First commercial CSP-Biomass Hybrid Power Plant in Spain

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About the project

The Borges termosolar plant, first commercial hybrid plant in the world, has been in operation since December 2012, in the town of Les Borges Blanques in the Catalonian province of Lleida. Abantia and Comsa Emte, in conjunction with local authorities and suppliers (MAN Diesel for the turbines, Intec for boilers and Siemens for the solar collectors) have set up this installation.

Project Overview	
Project Name	Borges Termosolar
Location	Les Borges Blanques (Lleida), Spain
Owner(s)	Abantia (50%) & Comsa EMTE (50%)
Technology	CSP-Biomass Hybrid
CSP	Parabolic troughs in 39 hectares
Thermal Power station	Primary fuel: Biomass Secondary fuel: Natural gas
Thermal Capacity	102 MW_{th} (56 MW_{th} solar and 36 MW_{th} biomass & 10 MW_{th} natural gas)
Power Plant Capacity	Gross: 24.8 MW; Net: 22. 5 MW
Annual generation	98 GWh
Cost (approx)	153 million Euros
Commissioned	December 2012
Status	Operational

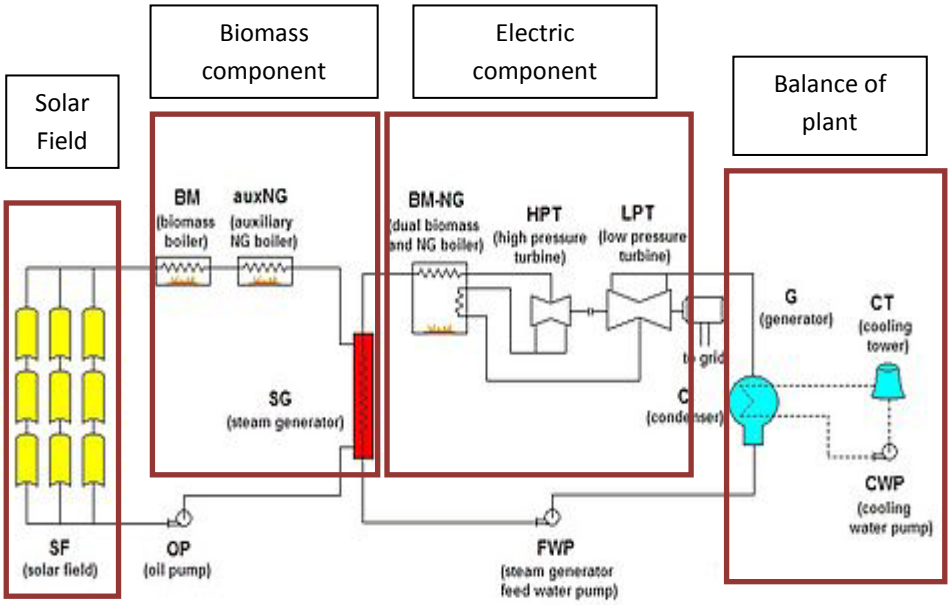
Thermosolar Borges, is the 22.5 MW Concentrated Solar Power (CSP) – biomass hybrid plant is the first hybridisation power plant that mixes thermo-electric power source with biomass system. The plant runs 24 hours a day by using solar power during the day and biomass power during the night. The fuel for biomass plant is mostly forestry biomass complemented with energy crops and farming waste. The gross and net power plant capacity is 24.8 MW and 22.5 MW respectively, which can supply to about 27,000 households, avoiding 24,500 tonnes of CO_2 emissions per year.

The CSP-Biomass hybrid power plant

The CSP-biomass plant extends in an area of 70 hectares (173 acres) and is mainly composed of 4 components: (1) the solar field; (2) the biomass (thermal) components; (3) the electrical components and (4) other components of the plant.

Solar component

The solar field (SF) consists of trough-shaped mirror reflectors to concentrate solar radiation on to receiver tubes containing thermal oil, which is heated to produce steam. The SF comprises of 336 solar collector assemblies (SCA). SF is comprised of 56 loops each having 6 SCAs. Each SCA is about 96 m long and consists of 8 modules or dishes). Therefore, in total there are 2688 dishes (each of 5.5 diameter and 12 meters long) are available covering a total solar field aperture area of about 183,120 m^2.



Biomass components

The biomass block comprises of one 22.5 MW_{th} biomass boiler (BM), one 14 MW_{th} dual biomass and natural gas boiler (BM-NG), one 10 MW_{th} natural gas conventional auxiliary boiler (auxNG) for assistance, and a steam generator (SG). The BM is inserted in series on the SF thermal oil loop. The steam generator works as a heat exchanger utilising heat of thermal oil (SF thermal oil loop) for generating the steam from feed water in water loop. The generated steam is then passed through BM-NG boiler to reach the desired temperature and pressure, which is required before entering the turbine.

Electric components

The electric block is composed of a 22.5 MWe steam turbine generator train and a power transformer. The turbo generator train comprises one high pressure turbine (HPT) followed by a low pressure turbine (LPT).

Other components

The other accessories of power plant include biomass processing & storage systems, cooling tower and other control systems.

Technology of the hybrid power plant

In Borges Termosolar plant, an advanced MARC-R turbine of MAN Diesel & Turbo make is installed. MARC-R turbine consists of two components:

Technology suppliers for various components

- Solar collectors - Siemens
- Turbo generator - MAN Diesel & Turbo
- Grate type boilers - Intec Energy
- Biomass supply and processing - COMSA EMTE Medio Ambiente

- MARC-2 backpressure turbine and
- MARC-6 condenser turbine

The MARC-2 turbine operates in 4-10 MW power range and accepts pressure up to 90 bar and maximum steam inlet temperature is 520°C whereas the MARC-6 turbine operates in the 15-40 MW power range and accepts pressure up to 121 bar and maximum steam inlet temperature is 530°C.The MARC-R group operates at full load efficiency of 37%.

Operation of the power plant

The SF parabolic troughs absorb solar energy and heat- thermal oil up to 400°C. In the steam generator, the thermal oil generates saturated steam at 40 bar and the dual biomass boiler (BM-NG) superheats this steam to 520°C.

At times, when solar field is not operational, 22.5 MW_{th} biomass boiler of the plant heats the thermal oil to 400°C. The hot thermal oil is then passed to through the second biomass boiler, where the thermal oil is superheated beyond 400°C. The total thermal capacity of the biomass boilers is 36 MW_{th}. The choice of this power level for the boiler is motivated by being able to achieve at least 50% of the workload of the turbine running at night. Below this level, the turbine efficiency decreases sharply. The use of natural gas as a fuel is depending on the meteorological conditions.

Hybridisation with biomass

The hybridisation of solar thermal power plant with biomass fired thermal power generation enables the plant to operate 24 hours a day, thus getting more use out of the installation. Capturing the sun's rays during the hours of sunlight, using parabolic trough collectors, is backed up during the night with the biomass plant coming into operation.-

The plant offers following advantages:

- With a 22.5 MW hybrid plant, electricity production of 98,000 MWh/yr is achieved, very close to the production of a 50 MW solar-mode plant (around 110,000 MWh/yr).
- Hybridisation makes the plant easier to manage, enabling electric energy production with very low or no solar radiation, and achieving plant operation of 6,500 hours a year.
- Due to hybridisation, steam turbine can operate continuously, avoiding the daily shut down/start up and consequently achieving greater efficiency from the power block, as well as from the plant's electrical infrastructure.
- Biomass utilisation, optimises capital expenditure, enabling a lower investment for similar electrical productions.
- Hybridization of CSP with biomass helps to avoid the clouds effect and lower any kind of potential hydraulic imbalance in the solar field.