

Experiences with Direct Injection of Biomass in PF Fired Boilers

David Waldron

17/04/2007

POWER SYSTEMS |

ALSTOM

Biomass today....

- Fuel characteristics
- Technical options
- Co-milling (utilising existing mills)
- Co-firing (providing new mills)
- Experience
- Performance



Biomass fuels



Logs ~45% H₂O



Woodchips ~17% H₂O



Pelletised wood ~10% H₂O

**Miscanthus
~20% H₂O**

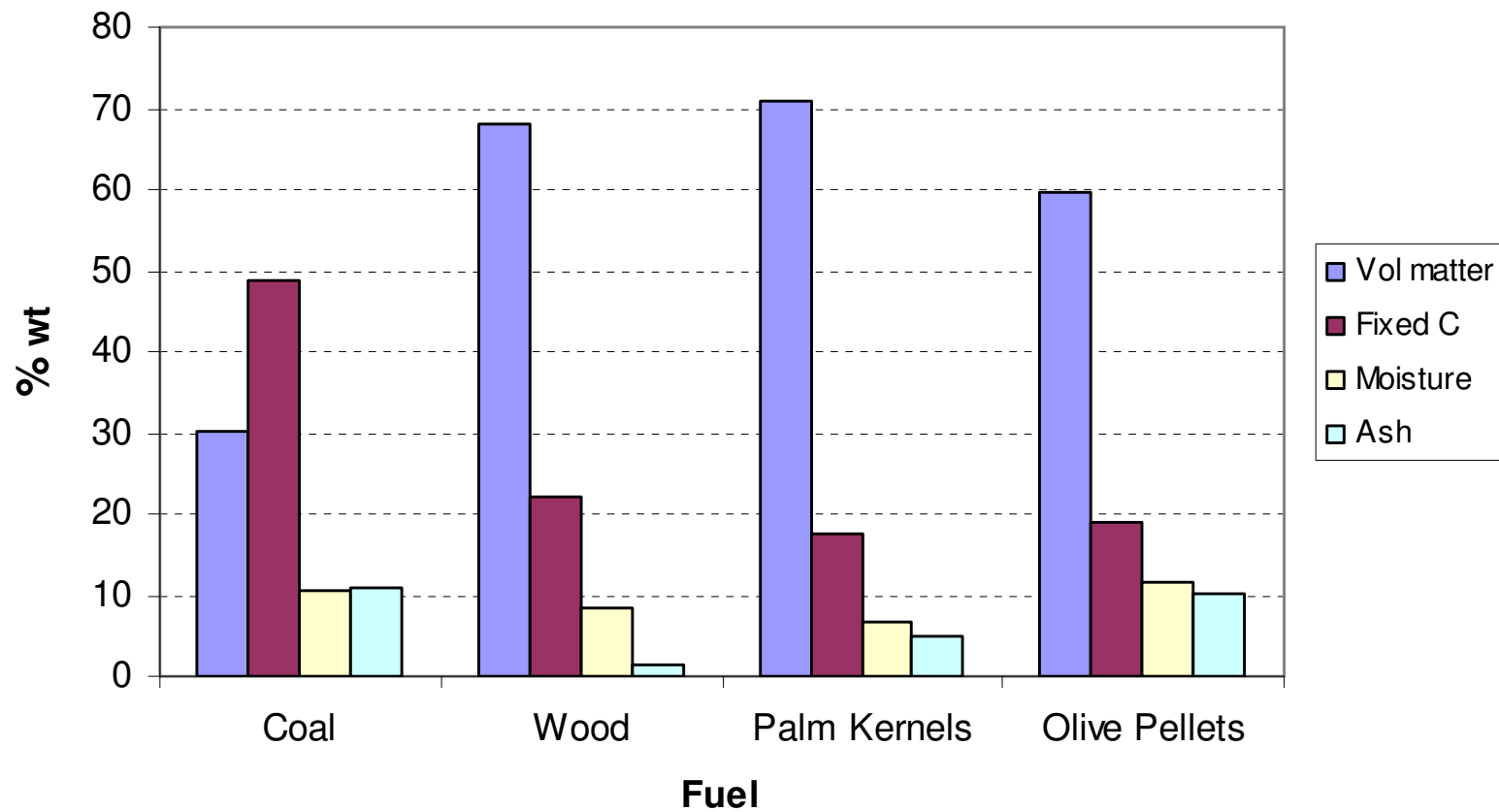


**Coppiced
Willow
~45% H₂O**

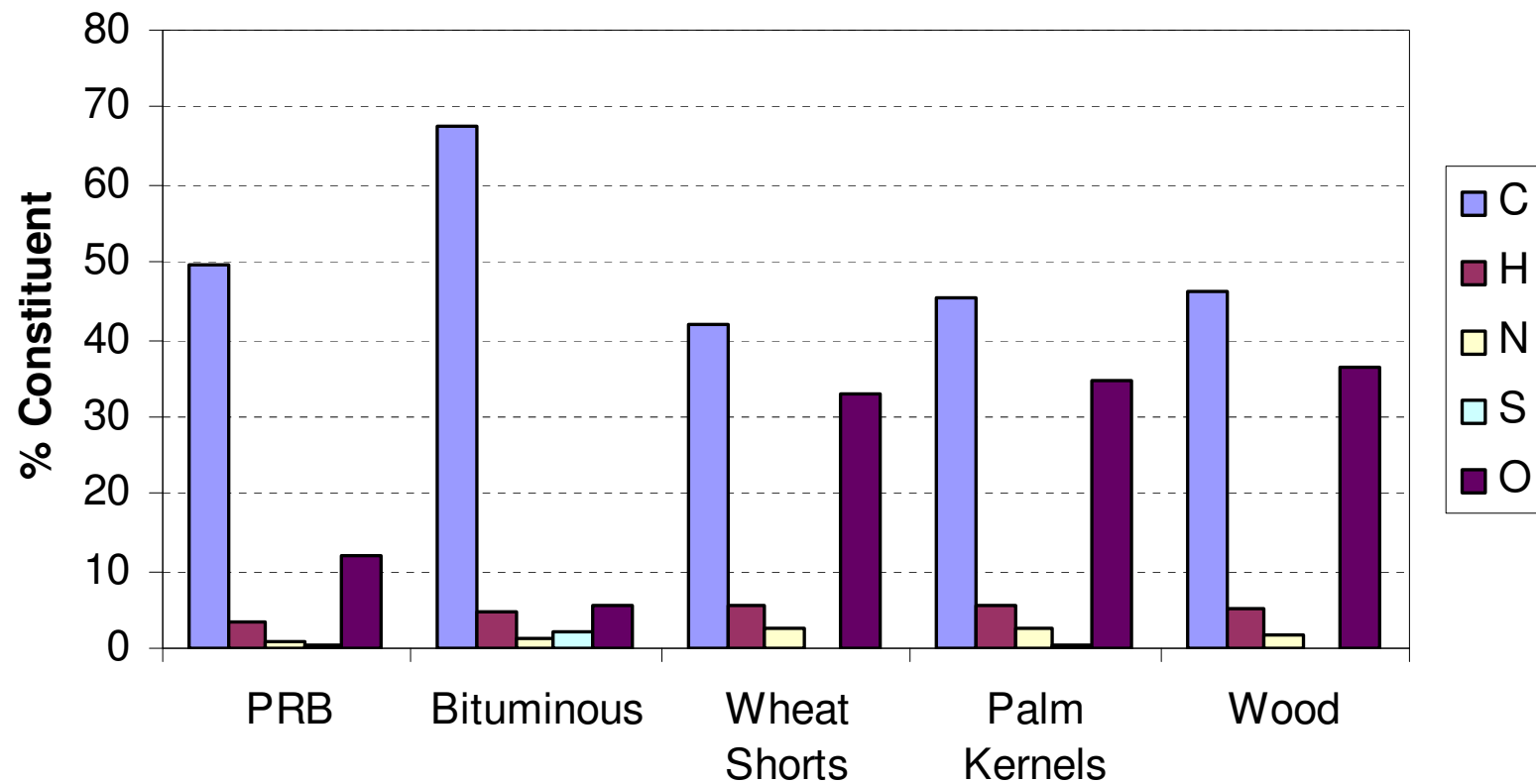
Biomass categories

| Untreated Biomass | Treated Biomass | Cultivated Biomass Energy crops | Residues and Waste- derived Fuels |
|--|--|---|---|
| <ul style="list-style-type: none">> fire wood> forest residues> straw> Palm Kernals | <ul style="list-style-type: none">> wood pellets> Olive pellets | <ul style="list-style-type: none">> Short Rotation Coppice / forestry (Willow / Poplar)> cereals> Miscanthus | <ul style="list-style-type: none">> residues from agriculture & industry> demolition wood> sewage sludge> waste derived fuels, RDF |

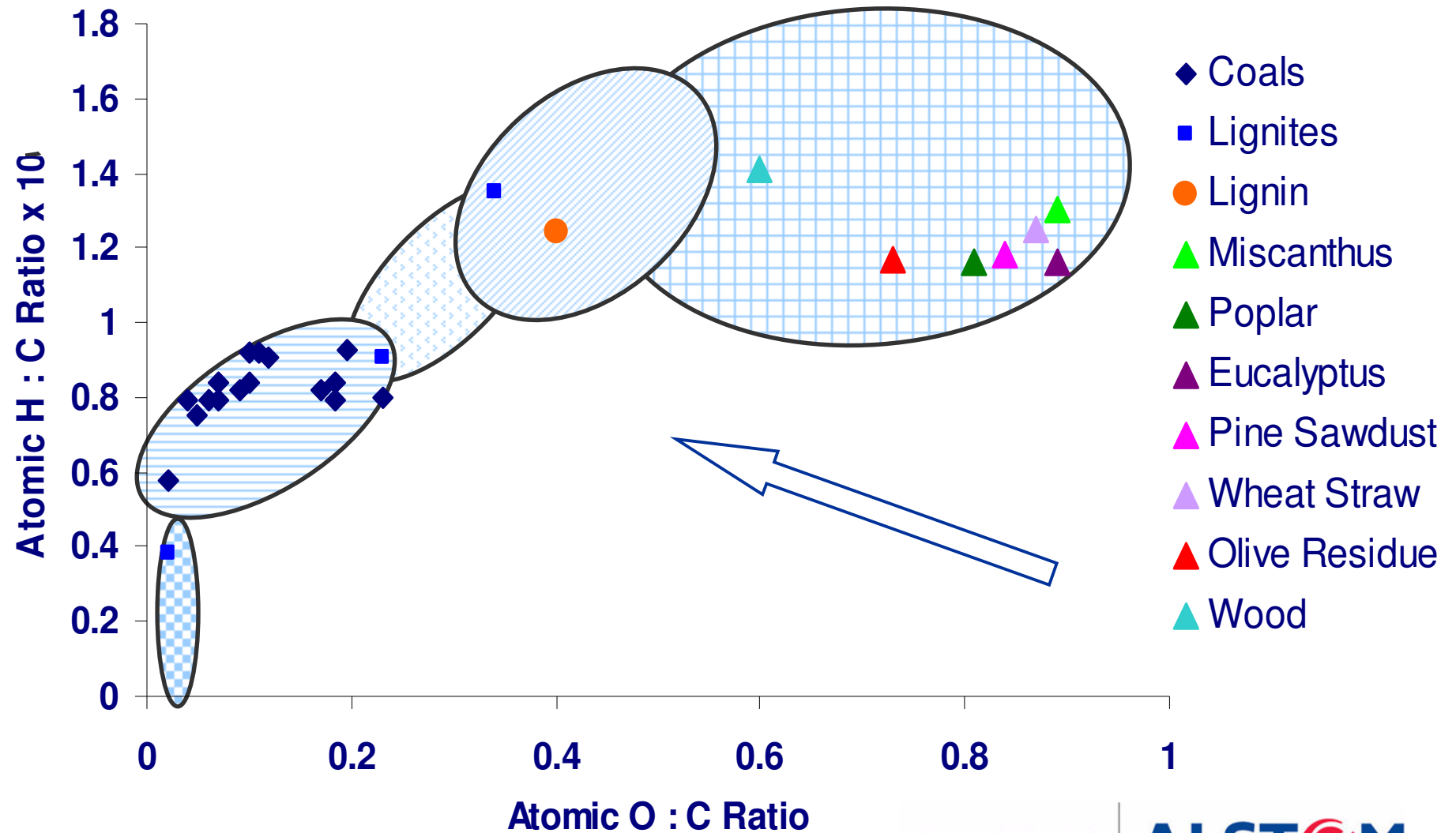
Proximate analysis



Ultimate analysis



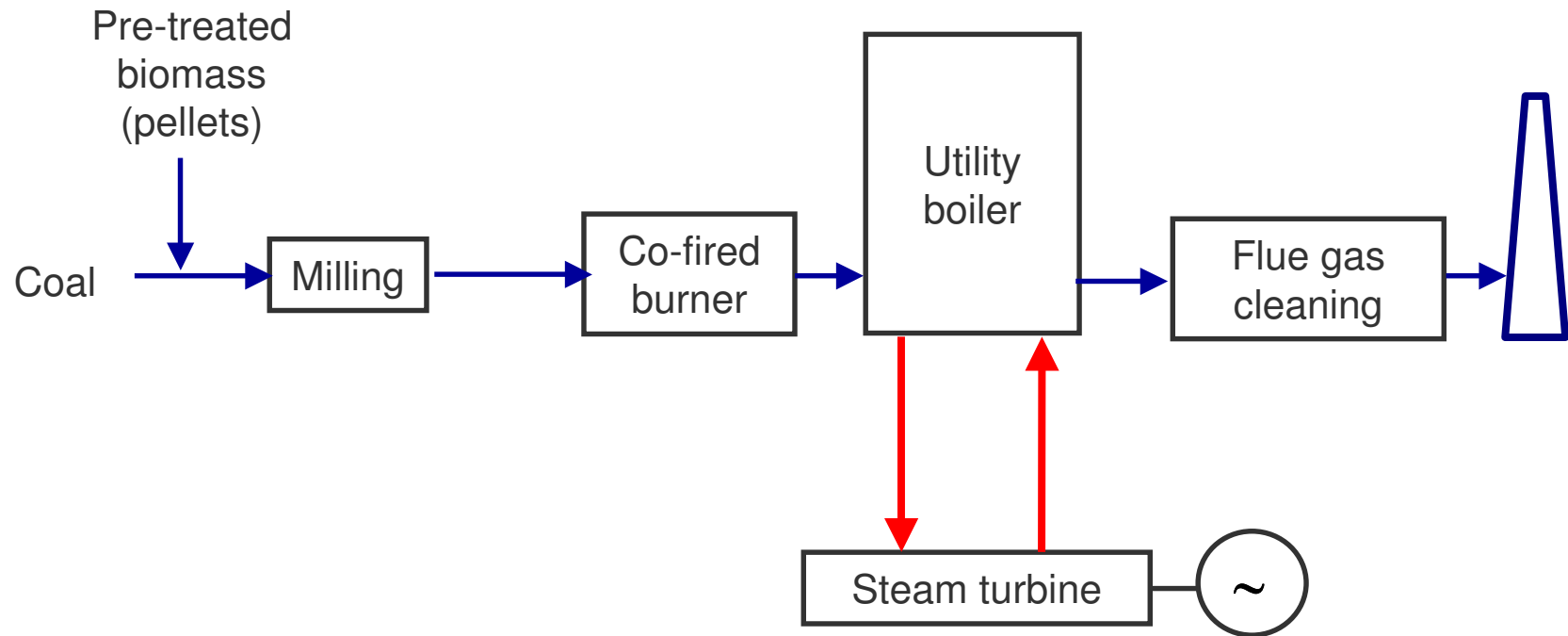
Fuel comparison



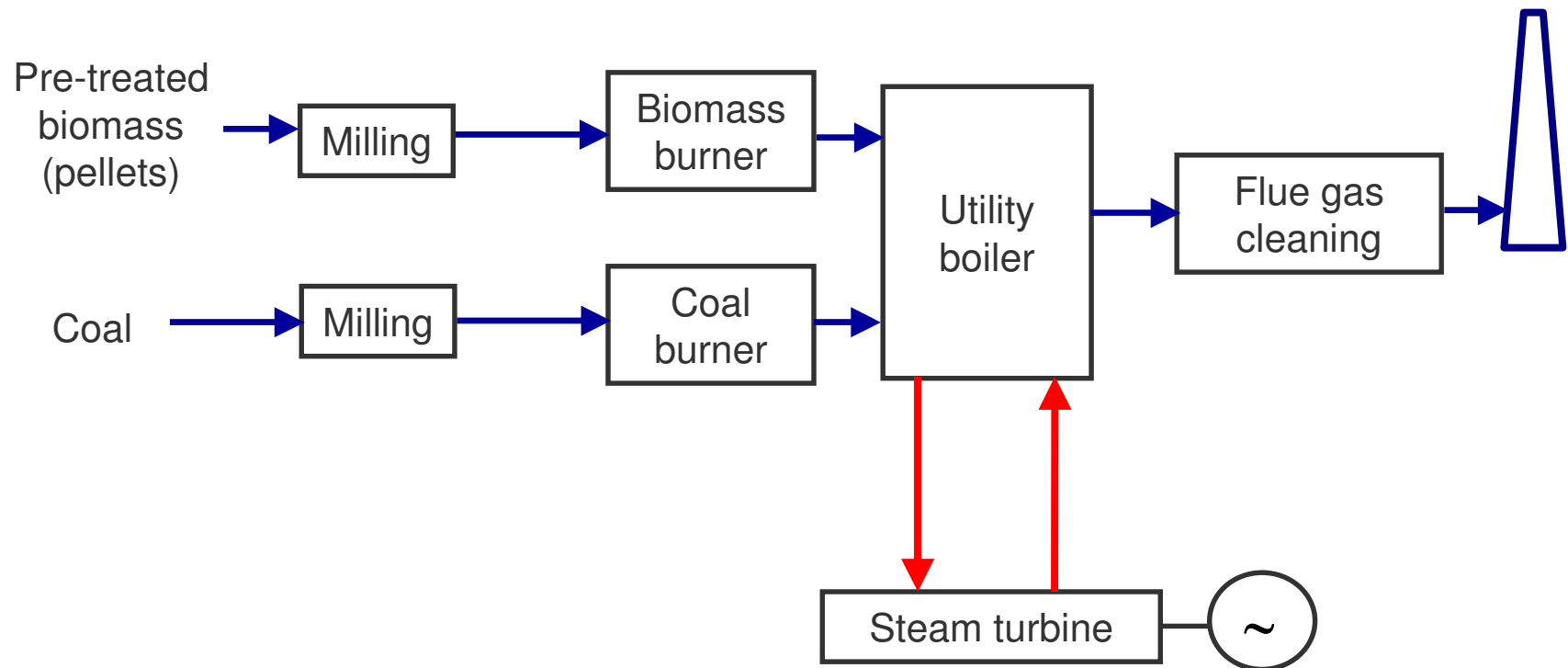
Options for firing biomass

- Co-firing – typically fire up to 10% mass
 - Lowest cost
 - blend 5% to coal yard or on belts
 - Uses existing mills, limits output
 - Stringy material can be problematic
 - Can reduce overall boiler capacity
- Dedicated systems - > 10% by mass
 - More flexible
 - Equipment can be specifically tailored for biomass

Biomass co-milling



Dedicated biomass co-firing



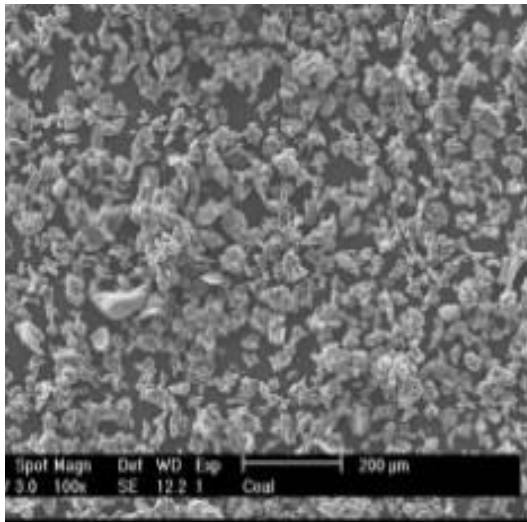
Fuel Variability & Acquisition

| Fuel | Coal | Wood | | Miscanthus | SRC | |
|------------------------------|-------|-----------------------------|----------------|------------------|-------------|-----|
| Form | | Pellets | Roundwood logs | Compressed bales | Wood chips | |
| Bale Weight (kg) | | | | 510 - 540 | | |
| Dimensions | <25mm | <12mm dia, max 50mm long | 100mm, 2m long | 1.2 x 1 x 2.4m | (25 - 50mm) | |
| Average Moisture (%) | 10 | 10 | 45 | 17 | 45 | 15 |
| Density (kg/m ³) | 800 | 600 | 556 | 700 | 300 | 165 |
| CV (MJ/kg) | 26 | 17 | 10 | 15 | 10 | 15 |
| Relative storage volume | 1.0 | 2.0 | 3.7 | 2.0 | 6.9 | 8.4 |

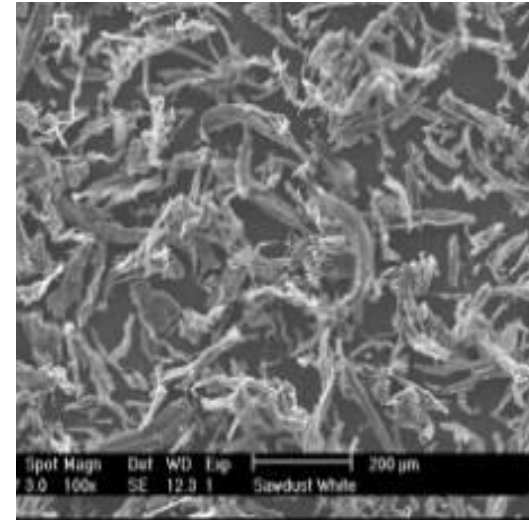
Typical 30MWth Coal-Biomass Flame



Biomass Combustion – Particle Shape

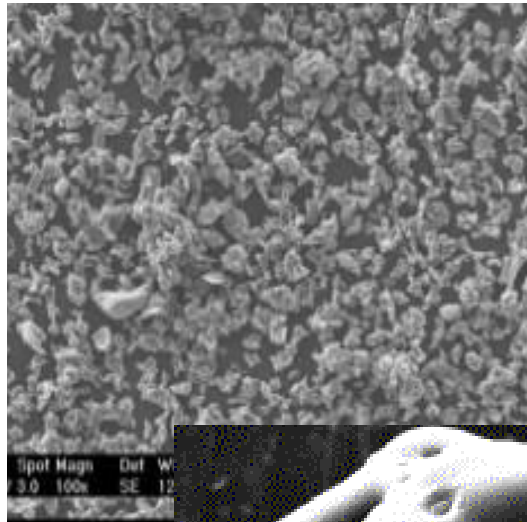


Pulverised
Coal Char

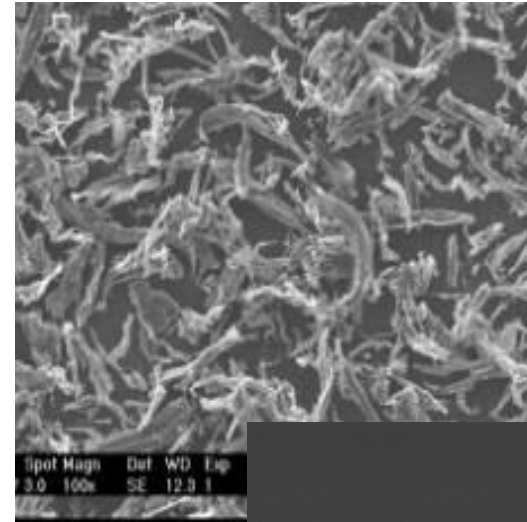


Pulverised
Wood
Char

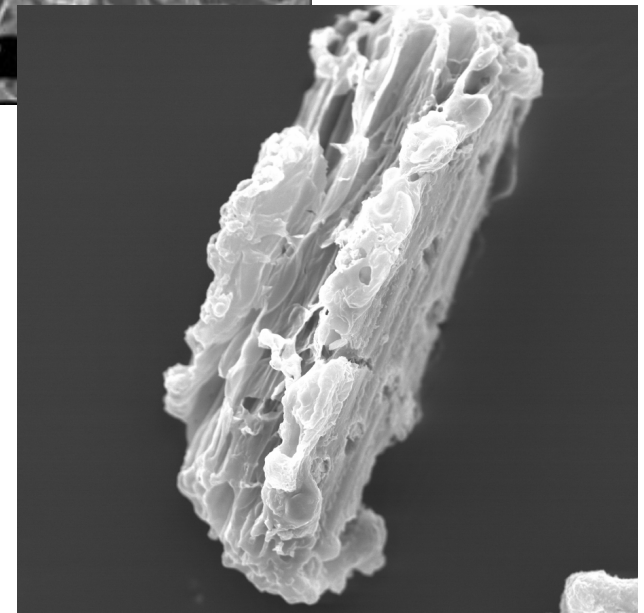
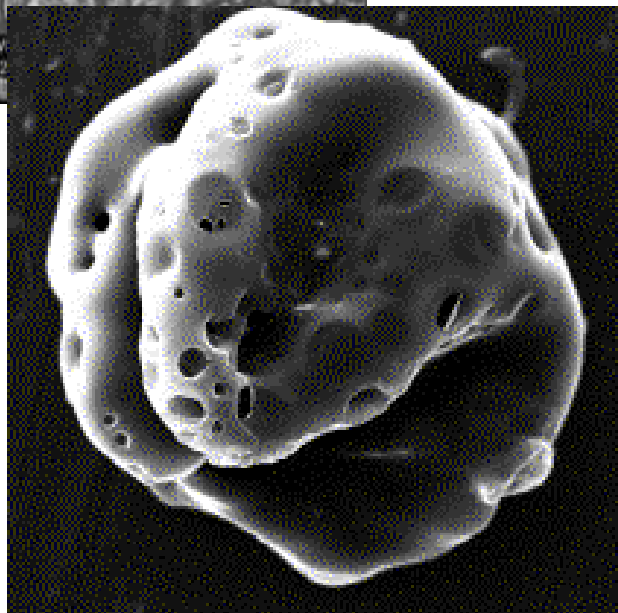
Biomass Combustion – Particle Shape



Pulverised
Coal Char



Pulverised
Wood
Char



Fiddlers Ferry Co-firing Scheme

SSE contract secured March 05

- Design and installation of two dedicated Biomass co-firing systems at SSE's Fiddler's Ferry Power Station on units 2 and 4.
- Commissioned in 1st Qtr 2006, this plant was the first dedicated Biomass Co-firing plant in the UK.
- Fiddlers' Ferry 4 x 500 MWe T-Fired Boilers – ALSTOM OEM
- Plant location – near Warrington, Merseyside, UK
- Fast track project executed in 2 phases
- Phase 1 – 4 month design study, customer engaged at all stages of project development, inc HAZOP
- Phase 2 – (EPC) Engineer, Procure and Construct two dedicated streams of Biomass co-firing, inc civils, mechanical & electrical installation and commissioning

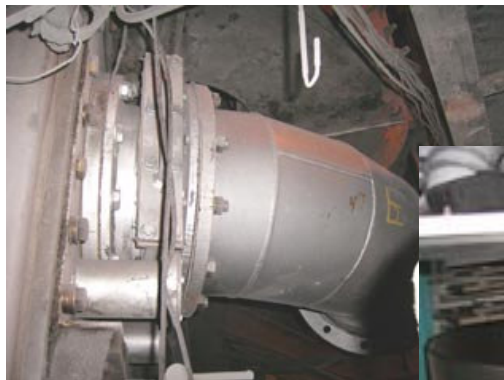
Biomass Co-firing

- **Scope of equipment supply:**
 - material handling equipment –conveyors
 - screens and magnetic separators
 - day storage / silo
 - rotary airlocks and fans

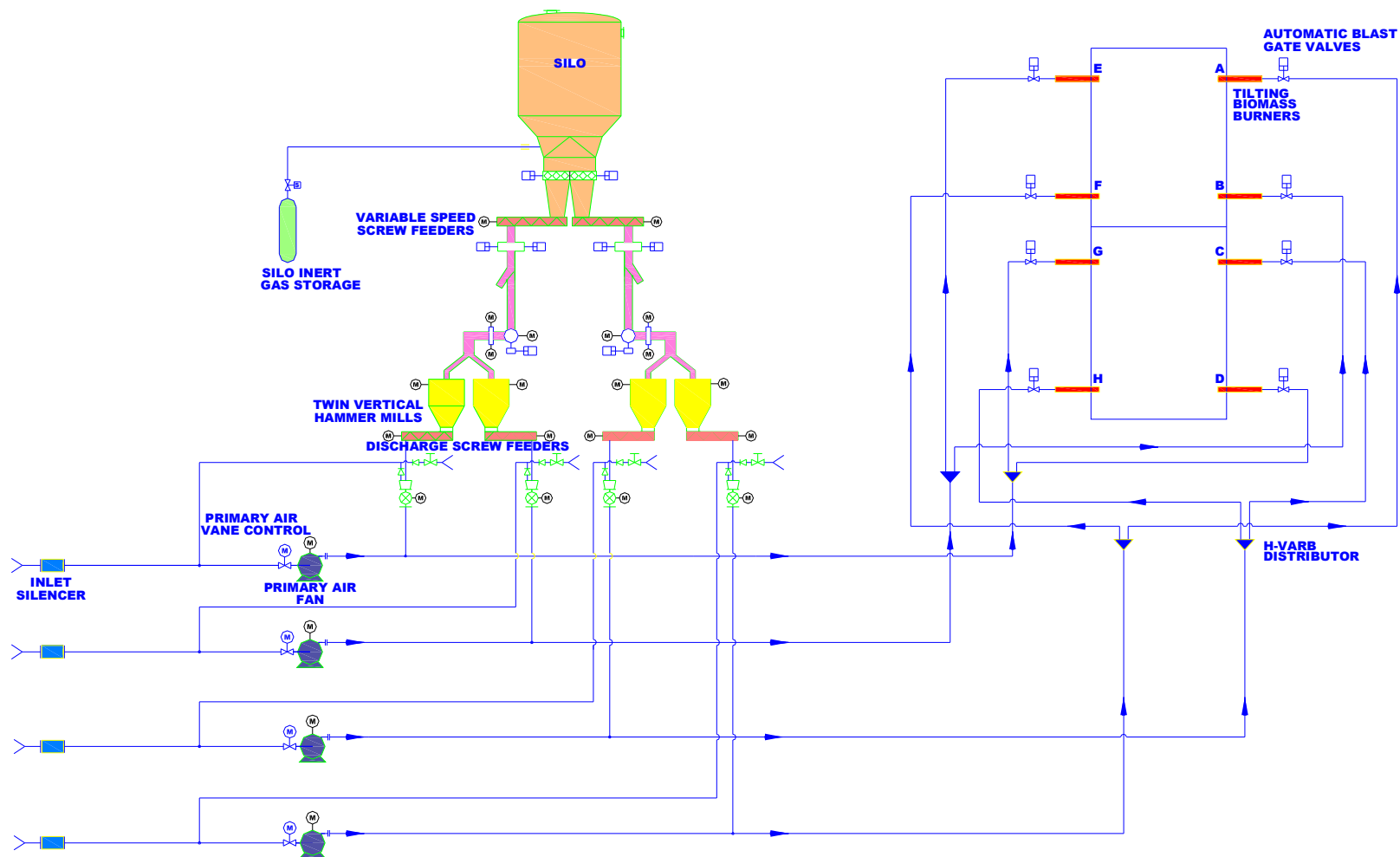


Biomass Co-firing

- **Scope of equipment supply:**
 - comprehensive fire & explosion suppression system
 - dust suppression system
 - screw feeders and hammer mills
 - electrical and fully automated / integrated control system
 - one elevation of 8 biomass burner nozzles and PF pipework



Fiddlers Ferry Co-firing Scheme Fuel Preparation & Supply Equipment



Fiddlers' Ferry Power Station



Fiddlers Ferry Co-firing Scheme



Modular Tower System

- **Tower system incorporates:**

- day storage / silo
- hammer mills and fans



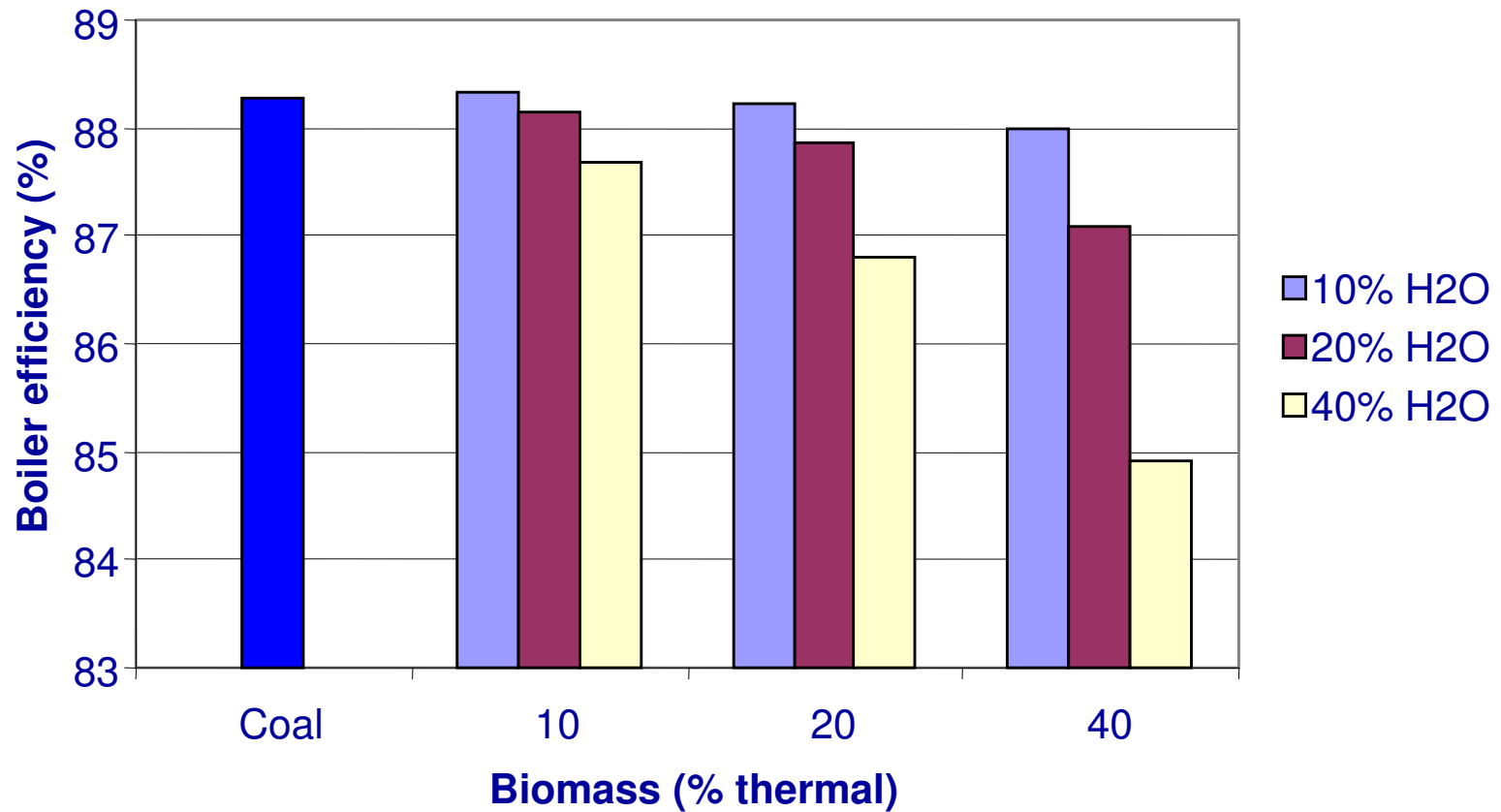
Fiddlers Ferry Co-firing Scheme



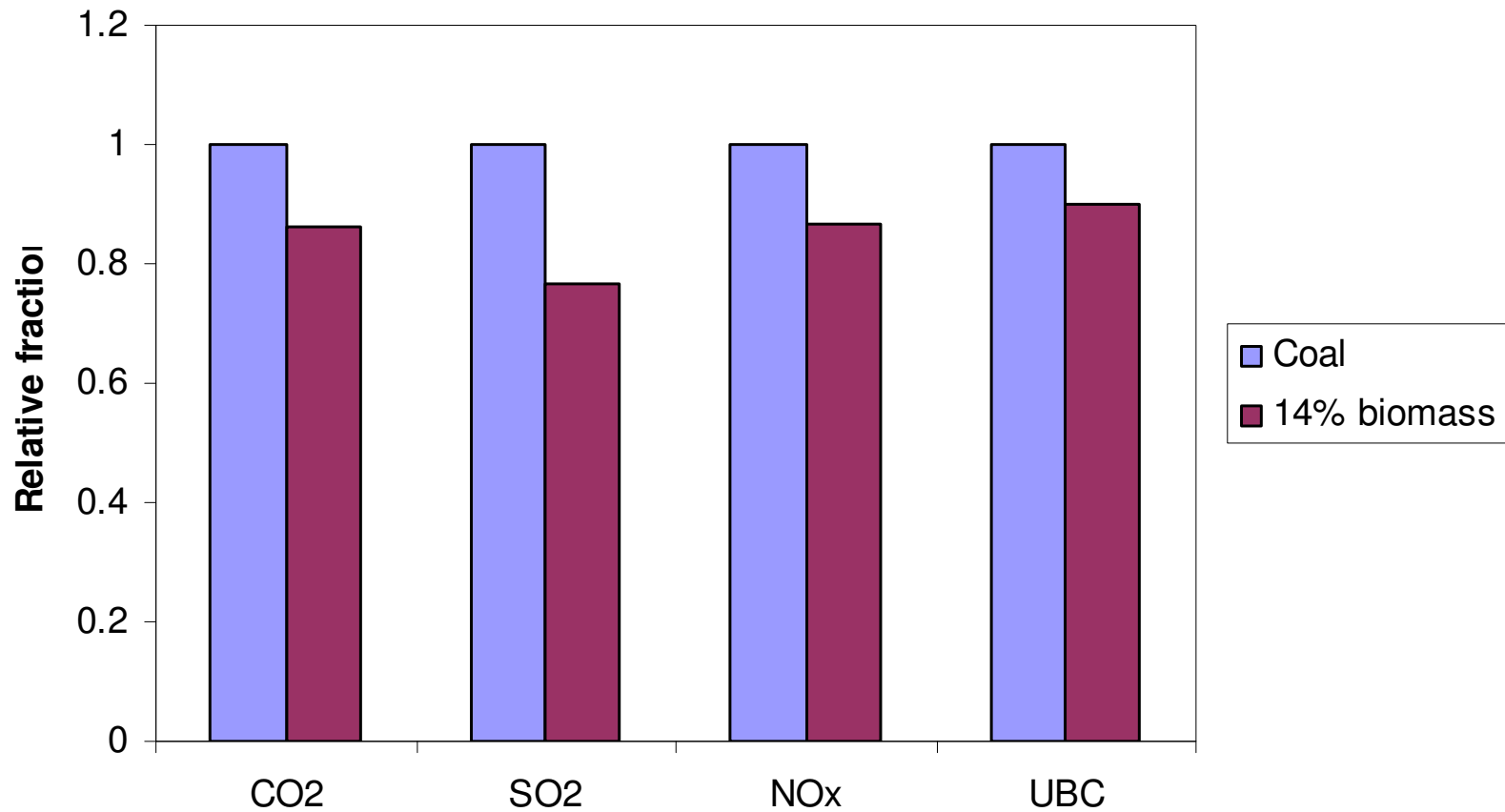
Biomass Co-firing - performance

- Converted unit designed to process up to 20% Biomass heat input basis per unit, equivalent to 100MWe
- Achieved up to 25% Biomass
- Each mill stream capable to process up to 1500 t/day of fuel
- Multi Biomass fuels e.g. wood pellets, palm kernels, olive stones, olive cake <15% moisture
- CO₂ savings per year = 800k t/annum (based on 60% capacity)

Effects on boiler efficiency



Co-firing performance



Summary

- Importance of Moisture content and density
- Biomass fuels contain high volatile content compared to coal allowing larger particle size
- Load / blend ratio limited by existing milling plant capacity for co-milling
- Dedicated systems allows optimisation of milling plant without compromising existing milling plant
- Typically CO₂, SO₂, NO_x and UBC reduction, however values depend upon fuel characteristics
- At Fiddlers Ferry during Nov 06 38kte of bio fuel was successfully burnt
- Fuel trials concur the wide fuel range required can be delivered.

Thank you for your attention

www.alstom.com

ALSTOM