10 MW Biomass Power Plant

Pollachi, Tamil Nadu

World's First Coconut Tree Waste Biomass Power Plant

Orient Green Power Company Limited

INTRODUCTION

Orient Green Power Company Limited (OGPL) is a leading independent renewable energy-based power generation company focused on developing, owning, and operating a diversified portfolio of renewable energy power plants. Currently its portfolio includes biomass, biogas, and wind energy projects at various stages of development.

As of April 2014, our total portfolio of operating assets included 510.355 MW of aggregate installed capacity, which comprises 424.355 MW of wind energy projects and 86 MW biomass projects. We have a diverse customer base with a mixture of off-take arrangements. Our customers include state electricity boards (SEBs), distribution companies, and private, commercial, and industrial consumers.

This case study provides a brief description of a 10 MW biomass-based power plant that uses coconut fronds as the primary fuel with details of its location, capacity, biomass sourcing, fuel collection strategy, incorporated improvements, problems faced during operation, cost of power generation and power purchase tariff, employment, and socio-economic development in the region. OGPL has the credential of constructing and operating the world's first biomass power plant with coconut tree wastes as the predominant fuel.

Chipped coconut frond in the foreground

Location

The 10 MW biomass power plant is located in Kariyanchettipalayam Village, Pollachi Taluk, Coimbatore District of Tamil Nadu. The biomass storage yard is spread over 10 acres.

Capacity of the plant

The power plant has a capacity of 10 MW with a generation capacity of about 75 million units annually, of which 67.5 million units can be evacuated; the rest (10% of the total) gets consumed as auxiliary power requirement within the plant.

Commissioning date

The plant was commissioned and synchronised with the grid during the month of July 2011, with 110 kV connectivity.

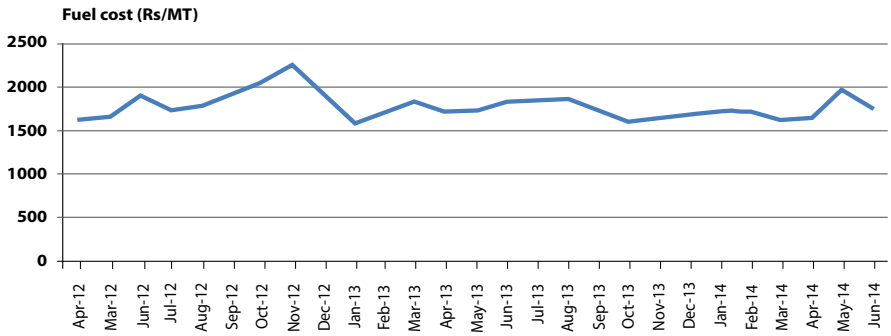
Investment

The total investment of the project was Rs 6638 lakh with the loan availed from the State Bank of India to establish the plant. As of FY 2014, the debt is about Rs 2400 lakh. The Ministry of New and Renewable Energy (MNRE) provided capital subsidy assistance of Rs 88.5 lakh.

Biomass sourcing

As per the biomass assessment done in June 2009, coconut residues were found to be the major form of biomass available in the district of Coimbatore. Coconut residue generation is estimated to be 1,285,536 MT per annum, and after local consumption the estimated surplus is 385,661 MT, which is about 300% of our annual requirement.

About 450 tonnes of agriculture waste is required per day to generate electricity for the 10 MW power plant. The biomass price varies from Rs 800 to Rs 2800 per tonne depending on the type, moisture wetness, and season. The average biomass price last year was Rs 1880 per tonne. The total biomass required per year is about 140,000 tonnes. Last year the biomass used included juliflora (40,000 tonnes); coconut waste (60,000 tonnes); and agro industrial waste like saw mill waste, plywood waste, sawdust, bagasse, wood bark, paddy husk (40,000 tonnes). Biomass stock was stored in the covered and uncovered storage yard. The covered storage yard is 80 x 65 x 15 m. Although a large quantity of biomass is stored in the open, storage




Coconut frond collection

under cover helps to reduce decay and avoids getting wet, especially in rainy season. Appropriate storage of biomass is important to ensure good plant load factor (PLF).

Biomass is sourced directly from farmers and through suppliers. For example, coconut fronds are sourced by small trucks with a holding capacity of 5 to 10 quintals. About 20 small truckloads of biomass are procured in this mode. The families who collect and transport the biomass earn about Rs 400 to 500 per truckload. A few families also pick up one to two quintals and transport them in small carts to the plant and get paid according to weight.

We are also planning to source a share of our biomass from captive energy plantations. We estimate that plantation intercropping (*Gliricidia* in coconut groves) in about 5000 acres of coconut farms (yielding 7.5 tonnes per acre per year) can supply 30% of our annual biomass requirement. This is expected to earn additional revenue for farmers from their lands.

Problem faced by the plant during fuel collection

- Brick kiln owners and process industries are availing the available biomass by offering higher prices; they can afford to pay more since the marginal increase in the price of biomass is still lower than the cost of coal.
- Moisture content increases during the monsoon season so the transportation costs increase.
- Lack of proper and safe covered storage at the site for the large quantity of biomass.
- Risk of fire due to storage in open yard.
- Higher insurance cost due to open storage.

Harvested energy crop

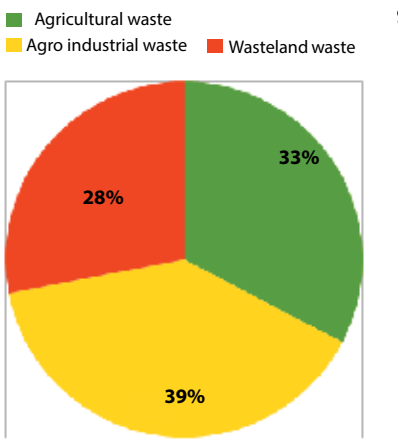
IMPROVEMENTS EMPLOYED IN THE OPERATION OF BIOMASS POWER PLANT

Fuel mix optimisation

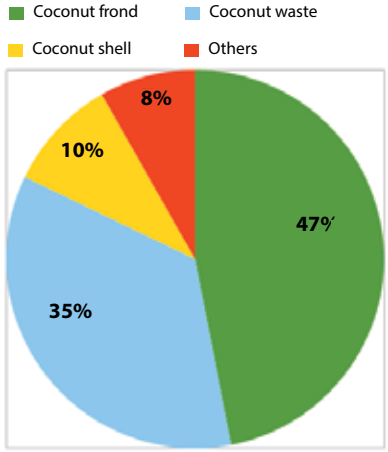
The fuel mix is continually improved so as to achieve the most appropriate mix taking into consideration the availability and acceptability of the fuels. Cheaply available fuel contains more moisture, sand, etc., while fuels with high gross calorific value as received are costly. Levelling the floors and providing a roof in the processed fuel areas have

Coconut frond chipping

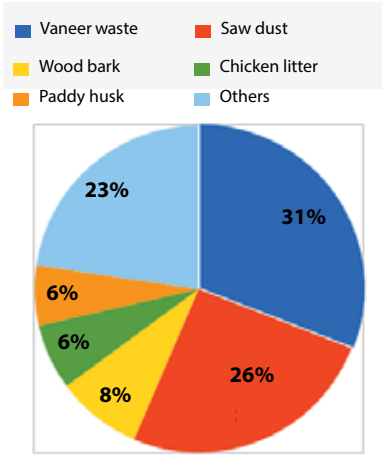
Fuel usage pattern



Agricultural residues usage



Agro industry waste usage



helped to ensure more or less uniform characteristic fuel feed to the boiler. The addition of proper sized equipment for fuel preparation has also helped to maintain a uniform fuel feed to the boiler, and has helped to increase the use of inexpensive and available dirty fuels such as coconut fronds.

Modifications made

1. The following modifications at the design stage have been carried out and have resulted positively in extending the operating hours of the boiler.
   - Change of material of construction for super heater - T11/T22 with TP 347 H
   - Increased clearances between the gooseneck and the coil
   - Increased pitch and provision of additional soot blowers
   - Interchanging position of primary and secondary super heater coils
2. The material for construction of the super heater coil was experimentally changed with one that contains more chromium and nickel. This was expected to extend the mean time between failures and has proved successful due to increased resistance to corrosion and to ash deposits on its surface. Because of this, the mean time between failures of super heater coils has increased, which resulted in increased PLF.
3. Arrangements to drain the build-up of ash in the gooseneck area and increase the frequency of soot blowing also helped to increase the performance of the boiler.
4. Variable frequency drives introduced for major equipment like FD, ID, and SA fans to reduce home load.
5. Dedicated shredders were developed and the lengthy coconut fronds were chopped uniformly to 2" lengths for better feeding into the boiler.
6. Accurate online measurement was introduced in the feeding belt for fuel.

Employment and socio-economic development in the region

The project has generated employment for the rural poor. They work in the collection, processing, and supply of the biomass fuels used. The plant employs about 45 people on a continuous basis for plant operation and maintenance. We also employ about 120 people in our biomass processing/feeding and in fuel yard management. About 500 people in the villages also find employment in sourcing biomass. It may be noted that a manufacturing enterprise with similar turnover may provide employment to only about 80 people in total.

Lessons learned

Though the plant was designed to use maximum quantity of coconut wastes, during the initial years of operation the plant had to be operated with more wood and juliflora. Because of this, the average fuel cost spiralled up to Rs 2500 per MT and the moisture content was 40%. The operation at this level of moisture neither yielded good efficiency nor economic viability and the plant continued to run at a loss. The fuel cost was almost Rs 5.00 per unit, and the tariff for sale was only Rs 6.50 per unit.

Because biomass fuels like juliflora, waste wood, and plywood wastes were being used by other industries, predominantly the dyeing units in the garment belt of Tirupur, the availability of biomass was an issue. Hence the decision was made to maximize the use of coconut fronds with proper chipping equipment installed. Currently the plant consumes almost 60% of its fuel requirement from coconut fronds.

The average cost of the fuel mix with 60% chipped coconut fronds is around Rs 1800 per unit with specific fuel consumption of 2.2 kg/unit. With this, the fuel cost per unit has been brought down to Rs 4.00–4.25 per unit, so the plant is now at least breaking even.

The typical problem of super heater coil scaling/corrosion of a biomass power plant was faced with minimum down time with elongated mean time between failures, even after the usage of coconut tree wastes, which normally has higher alkali and chlorine content when compared with other biomass.

The plant could be operated at more than 80% PLF using 60% coconut fronds. With the energy crops in place along with the current fuel mix with the same moisture content at 40%, it would be possible for us to make the project viable.

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