



Variations in woodchip and other fuels used in AFBI Hillsborough biomass boilers

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Wood Biomass fuels used at AFBI Hillsborough

- Woodchip
- Short rotation coppice Willow
- Short rotation forestry Poplar,
- Locally harvested Pine, Spruce and Brash
- Fuels produced on-site and bought in

Other biomass fuels used at AFBI Hillsborough

- Miscanthus (elephant grass)
- Non-wood pellets
- Waste animal feed

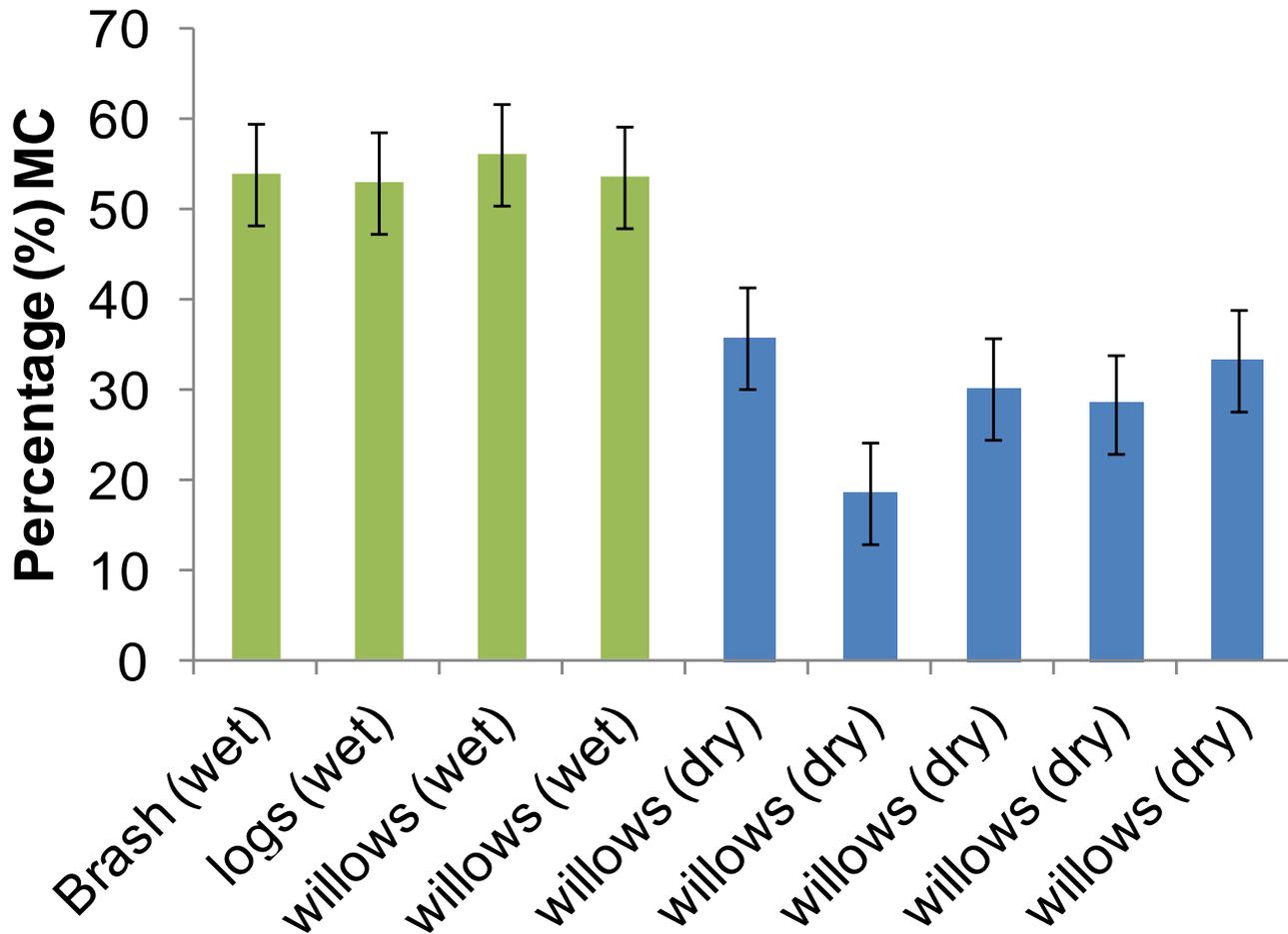
Biomass fuel quality

- Required moisture content range: 20% to 30%
- Fresh (high moisture content)- dried on site
- Dried (bought in)- used direct or dried further
- Maximum fuel size = 50mm diameter
- Fine particles ($\leq 3.15\text{mm}$) less than 20% (by weight)

Moisture content (% MC)

- % MC has varied greatly in wood fuels;
 - Maximum 57.5% (fresh (wet) pine chip)
 - Minimum 17.3 % (chip from 7 month old willow bales)
 - Average fresh (wet) chip ~52% MC
 - Dry (purchased) woodchip ranged 20 to 35% MC

%MC of Wet (fresh harvested) and Dried (purchased) fuels used at Hillsborough



Average %MC

Wet	Dry
51.5	29.2

Biomass fuels

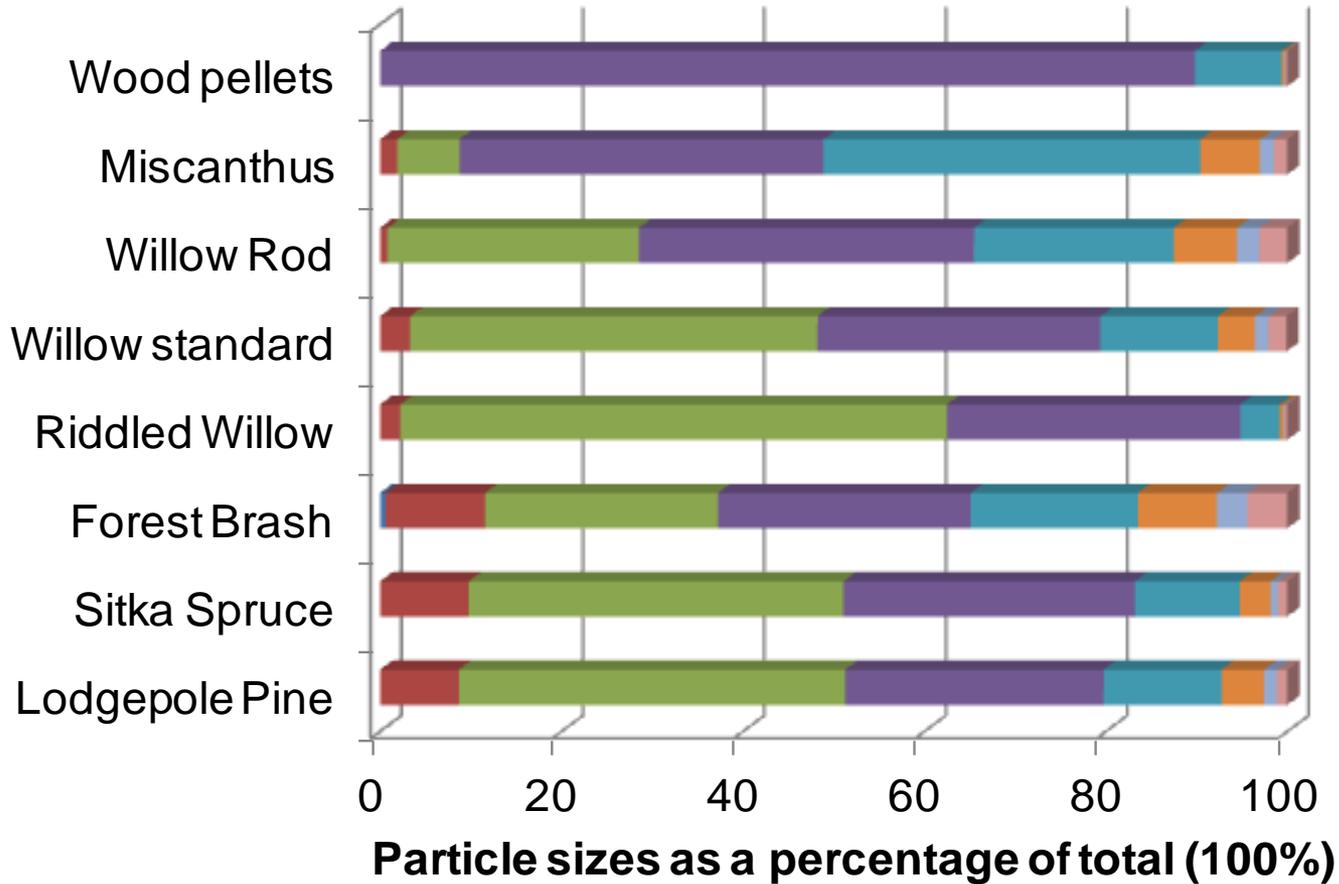
- Overall average MC = 39.2%
- These fuels required further drying
- Two of the dry purchased fuels > 30% MC
- These fuels were further dried to ~25% MC

Particle size determinations

- Particle sizes were determined for all fuels
- Sieve sizes were chosen for;
- Scientific purposes and;
- Compliance with woodchip Quality standards
 - G50 and G30

Particle proportions (%) of 8 fuels

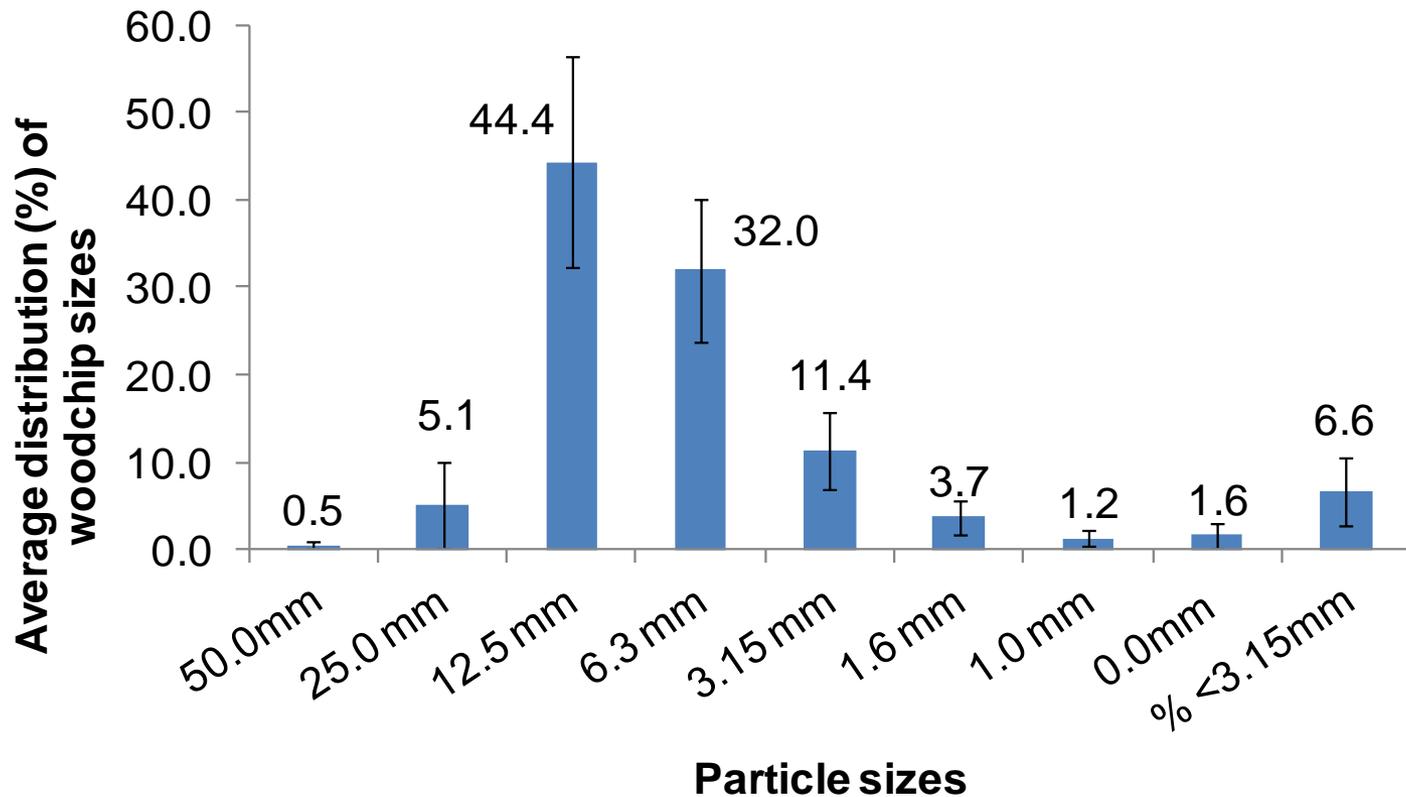
■ $\geq 50.0\text{mm}$ ■ $\geq 25.0\text{mm}$ ■ $\geq 12.5\text{mm}$ ■ $\geq 6.3\text{mm}$
■ $\geq 3.15\text{mm}$ ■ $\geq 1.6\text{mm}$ ■ $\geq 1.0\text{mm}$ ■ $\geq 0.0\text{mm}$



Examples of the 8 fuels



Woodchip- most common particle distributions



Particle size- cause and effect

- Wide differences in particle size distributions
- Type, age and production methods affect these differences- especially chipper type
- A small proportion of fine particles generally aids combustion
- Excess amounts of fine particles can have a negative effect

Quality standards of AFBI fuels

G30 standard	>16mm (<20%)	3mm to 16mm (60% to 100%)	<3mm (<20%)
Brash Average	8.6	78.8	12.6
Woodchip average	10.7	82.8	6.4
SRC willow average	2.9	90.1	7.0
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G 50 standard	> 32mm (<20%)	6mm to 32mm (60% to 100%)	<6mm (<20%)
Brash Average	0.5	72.8	26.7
Woodchip average	0.1	80.8	19.1
SRC willow average	0.0	82.0	18.0

➤ Only Brash failed to meet one quality criteria

Energy content of raw fuels.

- Energy content varies between fuels
- Age & exposure to elements affect energy values
- Typical dry matter (DM) energy ranges;
 - Willows: 17.51 - 21.04 MJ/kg
 - Pine, Spruce: 18.18 - 21.1 MJ/kg
 - Pellets: 19.57 - 20.06 MJ/kg
 - Miscanthus: 15.79 – 21.04 MJ/kg

Average all fuels = 19.43 MJ/kg (DM)

Ash residues from 8 fuel types

	Total Ash	Flue ash	Clinker	Grate ash
	(% of raw fuel)	(% of total ash)	(% of total ash)	(% of total ash)
Pine	0.5	51.4	5.0	43.7
Sitka	0.4	58.7	5.2	36.1
Forest brash	1.0	46.3	13.5	40.2
Riddled willows	1.5	31.5	21.3	47.2
Willow chip	1.1	48.1	4.2	47.7
Willow rods	1.4	52.8	2.1	45.1
Balcas pellets	0.3	45.9	3.8	50.3
Miscanthus	2.7	14.0	48.0	38.1

- Fuel with fines removed produced least flue ash but no less total ash
- Miscanthus- high ash residues due to chemical make up of the plant

AFBI Hillsborough Biomass fuels- General findings

- *All fuels were combustible*
- *%MC & particles influenced energy outputs*
- *Ash residue production varied between fuels*
- *High fines content often produced more fly ash*
- *Woodchip quality standards were acceptable*