Best available technology

B W E  B O I L E R S
**GREAT BIOMASS POTENTIAL**

**Facts**
The economic feasibility of the extensive use of biomass in energy production is supported by the regulatory framework and environmental policies based on the 2020 Climate & Energy Package of the EU, which is a set of binding legislation ensuring that the EU meets its climate and energy targets.

- 20% cut in greenhouse gas emissions (from 1990 levels)
- 20% of EU energy from renewables
- 20% improvement in energy efficiency

**Actions**
The targets imposed by the environment preservation needs will have to be further developed in order to move ahead projects presently stalling between unclear regulatory framework and financial constraints.

The spreading of co-combustion technology of biomass in coal fired power plants would increase the potential of quickly introducing renewable energy into existing power stations, and thus give combustion of biomass instead of coal a huge potential worldwide.

Furthermore a biomass conversion would allow an older unit to operate for an extended period under conditions that are both profitable and environmentally sound.
Based on more than three decades of experience in the field BWE Boilers is the best available technology (BAT) in the marked. The boiler is optimized to deliver; high boiler efficiency and steam parameters, low maintenance and operation costs and not least - a high availability and a long lifetime.

Today BAT has become a standard request to key technology providers from the stakeholders of renewable energy projects (i.e. authorities, politicians, power plant owners and investors).

The technologies for biomass combustion are proven, reliable and often integrated into urban heating systems.
The multi-fuel concept
On a straw-fired boiler it is possible to co-fire with other biomass fuels such as wood-chips, other agro-biomass, cotton stalkes, wood chips/pellets up to 50%wt/wt-%.

The BWE Boilers for biomass is of the drum type with natural circulation, it can be delivered in thermal sizes ranging from 40 to 130 MWth and at steam data up to 140 bar, 540°C. They are all bottom supported and include vibration grates that are water cooled and part of the evaporator high pressure system. Electric size is normally in the range of 10 to 45MWe.

The fuel feeding system
The straw feeding system and patented scarifier developed is adaptable to different types of square bales such as Heston and CLAAS. The straw bales are conveyed through two, three or four sets of straw feeding lines to the boiler. The BWE Boilers are designed and optimized for operation with corrosive and sticky ash caused by cereal straw combustion. Hence super heaters are designed as slagging super heaters using austenitic material grade.

BWE Boilers are found in biomass power plants in Sweden, the UK, Germany, China as well as Denmark.
**Grate-fired biomass boiler**

The standard grate-fired BWE Boilers are offered in the sizes of 40, 80 and 130 MJ/s. By modifying the design it can be tailor-made and adapted to customer requirement and optimised for the specific fuel, as straw or other higher density biomass fuels like wood chips. One type for straw feeding the grate through stokers and another type for higher density biomass fuels like wood chips using air-swept spreaders.

3 pass straw-fired boiler

By straw firing, the bales are conveyed through seal gate arrangements to the scarifiers where the bale is loosened before it is pressed through the water cooled ducts to the grate.

3 pass spreader-fired boiler

By wood chips firing, the fuel is blown into the furnace and onto the grate by air-swept spreaders.

2 pass boiler

As a compact and efficient alternative the 2 pass boiler with reheat is highly suited for wood chips.
The water cooled vibrating grate developed for biomass combustion can be applied for a fuel input up to 150 MWth. Generating steam with data as high as 140 bar and 540°C, an elevated plant efficiency is ensured.

The water cooled vibration grate represents BAT for straw combustion and provides a reliable operation with minimum of maintenance. The BWE Boiler is carefully designed with three passes, slagging super heaters, large super heater pitch and tubes in austenitic material grade.

The water cooled grate is designed as a membrane wall with air nozzles in the fins. The primary air in the range of 30% of the total air is distributed based on a predesigned and optimized hole pattern in the grate surface. The main combustion air is introduced through a number of air injection nozzles above the grate in connection to the furnace noses.
The grate vibrations generate a transport of fuel down the grate from the reception/ heating/drying zone to the area where the main combustion takes place, further down to the zone where the coke glows out and finally to the cooling zone for the ashes before falling into the slag hopper.

The grate is designed to operate with a huge variation in fuel moisture. The water cooled vibration grate offers very low maintenance costs and provides high availability and low power consumption. Typically the grate membrane is exchanged after more than 10 years of operation.
**HIGH EFFICIENCY TECHNOLOGIES**

**Reheat technology**
The reheat technology well known from large power plants is now also implemented in biomass power plants of smaller sizes. The reheat improves fuel efficiency and provides a higher plant output which is both an economic and environmental advantage by reducing CO₂ emissions.

A solid track-record of delivering boilers with reheat as well as wood chips grate-firing, is combined into the below concept.

**Flue gas treatment and condensation**
The Emission Limit Values (ELV) dictated by the Best Available Technology (BAT) are firming up in EU. BAT is challenged requiring Dry Sorbent Injection (DSI), Fabric Filter (FF) and Selective Catalytic Reduction (SCR) to meet the SO₂, PM and NOx Emission Limit Values.

The integrated and optimized Flue Gas Treatment (FGT) supplied with BWE boilers includes DSI, FF and SCR. The design allows the DSI and SCR to operate at sufficient temperature without any interference with the steam cycle and it allows meeting ELV even during plant disturbances.

The FGT solution can be extended with Flue Gas Condenser, Heat Exchanger and Combustion Air Humidifier for combined heat and power (CHP) optimization. This FGT extension allows flue gas exit temperatures down to 40°C and fuel utilization up to 103 % with an increase of 20% of the heat supplied to the district heating network.
MOST EFFICIENCY BIOMASS BOILER

USC 400 MWe biomass boiler
The Avedøre Power Plant, Unit 2, located in Denmark is one of the most efficient, fuel flexible, and environmentally friendly power plants in the world. The net output of the plant is 400 MWe, burning 1,000,000 tons of pellets yearly.

In addition to generating electricity, the plant also supplies heat to the Copenhagen district heating network.

The core of the plant is the Ultra Super Critical (USC) unit incorporating a once through Benson tangentially fired BWE Boiler.

The USC boiler of Unit 2 has been designed with a unique multi fuel firing system which makes it possible to utilize coal, heavy fuel oil, natural gas and wood pellets.

Based on 100% firing of wood pellets, the boiler still today has the world record for biomass boilers of 45% net electric efficiency, and can reach a fuel input of 800 MWth making it the largest biomass fired power plant in the world.
Why convert from fossil fuel to biomass?
Biomass is a renewable and carbon-neutral energy source, and as such it is a sustainable alternative to fossil fuels.

There is a strong political desire to implement renewable energy supply in many countries. This has led to economic incentives for biomass-based energy generation.

Also the emission of especially SO₂ and NOₓ tends to be lower for biomass than for fossil fuels. Therefore a biomass conversion of a fossil fired power station can reduce or even eliminate the cost of complying with current and future legislation.

Design basis
To design a robust and reliable biomass solution the following issues must be considered:

- Biomass properties (particle size, moisture, chemical composition)
- Boiler pressure part design (especially superheater pitch)
- Reusable equipment (coal silos, mills, pipes)
- Footprint (mills, dosing units)
- DeNOₓ/FGD/Ash consequences
- Burner openings (number, sizing)
- Slagging/fouling potential
- Allowable boiler de-rating
The multi fuel burner

Our Multi Fuel Burner is a flexible, robust and highly advanced assembly. The base design is adapted to the customer demands including Fuel Flexibility, Air Staging and Adjustable Swirl. This applies to all plants, burner arrangements and combustion air designs. The capacity of the MF Burner program ranges from 15 to 100 Mwt.

Based on the customer demands the burner will be designed for multiple fuels. Natural Gas, Heavy Fuel Oil, Light Fuel Oil, Bio Dust & Coal Dust can be designed into one single burner with automated switch over, but can also include fuels like Blast Furnace Gas, Coke Oven Gas and Corex Gas.

All fuels are controlled individually to obtain optimum flame shape, stability and temperature as well as ultra low NOx and CO emission. Air staging is important for this purpose and involves stratification of Primary, Secondary and Tertiary Air, Over Burner Air (OBA) and Over Fire Air (OFA).

Hot Burner Parts are made of ultra advanced high temperature resistant alloys. The material selection has evolved over decades and reached a level of excellence, in which long duration and economical and reliable operation can be expected.
In 1982, a BWE Boiler was supplied to the Herning Power Plant, and since 2002 the BWE Boiler has been converted from 100% fossil firing to 100% biomass firing, which makes the plant CO$_2$ neutral.

In 2008, the BWE Boiler was completely modified with 4 burners for pulverized biomass (wood pellets) inclusive of pulverized fuel piping and the necessary modifications of the primary and secondary air systems. The installation was completed in 2009.

After the conversion the Herning boiler is now able to fire a total of 240MWth from biomass reducing the CO$_2$ emissions of the plant by 325,000 tons/year compared to 100% coal firing.
Biomass is more complex and different in composition than anyone might expect. The fuel brings it all which in particular is true, when firing annual crops with a chemical composition more complex and aggressive than wood and wood like fuels. This saying applies in particular when firing biomass in a modern boiler with high steam parameters.

The chemical complexion in crops, typically generate very low ash melting temperatures and highly corrosive components. This aspect influences the BWE Boiler biomass design in unique ways in terms of physical design, cleaning technology and material selection.

The design and material selection has evolved over decades of experience and has today reached a level of excellence, in which long duration and economical and reliable operation can be expected.

Challenged on biomass fuels since the 1980’s, when focus was on straw, we today masters BAT in the efficient combustion of the most diversified biomass fuels.
**SERVICE**

BWSC has a long history of not only repair and service, but also operation and maintenance, together with the inhouse expertise on BWE Boilers, we are specialised and have a proven record in repair and maintenance of small and large scale boilers. By applying our rehabilitation and maintenance program, the lifetime of your boiler plant can be extended to make sure that it always performs at its best and is adapted to modern environmental requirements.

- Key services in our biomass boiler maintenance program:
  - Repair and renovation
  - Life extension
  - Efficiency improvement
  - Fuel conversions (coal, oil, natural gas, biomass), to reduce CO₂ and NOx emissions
  - High alloy steel quality work
  - Low-NOx firing systems
  - On site inspections and technical expertise
  - Annual services including 24/7/365 hotline
FACTS ABOUT BWSC

- World-leading turnkey EPC contractor and service provider for diesel, natural gas and renewable baseload power plants for electricity generation and thermal energy production
- More than 180 power plants designed and supplied in 54 countries
- Two decades of experience in operation and maintenance of power plants
- A comprehensive range of power plant support services, from spare parts to complete rehabilitation
- Training programmes for all aspects of power plant operation and maintenance
- Extensive experience in financing and development of power plant projects
- Headquarters in Denmark – widespread international sales and support network
- 900 employees in our main office and on power plants around the world
- 100% subsidiary of Mitsui Engineering & Shipbuilding Co. Ltd., Japan
- Certified according to ISO 9001 and OHSAS 18001
- Long-standing AAA rating, 2016 revenues: EURm 395

In 2017 BWSC entered the boiler business by acquiring Burmeister & Wain Energy A/S. BWE has developed, designed and delivered highly advanced steam boilers for public as well as private power distributors since 1852. With the experience and track record coming from the world’s oldest boiler producer, BWSC is now capable of delivering BWE Boilers.

Like BWSC, BWE has its roots in Burmeister & Wain.