

# ~~PILOT DENDRO~~ (IPIL-IPIL) THERMAL PROJECTS

by

JOSE U. JOVELLANOS \*

## Introduction

As a result of the oil crisis and the continuing escalation of the price of crude oil since 1973, the Philippines has to adopt an energy policy geared towards: (a) accelerating the search and exploitation of indigenous energy sources in order to reduce dependence on imported oil; and (b) implementing an energy conservation program.

In 1979, the estimated primary energy requirement of the country is the equivalent of 106 million barrels of oil, of which 30% is used for electric power generation and 70% for commercial, industrial and transportation uses. Electric power generation is supplied 75.7% from oil-burning plants, 19.8% from hydros and the balance from geothermal and coal-fired units.

By 1983, the national energy plan calls for oil burning plants to supply 57.1% of total electric generation, 24.0% by hydros, 12.3% from geothermal plants; 6.5% from coal-fired plants; and the balance of less than 0.1% from "non-conventional sources". Under the plan, non-conventional sources will include solar, wind and bio-mass.

Considering the present "state of the art" of electric power generation from non-conventional sources the use of bio-mass is the most promising to become commercially viable for the Philippines within the next 5-10 years.

## Biomass — A Non-Conventional Energy Source

Biomass (otherwise referred to in the energy literature as bio-conversion or bio-energy) is the use of plants and trees to produce energy. It is way of capturing solar energy through the phenomenon of photosynthesis and the production of carbon in plants and trees which are then burned for fuel.

Man has used wood as fuel since the dawn of time. Those of us who are old enough to remember must have seen during the 1930's wood-burning steam road rollers, pile drivers and hoists used by the Bureau of Public Works. Of course, these were later replaced by diesel-engine driven units. However, we still see sugar cane bagasse burned in the steam boilers of

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\* Senior Vice President, National Power Corporation

sugar mills either partially or wholly to produce process steam and motive power for the mill machinery and equipment.

In order that biomass can make a substantial contribution to our energy supply, we have to plan and organize "energy farms" side by side or integrated with "food farms" wherever conditions are favorable.

Some of the advantages of biomass as source of energy are:

1. Since vegetable matter generally contains less than 0.1 percent sulfur, wood is essentially sulfur-free.
2. The ash from the wood is directly re-usable on the land as a source of elements essential to plant growth.
3. Use of wood will not interfere with the carbon balance of the earth. In addition, living plants produce oxygen.
4. The use of wood fuel will not alter the heat balance of the earth.
5. Energy plantation fuel does not spill or leak and thus, does not have serious environmental consequences unlike oil spill and gas leaks.
6. The energy plantation is a perpetually renewable source of fuel.
7. Thermal pollution per unit of useful energy produced from wood will be approximately 25 percent lower than is likely to be the case for nuclear power systems for many years to come.
8. It is estimated that, compared with other means of conversion of solar energy into electricity, capital cost requirements are much lower.

#### The Ipil-Ipil (Dendro) Pilot Project

The Philippines is most fortunate that the ipil-ipil tree (Dendro) can grow prolifically in most areas of the Philippines. With a planting cycle of 3-4 years, an ipil-ipil farm can support a steam electric generating plant on a continuing and renewable basis. Ipil-ipil wood has an estimated heat value of 4170 to 445 Kcal/kg. A USAID study report has indicated that a 400-hectare ipil-ipil plantation will support a 1000 kw electric plant.

The Ministry of Energy and the National Power Corporation are presently implementing a 500-600 KW pilot plant which would generate electric power using ipil-ipil wood. The site selected for this pilot project is Paclolo, Magsaysay, Occidental Mindoro. Hopefully this pilot plant and the supporting ipil-ipil plantation will provide sufficient operating data on which to base the economic viability of larger-size plants in the future.

The search for suitable sites for the Pilot Dendro Thermal Power Plant started in November, 1978 and culminated in the selection of three sites as promising candidates. These sites are: Ayungon, Negros Oriental, Sto. Domingo, Ilocos Sur and Magsaysay, Occidental Mindoro.

The Bureau of Forest Development reforestation project in Barangay Paclolo, Magsaysay, Occidental Mindoro is the area considered as the most ideal for this pilot project, because BFD has already planted approximately

85 hectares of two-year old ipil-ipil and another 1000 hectares are being readied for planting. Total area of public forest land is 3,260 hectares.

Barangay Paclolo is about 17 kilometers from the municipality of San Jose and 15 kilometers from the poblacion of Magsaysay.

The area to be initially served with electricity from the pilot plant is Barangay Paclolo, a small community with about 134 potential customers and a logging concession located nearby which will supply the initial fuel requirements of the power plant in the interim period that the ipil-ipil trees have not yet matured. Out of the thirteen (13) barangays composing the municipality of Magsaysay, only the poblacion has so far been provided with electricity. The rest of the town could also be served up to the extent of the capacity of the pilot plant. GERMACOM, the logging concessionaire, is planning to put up a wood processing plant nearby, which can be a big potential daytime electric consumer. This will increase the plant utilization factor and reduce generation cost.

Since the plantsite selected is within the BFD reforestation area in Paclolo, the transportation cost for fuel will be minimized. A memorandum agreement for the supply of fuel at the plantsite is being prepared by a committee composed of representatives from the NPC, BED & BFD in order to arrive at a fair and just price per metric ton of ipil-ipil wood delivered at the plantsite.

The plantsite can be reached by a 1.6 km feeder road from the provincial highway. This feeder road needs improvement prior to delivery of electro-mechanical equipment to the plantsite. It is flooded most of the year since its elevation is below the ricefield level. However, filling material is available from nearby Caguray River, 3 km. from the plant site. The logging road within the plantation area also needs improvement to facilitate transportation and handling of fuel from plantation to plant stockpile area.

The estimated cost of the project follows:

Land/Land Rights	—	₱ 50,000.00
Electromechanical equipment & auxiliaries	—	5,500,000.00
Civil Works	—	1,800,000.00
Transmission Plant	—	600,000.00
Sub-Total	—	<u>₱7,950,000.00</u>
Contingencies 10%	—	795,000.00
Total	—	<u>₱8,745,000.00</u>
	Say	₱8,750,000.00

#### Project Schedule

Based on expected deliveries of equipment and materials which will govern the actual completion of the project, the pilot will become operational in late 1981 or early 1982.

SUPPLY OF EQUIPMENT & MACHINERY FOR IPIL-IPIL  
FIRED THERMAL PILOT POWER PLANT

I. WORKS & EQUIPMENT TO BE SUPPLIED BY THE CONTRACTOR

The following equipment to be furnished by the contractor, shall include but not necessarily limited to:

A. Boiler & Auxiliaries

Boiler

Wood Fuel combustion equipment

Fuel oil combustion equipment

Wood handling equipment mainly consisting of log shredder, chip storage silo, conveyor and feeders

Air & flue gas system consisting of FDF, IDF, dampers and ducts, Chimney

Chemicals feed equipment

Water softener

Instrumentation & controls

Steam sootblower

Piping

Span Parts and Special Tools

B. Turbine — Generator & Auxiliaries

Turbine — generator unit

Boiler Feed Pumps

Feedwater heater

Steam and water Piping (see item A)

Cooling Tower

Circulating Water Pumps

Condenser

Cooling water pump

Instrumentation and Controls (see item A)

Spare Parts & Tools

C. Electrical Equipment

Electric motors

Switch gear and wiring materials

The supply shall also include foundation bolts or items for anchoring equipment to the foundations.

## II. WORKS EXCLUDED IN THE CONTRACT

The supply does not include the following:

- All civil works and concrete foundations
- All field assembly and erection works
- Ipil-Ipil fuel conveying equipment upstream of shredder feed
- Water treatment facilities upstream of softener
- Piping materials beyond each battery limit such as:
  - Fuel oil piping upstream of oil service tank
  - Boiler blow down piping downstream of blow pit
  - Cooling water supply piping upstream of raw water pond
  - Make up water upstream of water softener
- Raw water and cooling water pond
- All consumable goods required for field erection and start-up such as:
  - Welding rods, red bricks, sand, gravel, lime, cement, fuel and others
- Electric devices to be connected to outside power source and consumers
- External power feed device for the start-up of the plant
- Dispatch of supervising personnel for field erection and start-up

## III. BOILER & AUXILIARIES

### A. Boiler

#### A.1 General

One (1) boiler of water tube, natural circulation type, two drums, with balanced draft, grate firing, oil firing, designed for outdoor installation.

The boiler equipment shall be supplied complete with drums, water tubes, headers, superheaters, refractory materials, insulating materials, steel casing, steel structure, gangway and ladder and all accessories such as soot blowers, water gauges, valves, pressure gauges etc.

#### Characteristics Data and Operating Conditions

The steam generator to be supplied shall have rating and operating conditions matching that of the steam turbine as outlined in the specifications. In addition, the steam generator shall provide auxiliary steam for supply of other services as fuel oil atomizing and heating, soot blowing, boiler feed pump, etc.

The said boiler rating shall be achieved with the boiler firing Ipil-Ipil wood as basic fuel. It shall also be achieved with the

boiler firing a combination of wood and fuel oil. Heaving fuel oil firing capability shall be up to 50% of the rated load.

Fuel characteristics and other data for attainment of the said rating are as follows:

Ipil-Ipil

— LHV (approx)	2400 kcal/kg
— Moisture Content (ave)	40%

Fuel Oil

— LHV	9700kcal/kg
Air Temperature at Boiler Outlet	27°C

## B. Wood Preparation & Handling Equipment

### B.1 General

The wood preparation and handling equipment shall consist of the following:

- One (1) conveyor for feeding logs into shredder
- One (1) log shredder of type & characteristics described below
- One (1) set of conveying lines and fan for pneumatic conveying of wood chips to storage silo
- One (1) chip storage silo of 50 m<sup>3</sup> capacity
- Complete with screw, feed regulator of 15 m<sup>3</sup>h capacity, feed valve
- One (1) set of conveying lines & fan for pneumatic conveying of wood chips to cyclone.
- One (1) set cyclone for air separation
- One (1) set of transport line from cyclone to boiler

### B.2 Log Shredder

Log shredder which will be used for preparing logs into wood chips shall have the following type & characteristics

Type	— Electric driven
Capacity (Nominal)	— 10 m <sup>3</sup> h
Log sizes	— 100-150 mm, dia 1000-1500 mm, length

## C. Air & Gas System

### C.1 Forced and Induced Draft Fans

One (1) Forced and Induced Draft Fan equipped with motors, couplings, dampers and other related accessories shall be supplied.

Forced draft fan shall be capable of supplying air in sufficient quantity to assure a regular combustion at any boiler load. A margin in capacity and delivery head of not less than 20% and 30% respectively is more preferable.

Induced draft fan shall be capable of handling combustion gas at any boiler load with perturbations. A margin in the capacity and delivery head of not less than 25% and 50% respectively is more preferable. Impeller of induced draft fan shall be of special erosion resistant material.

## 6.2 Air & Flue Gas Duct

The system shall include all duct work from forced draft fan to wind boxes and from boiler exhaust gas duct to chimney gassing the induced draft fan and boiler dust collector. Necessary items such as gasket, expansion joints and insulation materials shall also be included in the supply.

All the air and gas duct work will be constructed of steel plate of adequate thickness.

## C.3 Chimney

One (1) self supporting steel chimney shall be provided. The chimney height shall not be less than 25 meters above ground and shall have an approximate top diameter of 0.8 m. The final height and diameter that will give adequate draft & dispersion of products in the smoke will be determined by the contractor and approved by the contracting officer.

## D. Ash Handling System

One (1) dust collector of multicyclone type shall be provided. The dust collector shall be complete with sealing damper, ash hopper and ash container.

## E. Fuel Combustion Equipment

### E.1 Wood Fuel Combustion Equipment

The equipment to be furnished shall consist of a grate, rotary feeder with electric motor, fuel chute and relevant.

The grate shall be of type and characteristics capable of burning wood up to the maximum boiler demand.

A system of feeding the wood fuel to the boiler shall be made thru a rotary feeder. The feeder shall be capable

of regulating the flow of fuel in proportion to the boiler load. It shall also be capable of distributing fuel at the grate.

## E.2 Fuel Oil Combustion Equipment

### General

The following fuel oil burning equipment shall be supplied.

- One (1) oil service tank of 2Kl capacity
- One (1) fuel oil heater (for heating fuel oil to combustion temperature).
- Two (2) fuel oil injection pump, one stand-by
- Relevant fuel oil piping as described, valves, oil strainers, and other items necessary for the unit operation
- Air register
- Fuel oil burners of the steam atomizing type
- A system for starting up the boiler
- Fuel oil burning equipment capability shall be up to 50% of the rated load and is mainly used as auxiliary fuel

## F. Controllers, Instrument and Protection Equipment

### General

The control instrument and protection equipment shall include the following.

- Control desk & panels for steam generator and turbine
- Controller cabinets
- Instruments
- Annunciators

Controllers shall include the following:

- Combustion air flow remote controller
- Furnace draft controller

Instruments shall comprise the following:

- Fuel oil flow meter
- Draft Indicator
- Pressure gauges at Boiler Outlet
- Thermometer at Boiler Outlet
- Boiler Feedwater regulator (Thermostat Type)
- Feedwater Flow Meter

Annunciators Shall include:

- Drum level, high and low
- Water tank level, low
- Cooling water pressure, low
- Water tank pressure and temperature indicator



### G. Water Softener

The water softener shall be provided to supply make-up water to the boiler. The supply shall consist of a brine tank, ejector, valve and pressure gauge.

Type and characteristics are enumerated below:

Type — Nation exchange type

Capacity — 50 ton per cycle

Waterflow — 2 ton/h

Initial water hardness — 50 ppm as  $\text{CaCO}_3$

### H. Chemicals Injection Plant

The supply consist of the following:

- One (1) chemical tank and relevant piping to boiler drum
- One (1) chemical feed pump and motor

### I. Piping Materials

The following piping together with necessary insulating materials shall be furnished:

	FROM	TO
Steam Piping	Boiler	Turbine-generator
	Boiler	Boiler Feed Pump
	Boiler	Oil Heater & Oil Burner
Fuel Oil Piping	Fuel Service Tank	Oil Burner
Feed Water Piping	Water Softener	Water Tank
	Water Tank	Boiler
Condensate water Piping	Condenser	Water
Cooling Water Piping	Raw Water Pond	Cooling Tower
	Cooling Water Pond	Condenser
	Condenser	Raw Water Pond
Make-up Water Piping	Of approximately 200 meters	

### J. Spare Parts and Special Tools

#### a. Spare Parts

2 pcs. water level gauge glass with packing

1 lot — Manhole packing (100% of total required)

- 1 lot — Hanhole packing (100% of total required)
- 1 lot — water tubes (2% of total required)
- 1 lot — Fire grate (10% of total required)
- 1 pc — burner tip

b. Tools (per boiler)

- 1 lot — tube expander (1 set per size)
- 1 lot — tools for tube expander
- 1 lot — Spanners and trenches
- 1 lot — Tube cleaner (hydraulic type) w/ necessary rubber hose
- 1 set — ask scratching bar
- 1 set — tools for oil burner

### III. TURBINE-GENERATOR & AUXILIARIES

#### A. Steam Turbine

One (1) condensing steam turbine of type and characteristics described below shall be supplied complete with all accessories such as governor common bed, reduction gear, insulation and lagging, lubricating oil system, necessary valves, emergency trip device, local instruments such as tachometer, and special tools.

The governor shall be of hydraulic type.

#### Turbine Characteristics:

type	— condensing impulse turbine
Location	— Indoor
Steam Conditions at Turbine Inlet:	
Pressure	— 20 kg/cm <sup>2</sup> g
Temperature	— 350°C
Steam Flow at MCR	— 6,000 kg 1h
Turbine Exhaust Pressure	— 650 mm Hg vacuum

#### B. Generator

One (1) generator of the following characteristics shall be supplied:

Type	— open-guarded, self-cooling — brushless synchronous type
Location	— Indoor
Capacity	— 810 kvA
Pole	— 4 poles
Voltage	— 480 V
Phase	— 3

Frequency	— 60 Hz
Power Factor	— 80% lagging
Connection	— Star
Insulation	
(stator winding)	— Class B
(rotor winding)	— Class F

The generator shall be supplied complete with the necessary accessories, generator panel, AC excitor with panel, rotating rectifier space heater and synchronizing panel.

### C. Condenser

One (1) condenser of shell and tube type shall be supplied complete with heat exchanging tubes, valves and other accessories necessary for the proper operation of the unit.

The supply shall also include two (2) condensed water pump one (1) stand-by for delivery of condensed water to feedwater tank.

The condenser shall be operated with fresh water from the river.

The condenser must have the capability of condensing the steam exhaust of approximately 6,000 kg/h.

### D. Feedheating System and Boiler Fed Pumps

#### General

The feed heating system shall be supplied complete with all auxiliary equipment and accessories necessary for proper operation.

The feedheating system shall mainly include the following equipment:

- One (1) electric driven feedwater pump
- One (1) steam driven feedwater pump
- One (1) Feedwater tank of 10 M<sup>3</sup> capacity and of mild steel construction

#### Motor Driven Boiler Feed Pump

The motor driven boiler feedwater pump shall be of the horizontal centrifugal type. It shall be of capacity equal to 110% of the boiler maximum continuous rating. Boiler feed pump characteristics shall be determined in accordance with the requirements of the steam generator contractor.

The supply shall also include necessary coupling, valves and gauges.

### Steam Driven Boiler Feed Pump

This pump shall be of the reciprocating type. Auxiliary steam for the Boiler Feed Pump shall come from the Boiler. It shall be of capacity equal to 110% of the boiler maximum continuous rating. Boiler Feed Pump characteristics shall be determined in accordance with the requirements of the steam generator contractor.

The supply shall also include necessary items such as valves, pressure gauges and other accessories necessary for its unit operation.

## E. Circulating Water System

### General

Equipment for the circulating water system shall mainly include the following:

- One (1) cooling tower of type and characteristics described below:
- Two (2) make-up water pump, one stand-by
- Two (2) circulating water pump, one stand-by

### Cooling Tower

The following type or characteristics shall be supplied:

Type	— Forced draft
Capacity	— 350 M <sup>3</sup> /h
Inlet water temp.	— 45°C
Exit water temp.	— 35°C
Wet bulb temp.	— 29°C

All other accessories necessary for the operation of the cooling tower shall be supplied.

## IV. Electrical Equipment

The supply shall include the following:

- Switch gears together with wiring materials for all motors to be supplied
- Wiring materials from turbo-generator to generator panel.