

HIGH EFFICIENT BIOMASS ENERGY PRODUCTION

Best available technological solution for dry agro biomass combustion

200 million tons of straw is harvested in EU alone⁶⁾. Half of it is needed for livestock as well as other agricultural purposes, which means that up towards 100 million tons of straw is available for energy production, corresponding to 124,000 GWh/year⁵⁾⁷⁾.

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Combustion is far the most effective generation of heat and power from dry solid biomass. Electrical efficiency of 33,5%¹⁾ (LHV) has been proven on straw and new plants²⁾ are under construction with fuel efficiency above 103% in combined heat and power (CHP) mode.

Utilising biomass residues for energy

Residual biomass from agriculture such as straw provides an indisputable source for sustainable energy production. However, the straw is a very problematic fuel due to high chlorine, potassium and sodium content resulting in a corrosive ash with low melting point and requires a special boiler design. In Denmark, biomass boilers have been in operation on straw from wheat and maize for three decades. Step by step, the design has been improved and the steam parameters increased up to today's standard of 110 bar and 540 °C are considered as best available technology (BAT). The biomass combustions plants provide dispatchable power supply and support to the increased amount of renewable on the grid. The wide control range 30-105% in combination with heat accumulators

ensure the connection to the grid and the possibility to ramp up and down in parallel to the supply of district heating.

The Sleaford plant in Lincolnshire

The Sleaford plant in Lincolnshire, UK, is an example of BAT for straw fired boilers for power production. The project was executed in a consortium between BWSC and BWE with the latter as boiler supplier. It is built for a heat input of up to 120 MWth equivalent to a straw consumption of 30 tons/hour, summing up to 240.000 tons/year and generating up 38.5MW power, corresponding to approximately 65,000 households and businesses. It is also possible to use up to 22 % wood chips in the boiler. Replacing coal at the Sleaford plant reduces CO₂ emissions by more than 150,000 tons/year.

Recycling resources, utilising surplus heat and spurring jobs

The Sleaford plant's proven technology is designed for clean and efficient combustion of straw supplied mainly by farms within a 30-mile radius of Sleaford. Ash produced by the plant will be recycled as crop fertilizer.

The Sleaford plant is equipped with a flue gas cleaning system meeting the required emission limit values (IED ELV) for NO_x, SO₂ and particulate. As well as generating 38.5 MW electrical power, the surplus heat generated by the plant is used for district heating purposes in the Sleaford area (public swimming pool, bowling centre, football club and District Council's office). Long term contract with local farmers on fuel supply and 80 jobs during operations support the local economy by approximately £10 million/year.

Positive spin-off from Sleaford

In addition to Sleaford, another two turnkey straw-fired power plant projects have been secured with BWSC as consortium lead with BWE, allowing a further fuel flexibility by burning straw and miscanthus in combination with wood chips. Both projects, Brigg and Snetterton, are 10% larger in capacity compared to Sleaford and carried out in jointly ownership between PensionDenmark and BWSC with BWSC as O&M provider for 15 years

Boiler Characteristics

Steam parameter: 540 °C @ 112 bar

Boiler type: Drum, three pass, bottom supported
Fuel: Rectangular straw bales (New Holland, Heston or Claas type),

Additional fuel: 22% Wood chips

Start up fuel: Combined LDO/gas Burner

Boiler efficiency: 92,5% (LHV, EN12952-15)

Load range: 40-100% load

Load change rate: 3 %/min (4%/min with support fuel)

Combustion: 4 Screw stokers firing on water cooled vibrating grates

The upcoming EU requirements³⁾ for emissions valid from 2020/21 have forced the suppliers to improve flue gas treatment (FGT). Today integration of boiler and FGT⁴⁾ is well recognized as the best way to fulfill the new requirements.



Sleaford plant project setup

Developer: Eco2 Ltd
Plant Owner: Eco2 Lincs Ltd. Owned by Glennmont Partners
Lenders: 4 International Banks
EPC Contractor: BWSC A/S and BWE A/S in Consortium
O&M Contractor: BWSC A/S - 12 years
Contract start: December 2011
Delivery Time: 30 Months

The core of the plant is a vibration grate fired drum type boiler, the fuel is supplied to the site as rectangular bales (Heston, Claas and New Holland), which is stored in two 2200 m² straw barns, and the grate is an integrated part of the evaporator system of the natural circulated boiler, which is inclined to a low angle, still allowing it to be a part of the evaporator system, without the risk of steam build-up and thus overheating of the membrane. Typically, the grate membrane has a lifetime of more than 10 years of operation.

1) Sleaford (117 MWth) performance test

2) Lisbjerg (110 MWth) steam cycle CHP performed by COWI

3) LCP BREF AELs. Data can be verified by EU Environmental Agencies.

4) Snetterton (130 MWth) tail end SCR integrated with boiler flue gas cooler packages and Lisbjerg (110 MWth) tail end SCR, air humidification and flue gas condensing.

5) Average heating value 14 MJ/kg, average plant electrical efficiency 32%. Future plant > 100 MWth with reheat cycle can reach > 35%. Steam cycle can be confirmed by BWSC.

6) IEEP May 2012, Biomass future Feb 2012, Bioboost June 2013 etc.

7) Denmark is using 33% of the available straw for energy production (up to 2 mill tons / year)