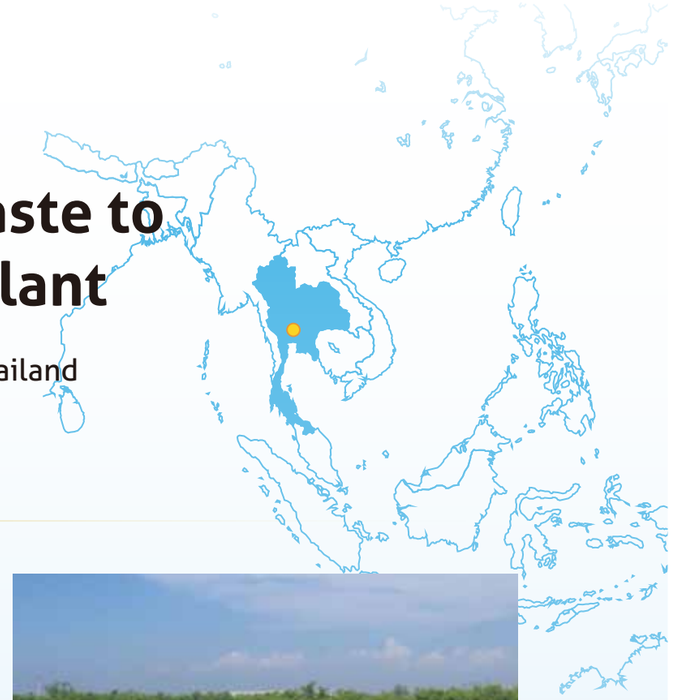
DP CLEANTECH
Clean energy, natural solutions

Specialist Coconut Waste to Clean Energy Power Plant

Mahachai Samut Sakhon Province, Thailand



Introduction

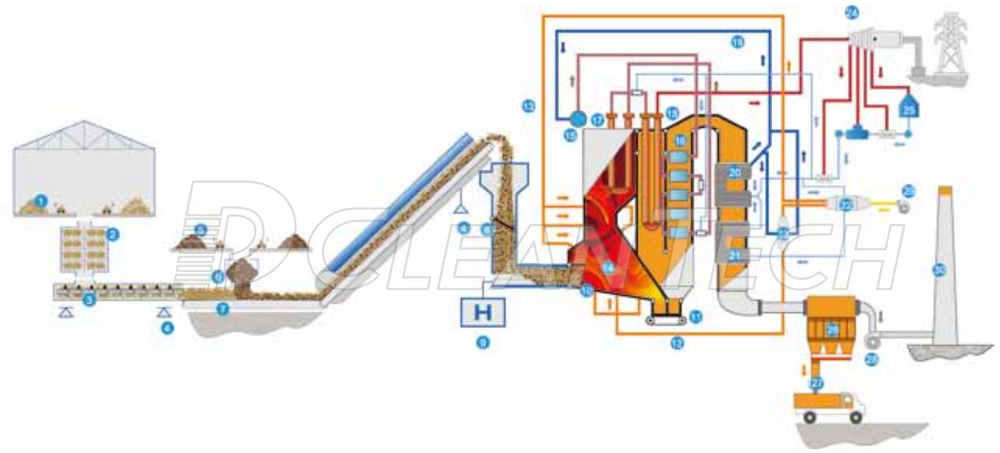
The Mahachai Green Power power plant in Thailand is one of the first plants in the world designed to utilise all the waste from coconuts and convert it to clean energy. It uses state-of-the-art technology and specific design adaptations developed through our experience in complex fuels in China and Europe. The unique 9.9MWe high pressure, high temperature plant was specifically designed to handle all coconut waste, including the husk, shell, frond, leaves and stems. The plant is delivered on a full EPC turnkey basis by DP CleanTech and the project scope therefore includes the supply and installation of all components, such as the Boiler, Steam Turbine, Water Cooling Tower, Water Treatment Plant, Fuel and Ash Handling, Electromechanical and Control systems, 22kV Transformer station and Switchgears. The plant commissioning completion is scheduled for 2015.

Plant Performance

The plant was designed on an end-to-end basis to ensure optimal integration of different components, and maximum efficiency and performance. For the boiler island, the specialist design allows all parts of the coconut plant to be used by permitting different types and sizes of coconut waste to be simultaneously combusted. This maximises the usage of the biomass.

The coconut powered boiler is designed to operate at high steam parameters 92 bar and 537°C, producing 9.9 MWe of electricity. The plant is designed to achieve an efficiency of 30% with a net Heat Rate of 13,250kJ/kWh , with a design fuel at 45%moisture content, whilst ensuring lower than regulatory standard emissions. The innovative design and customised corrosion resistant materials ensure long term performance and reduced maintenance downtime, allowing the plant to operate at full capacity for more than 7,900 hours per year.

Fuel	Coconut residues (husk, shell, bunch, frond, leaves, trunk)
Fuel consumption	Design fuel mix: 323t/d (45% moisture) or 167t/d (dry)
Calorific value	8.35 MJ/KG
Power output	9.9MWe (gross)
Steam flow	40t/h
Steam pressure	92 bar
Steam temperature	537 °C
Boiler efficiency	90%
Gross plant efficiency	31%
Availability	>7,900 hours/year



1 Shredded fuel
2 Walking floor
3 Screw conveyor
4 Weight cell
5 Non-shredded fuel
6 Feeding hopper
7 Belt conveyor
8 Pusher feeder
9 Hydraulic station
10 Vibrating grate
11 Slag conveyor
12 Primary air
13 Secondary air
14 Combustion chamber
15 Steam drum
16 Superheater 1
17 Superheater 2
18 Superheater 3
19 Boiler feed water
20 Economizer
21 Flue gas cooler
22 Air preheater 1
23 Air preheater 2
24 Steam turbine generator
25 Water-cooled condenser
26 ESP filter
27 Ash handling
28 ID fan
29 FD fan
30 Stack

At a community level, the development of the plant has created a substantial amount of local employment during the construction and development. In the future, the plant will sustain long term employment for operational employees as well as create value for local farmers through the processing of coconut waste.

Fuel Handling

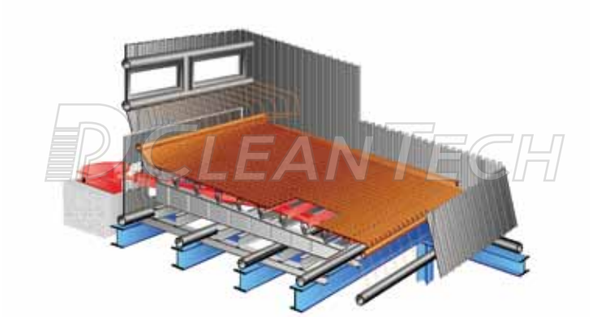
Fuel is stored in outdoor and indoor storage areas, and transported to the pusher feeder via an automatic moving floor, screw and belt conveyors, which are all delivered as redundant systems. The screw conveyor system is equipped with weight cells to ensure the proper mixing of the fuel and fuel consumption data management. Belt conveyors transport the fuel to the inlet hopper of the pusher feeder. There is also an alternative fuel inlet via a ground hopper directly on to the belt conveyors. The pusher feeder is a unique solution which will allow the combustion of pre-processed coconut shell, feeding the fuel into the boiler combustion chamber.

Combustion Process

The coconut waste is combusted on a water-cooled vibrating grate under carefully controlled conditions; the vibrating movements regulate the stages of combustion. The vibrating motion occurs in cycles which alternate between 1.5–3 minutes for a period of 3–5 seconds at a time. Part of the combustion air is fed to the furnace from beneath the grate and further combustion air is led to the furnace through nozzles situated above the grate.

Water-Cooled Vibrating Grate

DP CleanTech's water-cooled vibrating grate was designed and developed specifically for the combustion of biomass fuels and is one of few grates able to effectively accommodate mixtures of woody and herbaceous biomass fuel. The water-cooled vibrating grate is one of the most reliable combustion grates in the world. The vibration inhibits the formation of large slag particles, which are common in biomass combustion. This makes the grate suitable for burning fuels with high slagging and sintering propensities. In addition, a vibrating grate has fewer moving parts than a standard moving grate, and therefore requires less maintenance. The grate is divided into 3 primary air zones. The first section onto which the coconut is fed is subjected to high turbulence in order to help the release of volatile matter and moisture. The second stage is the pyrolysis, the third stage is for burning out. The fuel ash and slag are transported along the grate by the vibrating movement into the slag fall, then into a submerged slag conveyor, finally discharging into a slag pit.



High Pressure, High Temperature Boiler

The steam boiler is a water tube boiler with hanging superheaters. These produce 40 tons of steam per hour at 92 bar and 537°C. DP CleanTech's unique and well proven boiler is designed to operate at high temperature and high pressure. In addition, the specially selected materials and advanced temperature control counteracts the fouling and corrosive effects of the fuel. The steam produced is used in a conventional steam cycle turbine. The plant will supply approximately 9 MWe x 8000 hrs of electricity to the national grid per annum. The flue gas, having been cooled in the boiler, is cleaned in an electric filter before being discharged through the stack.

Flue Gas Cleaning

All gaseous plant emissions are well below regulatory standards, due to DP CleanTech's advanced combustion and emissions handling techniques. The power plant is provided with an electrostatic precipitator filter for removal of particulate matters. The fly ash is collected in a storage silo via a dense phase pneumatic transport system. The fly ash can be discharged from the silo into trucks for redistribution as fertilizer. The plant is equipped with a CEMS (Continuous Emission Monitoring System) for online monitoring of emissions.

Steam Turbine Generator

The steam turbine generator set in this plant was delivered by DPCT, and manufactured under supervision in China. The generator and gearbox are German manufactured and designed to produce electricity up to 9.9MW gross.

Substation: Transformer and Transmission System

A transformer station with medium voltage switchgears is the connection point to the 22kV grid of the Provincial Electricity Authority. The plant will supply approximately 72,000MWh of electricity to the provincial grid annually.

Clean energy, natural solutions

Specialist Coconut Waste to Clean Energy Power Plant

Mahachai Samut Sakhon Province, Thailand