The co-firing of biomass materials in large coal-fired boilers

Presentation to IEA Bioenergy Exco

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Copenhagen

May 2005

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Experience of biomass co-firing in Britain to date

- All of the coal-fired power plants in Britain are co-firing biomass, at least on a trial basis.
- The total number of ROCs (MWh) from biomass co-firing to date exceeds 1.8 million.
- The range of biomass materials co-fired includes:
  - wood in a variety of forms, principally sawdust or pellets,
  - imported dry residues from the olive oil and palm oil industries, and
  - Liquid biomass materials, principally talloil.

ROCs issued to date

Station	Capacity (MW_e)	Generator	Cumulative ROCs
Aberthaw	1,455	RWE npower	36,287
Cockenzie	1,200	Scottish Power	0
Cottam	2,000	EdF	44,150
Didcot	2,100	RWE npower	25,492
Drax	4,000	Drax Power	**241,955**
Eggborough	1,960	British Energy	10,092
Ferrybridge	2,035	SSE	**596,410**
Fiddlers Ferry	1,995	SSE	**305,807**
Ironbridge	970	E.on UK	98,337
Kingsnorth	2,034	E.on UK	131,254
Longannet	2,400	Scottish Power	**183,214**
Ratcliffe	2,010	E.on UK	12,440
Rugeley	1,000	Int. Power	67,569
Tilbury	1,085	RWE npower	2,635
West Burton	1,980	EdF	2,292

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Biomass co-firing by pre-blending and co-milling

- The majority of the stations are co-firing biomass by pre-blending the biomass with the coal, and co-milling and co-firing the blended fuel.
- In general, the co-firing ratio is less than 10% on a heat input basis.
- At these co-firing ratios, the effects on the performance of the boiler and the environment impacts have been modest.
- Most of the technical problems have been associated with the reception, storage and handling of the biomass materials
- The constraints on the co-firing ratio have been:
  - The availability of fuel,
  - The capacity of the biomass handling/blending system, and
  - The limitations of the coal milling equipment.

The co-milling of biomass with coal in coal mills

- In Britain, a range of biomass materials are being co-milled with coal in ball and tube mills, and in vertical spindle ball and ring, and roller mills.
- These mills depend on the coal particles being subject to brittle fracture, and this does not apply to most biomass materials.
- There is a tendency for the biomass particles to accumulate in the mill, during normal operation, and to take longer to clear the mill during shutdown.
- With vertical spindle mills there is also a tendency for the mill differential pressure and the mill power take to increase when co-milling biomass.
- The mill product topsize tends to increase, due to the lower particle density of the biomass, i.e. larger biomass particles can exit the classifier.
- There are mill safety issues when co-milling biomass, and there may be a requirement to modify the mill operating procedures when co-milling biomass.
- When co-milling wet biomass materials there will be an impact on the mill heat balance, and this may be a limiting factor.

Recent trends in biomass co-firing

- The general approach at a number of the stations has been as follows:
  - Establish co-firing by pre-blending and co-milling on the preferred fuel at minimum capital cost, and with short project lead times.
  - Obtain the Section 11 Variation for commercial co-firing activities.
  - Modify the Variation to permit greater flexibility in the fuel supply and the co-firing ratio.
  - Integrate the biomass co-firing into the normal station operations.
  - Upgrade the biomass reception, storage, handling and blending facilities, to increase throughput and reduce mechanical handling constraints, dust generation, etc.
  - Start consideration of the direct firing of the biomass to permit higher co-firing ratios.

Direct firing options for biomass

- The biomass has to be pre-milled either off-site or on-site,
- All direct co-firing systems involve pneumatic conveying of the biomass from the fuel reception/handling facility to the boiler house.
- There are three basic direct co-firing options:
  - Direct injection into the furnace with no combustion air,
  - Installation of new dedicated biomass burners, and
  - Injection of the biomass into the pulverised coal pipework or at the burner, and co-firing with coal through the existing burners.

Direct injection without combustion air

- Direct injection through the furnace wall with only conveying air and no flame stabilisation.
- Demonstrated, on a trial basis, in a downshot-fired boiler in Britain,
- Simple and cheap to install,
- Limited application for wall or corner-fired boilers.

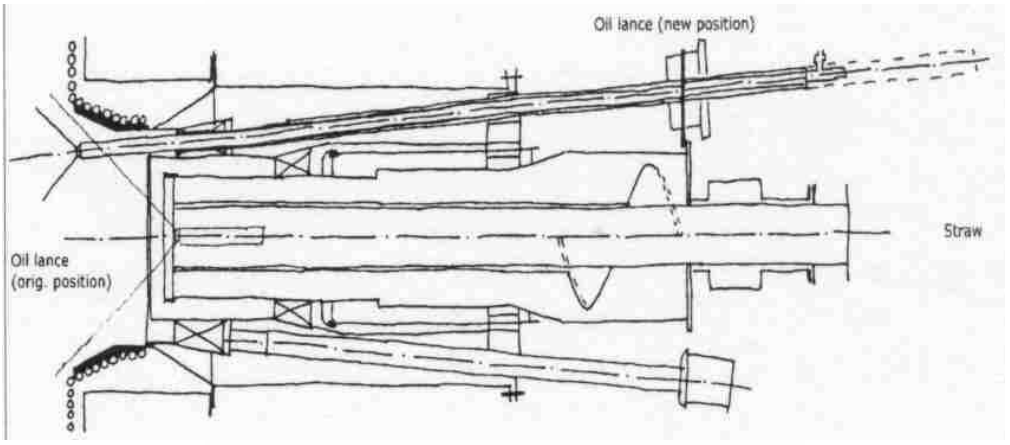
Installation of new, dedicated biomass burners

- Not yet demonstrated in Britain, but has been done in continental Europe.
- Modified pulverised coal burners or cyclone burners are being considered.
- New burner locations in rear or side walls.
- Secondary air supply required, i.e. significant ductwork modifications.
- The preferred new burner locations, and the impacts on the pulverised coal combustion and the furnace performance need to be assessed.
- The dedicated biomass burners have not been extensively demonstrated commercially.
- Complex and relatively expensive to install.

Injection of the biomass into the pulverised coal pipework or at the burner

- Not yet demonstrated in Britain, but has been done in continental Europe.
- Injection locations in the pulverised coal pipework are either at the mill outlet or local to the burners.
- Relatively simple and cheap to install, but there implications on the mill operation and control.
- The risks of interference with the operation of the coal firing system need to be assessed.
- If the biomass is to be injected at the burner, there are significant burner modifications required.

Studstrup coal-straw burner
Modified MB Mark III LNB



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Conclusions

- Direct co-firing projects are being developed in British coal-fired power plants as a means of increasing the co-firing ratio.
- A number of approaches are being adopted, depending on the fuel and the preferences of the operator, viz;
  - Direct injection to the furnace, with no combustion air,
  - Dedicated biomass burners,
  - Injection of the biomass into the pulverised coal pipework or at the burner.
  - No single preferred solution has been identified, as yet.