The firing and co-firing of biomass in large pulverised fuel boilers

W R Livingston
Doosan Babcock

Doosan Biomass Co-firing Experience

Date	Subject of contract	Site	Customer
2001	Biomass co-firing system Design study	Tilbury Power Station, England	**RWE**
2002	Biomass (olive residue) co-firing Consultancy and testing	Ferrybridge Power Station, Yorkshire, England	**AEP**
2003	Biomass co-firing trials	Ironbridge Power Station, Shropshire, England	**TXU**
2003	Biomass co-firing Consultancy and testing	Cottam Power Station, Lincolnshire, England	**EDF**
2003	Biomass co-firing Consultancy and trial work	Drax Power Station, Yorkshire, England	**Drax Power Ltd**
2004 – 2005	Biomass (sawdust) co-firing by pre-mixing and co-milling Consultancy and trial work	Cockenzie and Longannet Power Stations, Scotland	**Scottish Power**
2005	Direct injection system Prototype design	Drax Power Station, Yorkshire	**Drax Power,Ltd**
2005	Biomass (olive residue) co-firing Consultancy and testing	Kilroot Power Station, Northern Ireland	**AES**
2009	Direct biomass co-firing system study (25% heat input) FEED study	**Trenton Power Station, Canada**	**Nova Scotia Power Inc**
2009	Installation of 12 direct injection systems Commercial contract	Drax Power Station, Yorkshire	**Drax Power,Ltd**

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Doosan Biomass Mill and Boiler Conversion Experience

Date	Subject of contract	Site	Customer
1992-93	Conversion of coal mills and burners to 100% wood pellet firing Design study, Installation and commissioning	Hasselby CHP Station, Stockholm Sweden	**Hasselby Power**
2009	Conversion of Pulverisers from coal to 100% biomass (wood pellets) Design Study	Nanticoke, Ontario, UK	**Ontario Power Generation**
2010	Conversion of two E-mills from coal to wood pellet firing Commercial contract	Drax Power Station, UK	**Drax Power Ltd**
2010	100% Biomass Firing Feasibility Study	Uskmouth Power Station, UK	**SSE**
2010	100% Biomass Firing FEED Study	Atikokan Power Station, Canada	**Ontario Power Generation**
2010	Conversion of a pulverised coal boiler to the co-firing of biomass and natural gas Feasibility study	Nanticoke Power Station, Canada	**Ontario Power Generation**
2011	The conversion of a pulverised coal boiler to 100% wood firing Feasibility Study	Ironbridge Power Station, UK	**E.ON UK**
2011	The conversion of a pulverised coal boiler to 100% wood firing Feasibility Study	Tilbury Power Station, UK	**RWEnpower**
2011	100% Biomass Firing Commercial contract	Atikokan Power Station, Canada	**Ontario Power Generation**
2012	The conversion of a pulverised coal boiler to 100% wood firing Commercial Contract	Drax Power Station, UK	**Drax Power Ltd**
2012	The conversion of two 500 MW_e boilers to 100% biomass Commercial Contract	Ironbridge Power Station, UK	**E.ON UK**
2013	Conversion of Unit 2 Combustion System to 100% Biomass Commercial Contract	Drax Power Station, UK	**Drax Power Ltd**

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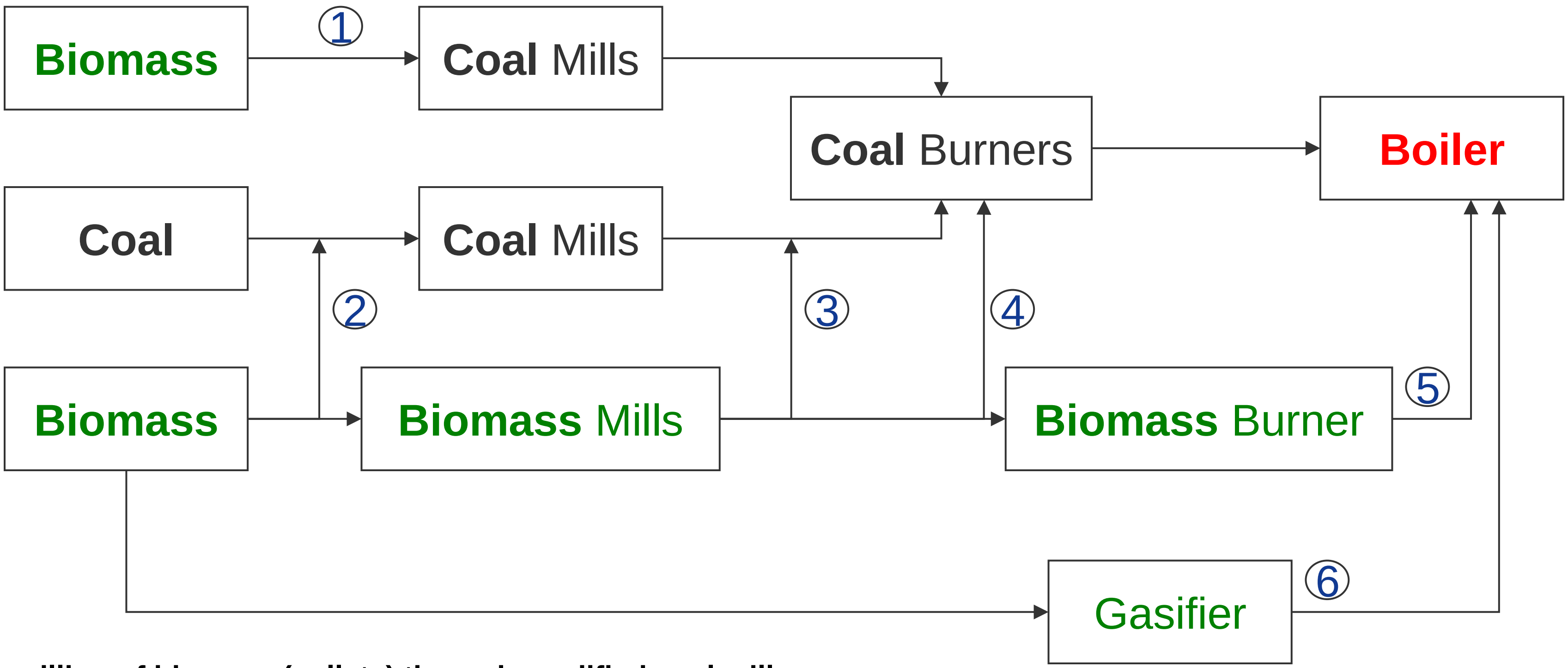
The principal direct and indirect biomass firing options



1. **The milling of biomass (pellets) through modified coal mills,**
2. **The pre-mixing of the biomass with the coal, and the milling and firing of the mixed fuel through the existing coal firing system,**
3. **The direct injection of pre-milled biomass into the pulverised coal pipework,**
4. **The direct injection of pre-milled biomass into modified coal burners or directly into the furnace,**
5. **The direct injection of the pre-milled biomass through dedicated biomass burners,**
6. **The gasification of the biomass, with combustion of the product gas in the boiler.**

Co-firing biomass by pre-mixing and co-milling

Biomass co-firing by pre-mixing with coal and co-milling

Co-firing by co-milling has been the preferred approach for stations co-firing biomass for the first time.

The capital investment is modest and is principally on the biomass reception, storage and handling facilities.

The project can be implemented in reasonable time.

This approach is attractive when there are concerns about the security of the biomass supply and the subsidy payments.

In general, this approach permits co-firing at levels up to 5-10% on a heat input basis.

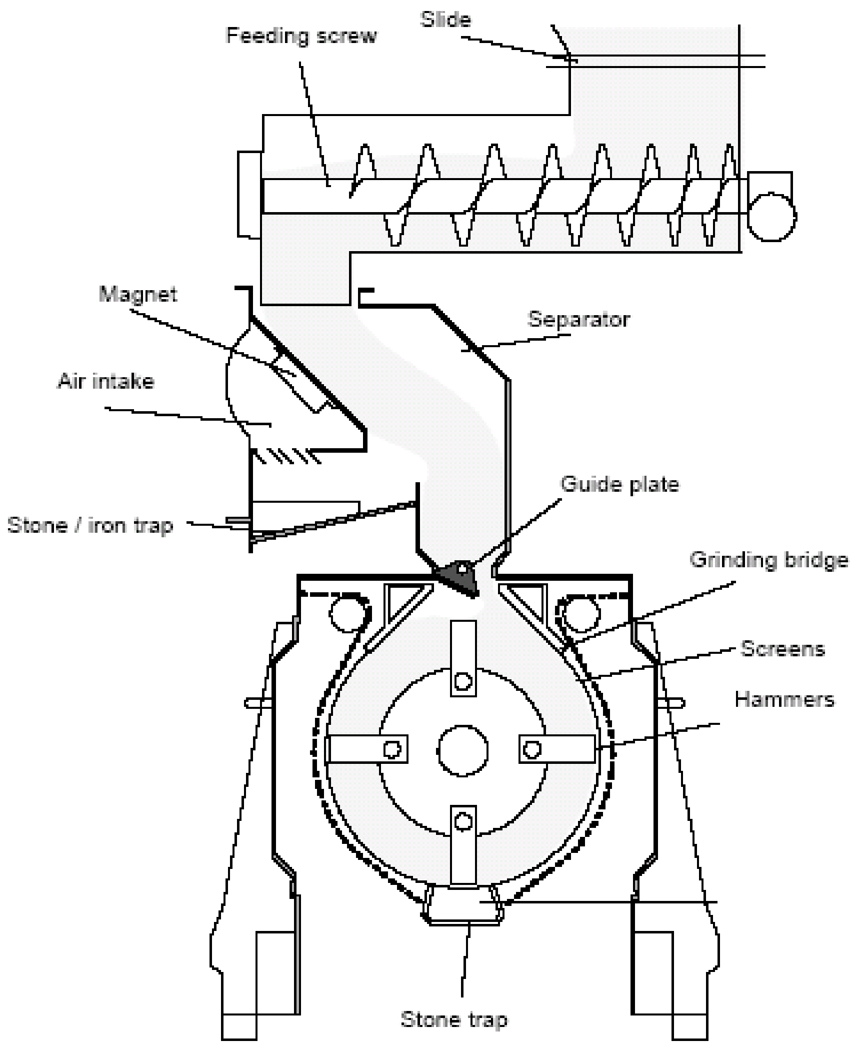
There are also safety issues with the bunkering and milling of the mixed coal-biomass material.

Biomass storage shed

Biomass pre-mixing system

Milling biomass materials to a size suitable for suspension firing

Schematic diagram of a hammer mill



Milling pelletised biomass in the existing coal mills

The coal mills are very robust, and have high availability and low maintenance requirements

The coal mill depends on a crushing mechanism, and tends to break the pellets back to a size distribution a little better than the parent sawdust.

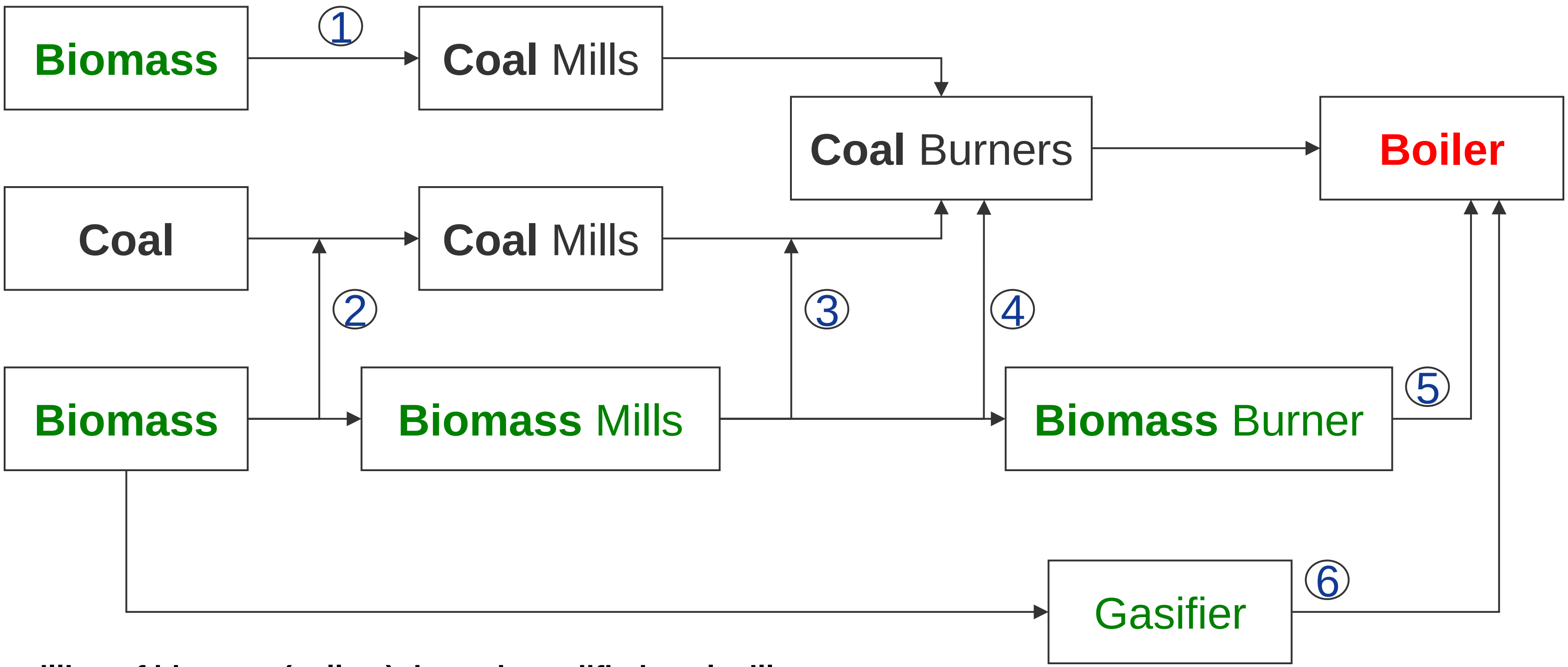
The mill has to be modified to provide the required product size and throughput, and to operate safely with a more reactive fuel.

The maximum heat input from the mill group is significantly derated, commonly to around 50-80% of that with coal, depending on the fuel and mill configuration.

The milling of wood pellets in coal mills, and the firing of the mill product through the existing pipework and burners, is done at a small number of power stations in Europe

Direct injection of pre-milled biomass

The principal direct and indirect biomass firing options



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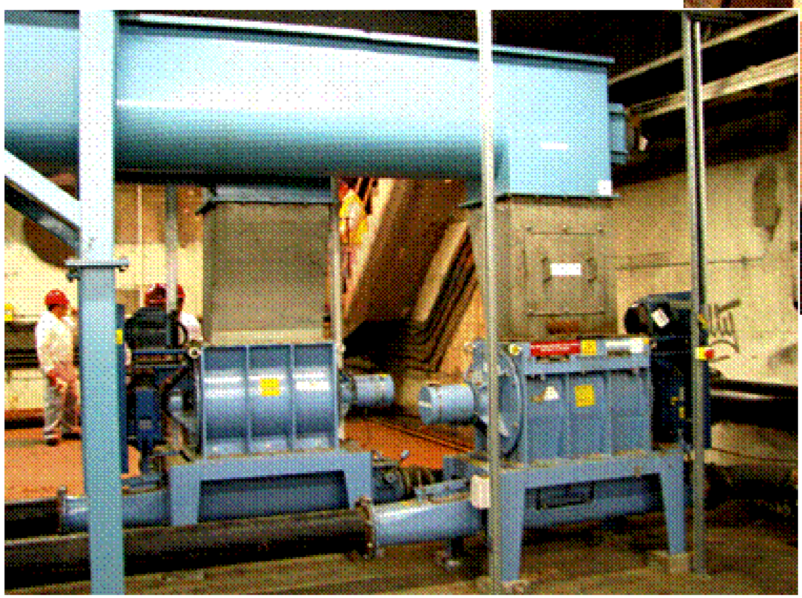
Direct Co-firing
The biomass metering and feeding system

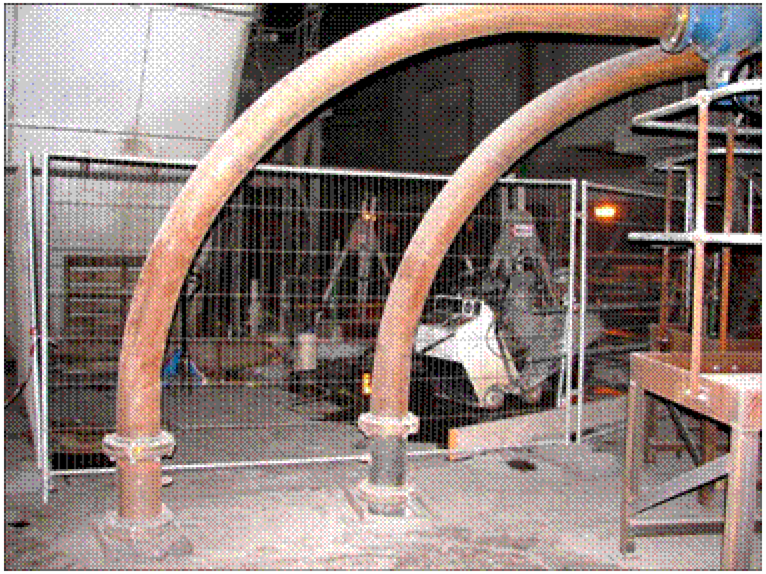
This prototype direct co-firing system has successfully co-fired a wide range of pre-milled biomass materials.

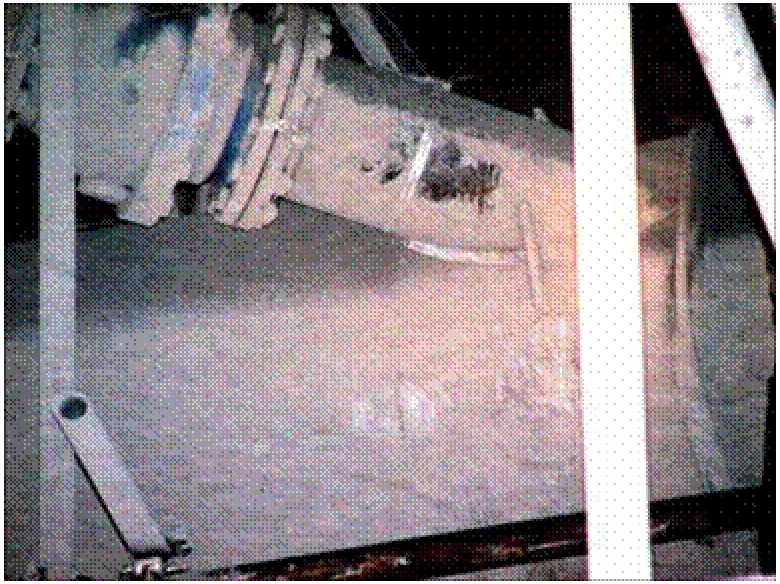


Drax Direct Co-firing
The biomass pipes and the injection point

The injection point is in the mill outlet pipes, just downstream of the product dampers. The injection point is a simple shallow angle T-in, fitted with an actuated shut-off valve for the biomass,

Both the mill and the burners are maintained within their normal operating envelopes for both the heat input and primary air flow rate. The maximum heat input from the mill group is not affected.





Summary of the biomass firing and co-firing options

All of the biomass firing and co-firing options listed above have been applied successfully, viz:.

The premixing and co-milling of the biomass at low mass ratio,
The modification of the coal mills to mill wood pellets,
The installation of hammer mills and the direct injection firing or co-firing of the milled biomass.

Combustion issues

Potential burner modifications

When pre-milled biomass materials are co-fired in the same burner with coal at less than 50% heat input, the impacts on the combustion are modest.

There is a tendency for the flame produced when firing 100% milled biomass with a topsize in the range 1- 3 mm to have the ignition plane located further out into the quarl than in a pulverised coal flame.

This is considered to be a result of the longer heating times required for the larger biomass particles compared to pulverised coal.

The result is that the flame monitor signal for the unmodified burners may be poorer than for a coal flame, particularly at reduced mill loads.

There is no indication that the flames are unstable.

The burner modifications are designed to bring the ignition plane back into the burner quarl, and improve the flame monitor signals.

Impacts on boiler performance and integrity

Technical impacts of biomass firing and co-firing

At low co-firing ratios the impacts on plant performance and emission levels have been modest for most biomass materials

At higher co-firing ratios, the concerns about impacts on plant will increase and this will affect biomass fuel flexibility.

When converting coal plant to 100% biomass, the range of fuels that can be fired are limited, generally to high quality wood materials.

The principal technical concerns are associated with the increased risks of excessive ash deposition, and high temperature corrosion of the boiler tubes.

Questions?

Thank You

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