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# The technical aspects of the firing and co-firing of torrefied materials in large pulverised coal-fired boilers.

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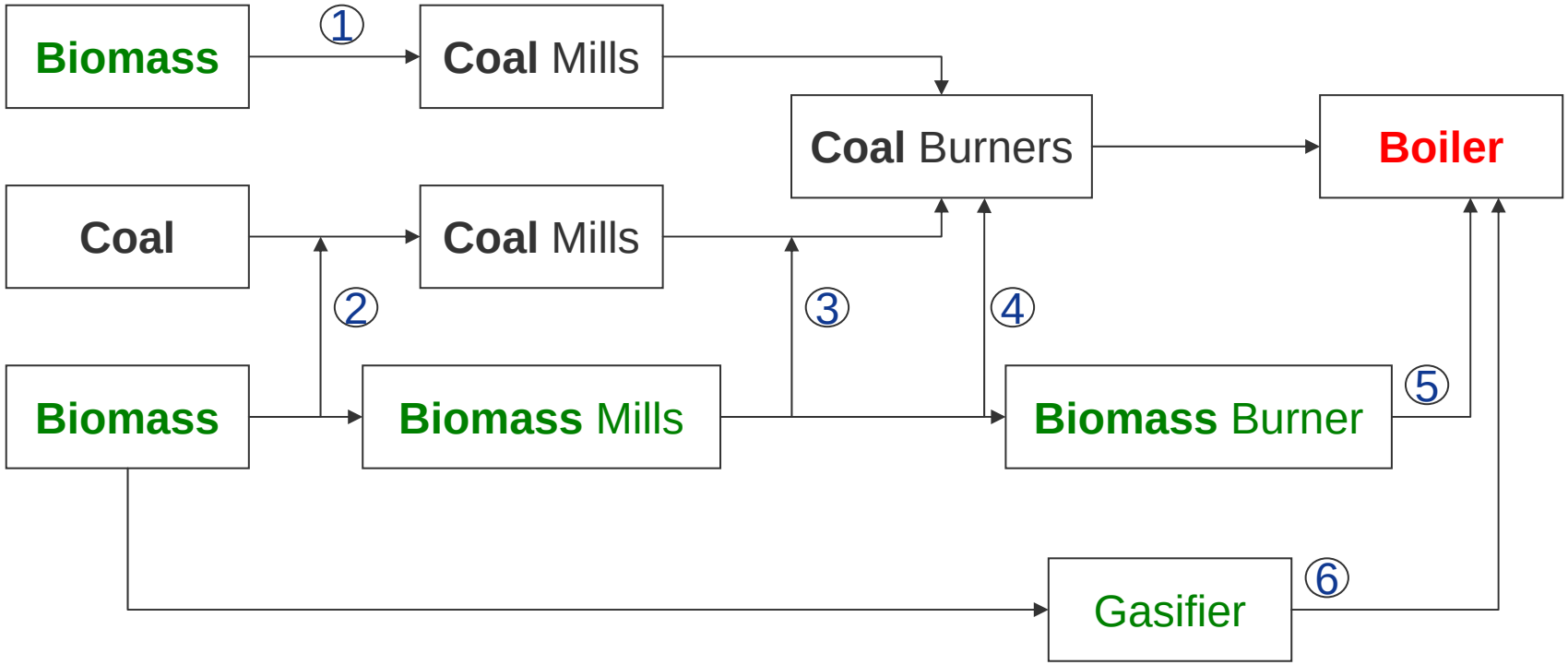
# Materials handling issues – general

- **Most biomass materials are easy to ignite, and have self-heating tendencies,**
- **Torrefied biomass materials have been processed at elevated temperatures and, in pelletised form, may have improved properties in this regard.**

- **Most biomass materials require covered storage, although the open storage of sawdusts and wet wood chips is practised.**
- **Torrefied materials tend to be hydrophobic in nature and have reduced tendencies to absorb moisture. They will also tend to be less prone to microbial activity.**

- **Many of the problems associated with the tendency of biomass materials to generate dust in handling and processing, will also apply with torrefied materials.**

# The principal direct and indirect biomass co-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.**

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# Milling pellets in coal mills

# Milling pelletised biomass in coal mills

- 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.
- The coal mills are very robust, and have high availability/low maintenance requirements. The coal mill tends to break the sawdust pellets back to the original dust size distribution.
- The mill has to be modified to operate with cold primary air, and to maximise the throughput.
- The heat input from the mill group is significantly derated when milling sawdust pellets, commonly to around 50-70% of that with coal.
- With torrefied materials or chars there is likely to be a finer mill product, i.e. significant size reduction of the primary particles will occur and there may be a higher mill throughput on a heat input basis.

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

# The co-milling of biomass with coal in coal mills

- A wide 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 from the mill during shutdown.
- With vertical spindle mills there is 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.

- Torrefied materials are much more subject to brittle fracture and should be suitable for co-milling with coal at much higher co-firing ratios.

# Safety issues when co-milling biomass in large vertical spindle coal mills

- The key issue in mill safety is avoiding hot primary air coming into direct contact with dry fuel.
- This is particularly important during certain mill operations such as:
  - planned and emergency shutdowns,
  - restarts after emergency shutdowns,
  - loss of coal or intermittent coal feed incidents, etc.
- Biomass has high volatile matter content, and combustible volatiles are released in significant quantities at temperatures above about 180ºC, i.e. at much lower temperatures than for bituminous coals.
- It is usually advisable to reassess and modify the mill operating procedures, to allow the co-milling of biomass safely.

- The safety issues will apply to torrefied biomass, but this materials has been processed at elevated temperatures, and may be more forgiving than raw biomass in this respect.

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# Direct injection co-firing systems

# Direct injection co-firing systems for biomass basic options

- **The biomass can be pre-milled, normally using hammer mills, to a size distribution suitable for suspension firing, either off-site or on-site.**
- **All direct injection co-firing systems involve the pneumatic conveying of the pre-milled biomass from the fuel reception and handling facility to the boiler house.**
- **There are three basic direct injection co-firing options:**
  - Direct injection into the furnace with no combustion air,
  - New, dedicated biomass burners, and
  - Injection of the biomass into the pulverised coal pipework or through modified burners.

- **The milling of torrefied biomass in hammer mills and other types of mill, should be easier and should provide a finer product than for raw biomass, with significant combustion benefits. There may be a reduced tendency to block the outlet screens.**

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# The impacts of torrefied biomass co-firing on boiler performance and integrity

# Overview of the impacts of the co-firing of biomass and torrefied biomass with coal in large pulverised fuel boilers.

- The risks of increased unburned carbon levels due to oversize biomass particles entering the flame should be reduced when co-firing torrefied materials.
- The ash-related impacts of biomass co-firing, i.e. the risks of increased slagging, fouling, erosion and corrosion will not be affected significantly by the torrefaction process.
- The impacts of biomass co-firing on the environmental performance of the boiler, i.e. the emission levels of gaseous and gas-borne species and the ash utilisation/disposal issues will not be affected significantly by firing torrefied material.

# Conclusions

- **Biomass co-firing with coal by pre-mixing and co-milling is being practised successfully, as a retrofit to existing plants, by a number of coal plant operators in Britain, continental Europe and elsewhere.**
- **Direct injection co-firing projects are currently being implemented as a means of increasing the co-firing levels.**
- **There is currently an increasing interest in the conversion of pulverised coal boilers to 100% biomass firing, principally in Britain and North America.**

- **It is anticipated that the principal role of the torrefaction of biomass in biomass firing and co-firing will be to provide a product in pelletised form, with improved handling and storage properties.**
- **The torrefied materials may have improved milling properties, both in conventional coal mills and hammers mills, compared to the raw biomass materials that are currently being utilised in pellet and other physical forms.**

# Thank you for your attention

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