of the factory piping in order to permit isolated operation during the off season. An air condenser is included which could be used both while processing as well as during the off season. This option would have no negative impact on processing capabilities. It would, however, offer a greater means to control surplus bagasse than Option 1.

Expanding the capacity of the air condenser from 1,000 kW (10-20 T/Hr) to 5,000 kW (50-100 T/Hr) would not be prohibitively expensive. Alternately, the process evaporators may be used to absorb the additional condensing load for export during the off season if provisions can be made for off season maintenance.

There are a variety of ways to provide additional condensing capability other than using the existing evaporators or an air condenser. The use of the existing cooling ponds or some degree of spray pond or cooling tower for cooling using a surface condenser can be considered.

Some factories do not use deaerating feedwater heaters. Installation of a deaerating feedwater heater not only increases condensing capability but improves boiler and steam cycle performance and efficiency.

The specific equipment provided to increase export from 1,000 kW to the 5,000 kW capacity of the proposed interconnect would depend on each particular factory's equipment arrangement as well as the actual quantities of surplus bagasse presently available. The cost estimates used in Table 13 used the Gunung Madu Mill in Lampung, South Sumatera,

as a model. This option would permit export during both the processing season as well as the off season up to 3,500 kW.

5.3.4 Generation/Export Option 3

A new 10,000 kW plant, using only bagasse for fuel, but capable of using both oil and other solid fuels, is the basis for this option. This boiler and turbogenerator option would be installed in a new or relocated facility either to replace existing systems or to work in tandem with one of the existing units while in crop and on a stand-alone basis while out of crop.[6] Surplus bagasse is increased by additional flue gas heat recovery devices on each existing boiler coupled with additional control devices to measure and control excess air to a minimum. In factories where no deaerating feedwater heater exists, one would be added to serve all existing boilers. During the off season, the surplus bagasse remaining is used to maintain export of electric energy.

Three factories studied by the BEST Project in Thailand had flue gas temperatures ranging from a low of 190°C (374°F) to a high of 250°C (482°F). A target exit gas temperature of 177°C (350°F) can be reasonably obtained with an engineered mix of economizers and air heaters. Excess air reportedly ranged from 30 percent to 70 percent, based on measurements of carbon dioxide. A target average excess air of 50 percent is reasonable provided boilers are equipped with air flow measurement and feedback control as well as reliable flue gas analyzers. In-situ oxygen analyzers are recommended for flue gas analysis as they are simpler to maintain than CO_2 analyzers and more sensitive in the low excess air ranges.

One potential candidate for such investments is the P.G. Gempolkrep mill in East Java. The mill is soon to be rebuilt and enlarged to 6,000-10,000 TCD crushing capacity. The 10 MW figure was chosen at this site as this seems to be the practical limit for PLN's substations to absorb electricity at 22 kV without resorting to export directly into the high voltage transmission system.[7] For local transmission, the mill would likely need to use the PLN system to wheel the power. Thus the investment costs are unlikely to vary with the ultimate customer. No change to sugar process equipment is required although some minor modifications in equipment and management practices may yield additional surplus bagasse.

Exporting up to 10,000 kW appears to be the practical limit if the power is to be absorbed into existing utility 22 kV distribution lines. Larger amounts might disturb the system. The Gunung Madu mill in Lampung, South Sumatera, was used as a model for this investment option. At the present time there is insufficient demand for a larger unit in the area around the Gunung Madu Mill. With current developments in the area, there may be some demand for electricity by industry within 2-3 years but most of this will be relatively small. However, by the end of the decade, industrial relocation off Java to the nearby area

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6 It is possible to install a 25 MW unit at some large mills. This option will be justifiable where it is feasible to use fuels other than bagasse, since the plant will need to operate for 10-11 months. Additionally, the output from such a plant will need to tie directly into transmission, 115 kV, in order to maintain system stability.

7 There are high voltage transmission lines near the Gempolkrep mill. In addition, there is a 22 kV line that follows the road from near Surabaya. Since this area is now industrializing rapidly, the demand for electricity is growing far faster than PLN's capacity to supply it. As a result, it is probably cost-effective for Gempolkrep to avoid the costs of providing electricity to the high voltage system given the large number of potential customers nearby. In addition, it was not clear form the resource analysis that there exists sufficient cane residue to support a larger plant for 4-6 months out of crop.

could lead to extensive demand for electricity with a concomitant justification for large investments at Gunung Madu or other nearby sugar mills.[8]

5.4 Capital Costs

Table 13 indicates the current installed costs for each option and the anticipated time required to design, procure, and install each option. These figures are adapted from calculations that were made for similar mills in Thailand, adjusted for the specifics of the Indonesian situations.

For Option 3, the high pressure unit that is to be installed for electricity export is compared to a similarly sized unit which would be used for the mill and perhaps for export of energy as at the Gunung Madu mill. It should be emphasized that these figures are provisional and do not reflect the specifics of mills in Indonesia. Such specifics can be uncovered during the second phase study.

Table 13: Summary Of Installed Costs Of Various Options (USD 000s)

Option:	1	2	3
Export Capacity (MW)	1 MW	4 W	10MW
Item			
A. Boiler & Auxiliaries	0	0	2,175
B. Turbogenerator & Piping	0	0	1,670
C. Cooling System	0	190	1,550
D. Factory Modifications	0	140	448
E. Electrical Interconnections	86	261	256
F. Tie Line Transformer	0	170	458
G. Tie Line	0	0	406
H. Design/Proj. Management	24	57	430
I. Contingency	10	68	788
J. Duty	24	162	783
K. Total Cost	**144**	**1,048**	**8,964**
L. Design, Procure, Install, (man months)	6	18	24

The figures for tie lines and interconnection to the PLN system are based on studies of such interconnections in Costa Rica and Thailand, among other countries studied. Even where the sugar mill may not tie into the PLN system, there will be substantial investment costs, of about the same magnitude to transmit and distribute electricity within the industrial complex.

A range of export capabilities is given for Options 2 and 3 (see Table 14). For Option 3, the lower level represents the capacity to export during the factory off season with no usage of existing factory power or condensing equipment.[9] The higher level represents the tie line

[8] The presence of another 10,000 TCD mill nearby with at least one more in the planning stage in Lampung province suggests that this location may support a large bagasse and cane tops/leaves mill at some point in the future. Today, the only population in the area consists of workers at the mill and their relatives.

[9] In other words, the plant can operate as a stand-alone facility.

capacity and also indicates a level which might be achieved during processing by utilizing the existing power and condensing equipment.

It should be noted that the additional costs for exporting power are significantly lower in new plants than are the full installation costs of the high pressure boiler and extracting-condensing TG set. In the case of Option 3, the total costs of a high pressure boiler and an extracting-condensing turbogenerator total USD 8.96 million while the entire unit would cost USD 20.6 million. However, the low pressure system, which the mill requires regardless of electricity exports, costs USD 11.6 million.

5.5 Range of Export Capabilities

As has been stated previously, each factory is unique. Processing rate, total tons of cane processed, cane quality and equipment arrangements dramatically affect the amount of bagasse energy available for producing electric energy for export. For purposes of this investigation a range of export is given for general guidance only. This range represents the capabilities of plants which process less than one million tons per year of cane up to plants which process two million tons of cane. Exact predictions of export capabilities can only be achieved following an in-depth investigation of individual factory equipment, operations, and heat balances.

Table 14 summarizes those probable ranges of export power and energy for each option, utilizing existing supplies of bagasse. From Table 14, it can be concluded that burning of oil in existing boilers (Options 1 and 2) is prohibitive except under extreme emergencies. Additionally, the export of electric energy from bagasse during the off season is probably not practical (except for facilitating bagasse disposal) in those factories with high heat rates. These are factories where the boiler steam pressures are 15 kg/cm^2 or less.

Table 14: Ranges of Export Options for Power and Energy

Option	1	2	3
Cane Processed, T/Yr (x 10^6)	0.8-2.0	0.8-2.0	0.8-2.0
Avg Net Export While Processing, MW	1	1-3.9	5-10
Avg Net Export Off Season, MW	0	0.66-3.9	5-10
Net Export Annual, kWh/Yr (x 10^9)	4	7-26	19.7-40
Bagasse Consumed for Export, 10^3 T/Yr	12	40	46-93.2
NPHR-Bagasse-Grinding (x 1,000)	27.5-40	27.5-40	20
NPHR-Bagasse-Off Season (x 1000)	40-80	40-80	20
NPHR-Oil-Off Season (x 1,000)	30-60	30-60	14

Note: NPHR=Net Plant Heat Rate, BTU/kWh Heat rates, electricity export, and fuel consumption are given for the high pressure Option 3 plant only.

6.0 Economics of Investment in Cane Power Systems

The generation options outlined in Section 5 must be examined in terms of their investment, generation and operating costs in order to evaluate the attractiveness of investments. These are analyzed for each option in this section, followed by an analysis of purchase power price issues. Returns on investment are analyzed in Section 7, Financial Analysis.

For the government or industrial users, the ultimate buyers of the electricity, there are two major economic issues. These are the level and structure of the purchase prices, and the stability and management of the distribution grid in the areas where power will be exported to the system. Where the electricity will be exported off-site, say to a nearby industrial estate, PLN will be concerned if it is asked to wheel power through its system to the estate.[10]

6.1 Generation and Operating Costs

In Table 13 (see Section 5), detailed cost estimates were given for the three major generation options. Using those cost estimates, the team's economists were able to estimate the likely generation costs under a variety of investment and plant utilization scenarios. There are three major elements of generating cost:

1. Investment in boilers and turbogenerators;
2. Rate of utilization of the plant; and
3. Fuel costs, which consist of the purchase price of the fuel as well as the net heat rate (fuel consumption per kWh) of the power plant.

Interest rates may have an important impact on generation costs for some of the more sizable options which involve new plant and equipment. In addition, the simple availability of feedstocks may prove an important issue when it comes to whether an investor will go forward.[11] In this study, the team has assumed that the required volumes of fuel will be available at a price that is sufficient to ensure their supply.[12] Fuel price issues are discussed below in section 6.5.

6.2 Option 1

This investment is designed to export electricity only during the milling season. It is low efficiency (60,000-80,000 BTU per kWh) and will consume all of a mill's surplus bagasse during the milling season. A typical plant configuration, designed to export one MW during the milling season, has the investment and operating costs that are shown in Table 15.

The total investment, Rp 270 M (USD 145,000), is just a fraction of the cost of new generating capacity. However, the low investment cost is tempered by two considerations. First, the fuel consumption is high. Second, the plant has a low utilization rate, certainly

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10 If a mill must wheel power through PLN lines, then PLN must be assured of the quality and continuity of the power supply from the generator. In addition, PLN will ask for compensation when it is asked to supply electricity to the estate in the event of a forced outage at the sugar mill.

11 This issue may be locally important if a sugar mill is relatively isolated or if there are a number of competitors for the sugar mill's bagasse. These might include fiberboard or pulp mills.

12 Another project, supported by USAID, has investigated the feasibility of gathering the cane trash and leaves to use as fuel for power generation. The project concluded that the costs of delivering cane trash to a sugar mill were competitive with coal and less expensive than heavy fuel oil.

less than 50 percent,[13] compared with the 60 percent or more that PLN's large new facilities show. A small investment amortized over a small output can still be expensive relative to PLN's facilities.

In general plant factors below 10-15 percent turn out to be uncompetitive relative to PLN's costs. However, if the plant is well used, more than 20 percent of the total year, its net capital costs turn out to be quite low (see the 25 percent utilization case). Table 15 shows the capital charges and total costs of generation for Option 1. The Best, Medium, and Worst cases refer to the net capital costs and fuel cost/fuel consumption variables. Thus, low utilization of the plant corresponds with the worst case and therefore high costs. Conversely, high utilization corresponds with low capital costs and is the best case.

The Table also shows that at low utilization rates (15 percent), the net capital cost of a one MW plant opting for immediate export will have capital charges of about Rp 34 per kWh. When combined with the low thermal efficiency of the boiler and turbogenerators in such a mill, the overall costs of generation could go as high as Rp 78 per kWh (Table 15 "worst" case). At the operating efficiencies typical of such mills and with bagasse valued at Rp 7,500/ton (USD 4/ton), the cost of fuel comes to roughly Rp 30 per kWh. With low investment in the mill's generation system, the costs of interconnection dominate the total investment charge.

Table 15: Option 1: Investment Costs and Operational Parameters

	Rupiah	USD
Investment		
Mechanical (includes plant modifications)	110×10^6	59,000
Electrical (Includes metering and switchgear)	160×10^6	86,000
Generating Costs (per kWh)		
Fuel @ $2/ton	14.904	0.008
@ $4/ton	29.808	0.016
@ $6/ton	44.712	0.024
Capital Charges@ 15% plant factor	33.534	0.018
@ 25% plant factor	20.12	0.011
@ 40% plant factor	12.668	0.007
Total Costs (per kWh)		
Best	27.572	0.015
Medium	49.928	0.027
Worst	78.246	0.042

Note: The base case assumptions include a 10 percent real interest rate. No use of cane tops or trash is assumed and the heat rate for the boiler is assumed to range from 27,500-40,000 BTU/kWh during the grinding season and ~80,000 BTU/kWh in the off season.

13 This figure refers to the proportion of the total hours in a year that the plant is operating. Thus a 25% utilization rate means that the plant operates 2190 hours (i.e., 0.25 x 8760).

6.3 Option 2

This generation choice requires that the mill make a greater investment in its internal generation system. In addition, there will be some modifications of plant operations to accommodate the greater net export of power, up to four MW. In comparison to the first option, both the mechanical and electrical investments appear to be far greater. However, the investment is expected to be amortized over a greater operating year. In an optimistic case, such a plant could operate as frequently as existing thermal power stations, or 65 percent of the time.[14] In the worst case, it is assumed that the plant could export only half the time during its milling season, hence the 25 percent figure. The required investments for this option were shown in Table 10 (section 5) and summarized in Table 16 below.

Option 2 has greater plant utilization rates than does Option 1. Correspondingly, the unit generation costs (per kWh) should generally be lower than is the case for Option 1. The range of capital charges and fuels costs is shown in Table 16. The median value of the capital costs, Rp 26 per kWh is about ten percent less than the median capital cost in the first option.

If the plant is utilized at a 65 percent rate, the net capital charges will be as low as Rp 20 per kWh. With higher efficiency overall, Option 2 shows fuel costs of just Rp 18 per kWh when bagasse is Rp 7,500/ton ($4/ton). Total generation costs, shown at the bottom of Table 16 range from just about Rp 29 per kWh to Rp 80 per kWh. The median value is Rp 44 per kWh. The second Option is less costly for each of the cases examined due to the relatively high fixed cost of electrical interconnection in the first Option.

Table 16: Option 2 Investment Costs and Operational Parameters

		Rupiah	USD
Investment			
Mechanical (includes plant modifications)		$1,149.4 \times 10^9$	617,000
Electrical (Includes metering and switchgear)		802.9×10^9	431,000
Generating Costs (per kWh)			
Fuel	@ $2/ton	9.315	0.005
	@ $4/ton	18.63	0.010
	@ $6/ton	27.945	0.015
Capital Charges	@ 25% plant factor	52.164	0.028
	@ 50% plant factor	26.082	0.014
	@ 65% plant factor	20.493	0.011
Total Costs (per kWh)			
Best		29.808	0.016
Medium		44.712	0.024
Worst		80.109	0.043

Note: The base case assumptions include a 10 percent interest rate. No use of cane tops or trash is assumed and the heat rate for the boiler is assumed to range from 27,500-40,000 BTU/kWh during the grinding season and ~80,000 BTU/kWh in the off season.

[14] This presumes that efficient operation during milling leaves significant excess bagasse and that other low-cost fuels, including cane tops and leaves, are available. The option is not intended to burn a commercial fuel such as heavy fuel oil or coal.

6.4 Option 3

As with Options 1 and 2, the third alternative is designed to integrate with an existing sugar mill. However, a new boiler and turbogenerator system would be added to the plant. The new equipment would be sized to use available surplus bagasse that could be generated with improvements in overall operational efficiency of a mill, especially in the use of bagasse. In addition, the existing tie line would be replaced with one that connects directly into the PLN's 22 kV system. With a new boiler and generator system, the thermal efficiency of the operation would be greatly increased. Such a mill might need perhaps half as much fuel to generate one kWh as either of the lower efficiency options. The case examined in Table 17, below, is for the **additional costs that are necessary to raise the thermal efficiency of the plant and to export power.** It is assumed that the plant would undertake the basic boiler and turbogenerator (TG) expenditures regardless of the power export option.

For a mill that intends to install new boilers and turbogenerators, the *additional* cost of investments for power export may be attractive. The marginal option shows the additional costs of investment for electricity export when a mill *must* purchase a new boiler and power system. The investments that are additional to a standard sugar mill boiler and turbogenerator are:

* Additional equipment for the boiler;
* Additional turbogenerator equipment and piping;
* Modifications to the mill itself so that the steam for the power generation system takes priority over the steam for the milling process; and
* Tie line transformer and the tie line itself.

Table 17: Option 3 Investment Costs and Operational Parameters

	Rupiah	USD
Investment		
Mechanical (includes plant modifications)	14,531 x 10^9	7,800,000
Electrical (Includes metering and switchgear)	2,049 x 10^9	1,100,000
Generating Costs (per kWh)		
Fuel @ $2/ton	5.589	0.003
@ $4/ton	11.178	0.006
@ $6/ton	16.767	0.009
Capital Charges@ 50% plant factor	27.014	0.015
@ 65% plant factor	19.562	0.011
@ 75% plant factor	17.699	0.010
Total Costs (per kWh)		
Best	23.288	0.013
Medium	30.74	0.017
Worst	43.781	0.024

Note: The base case assumptions include a 10 percent interest. No use of cane tops or trash is assumed and the heat rate for the boiler is assumed to be 20,000 BTU/kWh at all times on either bagasse or fuel oil.

With median unit capital charges of Rp 20 per kWh, Option 3 generates electricity at a total cost of Rp 23-30 per kWh. Infrequent operation, combined with high fuel costs can raise the total generation cost to as much as Rp 44/kWh, well below the other two options.

Given the higher efficiency of such a unit, the fuel costs will be just over Rp 11/kWh when bagasse is valued at Rp 7,500/ton (USD 4/ton). The reader should note that these costs are only for bagasse-fueled generation. The large boilers may use #6 oil or other available fuels for part of year. The average annual cost for such combined fuel generation will depend on the proportion of the fuel supply that is bagasse and that which is oil or other purchased fuels. Other fuel options may exist which enable the mill to use relatively inexpensive fuel throughout the year. In particular, recent trials with collection and use of cane trash have shown that it may be possible to collect this trash and transport it to a mill in the off-season at prices that are competitive with fuel oil. The trash, consisting of tops and leaves left in the field, has been baled and transported at prices of about USD 25/ton (Rp 46,575) which compares favorably with fuel oil on an energy equivalent basis.[15] Trials will continue to determine optimal collection, baling, and transporting modes for this potential fuel.

6.5 Fuel Price Issues

The availability and cost of fuel is a key determinant of the feasibility of cane-derived power. Hence, concerns about fuel supply and price remain essential to any feasibility study of power export from one or more sugar mills. This mission sought to define the types of projects that might merit further study. Nevertheless, the team was able to gather some data on the availability and price of bagasse and cane tops/leaves.

At the present time there is some use of bagasse in the paper and pulp industry. Sugar mills report selling bagasse at prices ranging from Rp 3,000-12,000/ton. These prices translate to as much as Rp 20,000/ton at the pulp or paper mill gate, a price that some pulp mills reported paying. The highest figure that the consultants encountered was Rp 8,500/ton.[16]

Typically, the high cost of transporting bagasse precludes the existence of an extensive market for that material. As a result, the prices received by mills will tend to fall in the lower range. In fact, the value of bagasse at the mill may sometimes be low or even negative, as long as the alternative uses for the material are limited, competing with such other feedstocks as wood pulp and fiber crops (e.g., kenaf). This means that as long as the value of the bagasse in generating power is competitive with what mills would otherwise receive, power generation is an attractive option.[17]

Given the relatively high transport costs of bagasse, the apparent value of the bagasse to board and pulp mills exceeds Rp 7,500/ton. At the same time, those sugar mills that are located far from board mills are unlikely to find any market for their surplus bagasse. In

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15 The present cost of procuring the cane trash works out to $1.45/million BTU, about half the cost of heavy fuel oil delivered to such a site.

16 These bagasse prices contrast with typical prices in the Rp 3.500-7,500/ton *ex mill*, that were reported in Thailand by an earlier Winrock team. The team was told that bagasse transport costs typically ranged from Rp 3,500-10,000/ton. These costs are about the same as bagasse transport costs in Thailand.

17 A price of Rp 7500/T corresponds to approximately Rp 700 per million BTU. As a point of reference, the current world crude oil price, USD 28/bbl, is about USD 5.00 per million BTU or Rp 9300 per million BTU.

most cases, bagasse has a value to the mill of less than Rp 7,500/ton (wet). This figure was chosen as the baseline value for fuel when making comparisons among different generation investment options. All mills will incur some costs as they must hire crews to maintain the bagasse piles, prepare them for use and dispose of ash.

Instead of simply assuming some value for fuel, utilities often find it helpful to calculate what the fuel is worth to the power plant; in other words, what can the generator pay for fuel. This figure is an important one for resource owners when there are alternative uses for the resource, such as pulp or board manufacture. This measure of a fuel's value is called the **fuel netback value**, and is the *maximum* that a user can pay for fuel given the following data:

* The cost of the capital investment;
* The frequency with which the equipment is used - i.e., dispatch;[18]
* The efficiency of the plant (BTU/kWh); and
* The price at which the power is purchased.

The *annual* fuel netback value is calculated as:

$$NB_{fuel} = \text{Elec. Price per kWh} - \frac{\text{(annual capital charge + annual O\&M charge)}}{\text{(kWh generated in year)}}$$

In a similar way, we have calculated the netback value of fuel using present value methods as follows:

$$NB_{fuel} = \frac{\text{Present Value of Receipts - Present Value of non-fuel Costs}}{\text{Total kWh generated}}$$

The present value of receipts is the present value of sales of electricity generated from bagasse or other fuels and sold to the power company. It does not include power use internal to the mill. The latter formula is used in the tables which follow this section.

The netback value shows how much a generator can pay for fuel on a per kWh basis. Once we know the netback value of fuel on an output basis, it is an easy conversion to calculate the value of that fuel on an input basis (per ton or per million BTU). In this report, the convention of expressing fuel netback values in Rupiahs per ton of bagasse or dollars per million BTU will be used as appropriate.

For example, take the case of plant Option 3 (See Table 17). Suppose that the purchase price for 1 kWh = Rp 75.[19] Suppose further that the capital cost of generation, based on dispatch of 5694 hours annually (i.e., 65%) is Rp 19.6/kWh. Using the first netback formula given above, we get:

$$NB_{fuel} = \text{Rp } 75 - \text{Rp } 19.6 = \underline{\underline{\text{Rp } 55.4}}$$

In other words, the generator can pay Rp 55.4 in fuel charges to generate one kilowatt hour of electricity. Since the heat rate of the plant is 20,000 BTU/kWh, we calculate that Rp 55.4 is the value of 20,000 BTU. This figure is equivalent to a value of Rp 2,770 per

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18 This determines the number of kWh over which each unit of investment is amortized. As was shown in Section 3.B.4.1., infrequent use of the additional capital equipment affects unit capital costs adversely. High unit capital costs in turn reduce the value of any given fuel to a generator.

19 The World Bank's Energy Pricing Policy Study for Indonesia showed that PLN's avoided costs ranged from Rp 80 in thermal units to Rp 90 in some combustion units, at present world oil prices.

million BTU ($1.49) or $8.33 (Rp 15,512) per barrel of oil equivalent, far below current market prices for fuel oil. In other words, given the prices, costs and efficiencies of the equipment, along with the frequency of use (dispatch), the plant cannot afford to pay more than Rp 30,193 per ton of bagasse at 10.9 million BTU per ton. *Since this value exceeds the price that the mill might get from a board mill for its bagasse, power generation is an attractive end use for the bagasse in this case.*

If dispatch goes up, then the fuel netback value will rise as well. Conversely, if dispatch goes down, then the price that a mill can pay for fuel will fall as well. In a similar way, each of the four factors listed above directly affects the value of fuel to the plant. If dispatch, for example, rose to 75 percent or 6570 hours annually, the netback value of fuel would rise as follows, assuming the other parameters remained constant:

$$NB_{fuel} = \text{Rp } 75 - \text{Rp } 17.7 = \underline{\underline{\text{Rp } 57.3}}$$

With such a netback value per kWh (20,000 BTU), the value of one million BTU rises to Rp 2,865 ($1.54). This figure is equivalent to Rp 31,228 per ton ($17) or $8.61/ barrel of oil equivalent (BOE) (Rp 16,044).

When a netback value exceeds the cost of acquiring the fuel, then the mill can justify the investment. However, if the fuel netback value is low or negative, this usually indicates that the capital is too expensive, the power purchase price too low or the boiler too inefficient. Using a range of potential power purchase prices, the team calculated the fuel netback value for each of the model plants. Purchase prices for electricity were adjusted to the particulars of a mill's location. Thus in East Java, the PLN optional generation uses coal for baseload generation and gas turbines for peaking. In Lampung the alternative generation source is diesel, slow speed (using heavy fuel oil) for baseload, and high speed (using ADO) for peaking. These values are shown in the summary tables which follow the rate of return discussion.

7.0 FINANCIAL ANALYSIS OF CANE POWER INVESTMENTS

7.1 Investment Analysis Approach

Using the cost information contained in sections 5 and 6, it was possible to calculate the financial returns associated with each of the potential investments. A total of six cases were investigated for each of the mills studied. Using a real discount rate of 10 percent, the following financial calculations were made:

* Benefit cost ratio;
* Annualized benefit cost ratio;
* Internal rate of return; and
* Fuel netback value.

In addition, the netback value for bagasse in each of the cases is presented along with the financial information. The netback value that is associated with the ten percent discount rate (no inflation) cases is the one that should be compared across the different alternatives. To see how inflation of variable costs might affect the financial analysis, a separate set of calculations was made using an inflation rate of eight percent in addition to the ten percent real discount rate. These results will differ from the real-discount-rate-only approach in that they discount the capital investments more heavily, at 18 percent total, and thus will tend to show higher returns on investment.

The first three terms have become standard in economic and financial literature and are not explained here. The annualized benefit cost ratio (ABC) gives the average rate at which the returns for the proposed investment exceed or fall below the discount rate that is used in the analysis. For example, if the discount rate is ten percent and the ABC = 12.5 percent, this means that the average annual return on the project exceeds the discount rate by 2.5 percent annually, compounded. The ABC provides an effective method of checking results across alternative investments, when other measures might yield inconsistent or misleading results.

The ABC is defined as

$$ABC = (PVB/PVC)^{(1/n)} - 1$$

where:

PVB = Present Value of Benefits

PVC = Present Value of Costs

n = the number of years for which cash flows are calculated

The six tables which follow provide a summary of the financial calculations that were performed for the various investment options. Each of the three cases is analyzed in nominal Rupiah (Rp).

In the tables, results are given for two different energy sales contract regimes. It was necessary to assume two types of contracts, in lieu of any specific guidance from PLN:

> The first type of power sale occurs when the mill sells electricity to the grid or within an estate on a spot basis. In such cases, the generator will be paid only for the energy that is displaced at a given time of day. In each of the three examples, the peak shoulder and base energy prices vary according to the presumed fuel that is displaced. The contract has a duration 20 years.

The second type of contract contains an energy payment, equivalent to the avoided energy cost of a baseload facility. The capacity payment is equivalent to Rp 25-35/kWh, depending on location.[20] These contracts have a duration of 20 years.

Each of the four measures of merit noted above will have some meaning for investors or analysts. However, the two measures that are particularly important in the present context are the ABC and the fuel netback value. The full results of the financial analyses are published in Annex 8. In order to complete these analyses, it was necessary to make assumptions about interest rates, costs (based on BEST Project's previous efforts) and other operational or financial parameters. Each of these parameters is listed in each of the tables for each case.

7.2 Option 1 Results

With high fuel consumption, this option is attractive under all of the cases considered. However, it is feasible in terms of bagasse netback values only if the mill can export power for about 25 percent of the year or more. A plant factor of 25% means that the mill will export power for more than half its annual milling hours. Further, it is probable that the mill will be dispatched during peak and "shoulder" times, roughly from 7:00 A.M. through 8:00 P.M. Thus when a mill is out of cane, its power purchase agreement may require it to continue delivering energy or face penalties.[21] As Table 18 shows, the ABC rises above the discount rate in all cases, due to the low interest rate that a government-owned mill will pay. With inflation of the costs and revenues, the worst case shows relatively high returns. If the mill can export electricity for 40 percent of the year, about 85 percent of its own operating hours, the benefit-cost ratio rises above three for the capacity payment contract. More important, the ABC is well above the discount rate in both cases.

The assumptions behind this financial and economic analysis are shown in detail in Annex 8. Each example lists the key operating parameters and assumptions. For Mill Option 1, the more important assumptions include the following:

Size of Mill	1 MW
Annual Hours of Operation (worst, best)	1,314-2,066 (15-35%)
Fuel Consumption While Exporting	80,000 BTU/kWh
Bagasse Consumption	7.42 kg/kWh
Bagasse Price	Rp 2,500-7,500/ton
Loan Costs	10% real, 18% nominal
Power Purchase Prices (Rp per kWh)	
Energy Sales Only	90 for peak 55 for shoulder and base
Energy & Capacity Payments	25 for capacity, 55 for energy

However, even with relatively attractive returns, the high fuel consumption rates in these mills preclude the mill paying more than Rp 7,821 for fuel. For the spot sales regime, even the best case fuel netback value is just above the costs that mills will incur in moving the

[20] The capacity payment will vary with the avoided cost in a given region. Thus where the avoided cost represents a thermal unit, the capacity credit is Rp 25/kWh. Where the avoided cost represents a diesel unit, the avoided capacity cost is Rp 35/kWh. All these figures are from the World Bank's EPPS.

[21] If a mill receives a capacity payment for its power, then the contract will undoubtedly contain penalty clauses. However, the smaller mills are likely to sell energy only, since they will have no capability of using fuel oil economically in the absence of bagasse.

bagasse around the mill and feeding it to the boiler during periods when the cane processing is down.

Table 18: Results of Option 1 Financial Analysis

Case	Measure	Energy Sales Only	Energy & Capacity Payment
Worst	Benefit Cost Ratio	1.21	1.65
	ABC (%)	10.87	12.29
	Fuel Netback Value (Rp/T)	3,327.65	5,741.83
Best	Benefit Cost Ratio	2.63	3.57
	ABC	13.05	14.5
	Fuel Netback Value (Rp/T)	5,406.83	7,821.02

7.3 Option 2 Results

The improved fuel consumption and greater length export year in comparison to Option 1, up to 65 percent, make both ABCs and netbacks higher at this mill. In addition, the alternative sources of electricity in Lampung province are all quite expensive, using diesel fuel. Using nominal Rupiah, the ABCs for the mill are well above the discount rate in all cases, even when the plant factor is just 50 percent. In the other cases the ABCs range from 12.93 percent to 16.83 percent under the best conditions. Perhaps the major factor supporting higher returns for the Lampung mills is the higher avoided cost for electricity in that area. Alternatives for baseload generation consist largely of diesel units, slow speed or high speed.

The assumptions behind this financial and economic analysis are shown in detail in Annex 8. Each example lists the key operating parameters and assumptions. Some of the differences between Mills 1 and 2 include the greater efficiency and capacity of Mill 2 along with improved plant factors. Due to the location of Mill 2 (the Gunung Madu Mill in Lampung was used as a model), the capacity payment is higher to cover the avoided costs of new capacity in that province. For Mill Option 2, the more important assumptions include the following.

Size of Mill	3.5 MW
Annual Hours of Operation (worst, best)	3,504-5,694 (40-65%)
Fuel Consumption While Exporting	30,000 BTU/kWh
Bagasse Consumption	2.84 kg/kWh
Bagasse Price	Rp 2,500-7,500/ton
Loan Costs	10% real, 18% nominal
Power Purchase Prices (Rp per kWh)	
Energy Sales Only	90 for peak 55 for shoulder and base
Energy & Capacity Payments	35 for capacity, 55 for energy

Fuel netback values are far higher in this case than in Option 1, due largely to the lower fuel consumption per kilowatt hour in this plant and to the higher power purchase prices obtainable. For the long term contracts, the netback values are all above Rp 16,000/ton, far

more than the bagasse will be worth for other uses, ex mill. In the spot sales cases, the netback values are in the Rp 9,400-10,600 range.

The fuel netback values for this option show that it may be possible and economically feasible to fuel the plant with cane tops and leaves. The fuel netback values for bagasse in the more attractive options, as high as Rp 15,000-17,500/ton, are equivalent to about Rp 30,000/ton or more for dried cane tops and leaves. This price is competitive with the prices obtained by farmers who sell these materials to feed plants for export to Japan. In addition, the prices for the tops and leaves are within the range identified in the Thailand study for baling and transportation costs for leaves and tops. Given the high concentration of sugar cane around the Gunung Madu mill, the use of tops and leaves may be attractive to the operators to keep the plant exporting power for virtually the entire year. The fuel netback value on an energy basis is still insufficient to justify the use of oil to extend the exporting season, making tops and leaves perhaps more attractive.

Table 19: Results of Option 2 Financial Analysis

Case	Measure	Energy Sales Only	Energy & Capacity Payment
Worst	Benefit Cost Ratio	1.68	2.58
	ABC (%)	12.40	14.39
	Fuel Netback Value (Rp/T)	9,426.39	16,420.17
Best	Benefit Cost Ratio	2.80	4.27
	ABC	14.78	16.83
	Fuel Netback Value (Rp/T)	10,654.44	17,648.23

7.4 Option 3 Results

The large scale export of electricity in a high pressure generation situation gives acceptable returns when the plant is used as a baseload unit, earning a capacity credit from the buyer. The spot sales options are generally only attractive if capacity utilization can reach 75 percent, given the initial investments that are required. In the best case, low cost generation of electricity permits the mill owners to earn ABCs of 11.50 percent and 12.92 percent, respectively for the spot and long term contracts. This mill is assumed to enjoy semi-concessional rates for borrowing at 12.5 percent interest.

The assumptions behind this financial and economic analysis are shown in detail in Annex 8. Each example lists the key operating parameters and assumptions. Some of the differences between Mills 2 and 3 include the greater efficiency and capacity of Mill 2 along with improved plant factors. With sufficient investment, the Gunung Madu mill, used as a model for Option 2, could be converted to an Option 3 type mill. The model used in the present case is the Gempolkrep mill in East Java. Located near large thermal power plants, the avoided costs are equivalent to those for new thermal plants in the PLN Java grid.

For Mill Option 3, the more important assumptions include the following:

Size of Mill	10 MW
Annual Hours of Operation (worst, best)	4,380-6,750 (50-75%)
Fuel Consumption While Exporting	20,000 BTU/kW
Bagasse Consumption	1.92 kg/kWh
Bagasse Price	Rp 2,500-7,500/ton
Loan Costs	10% real, 13% nominal
Power Purchase Prices (Rp per kWh)	
Energy Sales Only	90 for peak 55 for shoulder and base
Energy & Capacity Payments	25 for capacity, 55 for energy

The high efficiency of the Option 3 boiler and turbogenerator combination makes the fuel netback values for the case about equal to those for the Option 2 example. Given the large capital investments, the returns for the capacity payment case are quite steady. Under long term contract sales, the fuel netbacks are a minimum of Rp 10,700 and range up to Rp 16,500, under best case conditions. For the spot sales contracts, fuel netback values are still relatively attractive, almost Rp 10,000/ton in the best case.

Table 20: Results of Option 3 Financial Analysis

Case	Measure	Energy Sales Only	Energy & Capacity Payment
Worst	Benefit Cost Ratio	0.98	1.34
	ABC (%)	9.92	11.32
	Fuel Netback Value (Rp/T)	3,702.12	10,732.2
Best	Benefit Cost Ratio	1.39	1.89
	ABC	11.50	12.92
	Fuel Netback Value (Rp/T)	9,500.47	16,530.55

The use of cane tops and leaves may be feasible at such a plant, especially if it is to operate for most of the year as a baseload unit. With netback values for fuel in the same range as the Option 2 example, it will be possible for the mill to use tops and laves as fuel as long as prices remain around Rp 30,000/ton or below. As with the smaller power plants, the use of oil does not appear to be feasible for out-of-crop operation unless the purchase price is raised to reflect an avoided cost of diesel generators rather than thermal units.

7.5 Power Sales Contracting Issues

If PLN is the purchaser, it will want to control dispatch. This means that the owner of the power generating unit must allow the total number of hours of power sales to be determined by the customer (within the limits of the contractual framework). This has several implications. First, it rules out the type of casual or occasional power sales that many factories might prefer at low levels of investment and power export. Second, it places most of the financial risk onto the generator. Third, it imposes staffing and equipment costs on the generator in return for the higher prices that may accompany centralized dispatch

From the utility company's point of view, control over dispatch is crucial to the job of running a reliable and cost-minimizing electric power system. Several factors influence the utility's desire to control dispatch. First, the costs of other generating units in the system owned by PLN may vary throughout the year. This is especially true in the case of hydro facilities but will also apply to some extent to generating units that consume fuel oil.[22] Second, the utility must be able to schedule maintenance around its least cost generation program to make sure that there is sufficient reserve power in the peak demand periods. Third, the utility will need assurance that a non-utility source will be available when it is needed regardless of the processing situation at the sugar mill itself.

For the generators, there are several financial implications of dispatch coming from the purchaser. These are:

* Uncertainty about the number of hours which will be purchased in any given month;
* Competition with the utility's own generation units, especially hydro, during periods favorable to the utility's own facilities; and
* Calls on the mill to give priority to electricity production during the sugar milling season.

Each one of these factors is reasonable and can be covered in an appropriate contract. However, one of the net results of the utility gaining control over dispatch is that the uncertainty may be borne to an additional degree by the generator. Similarly, a mill providing electricity within an industrial estate will find it necessary to adjust its operating practices in such a way that power to the other industries in the estate is maintained.

7.5.1 Power Purchase Price Issues

At the present time there is no final set of purchase price terms for cogenerators or independent power producers. As a result, the team's energy economist used the proposed tariff structure that is based on the opportunity costs of alternative generation sources. The proposed buyback tariffs are of two types, spot sales and long term contracts. The spot sales tariff has three parts, for peak, shoulder, and baseload supply. Each of the spot sales categories may represent a different generation mix.

In the rate of return analysis, the term used for spot sales is ten years. For the capacity contract sales, the term is 20 years. The payment to generators consists of 2 parts, a capacity charge and an energy charge. The energy charge is made equal to PLN's expected fuel charge were the utility to provide this power. Similarly, the capacity charge is based on the alternative generation source in that area. In East Java, a baseload coal or gas plant is assumed to be the alternative investment while the alternative baseload generation source for South Sumatera is assumed to be slow speed diesel.

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22 This has to do with the economics of seasonal demands for various fuels and the responses of the refining system to those changes in demand. The availability, and therefore the price, of heavy fuel oil will vary from one season to another as a result of these refining changes. In most cases, the milling season coincides with the low season at PLN's hydro facilities. Therefore, the electricity produced will be relatively more valuable to PLN that if it were replacing output from the hydro facilities.

8.0 CONCLUSIONS AND RECOMMENDATIONS

This study reports on the results of preliminary investigations of the plausibility for initiating sugar or palm oil diversification projects in Indonesia. Though preliminary in nature, the study lays the groundwork for further study of the investment opportunities in the area of energy production as well as a review of other options for using waste products from the sugar and palm oil industries. The following conclusions and recommendations are presented to indicate steps to be taken towards a more optimal utilization of sugar and palm oil waste products.

The principal conclusions of the diversification study are:

1. A large volume of waste is produced in both the sugar and palm oil industries;

2. These wastes, totalling more than 13 million tons annually, could provide feedstock and raw materials for a variety of industries and products.

3. In the palm oil industry, the empty fruit bunches may provide locally significant fuel sources for electricity in some locations. Such generation can cut service costs and improve the reliability of power delivery.

4. Investment in a small generation station at PTP's Adolina mill appears to offer attractive financial returns, in excess of 40 percent.

5. At sugar mills, improved efficiency could provide large quantities of surplus bagasse for power generation. In some locations, such mill-based power could alleviate local shortages as well as provide incentives for location of biomass-based industries.

6. Investments at several existing or planned mills could provide electricity at prices well below current PLN tariffs. Based on potential PLN savings, several of these investments offer attractive rates of return in excess of 20 percent.

The principal recommendation of the BEST Project team are as follows:

1. A follow-up study needs to be made of the technical, economic and commercial feasibility of designing new, large sugar cane mills to high energy efficiency standards with the goal of generating baseload, year-round electricity from bagasse.

2. Detailed studies should be made regarding planned expansions at both public and private sugar mills. In addition to the focus on expanding mills, the study team recommends that the follow-up study look at several existing mills and investigate ways of making such mills net electricity exporters, both on a seasonal and a year-round basis.

3. To the extent that new product industries appear commercially feasible based on sugar industry wastes, it is possible that new power production could help create biomass-based growth centers in which industries producing such products as chemical, vitamins, MSG, alcohols, fiberboard and other products would be located on the grounds of the sugar mills. Power studies noted in 1 and 2 should examine power demands for these industries.

4. The team recommends that the feasibility of using EFBs for electrical generation in areas close to villages, industries and transmission lines be further examined. This study should concentrate on the feasibility of establishing a central power plant in the

Medan area that would use EFBs from several neighboring palm oil plants. Such plants could also become the basis of biomass-based growth centers, as in the case of sugar mills.

5. Last, the study team recommends that Perkebunan actively monitor research and commercial development in furfural, vitamins, fiberboard, alcohols and other products noted above. Continued research in the sugar and palm industries and their byproducts is essential to full utilization of these resources, and Perkebunan and private sugar companies should consider direct support for such research.

ANNEXES

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Annex 1. Palm oil mills in Indonesia, 1990

Province	Name	Location	Capacity (T/hr)	Owner
1 Aceh	T. Seumantoh	T. Seumantoh	60	PT. Perkebunan I
2 Aceh	Pulau Tiga	Pulau Tiga	30	PT. Perkebunan I
3 Aceh	Seumayam	Seumayam	20	Socfindo
4 Aceh	Sei Liput	Sei Liput	20	Socfindo
5 Aceh	Seunagan	Seunagan	20	Socfindo
6 Aceh	Mopoli Raya	Langsa	30	PT. Mopoli Raya
7 Aceh	Parasawita	Langsa	30	PT. Parasawita
8 Aceh	PPP	Kuala Simpang	30	PPP
9 North Sumatera	Sawit Seberang	Sawit Seberang	40	PT. Perkebunan II
10 North Sumatera	Kuala Sawit	Kuala Sawit	60	PT. Perkebunan II
11 North Sumatera	Bohor Lama	T. Beringin	30	PT. Perkebunan II
12 North Sumatera	Sawit Hula	Sawit Hula	40	PT. Perkebunan II
13 North Sumatera	PD. Brahrang	Binjai	40	PT. Perkebunan II
14 North Sumatera	Sawit Langkat	PD. Langkat	40	PT. Perkebunan VII
15 North Sumatera	Rapala	Gebang	10	PT. Rapala
16 North Sumatera	T. Gunung	T. Gunung	10	PT. Serdang Julu
17 North Sumatera	Jaya Baru Pertama	PKI. Susu	30	PT. Jaya baru Pert
18 North Sumatera	Turangi	Turangi	20	P.. Lonsum
19 North Sumatera	Pagar Merbau	Pagar Merbau	60	PT. Perkebunan IX
20 North Sumatera	Adolina	Adolina	30	PT. Perkebunan VI
21 North Sumatera	Pabatu	Pabatu	30	PT. Perkebunan VI
22 North Sumatera	Tiw	Tiw	20	PT. Perkebunan VI
23 North Sumatera	Rambutan	T. Tinggi	20	PT. Perkebunan V
24 North Sumatera	Matapao	Matao	20	PT. Socfindo
25 North Sumatera	Bangun Bandar	D. Masihul	30	PT. Socfindo
26 North Sumatera	Indapocan	S. Ruluh	20	PT. Indapocan
27 North Sumatera	Sumber Sawit	MakmLaut Tador	30	PT. Sumber Sawit M
28 North Sumatera	Tinjowan	Tinjowan	60	PT. Perkebunan VI
29 North Sumatera	Air Batu	Air Batu	30	PT. Perkebunan VI
30 North Sumatera	Pulau Raja	Pulau Raja	40	PT. Perkebunan VI
31 North Sumatera	Berangir	Berangir	30	PT. Perkebunan VI
32 North Sumatera	Teluk Dalam	Teluk Dalam	30	PT. Perkebunan VI
33 North Sumatera	Ajamu	Ajamu	20	PT. Perkebunan VI
34 North Sumatera	Sungai Silau	Kisaran	60	PT. Perkebunan V
35 North Sumatera	Negeri Lama	Negeri Lama	20	PT. Socfindo
36 North Sumatera	Aer Loba	Aer Loba	60	PT. Socfindo
37 North Sumatera	Tanah Gambus	Kisaran	30	PT. Socfindo
38 North Sumatera	Jaya Baru	Kisaran	30	PT. Jaya Baru
39 North Sumatera	Rambung Sialang	Kisaran	30	PT. Lonsum
40 North Sumatera	Dolok	Dolok	30	PT. Lonsum
41 North Sumatera	Gunung Melayu	Kisaran	30	PT. Lonsum
42 North Sumatera	SS. Luitur	Kisaran	30	PT. Sawit Sejati L
43 North Sumatera	RGM	Kisaran	30	PT. RGM
44 North Sumatera	Kuala Guning	Kisaran	20	PT. Kuala Gunung
45 North Sumatera	Bah Jambi	Bah Jambi	60	PT. Perkebunan VII
46 North Sumatera	Dolok Ilir	Dolok Ilir	60	PT. Perkebunan VII
47 North Sumatera	D. Sinumbah	Dolok Sinumbah	30	PT. Perkebunan VII
48 North Sumatera	G. Bayu	Gunung Bayu	30	PT. Perkebunan VII
49 North Sumatera	Mayang	Mayang	60	PT. Perkebunan VII
50 North Sumatera	Pasir Mandoge	Pasir Mandoge	60	PT. Perkebunan VII
51 North Sumatera	Bukit Maraja	Bukit Maraja	40	PT. Tolan Tiga (Si
52 North Sumatera	Parlabian	Parlabian	60	PT. Tolan Tiga (Si

Annex 1. (cont'd)

Province	Name	Location	Capacity (T/hr)	Owner
53 North Sumatera	Aek Nabara	Aek Nabara	60	PT. Perkebunan III
54 North Sumatera	Aek Torop	Aek Torop	60	PT. Perkebunan III
55 North Sumatera	Sisumut	Sisumut	30	PT. Perkebunan III
56 North Sumatera	PD. Halaban	PD. Halaban	60	PT. Sadang Mas
57 North Sumatera	Langga Payung	Langga Payung	30	PT. Unknown
58 North Sumatera	Asam Jawa	Binanga Mandal	30	PT. Asam Jawa
59 North Sumatera	KP. Pajak	R. Prapat	30	PT. Umada
60 North Sumatera	Torgamba	Torgamba	60	PT. Perkebunan IV
61 North Sumatera	S. Daun	S. Daun	60	PT. Perkebunan IV
62 North Sumatera	S. Meranti	S. Meranti	60	PT. Perkebunan IV
63 North Sumatera	Tanah Putih	Tanah Putih	30	PT. Perkebunan IV
64 Riau	Tandun	Tandun	60	PT. Perkebunan II
65 Riau		Tandun	30	PT. Perkebunan II
66 Riau	S. Buatan	S. Buatan	30	PT. Perkebunan II
67 Riau	S. Rokan	S. Rokan	60	PT. Perkebunan V
68 Riau	S. Tapung	S. Tapung	30	PT. Perkebunan V
69 Riau	S. Galuh	S. Galuh	30	PT. Perkebunan V
70 Riau	Air Molek	Air Molek	60	PT. Tunggal Perkas
71 Jambi	Sei Bahar	Sei Bahar	10	PT. Perkebunan IX
72 Bengkulu	Bengkulu	Bengkulu	30	PT. Perkebunan XXI
73 South Sumatera	Betung	Betung	60	PT. Perkebunan X
74 South Sumatera	Gardu Harapan	Gardu Harapan	30	PT. Perkebunan X
75 South Sumatera	Minanga Ogan	Batu Raja	30	PT. Minanga Ogan
76 Lampung	Bekri	Bekri	40	PT. Perkebunan X
77 Lampung	Rejosari	Rejosari	30	PT. Perkebunan X
78 West Java	Kerta Jaya	Rangkas Bitung	30	PT. Perkebunan X
79 West Kalimantan	Ngabang	Ngabang	30	PT. Perkebunan VII
80 West Kalimantan	Gunung Meliuu	Gunung Meliuu	60	PT. Perkebunan VII
81 East Kalimantan	Semuntai	Semuntai	30	PT. Perkebunan VI
82 SE Sulawesi	Luwu	Luwu	30	PT. Perkebunan XXI
83 Irian Jaya	Parati	Monoxwari	30	PT. Perkebunan II

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Annex 2. Material and Energy Balances for Palm Oil

Table A2.1 Example of Annual Material Balance for Good Commercial Practice in Palm Oil Production *

	Per Hectare	Per Acre
Trees (number)	136	55
Fruit Bunches (number)	815	330
Mass (weight) fresh Fruit bunches**	13,444 kg	12,000 lb
Fruit	7,730 kg	6,900 lb
Bunch Stalks (wet)	5,714 kg	5,100 lb
Bunch Stalks (dry)	2,286 kg	2,040 lb
Palm Oil	2,689 kg	2,400 lb
Palm Fruit Fiber (wet)	2,722 kg	2,430 lb
Palm Fruit Fiber (dry)	1,361 kg	1,215 lb
Palm nuts (wet)	2,319 kg	2,070 lb
Palm nuts (dry)	1,391 kg	1,242 lb
Nut shells (dry)	618 kg	522 lb
Palm kernels (dry)	773 kg	690 lb
Palm kernel oil	363 kg	324 lb
Palm kernel cake	410 kg	366 lb
Palm fronds (number)	1111	450
Palm fronds (wet)	6,050 kg	5,400 lb
Palm fronds (dry)	1,815 kg	1,630 lb

* Because of widely varying characteristics from one genetic strain to another, the figures shown can not be interpreted as applying generally.

** All production data given is for a mature stand.

Source: Alenxander J. Akor, *The Oil Palm Industry as an Energy Resource: Prospects and Problems*, A.S.A.E. Annual Meeting, March 1980.

Figure A.2 Example Material Balance for Oil Palm Processing (nominal weight units)

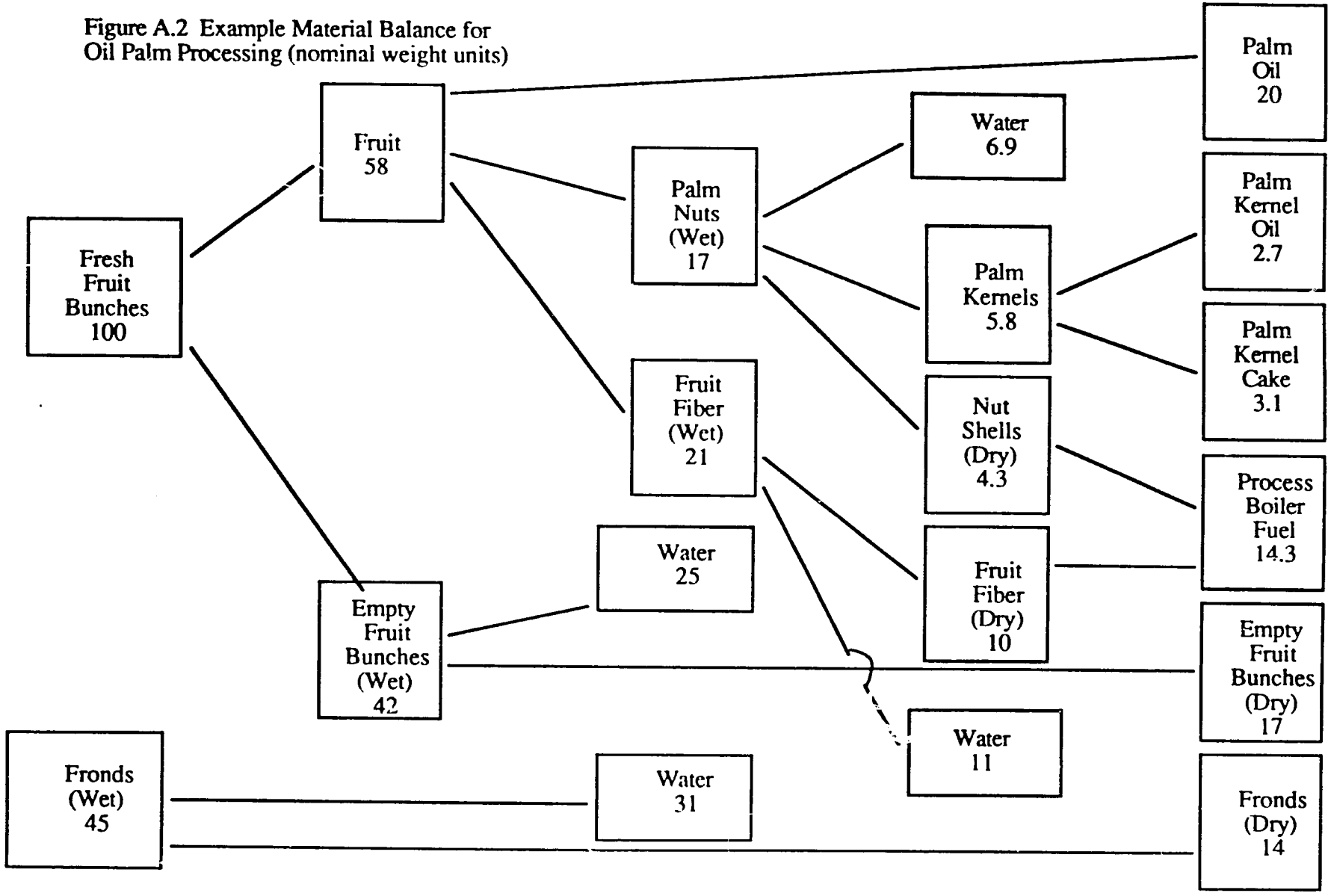


Table A2.2 Energy Balance, Annualized* over a 30-year span, for a 136-Tree Oil-Palm Stand on One Hectare.

Operation	Energy Input, kJ	Energy Output, kJ
Pre-processing energy inputs (includes land clearing, nursery, fertilizers, harvesting, transportation, etc**)	4,820,732	
Fruit sterilization	8,295,086 ****	
Fruit stripping	113,488	
Maceration	98,893	
Pressing	486,704	
Separation	111,732	
Fiber drying	5,283,777 ****	
Nut drying	7,205,503 ****	
Nut cracking	195,297	
Kernel oil extraction	1,557,239	
Palm oil		88,750,948
Palm kernel oil		12,034,427
Fiber		21,135,106 ****
Nut shell		9,596,984 ****
Palm kernel cake		6,366,931
Subtotal	28,168,452	137,884,396
Current Practice Subtotal ****	7,384,086	107,152,306
Bunch stalks *****		26,624,644
Palm fronds *****		24,662,154
Total	28,168,452	189,171,194

* Average annualized yield over a 30-year span is 83.47% of that of the annual yield of a mature stand.

** Manual operations charged at 5384 kW/$(1976).

*** 25kg N, 25kg P_2O_5 and 37kg K_2O per hectare.

**** In current practice with full scale processing, fiber and nut shells are burned to provide heat for all processing operations. In some cases this heat is also used to generate electrical or mechanical power for all in-plant operations (power generation not considered in current practice subtotal shown here.)

***** Currently palm fronds and bunch stalks are not generally used as energy sources, although there exists a potential for such use.

Source: Alexander J. Akor, *The Oil Palm Industry as an Energy Resource: Prospects and Problems*, A.S.A.E. Annual Meeting, March 1980.

Annex 3. Pulp and paper statistics

A3.1 Total production, import, export, and consumption of paper in Indonesia 1981-1986.

Year	Production	Export	Import	Consumption
1981	259,600	1,149	279,900	538,351
1982	329,700	5,599	307,000	631,101
1983	362,800	10,856	283,500	635,444
1984	402,700	36,300	267,000	633,400
1985	506,000	37,212	233,000	701,788
1986	609,700	64,616	176,000	721,584

Source: Asean Pulp and Paper Industry Club (APPIC)

A3.2 Production, Import, Export and Consumption of Paper for News Print in Indonesia, 1981-1985.

Year	Production (ton)	Import (ton)	Export (ton)	Consumption (ton)
1981	-	100,400	-	100,400
1982	-	120,000	-	120,000
1983	-	120,100	-	120,100
1984	-	118,100	-	118,100
1985	62,600	99,400	2,000	160,000

Source : Asean Pulp and Paper Industry Club (APPIC).

A3.3 Quantity of imported pulp to Indonesia, 1981-1986.

Year	Quantity
1981	85,789
1982	85,620
1983	107,540
1984	106,475
1985	214,979
1986	255,400

Source: Central Bureau of Statistics

A3.4 Projection of Paper Consumption in Indonesia in 1990-1993.

Year	Total Population	Consumption/Cap.	Total Consumption
			- kilograms -
1990	182,349,985	4	729,399,940
1991	185,996,985	4	748,987,940
1992	189,716,924	4	758,867,696
1993	198,511,263	4	774,045,052

A 3.5 List of Pulp and Paper Factories Using Bagasse

Company	P.T. Keitas Leces	P.T. Pakerin	P.T. Tjiwi Kimi
Type	Public	Private	Private
Location	Probolinggo East Java	Bangun, Mojokerto East Java	Tarik, Mojokerto East Java
Phone #	(0335) 21993	(031) 316173	(0321) 21574 (0321) 21575
FAX #	(0335) 21628	(031) 314345 (031) 317223	(0321) 21615
Jakarta Office Phone #	7202773		3104648
Jakarta Office FAX #	771416		
Capacity	156,000 T (1990 Production)	141,000 T/Yr	144,000 T/Yr
Raw Materials	Rice Straw, Bagasse	Bagasse, Waste Paper, Chemicals	Pulp, Bagasse, Waste Paper
Products	Newsprint, Writing, Wrapping	Corrugating Medium, Kraft Liner, Boards	Writing, Printing, Coated Boards
Capital Investment	USD 176 Million	Rp 153.7 Billion	Rp 269 Billion
Employees	3,900	1,500	3,835

Source: The Indonesian Pulp and Paper Association, 1990.

Annex 4. List of sugar factories in Indonesia

Island/Firm/Factory	Kabupaten	Season	Milling Capacity TCD	Sugar T/Yr	Molasses T/Yr	Boiler Capacity T/Hr	Generator Capacity kW	Excess Bagasse T/Yr
Java:								
PT. Perkebunan XIV								
Kadhipanten	Majalengka	May-Oct	1,269	1,422	4,950	37	991	
Jatiwangi	Majalengka	May-Sep	1,103	9,575	3,504	32	862	
Gempol	Cirebon	Jun-Sep	1,144	5,521	2,226	33	894	
Sindang Laut	Cirebon	May-Oct	1,832	24,182	10,063	53	1,431	
Karang Suwung	Cirebon	May-Oct	1,225	14,183	6,032	36	957	
Tersana Baru	Cirebon	May-Oct	2,868	30,278	12,384	84	2,241	21,721
Jatitujuh	Majalengka	Jun-Oct	3,893	15,104	13,842	114	3,041	21,968
Subang	Subang	Jun-Nov	3,243	25,300	19,337	95	2,534	25,203
		Total	**16,577**	**137,575**	**72,338**	**484**	**12,951**	**68,892**
PT. Perkebunan XV-XVI								
Banjaratma	Brebes	May-Oct	1,584	18,028	6,690	49	1,238	
Jatibarang	Brebes	Apr-Oct	2,024	27,274	9,941	59	1,581	
Pangka	Tegal	May-Oct	1,775	21,491	9,223	52	1,387	
Sumberharjo	Pemalang	Apr-Oct	2,026	27,048	11,686	59	1,583	17,350
Sragi	Pekalongan	Apr-Nov	3,594	50,480	26,137	105	2,808	39,139
Cepiring	Kendal	Apr-Oct	1,646	21,075	8,754	48	1,286	
Rendeng	Kudus	Apr-Oct	2,058	27,271	12,755	60	1,608	18,541
Mojo	Sragen	Apr-Oct	2,776	36,472	16,462	81	2,169	25,284
Tasikmadu	Karanganyar	Apr-Dec	3,426	47,832	16,743	100	2,677	31,374
Colomadu	Karanganyar	May-Nov	1,226	15,048	8,673	36	958	
Ceper Baru	Klaten	Apr-Oct	1,567	22,451	6,741	46	1,224	
Gondang Baru	Klaten	Apr-Oct	1,599	20,973	6,583	47	1,218	
Kalibagor	Banyumas	Jun-Aug	1,205	4,894	2,589	35	941	
		Total	**26,506**	**340,337**	**142,977**	**777**	**20,678**	**145,935**
PT. Perkebunan XX								
Sudhono	Ngawi	May-Nov	2,497	27,734	15,467	73	1,951	21,507
Purwodadi	Magetan	May-Nov	2,047	23,655	10,459	60	1,599	
Rejosari	Magetan	May-Nov	1,996	24,522	10,425	58	1,559	
Pagottan	Madiun	May-Nov	1,823	30,870	9,705	53	1,424	16,243
Kanigoro	Madiun	May-Nov	1,892	22,265	11,183	55	1,478	16,296
		Total	**10,255**	**129,066**	**57,239**	**299**	**8,011**	**54,046**
PT. Perkebunan XXI-XXII								
Krian	Sidoarjo	May-Dec	1,175	20,555	9,380	34	918	
Watutulis	Sidoarjo	May-Nov	1,772	24,968	12,290	52	1,384	
Tulangan	Sidoarjo	May-Dec	1,201	17,224	8,620	35	938	
Kremboong	Sidoarjo	Jun-Dec	1,290	19,885	10,490	38	1,008	
Gempolkrep	Mojokerto	May-Dec	4,500	73,784	32,610	131	3,516	48,560
Jombang Baru	Jombang	May-Nov	1,930	25,753	13,475	56	1,508	18,247
Cukir	Jombang	Jun-Dec	2,189	33,038	16,667	64	1,710	21,671
Lestari	Nganjuk	May-Nov	2,892	31,084	17,617	84	2,259	25,338
Merican	Kediri	May-Nov	2,305	32,079	14,609	67	1,801	24,766
Pesantren Baru	Kediri	May-Dec	5,019	84,592	41,112	146	3,921	53,663
Ngadirejo	Kediri	May-Nov	4,568	48,364	26,002	133	3,569	37,535
Mojopanggung	Tulungagung	May-Oct	1,885	16,422	9,906	55	1,473	
		Total	**30,726**	**427,748**	**212,778**	**895**	**24,005**	**229,780**
PT. Perkebunan XXIV-XXV								
Kedawung	Pasuruan	Jun-Nov	3,185	34,079	17,464	93	2,488	25,225
Wonolangan	Probolinggo	May-Nov	1,296	18,662	8,488	38	1,013	
Gending	Probolinggo	May-Nov	1,297	19,700	7,940	38	1,013	
Pajarakan	Probolinggo	Jun-Nov	1,149	10,018	4,911	34	898	
Jatiroto	Lumajang	May-Dec	5,818	84,395	46,363	170	4,545	61,630
Semboro	Jember	Jun-Dec	5,405	59,888	34,219	158	4,223	49,496
De Maas	Situbondo	Jun-Oct	900	8,234	4,236	26	703	
Wringinanom	Situbondo	Jun-Nov	1,090	12,735	6,071	32	852	
Olean	Situbondo	Jun-Oct	1,077	10,616	5,176	31	841	
Panji	Situbondo	Jun-Oct	1,840	15,414	8,164	54	1,438	
Asembagus	Situbondo	May-Nov	2,165	29,940	14,846	73	1,953	15,592
Prajekan	Bondowoso	May-Dec	2,869	41,066	20,346	84	2,241	28,971
		Total	**28,091**	**344,747**	**178,224**	**831**	**22,208**	**180,914**

Annex 4. (cont'd)

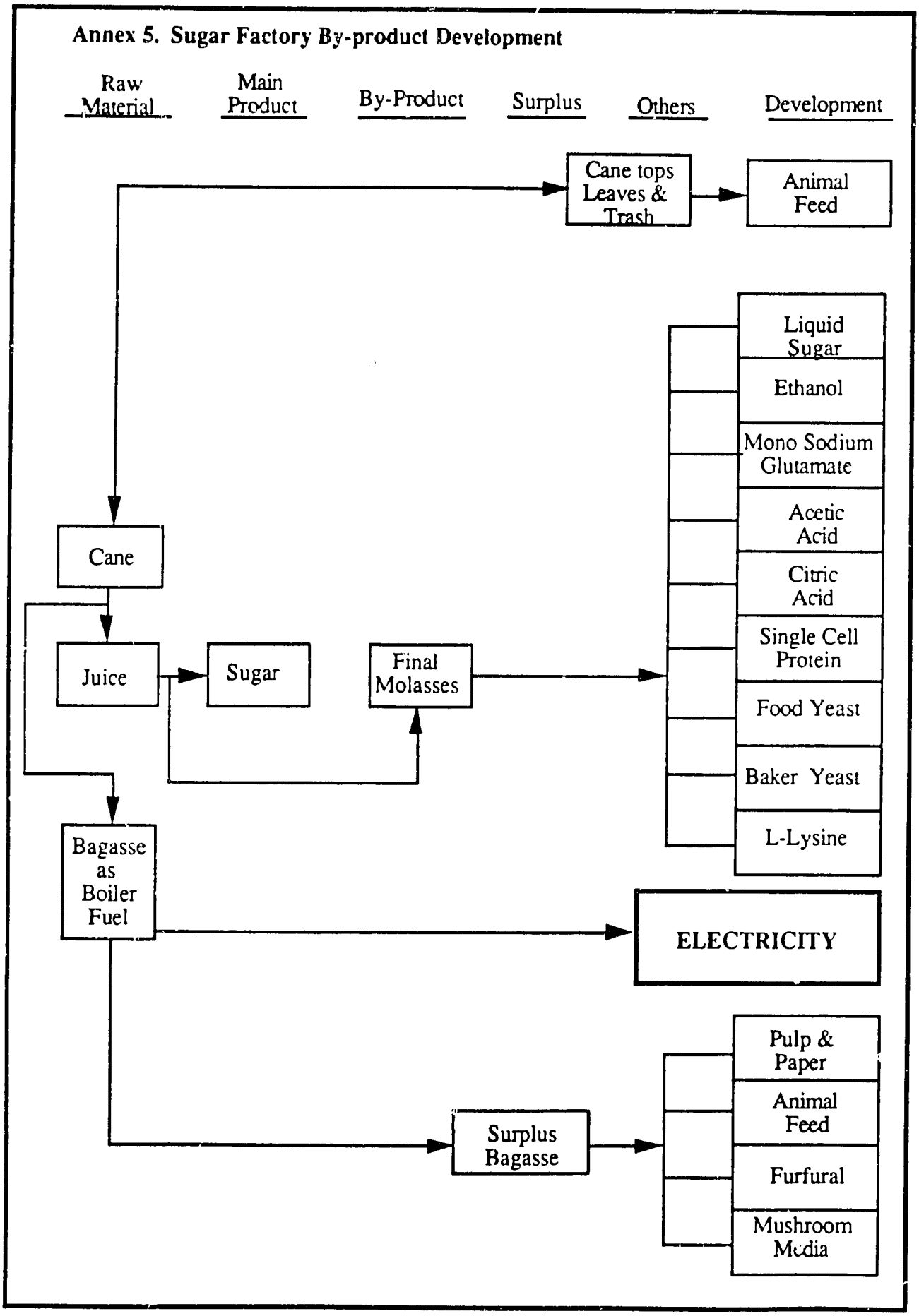
Island/Firm/Factory	Kabupaten	Season	Milling Capacity TCD	Sugar T/Yr	Molasses T/Yr	Boiler Capacity T/Hr	Generator Capacity kW	Excess Bagasse T/Yr
PT. Bapippundip								
Pakis Baru	Pati	May-Nov	2,485	32,862	13,150	72	1,941	21,526
PT. Tri Gunabina								
Kebon Agung	Malang	May-Nov	3,727	46,258	26,279	109	2,912	33,392
Trangkil	Pati	May-Nov	2,710	45,986	18,081	79	2,117	27,768
		Total	**6,437**	**92,244**	**44,360**	**188**	**5,029**	**61,160**
PT. Madu Baru								
Madujkismo	Bantul	May-Oct	2,822	31,336	14,034	92	2,205	
PT. Imaco								
Rejoagung Baru	Madium	May-Nov	4,293	48,902	20,032	125	3,354	41,438
rebat BAru	Malang	May-Nov	6,458	67,472	39,447	188	5,045	47,631
		Total	**10,751**	**116,374**	**59,479**	**313**	**8,399**	**89,069**
PT. Pabrik Gula Candi								
Candi	Sidoarjo	May-Dec	1,441	18,056	13,225	42	1,126	
Sub-total Government Estates			112,155	1,379,473	663,556	3,286	87,853	679,567
Sub-tota Private Estates			23,936	290,872	144,248	707	18,700	171,755
Total for Java			136,091	1,670,345	807,804	3,993	106,553	851,322
Sumatera:								
PT. Perkebunan IX								
Sei Semayang	Deli-Serdang	Jan-Jul	3,732	28,969	18,298	109	4,859	
Kwalamadu	Binjai	Jan-Jul	3,712	31,517	19,216	108	4,833	
		Total	**7,444**	**60,486**	**37,514**	**217**	**9,692**	**0**
PT. Perkebunan XXI-XXII								
Cinta Manis	Ogan Komering	May-Nov	4,546	42,749	27,045	133	5,919	42,755
Bunga Mayang	Lampung Utara	May-Nov	4,979	36,958	31,138	145	6,485	43,131
		Total	**9,525**	**79,707**	**58,183**	**278**	**12,404**	**85,886**
PT. Perkebunan XXIV-XXV								
Takalar	Takalar	Jun-Oct	2,926	19,093	12,120	85	3,810	16,511
Pelaihari	Tanah Laut	Jun-Oct	3,680	19,219	18,883	107	4,792	
		Total	**6,606**	**38,312**	**31,003**	**192**	**8,602**	**16,511**
PT. Gunung Madu Plant								
Gunung Madu	Lampung Teng	Apr-Oct	9,888	115,273	45,742	288	12,875	150,000
PT. Gula Putih Mataram								
Gula Putih Mataram	Lampung Teng.	May-Oct	5,950	60,022	56,416	261	11,654	
Sulawesi:								
Perkebunan XX								
Bone	Bone	Jul-Nov	1,997	13,263	6,604	58	2,600	
Camming	Bone	Jul-Oct	2,578	9,965	6,579	75	3,357	
		Total	**4,575**	**23,228**	**13,183**	**133**	**5,957**	**0**
Sub-total Government Estates			28,150	201,733	139,883	820	36,655	102,397
Sub-total Private Estates			19,838	175,295	102,158	549	24,529	150,000
Total off Java:			47,988	377,028	242,041	1,369	61,184	252,397
Total for Indonesia			184,079	2,047,373	1,049,845	5,362	167,737	1,103,719

Annex 4A Projected locations for sugar factory development on the outer islands of Indonesia

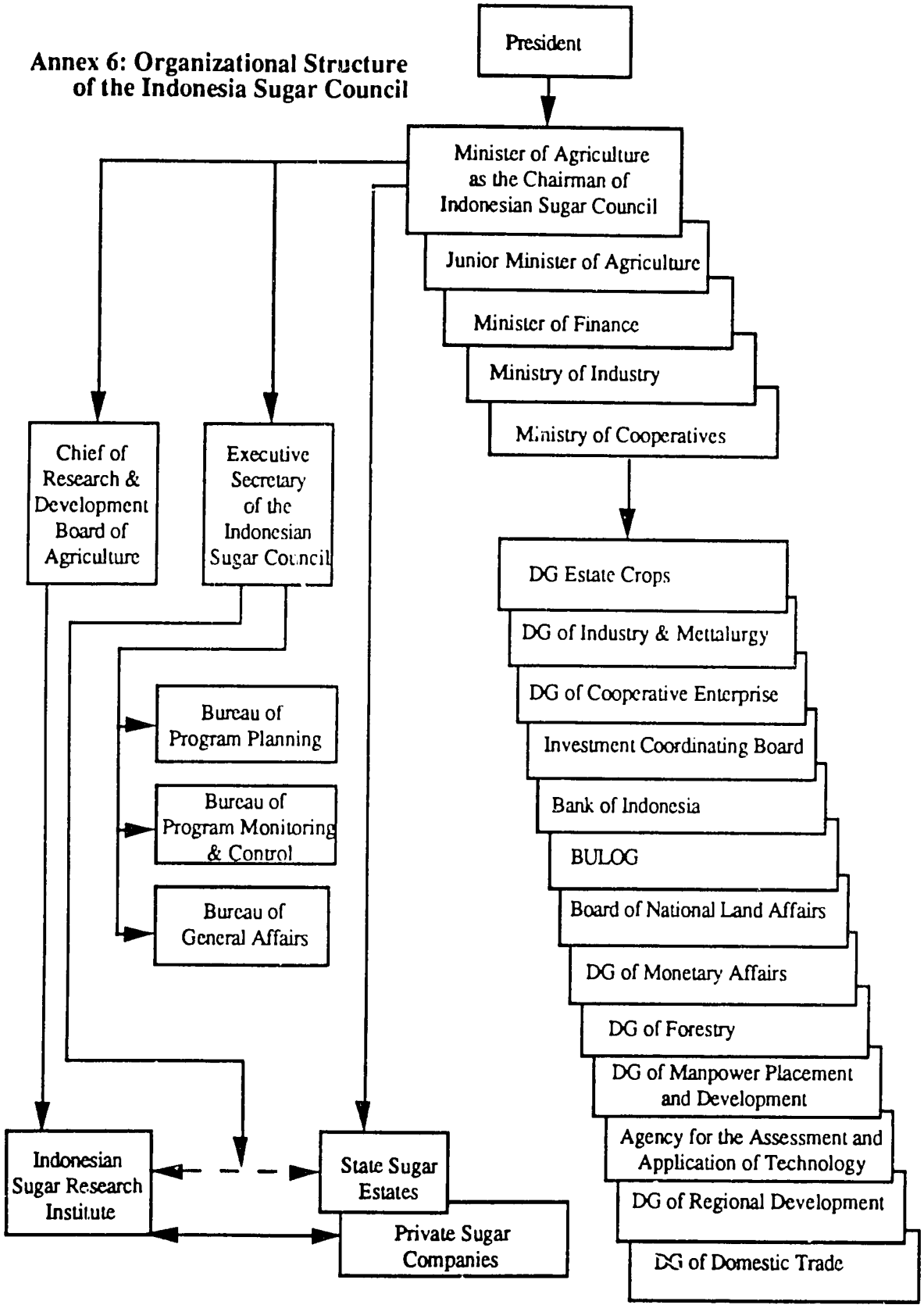
Province	Site	Factory Size - TCD -	Plantation Size - Hectares -
South Sumatera	Lampung Province (4)	8-10,000 (4)	20-90,000 (4)
South Sumatera	Batu Raja	5,000	30,000
North Sulawesi*	Batuyman	8,000	20,000
Southeast Sulawesi	Tinangatea	4,500	15,000
East Timor	Los Palos	3,000	6,000
Maluku	Yamdena	6,000	20,000
Irian Jaya	Naquias	5,500	20,000
Totals		68,000	211,000

* Government Estate

Annex 5. Sugar Factory By-product Development



Annex 6: Organizational Structure of the Indonesia Sugar Council



Annex 7. Cane Tops and Leaves as Export Animal Feed

The production process is comprised of the following steps:

1. The wet cane tops to be dried under the sun on the drying floor.
2. By conveyer, the cane tops are carried into a crusher and crushed into small cuts to reduce the water content.
3. The cane tops are then cut into short cuttings by means of cutting machine.
4. The short cuttings of cane tops are first dried at the temperature of 200 degrees centigrade before entering the 3-pass rotary drier where the temperature is about 500 degrees centigrade.
5. The dried cane tops are cleaned from dust in a cyclone.
6. The cane tops are further mixed with some sugar molasses before being pressed and baled in the blocking machine into the size of 25 cm x 25 cm x 75 cm.
7. The product containing less than 12 % water weighing 20 Kg per bale to be pack into nested plastic bags and ready to be sold as cattle feed.

Annex 8: Financial Analysis Tables

The Tables that follow contain detailed financial information about the three options that were identified in the definitional mission to Indonesia. These tables are compiled in an Income statement format. Costs and revenues are listed for 22 years total, two for construction/investment and 20 for operations. The cost and revenue figures are given in the Tables in billions of Rupiah.

Assumptions regarding size of the power export, in MW and kWh, fuel consumption and fuel costs are listed in the upper left corner of the statement. Next to the listing of operational parameters is a box with the relevant financial analysis results. Each of these measures has been discussed in the main text. The numbers to the left of the case, a 1 or 2, refer to the power sales regime that is explained in the revenues section of the Table. The benefit/cost ratio is a dimensionless number which represents the ratio of the present values of both benefits and costs.[1] A figure above 1 indicates that the project is feasible in principle. The internatl rate of return of the project is a measure of the potential return on the excess cash flows from the project. If the IRR exceed some specific figure, usually known as the "hurdle" rate, the project is considered feasible.

To overcome drawbacks in both the B-C ratio and the internal rate of return, here is an annualized benefit/cost (ABC) figure calculated for each of the two power sales options for each investment option. An ABC figure in excess of the discount rate (shown in the upper left corner) indicates the annual rate at which the benefits of the investment exceed the costs of that investment. The ABC is explained in the text and is considered to be a more stable and complete measure of project economics than the other ratios given. In particular, it does not tend to "blow up" and overstate potential returns as the IRR may.

The fuel netback value for bagasse is given at the end of the Table and is computed for both power sales options. A netback value in excess of the expected cost of bagasse indicates that the expected revenues can cover all equipment and fuel costs and leave a surplus for investors. To estimate the fuel netback value for cane tops and leaves, multiply the netback value in the Table by 2.

Following the summaries of assumptions and results is the listing of costs, variable and fixed. Under variable costs four categories are listed along with a total. All of these cost elements were compiled using the best available estimates for each of the cases.

Investments and fixed costs are next in the Tables, with the major parameters, including the interest rate, all changeable by the user of the model that created the statement. At the present time, the analysis uses concessional rates of 10% and both 11.5% and 12.5% for the public sector mills of 1 MW and 10 MW, respectively. The private sector mill is assumed to borrow money at 18%. In each case it was assumed that the owners of the mill financed 20% of the investment with their own money or from retained cash flow, borrowing the rest.

The positive and negative cash flows are then summarized, with a section that includes some key assumptions about the value of the electricity to the power company or some other purchaser (see the main text for this discussion). Finally, the annual cash flows are presented for the two power purchase options.

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[1] The net present value is computed by subtracting the present value of costs from the present value of benefits. A NPV greater than 0 is equivalent to a PVB/PVC >1.

The second page of the printout contains the out-years for costs and revenues, including an assumed renovation of the boiler and TG unit in years 11 and 12.

Six cases are presented, illustrating the types of analyses that are needed to satisfy potential lenders and showing the effects of different assumptions regarding inflation, plant operation, and the like. Option 1 is presented in best case and worst case (among the feasible) examples in nominal rupiah. The use of nominal rupiah would be appropriate for local decisionmakers, including government, since the cash flows will involve only local currency. Option 2 is shown in a constant Rupiah format that corresponds to the desired format of international development lenders. A case with identical parameters in nominal rupiah follows the constant rupiah case. The third option is shown in constant and nominal rupiah for identical sets of operational parameters.

Key Operating Parameters

Size of Mill Export (MW)		1
Annual Hours of Operation		2190
Kwh/year output		2,190,000
Plant Heat Rate	btu/kWh	60,000
Bagasse Consumption	kg/kWh	5.59
Bagasse Price	Rp/T	4,000
Discount Rate		10%

Financial Analysis

Present Value of Costs	1.12	Annualized Benefit Cost	
Present Value of Benefits		1	11.74%
1	1.64	2	13.17%
2	2.23	Internal Rate of Return	
Benefit Cost Ratio:		1	37.62%
1	1.46	2	80.30%
2	1.99	Fuel Net Back Value: Rp/tonne	
		1	4,284
		2	6,698

Note: the PV figures are in Rp billions

Expenditures & Investments

Year	0	1	2	3	4	5	6	7	8	9
Variable Costs	Rp/kWh	Inflation Rate (%/year)	Billions of Rupiah							
Fuel	22.36	6%	0.00	0.00	0.05	0.05	0.06	0.06	0.06	0.07	0.07	0.07
Spare Parts	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M	7.05	8%	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Management	0.5	8%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Variable Costs			0.00	0.00	0.07	0.07	0.07	0.08	0.08	0.09	0.10	0.10
Investment & Fixed Costs												
Investment in Fixed Plant			0.13	0.18								
Equity =		20%	0.03	0.04								
Loan Rate		18%										
Loan Period (years)		10										
Amount Borrowed			0.10	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan Outstanding			0.10	0.26	0.27	0.26	0.25	0.23	0.21	0.18	0.16	0.13
Interest Payments			0.00	0.00	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02
Principal Payments			0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04
Interest During Construction			0.01	0.01								
Total Investment & Financing Cash Flows			0.03	0.04	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.06
Total Outflows			**0.03**	**0.04**	**0.12**	**0.13**	**0.13**	**0.14**	**0.15**	**0.15**	**0.15**	**0.16**

Revenues

Year	0	1	2	3	4	5	6	7	8	9
Electricity Sales	Rp/kWh	Inflation (%/year)								
1. Energy Sales Only										
Peak	90	8%	0.02	0.03	0.03	0.03	0.03	0.04	0.04	0.04
Shoulder	55	8%	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09
Base	55	8%	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09
2. Avoided Cost Contracts										
Capacity	25.36	8%	0.06	0.06	0.06	0.07	0.08	0.08	0.09	0.10
Energy	55	8%	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21
Total Inflows: 1. Energy Payments Only	0.00	0.00	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.22
Total Inflows: 2. Avoided Cost Contracts	0.00	0.00	0.18	0.19	0.21	0.22	0.24	0.26	0.28	0.30
Total Cash Flows										
1. Energy Payments Only	-0.03	-0.04	0.01	0.01	0.02	0.03	0.02	0.04	0.05	0.06
2. Avoided Cost Contracts	-0.03	-0.04	0.05	0.06	0.07	0.08	0.09	0.11	0.13	0.14

1 MW Electricity Export During Milling Season: Public Sector Mill

10	11	12	13	14	15	16	17	18	19	20	21
0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.14	0.15
0.00	0.00	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.11	0.11	0.20	0.19	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.09	0.05	0.00									
-0.02	-0.01										
-0.04	-0.05										
0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.17	**0.17**	**0.20**	**0.19**	**0.14**	**0.15**	**0.16**	**0.17**	**0.18**	**0.19**	**0.20**	**0.21**
0.05	0.05	0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.10	0.11
0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.17	0.18	0.19	0.21	0.23
0.10	0.10	0.11	0.12	0.13	0.14	0.15	0.17	0.18	0.19	0.21	0.23
0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.18	0.19	0.21	0.22	0.24
0.22	0.24	0.26	0.28	0.30	0.33	0.35	0.38	0.41	0.45	0.48	0.52
0.24	0.26	0.28	0.30	0.33	0.35	0.38	0.41	0.44	0.48	0.52	0.56
0.33	0.35	0.38	0.41	0.44	0.48	0.52	0.56	0.60	0.65	0.70	0.76
0.07	**0.09**	**0.08**	**0.11**	**0.19**	**0.21**	**0.22**	**0.24**	**0.27**	**0.29**	**0.32**	**0.34**
0.16	**0.18**	**0.18**	**0.22**	**0.31**	**0.33**	**0.36**	**0.39**	**0.43**	**0.46**	**0.50**	**0.55**

Key Operating Parameters

Size of Mill Export (MW)		1
Annual Hours of Operation		3504
Kwh/year output		3,504,000
Plant Heat Rate	btu/kWh	60,000
Bagasse Consumption	kg/kWh	5.59
Bagasse Price	Rp/T	4,000
Discount Rate		10%

Financial Analysis

Present Value of Costs		1.45	Annualized Benefit Cost	
Present Value of Benefits			1	12.74%
	1	2.63	2	14.19%
	2	3.57	Internal Rate of Return	
Benefit Cost Ratio:			1	81.99%
	1	1.81	2	143.24%
	2	2.47	Fuel Netback Value: Rp/tonne	
Note: the PV figures are in Rp billions			1	5,173
			2	7,587

Expenditures & Investments

Year	0	1	2	3	4	5	6	7	8	9
Variable Costs	Rp/kWh	Inflation Rate (%/year)	Billions of Rupiah							
Fuel	22.36	6%	0.00	0.00	0.08	0.08	0.09	0.09	0.10	0.10	0.11	0.12
Spare Parts	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M	4.41	8%	0.00	0.00	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03
Management	0.5	8%	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Variable Costs			0.00	0.00	0.10	0.10	0.11	0.11	0.12	0.13	0.14	0.15
Investment & Fixed Costs												
Investment in Fixed Plant			0.13	0.18								
Equity =		20%	0.03	0.04								
Loan Rate		18%										
Loan Period (years)		10										
Amount Borrowed			0.10	0.16	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan Outstanding			0.10	0.26	0.27	0.26	0.25	0.23	0.21	0.18	0.16	0.13
Interest Payments			0.00	0.00	-0.05	-0.04	-0.04	-0.04	-0.04	-0.03	-0.03	-0.02
Principal Payments			0.00	0.00	-0.01	-0.01	-0.02	-0.02	-0.03	-0.03	-0.03	-0.04
Interest During Construction			0.01	0.01								
Total Investment & Financing Cash Flows			0.03	0.04	0.06	0.06	0.06	0.06	0.07	0.06	0.06	0.06
Total Outflows			**0.03**	**0.04**	**0.15**	**0.16**	**0.17**	**0.17**	**0.19**	**0.19**	**0.20**	**0.20**

Revenues

Year	0	1	2	3	4	5	6	7	8	9
Electricity Sales	Rp/kWh	Inflation (%/year)								
1. Energy Sales Only										
Peak	90	8%		0.04	0.04	0.05	0.05	0.05	0.06	0.06	0.07
Shoulder	55	8%		0.08	0.09	0.10	0.11	0.11	0.12	0.13	0.14
Base	55	8%		0.08	0.09	0.10	0.11	0.11	0.12	0.13	0.14
2. Avoided Cost Contracts											
Capacity	25.36	8%		0.09	0.10	0.10	0.11	0.12	0.13	0.14	0.15
Energy	55	8%		0.19	0.21	0.22	0.24	0.26	0.28	0.31	0.33
Total Inflows: 1. Energy Payments Only			0.00	0.00	0.21	0.22	0.24	0.26	0.28	0.30	0.33	0.35
Total Inflows: 2. Avoided Cost Contracts			0.00	0.00	0.28	0.30	0.33	0.35	0.38	0.41	0.45	0.48
Total Cash Flows												
1. Energy Payments Only			**-0.03**	**-0.04**	**0.05**	**0.06**	**0.08**	**0.09**	**0.09**	**0.12**	**0.13**	**0.15**
2. Avoided Cost Contracts			**-0.03**	**-0.04**	**0.13**	**0.14**	**0.16**	**0.18**	**0.19**	**0.23**	**0.25**	**0.28**

1 MW Electricity Export During Milling Season: Public Sector Mill

10	11	12	13	14	15	16	17	18	19	20	21
0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.24
0.00	0.00	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05	0.05	0.06	0.06
0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01
0.16	0.17	0.26	0.25	0.20	0.21	0.22	0.24	0.25	0.27	0.29	0.31
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.09	0.05	0.00									
-0.02	-0.01										
-0.04	-0.05										
0.06	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.21	**0.22**	**0.26**	**0.25**	**0.20**	**0.21**	**0.22**	**0.24**	**0.25**	**0.27**	**0.29**	**0.31**
0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17
0.16	0.17	0.18	0.20	0.21	0.23	0.25	0.27	0.29	0.31	0.33	0.36
0.16	0.17	0.18	0.20	0.21	0.23	0.25	0.27	0.29	0.31	0.33	0.36
0.16	0.18	0.19	0.21	0.22	0.24	0.26	0.28	0.30	0.33	0.36	0.38
0.36	0.39	0.42	0.45	0.49	0.52	0.57	0.61	0.66	0.71	0.77	0.83
0.38	0.41	0.45	0.48	0.52	0.56	0.61	0.66	0.71	0.77	0.83	0.89
0.52	0.56	0.61	0.66	0.71	0.77	0.83	0.89	0.96	1.04	1.13	1.22
0.17	**0.19**	**0.19**	**0.24**	**0.32**	**0.35**	**0.38**	**0.42**	**0.46**	**0.50**	**0.54**	**0.59**
0.31	**0.34**	**0.35**	**0.41**	**0.51**	**0.55**	**0.60**	**0.65**	**0.71**	**0.77**	**0.84**	**0.91**

3.5 MW Electricity Export Throughout Year: Gunung Madu Mill Example

Key Operating Parameters

Size of Mill Export (MW)		3.5
Annual Hours of Operation		4380
Kwh/year output		15,330,000
Plant Heat Rate	(btu/kWh)	30,000
Bagasse Consumption	(kg/kWh)	2.84
Bagasse Price	(Rp/T)	7,500
Discount Rate		10%

Financial Analysis

Present Value of Costs		7.32	Annualized Benefit Cost Ratio	
Present Value of Benefits			1	12.07%
1		11.50	2	14.06%
2		17.58	Internal Rate of Return	
Benefit Cost Ratio:			1	51.98%
1		1.57	2	114.36%
2		2.40	Fuel Netback Value: Rp/tonne	
Note: the PV figures are in Rp billions			1	22,471.95
			2	38,901.70

Expenditures & Investments

Billions of Rupiah

Year	0	1	2	3	4	5	6	7	8	9
Variable Costs (Rp/kWh; Inflation Rate %/year)										
Fuel 21.28 8%	0.00	0.00	0.33	0.35	0.38	0.41	0.44	0.48	0.52	0.56
Spare Parts NA NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M 5.76 6%	0.00	0.00	0.09	0.09	0.10	0.11	0.11	0.12	0.13	0.13
Management 0.5 8%	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Variable Costs	0.00	0.00	0.42	0.45	0.49	0.53	0.57	0.61	0.66	0.70
Investment & Fixed Costs										
Investment in Fixed Plant (Rp bn)	1.15	0.62								
Equity (Rp bn) = 20%	0.23	0.12								
Loan Rate 18%										
Loan Period (years) 10										
Amount Borrowed	0.92	0.58	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan Outstanding	0.92	1.50	1.55	1.48	1.41	1.32	1.22	1.08	0.94	0.77
Interest Payments	0.00	0.00	-0.27	-0.26	-0.24	-0.23	-0.21	-0.19	-0.16	-0.13
Principal Payments	0.00	0.00	-0.06	-0.07	-0.09	-0.10	-0.13	-0.15	-0.17	-0.20
Interest During Construction	0.08	0.05								
Total Investment & Financing Cash Flows	0.23	0.12	0.33	0.33	0.33	0.33	0.34	0.33	0.33	0.33
Total Outflows	**0.23**	**0.12**	**0.75**	**0.79**	**0.82**	**0.86**	**0.91**	**0.94**	**0.99**	**1.04**

Revenues

Year	0	1	2	3	4	5	6	7	8	9
Electricity Sales (Rp/kWh; Inflation %/year)										
1. Energy Sales Only										
Peak 90 8%			0.17	0.19	0.20	0.22	0.23	0.25	0.27	0.30
Shoulder 55 8%			0.37	0.40	0.43	0.46	0.50	0.54	0.58	0.63
Base 55 8%			0.37	0.40	0.43	0.46	0.50	0.54	0.58	0.63
2. Avoided Cost Contracts										
Capacity 35 8%			0.54	0.59	0.63	0.68	0.74	0.80	0.86	0.93
Energy 55 8%			0.84	0.91	0.98	1.06	1.15	1.24	1.34	1.45
Total Inflows: 1. Energy Payments Only	**0.00**	**0.00**	**0.91**	**0.98**	**1.06**	**1.14**	**1.23**	**1.33**	**1.44**	**1.55**
Total Inflows: 2. Avoided Cost Contracts	**0.00**	**0.00**	**1.39**	**1.50**	**1.62**	**1.74**	**1.88**	**2.04**	**2.20**	**2.37**
Total Cash Flows										
1. Energy Payments Only	**-0.23**	**-0.12**	**0.15**	**0.19**	**0.24**	**0.28**	**0.32**	**0.39**	**0.45**	**0.52**
2. Avoided Cost Contracts	**-0.23**	**-0.12**	**0.63**	**0.71**	**0.79**	**0.89**	**0.98**	**1.09**	**1.21**	**1.34**

10	11	12	13	14	15	16	17	18	19	20	21
0.60	0.65	0.70	0.76	0.82	0.89	0.96	1.03	1.12	1.21	1.30	1.41
0.00	0.00	0.29	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.24	0.25	0.27
0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.03	0.03	0.03	0.03
0.76	0.82	1.17	1.10	1.02	1.10	1.18	1.27	1.37	1.47	1.59	1.71
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.56	0.33	0.04									
-0.09	-0.05										
-0.24	-0.28										
0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.09	**1.15**	**1.17**	**1.10**	**1.02**	**1.10**	**1.18**	**1.27**	**1.37**	**1.47**	**1.59**	**1.71**
0.32	0.34	0.37	0.40	0.43	0.47	0.51	0.55	0.59	0.64	0.69	0.74
0.68	0.73	0.79	0.86	0.92	1.00	1.08	1.16	1.26	1.36	1.47	1.58
0.68	0.73	0.79	0.86	0.92	1.00	1.08	1.16	1.26	1.36	1.47	1.58
1.00	1.08	1.17	1.26	1.37	1.47	1.59	1.72	1.86	2.01	2.17	2.34
1.56	1.69	1.82	1.97	2.12	2.29	2.48	2.67	2.89	3.12	3.37	3.64
1.68	**1.81**	**1.96**	**2.11**	**2.28**	**2.46**	**2.66**	**2.87**	**3.10**	**3.35**	**3.62**	**3.91**
2.56	**2.77**	**2.99**	**3.23**	**3.49**	**3.77**	**4.07**	**4.39**	**4.75**	**5.13**	**5.54**	**5.98**
0.59	**0.66**	**0.79**	**1.01**	**1.26**	**1.37**	**1.48**	**1.60**	**1.74**	**1.88**	**2.03**	**2.20**
1.47	**1.62**	**1.82**	**2.13**	**2.47**	**2.67**	**2.89**	**3.12**	**3.38**	**3.65**	**3.95**	**4.27**

3.5 MW Electricity Export Throughout Year: Gunung Madu Mill Example

Key Operating Parameters

Size of Mill Export (MW)		3.5
Annual Hours of Operation		4380
Kwh/year output		15,330,000
Plant Heat Rate	(btu/kWh)	30,000
Bagasse Consumption	(kg/kWh)	2.84
Bagasse Price	(Rp/T)	7,500
Discount Rate		10%

Financial Analysis

Present Value of Costs		5.10	Annualized Benefit Cost Ratio	
Present Value of Benefits			1	11.02%
	1	6.37	2	12.99%
	2	9.75	Internal Rate of Return	
Benefit Cost Ratio:			1	36.53%
	1	1.25	2	105.72%
	2	1.91	Fuel Netback Value: Rp/tonne	
Note. the PV figures are in Rp billions			1	9,645.67
			2	18,752.80

Expenditures & Investments

Year	0	1	2	3	4	5	6	7	8	9
Variable Costs (Rp/kWh; Inflation Rate (%/year))	Billions of Rupiah									
Fuel (21.28; 0%)	0.00	0.00	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
Spare Parts (NA; NA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M (5.76; 0%)	0.00	0.00	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Management (0.5; 0%)	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Total Variable Costs	0.00	0.00	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
Investment & Fixed Costs										
Investment in Fixed Plant (Rp bn)	1.15	0.62								
Equity (Rp bn) = 20%	0.23	0.12								
Loan Rate 18%										
Loan Period (years) 10										
Amount Borrowed	0.92	0.58	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan Outstanding	0.92	1.50	1.55	1.48	1.41	1.32	1.22	1.08	0.94	0.77
Interest Payments	0.00	0.00	-0.27	-0.26	-0.24	-0.23	-0.21	-0.19	-0.16	-0.13
Principal Payments	0.00	0.00	-0.06	-0.07	-0.09	-0.10	-0.13	-0.15	-0.17	-0.20
Interest During Construction	0.08	0.05								
Total Investment & Financing Cash Flows	0.23	0.12	0.33	0.33	0.33	0.33	0.34	0.33	0.33	0.33
Total Outflows	**0.23**	**0.12**	**0.75**	**0.75**	**0.75**	**0.75**	**0.76**	**0.75**	**0.75**	**0.75**

Revenues

Year	0	1	2	3	4	5	6	7	8	9
Electricity Sales (Rp/kWh; Inflation (%/year))										
1. Energy Sales Only										
Peak (90; 0%)			0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
Shoulder (55; 0%)			0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Base (55; 0%)			0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
2. Avoided Cost Contracts										
Capacity (35; 0%)			0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
Energy (55; 0%)			0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
Total Inflows: 1. Energy Payments Only	**0.00**	**0.00**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**
Total Inflows: 2. Avoided Cost Contracts	**0.00**	**0.00**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**
Total Cash Flows										
1. Energy Payments Only	**-0.23**	**-0.12**	**0.15**	**0.15**	**0.15**	**0.15**	**0.14**	**0.15**	**0.15**	**0.15**
2. Avoided Cost Contracts	**-0.23**	**-0.12**	**0.63**	**0.63**	**0.63**	**0.63**	**0.62**	**0.63**	**0.63**	**0.63**

3.5 MW Electricity Export Throughout Year: Gunung Madu Mill Example

10	11	12	13	14	15	16	17	18	19	20	21
0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33
0.00	0.00	0.29	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
0.42	0.42	0.71	0.58	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.56	0.33	0.04									
-0.09	-0.05										
-0.24	-0.28										
0.33	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.75	**0.75**	**0.71**	**0.58**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**	**0.42**
0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54	0.54
0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84	0.84
0.91	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**	**0.91**
1.39	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**	**1.39**
0.15	**0.15**	**0.20**	**0.33**	**0.48**	**0.48**	**0.48**	**0.48**	**0.48**	**0.48**	**0.48**	**0.48**
0.63	**0.63**	**0.88**	**0.81**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**	**0.96**

Key Operating Parameters

Size of Mill Export (MW)		10
Annual Hours of Operation		5694
Kwh/year output		56,940,000
Plant Heat Rate	(btu/kWh)	20,000
Bagasse Consumption	(kg/kWh)	1.92
Bagasse Price	(Rp/T)	7,500
Discount Rate		10%

Financial Analysis

Present Value of Costs	35.83	Annualized Benefit Cost Ratio	
Present Value of Benefits		1	10.80%
1	42.71	2	12.22%
2	58.08	Internal Rate of Return	
Benefit Cost Ratio:		1	17.59%
1	1.19	2	36.21%
2	1.62	Fuel Netback Value: Rp/tonne	
Note: PV figures are in Rp billions		1	16,928.91
		2	33,443.92

Expenditures & Investments

Billion Rupiah

Year	0	1	2	3	4	5	6	7	8	9
Variable Costs (Rp/kWh; Inflation Rate (%/year))										
Fuel (14.39; 6%)	0.00	0.00	0.82	0.87	0.92	0.98	1.03	1.10	1.16	1.23
Spare Parts (NA; NA)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M (14.66; 8%)	0.00	0.00	0.83	0.90	0.96	1.04	1.11	1.20	1.29	1.38
Management (0.5; 8%)	0.00	0.00	0.03	0.03	0.03	0.04	0.04	0.04	0.05	0.05
Total Variable Costs	0.00	0.00	1.68	1.80	1.92	2.05	2.19	2.34	2.50	2.67
Investment & Fixed Costs										
Investment in Fixed Plant (Rp bn)	6.69	10.00								
Equity (Rp bn) = 20%	1.34	2.00								
Loan Rate 13%										
Loan Period (years) 10										
Amount Borrowed	5.35	8.33	0.52	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan Outstanding	5.35	13.69	14.21	13.45	12.61	11.65	10.58	9.37	8.01	6.48
Interest Payments	0.00	0.00	-1.69	-1.60	-1.49	-1.37	-1.24	-1.09	-0.92	-0.73
Principal Payments	0.00	0.00	-0.75	-0.85	-0.95	-1.07	-1.22	-1.36	-1.53	-1.72
Interest During Construction	0.33	0.52								
Total Investment & Financing Cash Flows	1.34	2.00	2.45	2.45	2.45	2.45	2.46	2.45	2.45	2.45
Total Outflows	**1.34**	**2.00**	**4.13**	**4.24**	**4.36**	**4.49**	**4.64**	**4.79**	**4.94**	**5.11**

Revenues

Year	0	1	2	3	4	5	6	7	8	9
Electricity Sales (Rp/kWh; Inflation (%/year))										
1. Energy Sales Only										
Peak (90; 8%)			0.64	0.69	0.75	0.81	0.87	0.94	1.02	1.10
Shoulder (55; 8%)			1.36	1.47	1.59	1.72	1.85	2.00	2.16	2.33
Base (55; 8%)			1.36	1.47	1.59	1.72	1.85	2.00	2.16	2.33
2. Avoided Cost Contracts										
Capacity (25.36; 8%)			1.44	1.56	1.68	1.82	1.96	2.12	2.29	2.47
Energy (55; 8%)			3.13	3.38	3.65	3.95	4.26	4.60	4.97	5.37
Total Inflows: 1. Energy Payments Only	**0.00**	**0.00**	**3.37**	**3.63**	**3.93**	**4.24**	**4.58**	**4.94**	**5.34**	**5.77**
Total Inflows: 2. Avoided Cost Contracts	**0.00**	**0.00**	**4.58**	**4.91**	**5.34**	**5.76**	**6.23**	**6.72**	**7.26**	**7.84**
Total Cash Flows										
1. Energy Payments Only	**-1.34**	**-2.00**	**-0.76**	**-0.61**	**-0.44**	**-0.25**	**-0.06**	**0.16**	**0.40**	**0.66**
2. Avoided Cost Contracts	**-1.34**	**-2.00**	**0.45**	**0.70**	**0.97**	**1.27**	**1.58**	**1.94**	**2.32**	**2.73**

10 MW Electricity Export Throughout Year: New Boiler and TG Example

10	11	12	13	14	15	16	17	18	19	20	21
1.31	1.38	1.47	1.56	1.65	1.75	1.85	1.96	2.08	2.21	2.34	2.48
0.00	0.00	1.67	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.49	1.60	1.72	1.85	1.99	2.14	2.30	2.47	2.65	2.85	3.07	3.30
0.05	0.06	0.06	0.07	0.07	0.08	0.08	0.09	0.10	0.11	0.11	0.12
2.85	3.04	4.92	5.97	3.71	3.96	4.23	4.52	4.83	5.17	5.52	5.90
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.76	2.83	0.66									
-0.51	-0.27										
-1.93	-2.17										
2.45	2.45	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5.29	**5.49**	**4.92**	**5.97**	**3.71**	**3.96**	**4.23**	**4.52**	**4.83**	**5.17**	**5.52**	**5.90**
1.19	1.28	1.38	1.49	1.61	1.74	1.88	2.03	2.19	2.37	2.56	2.76
2.52	2.72	2.94	3.18	3.43	3.70	4.00	4.32	4.67	5.04	5.44	5.88
2.52	2.72	2.94	3.18	3.43	3.70	4.00	4.32	4.67	5.04	5.44	5.88
2.67	2.89	3.12	3.37	3.64	3.93	4.24	4.58	4.95	5.34	5.77	6.23
5.80	6.26	6.76	7.30	7.89	8.52	9.20	9.93	10.73	11.59	12.51	13.52
6.23	**6.73**	**7.27**	**7.85**	**8.47**	**9.15**	**9.88**	**10.67**	**11.53**	**12.45**	**13.45**	**14.52**
8.47	**9.15**	**9.88**	**10.67**	**11.52**	**12.44**	**13.44**	**14.51**	**15.68**	**16.93**	**18.28**	**19.75**
0.94	**1.24**	**2.34**	**1.88**	**4.77**	**5.13**	**5.85**	**6.15**	**6.69**	**7.29**	**7.93**	**8.62**
3.18	**3.66**	**4.96**	**4.70**	**7.81**	**8.48**	**9.21**	**9.99**	**10.84**	**11.76**	**12.76**	**13.85**

10 MW Electricity Export Throughout Year: New Boiler and TG Example

Key Operating Parameters

Size of Mill Export (MW)		10
Annual Hours of Operation		5694
Kwh/year output		56,940,000
Plant Heat Rate	(btu/kWh)	20,000
Bagasse Consumption	(kg/kWh)	1.92
Bagasse Price	(Rp/T)	7,500
Discount Rate		10%

Financial Analysis

Present Value of Costs		27.98	Annualized Benefit Cost Ratio	
Present Value of Benefits			1	9.24%
1		23.68	2	10.64%
2		32.19	Internal Rate of Return	
Benefit Cost Ratio:			1	1.50%
1		0.85	2	19.8[illegible]%
2		1.15	Fuel Netback Value: Rp/tonne	
Note: PV figures are in Rp billions			1	1,577.15
			2	10,731.55

Expenditures & Investments

Variable Costs	Rp/kWh	Inflation Rate (%/year)	Year 0	1	2	3	4	5	6	7	8	9
			Billion Rupiah									
Fuel	14.36	0%	0.00	0.00	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
Spare Parts	NA	NA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
O&M	14.66	0%	0.00	0.00	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
Management	0.5	0%	0.00	0.00	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Variable Costs			0.00	0.00	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
Investment & Fixed Costs												
Investment in Fixed Plant (Rp bn)			6.69	10.00								
Equity (Rp bn) =		20%	1.34	2.00								
Loan Rate		12%										
Loan Period (years)		10										
Amount Borrowed			5.35	8.32	0.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Loan Outstanding			5.35	13.67	14.17	13.40	12.54	11.58	10.50	9.28	7.93	6.41
Interest Payments			0.00	0.00	-1.62	-1.53	-1.42	-1.31	-1.18	-1.03	-0.87	-0.69
Principal Payments			0.00	0.00	-0.77	-0.86	-0.96	-1.08	-1.22	-1.35	-1.52	-1.70
Interest During Construction			0.32	0.50								
Total Investment & Financing Cash Flows			1.34	2.00	2.39	2.39	2.39	2.39	2.40	2.39	2.39	2.39
Total Outflows			**1.34**	**2.00**	**4.07**	**4.07**	**4.07**	**4.07**	**4.08**	**4.07**	**4.07**	**4.07**

Revenues

Electricity Sales	Rp/kWh	Inflation (%/year)	2	3	4	5	6	7	8	9
1. Energy Sales Only										
Peak	90	0%	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
Shoulder	55	0%	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
Base	55	0%	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
2. Avoided Cost Contracts										
Capacity	25.36	0%	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
Energy	55	0%	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13

	0	1	2	3	4	5	6	7	8	9
Total Inflows: 1. Energy Payments Only	**0.00**	**0.00**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**
Total Inflows: 2. Avoided Cost Contracts	**0.00**	**0.00**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**
Total Cash Flows										
1. Energy Payments Only	**-1.34**	**-2.00**	**-0.70**	**-0.70**	**-0.70**	**-0.70**	**-0.71**	**-0.70**	**-0.70**	**-0.70**
2. Avoided Cost Contracts	**-1.34**	**-2.00**	**0.51**	**0.51**	**0.51**	**0.51**	**0.50**	**0.51**	**0.51**	**0.51**

10 MW Electricity Export Throughout Year: New Boiler and TG Example

10	11	12	13	14	15	16	17	18	19	20	21
0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82
0.00	0.00	1.67	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83
0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
1.68	1.68	3.36	4.18	1.68	1.68	1.68	1.68	1.68	1.68	1.68	1.68
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.71	2.81	0.68									
-0.48	-0.26										
-1.90	-2.13										
2.39	2.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4.07	**4.07**	**3.36**	**4.18**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**
0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64
1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36	1.36
1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13	3.13
3.37	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**	**3.37**
4.58	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**	**4.58**
-0.70	**-0.70**	**0.01**	**-0.82**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**	**1.68**
0.51	**0.51**	**1.22**	**0.39**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**	**2.89**

The Office of Energy

The Agency for International Development's Office of Energy plays an increasingly important role in providing innovative approaches to solving the continuing energy crisis in developing countries. Three problems drive the Office's assistance programs: high rates of energy and economic growth accompanied by a lack of energy, especially power in rural areas; severe financial problems, including a lack of investment capital, especially in the electric sector; and growing energy-related environmental threats, including global climate change, acid rain, and urban air pollution.

To address these problems, the Office of Energy leverages financial resources of multilateral development banks such as The World Bank and the InterAmerican Development Bank, the private sector, and bilateral donors to increase energy efficiency and expand energy supplies, enhance the role of private power, and implement novel approaches through research, adaptation, and innovation. These approaches include improving power sector investment planning ("lease-cost" planning) and encouraging the application of cleaner technologies that use both conventional fossil fuels and renewable energy sources. Promotion of greater private sector participation in the power sector and a wide-ranging training program also help to build the institutional infrastructure necessary to sustain cost-effective, reliable, and environmentally-sound energy systems integral to broad-based economic growth.

Much of the Office's strategic focus has anticipated and supports recently-enacted congressional legislation directing the Office and A.I.D. to undertake a "Global Warming Initiative" to mitigate the increasing contribution of key developing countries to greenhouse gas emissions. This strategy includes expanding least-cost planning activities to incorporate additional countries and environmental concerns, increasing support for feasibility studies in renewable and cleaner fossil energy technologies that focus on site-specific commercial applications, launching a multilateral global energy efficiency initiative, and improving the training of host country nationals and overseas A.I.D. staff in areas of energy that can help to reduce expected global warming and other environmental problems.

To pursue these activities, the Office of Energy implements the following seven projects: (1) The Energy Policy Development and Conservation Project (EPDAC); (2) The Biomass Energy Systems and Technology Project (BEST); (3) The Renewable Energy Applications and Training (REAT); (4) The Private Sector Energy Development Project (PSED); (5) The Energy Training Project (ETP); (6) The Conventional Energy Technical Assistance Project (CETA); and (7) its follow-on Energy Technology Innovation Project (ETIP).

The Office of Energy helps set energy policy direction for the Agency, making its projects available to meet generic needs (such as training), and responding to short-term needs A.I.D.'s field offices in assisted countries.

Further information regarding the Office of Energy's projects and activities is available in our Program Plan, which can be requested by contacting:

Office of Energy
Bureau for Science and Technology
U.S. Agency for International Development
Room 508, SA-18
Washington, D.C. 20523-1810
Tel: (703) 875-4052

KPB Perkebunan

KPB stands for Kantor Pemasaran Bersama, Perkebunan, which is the Joint Marketing Office of Perkebunan, the Indonesian state plantation company. The Joint Marketing Office was established by the Board of Directors of PT. Perkebunan I-XXXI (plantation companies I through XXXI) shortened PTP I-XXXI.

KPB Perkebunan has the following missions:

- to market all commodities produceed by the state-owned plantation companies in accordance with economic principles to maximize revenues.
- to administer all commodities ready for sale.
- to collect all necessary information, to analyze them, and to distribute them to PTP's in order to develop the market.
- to execute all transactions directly or through collaboration with overseas offices.
- to arrange shipments and collect payment accordingly.
- to settle all claims from customers.
- to make all promotion activities domestically or in foreign countries.
- to prepare end-of-year reports about eh carrying-out of its mission and make workplans for the coming year.
- to prepare market analyses and estimates for the coming year.

KPB Perkebunan has branches and outpost offices, especially in locations near to producing areas from where shipment is to be made. Sales are centralized in Jakarta, but shipping and documentation is arranged by the branch offices where the commodity originates.

Branch Offices:

1. KPB Perkebunan
   Jl. Balai Kota No. 8
   Medan 20111

2. KPB Perkebunan
   Prince Building Lt. 7-8
   Jl. Jendral Sudiman No. 3-4
   Jakarta

3. KPB Perkebunan
   Jl. Fakhrudin No. 14
   Jakarta

4. KPB Perkebunan
   Jl. Sikatan No. 1
   Surabaya 60175

Sub-branch Offices:

1. KPB Perkebunan
   Jl. Gadjah Mada No. 100
   Semarang

2. KPB Perkebunan
   Jl. Masjid Raya No. 94
   Ujung Pandang

All financial transactions are channeled through state-owned commercial banks like Bank Bumi Daya, Bank Dagang Negara, Bank Exim, etc.

KPB Perkebunan also works in cooperation with overseas offices which are established in the same way and by the same companies. All transactions with KPB could be channeled without extra cost to clients through:

1. Messrs. Indoham
   28-30 Ferdinanstras
   2000 Hamburg Germany
   Tel: (41) 327534
   Fax: (41) 2163702

2. PTP Commodities Ltd.
   260 Fifth Ave., Suite 401
   New York, NY 10001
   Tel: (212) 488-8336, 37, 39, 40
   Fax: (212) 488-8291

These two companies can also act as claim settlers. KPB has relationships with shipping companies, warehouses, and forwarders. KPB also has data and information exchange agreements with major international market organizations.

KPB Perkebunan makes all efforts to necessary to develop best added-value to the commodities by developing down-stream industry and encouraging investors to cooperate in joint ventures, counter trade, counter purchase, longterm supply contracts, etc.

All interested parties are requested to contact:

Jl. Taman Cut Mutiah No. 11 Jakarta 10330
P.O. Box 4401/JKT - Indonesia
Tel: (021) 337136, 3106685, 3101497, 334282, 336919
Fax: (021) 335091, 336919 Telex. 46336 APBP IA