BIOMASS FOR BIOENERGY

Pellets Factsheet

What are pellets?

Pellets are obtained from the process of size reduction, drying and compressing biomass into cylindrical shapes (typically 1 cm long). The main purpose of pelletising biomass is densification to optimise handling and transport and to create a product that flows. Pellets are typically used to generate electricity in power stations or to generate heat in domestic wood heaters and commercial furnaces and boilers. Biomass used for making pellets may be derived from forestry or agricultural residues. Forestry residues may include sawmill residues (e.g. sawdust, offcuts) and harvest residues (e.g. small branches) and low-quality small logs for which no other market is available. Agricultural residues may include wheat straw, grape marc, sugar cane bagasse and others.

Global wood pellet markets have grew by 12% between 2012 and 2018, from about 19.5 million metric tonnes (MMT) in 2012 to about 35.4 MMT in 2018. This volume was primarily made up of traditional white pellets, which have a moisture content of 7-10%.

Figure 1: White pellets

An alternative to white pellets are black pellets, which are derived by torrefaction or steam-explosion (SE) processes. In torrefaction, biomass is heated up to 200-340°C in an atmosphere depleted of oxygen. SE pellets are exposed to saturated steam, with the subsequent steam-explosion resulting in a rapid release of pressure causing a breakdown of the wood fibre into very small particles. While white pellets are the main type currently used, black pellets offer significant advantages such as reduced moisture content and higher calorific value, bulk density, energy density and water repellency – reducing losses during storage (Table 1). SE pellets offer the additional advantage of producing almost no dust in handling, reducing explosion risk.

Figure 2: Pellet mills at the Altus Renewables facility in Maryborough, Queensland

One example of a pellet producing facility in Australia is the Altus Renewables plant in Maryborough, QLD (Figure 2), which produces around 120,000 tonnes of pellets from pine sawmill residues for export power station markets.

How are pellets used to generate electricity?

Pellets are used for electricity generation in stand-alone biomass power stations or in coal-fired power stations (co-firing with coal). One example of a large biomass power station fuelled by pellets is Drax Power in the UK (Figure 3), which supplies on average 9.3% of the UK's electricity needs. Four of the six 650 MW units at this facility have been converted to use white pellets.

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	Wood chips	White pellets	Torrefied pellets	SE pellets	Charcoal	Coal
Moisture content (wt%)	30-55	7-10	1-5	4-6	1-5	10-15
Calorific value (LHV, MJ/kg)	7-12	15-17	18-22	19-20	30-32	23-28
Volatile matter (wt%, db)	75-84	75-84	55-80	70-80	10-12	15-30
Fixed carbon (wt%, db)	16-25	16-25	22-35	23-30	85-87	50-55
Bulk density (kg/l)	0.20-0.30	0.55-0.65	0.65-0.80	0.75-0.80	0.18-0.24	0.80-0.85
Vol. energy density (GJ/m^3)	1.4-3.6	8-11	12-19	12-15	5.4-7.7	18.24
Hygroscopic properties	Hydrophilic	Hydrophilic	Moderately Hydrophobic	Hydrophobic	Hydrophobic	Hydrophobic
Biological degradation	Fast	Moderate	Slow	None	None	None
Product consistency	Limited	High	High	High	High	High
Transport cost	High	Medium	Low	Low	Medium	Low

Table 1: Key characteristics of fuels for power generation

At low co-firing ratios of white pellets (~5%), minimal modifications to existing pulverized coal facilities are required. In terms of biomass needs, a level of co-firing of around 5% in one of the 660 MW units at Bayswater Power Station at the NSW Hunter Valley would require approximately 90,000 tonnes of white pellets per annum.

Use of black pellets allows for an increase in co-firing (~10%), also with minimal modifications required. Use of biomass results in lower electricity outputs per unit mass of fuel compared to the use of coal due to differences in chemical composition; the energy content of one tonne of white pellets is approximately 4,800 kWh, whereas the energy content of one tonne of coal is around 6,000 kWh. This difference is reduced with the use of black pellets. However, with modest modifications to the power station, such as adding coal mills and changes to the burners and fuel feed pipes, a higher volume of pellet fuel can be fed to the boiler and thus the power output will be the same as from coal. One of the key advantages of biomass compared to other renewables is that it is a dispatchable energy source. Biomass can play a significant role in long-term stability of the electricity grid, especially when intermittent renewable sources such as solar and wind are deployed more widely.

What are the costs of producing pellets?

The cost of producing pellets is dependent on a number of factors. A typical breakdown of cash flows for a facility producing pellets for domestic consumption suggests that procurement of the fibre is the most costly component, at around AU$60-75 per tonne of pellet fibre produced. Operational costs vary depending on the energy source for drying and the initial moisture content of the feedstock and may range between AU$25-40. Assuming use for local power generation, the costs of moving the pellets from the mill to the power plant may be AU$10-20. An economically viable pellet mill project must typically generate at least AU$26-$33 in EBITDA (earnings before interest, taxes, depreciation and amortization) per tonne produced.

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What are the climate implications of using pellets for electricity generation?

Use of coal and biomass pellets to generate electricity involves combustion, which results in carbon dioxide (CO_2) emissions. However burning biomass emits carbon that is part of the natural, short-term carbon cycle, whereas burning coal releases carbon that has been buried in the ground for millions of years. The release of the carbon from a fossil fuel source has a known negative impact on the climate. The energy generated from biomass is considered renewable, provided the biomass used is derived from sustainably managed systems where the biomass removed is replaced by new growth. In order to ensure the sustainable nature of biomass used for energy generation, it is important that rigorous sustainability governance is in place. Similar systems are already in place for a range of different industries (e.g. certification systems for the timber industry).

The important role that bioenergy is expected to play in climate mitigation is highlighted by the recent IPCC report on mitigation pathways for keeping warming to 1.5°C: the share of primary energy provided by bioenergy increases from 10.3% in 2020 to 26.4% by 2050 across the full range of 1.5°C pathways analysed. A critical element in the fight against climate change is the need to keep fossil fuels underground. This requires significant changes to current production and energy systems. As the IPCC recognises, a mix of renewable energy options that includes the use of biomass for electricity generation is critical to achieve this objective. Further, bioenergy with carbon capture and storage (BECCS) is an emerging technology, which may be deployed in biomass-fuelled power stations, with potential to achieve net negative GHG emissions. There are already pilot projects in place (e.g. Drax power station in the UK, Figure 3).

Figure 3: Drax power station in the UK.

Why is the use of pellets attractive for renewable energy generation in NSW?

- Dispatchable renewable power from use of pellets in power stations – gradually phasing out coal with reduced disruption to regional communities.
- Unique opportunity to combine biomass production and grid-scale electricity generation locally.
- Significant socio-economic benefits by the creation of long-term employment in the various stages of the supply chain (growing and harvest of biomass; transport; pellet manufacture).
- Significant export potential – lowering investment risk.
- Opportunity to grow biomass crops in marginal, unproductive lands or for mine site rehabilitation.
- The presence of pelletising facilities which can process low quality biomass provides a market for biomass that may be generated from natural disasters. such as bushfires and disease outbreaks, whilst assisting with climate mitigation by providing renewable energy.

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What research is NSW DPI doing on pelletising?

NSW DPI has commissioned techno-economic assessments of the feasibility of co-firing biomass with coal in NSW power plants. The assessments include the technical viability of using biomass in key coal-fired power stations at the Hunter Valley and Central Tablelands; the availability of sustainably derived biomass; and the optimum location of biomass-processing facilities. This research also investigates opportunities for greenfield development in areas where biomass is abundant but too far from existing power generation facilities. The research considers technological options for pelletising and uses a Life Cycle Assessment framework to underpin the environmental impacts of generating electricity from varying levels of co-firing with biomass pellets.

This research is aligned with other research under way by NSW DPI which includes assessment of the potential for dedicated biomass crops in marginal, unproductive land; options for biomass handling and storage; the potential for electricity generation from hybrid solar-biomass power stations; the contribution of biomass to a 100% renewable electricity grid; and the social impacts on regional communities of large-scale bioenergy projects.

Potential impacts of the research

- Investors and energy providers will have greater confidence in the business case for the manufacture and use of pellets for electricity generation in NSW.
- NSW government decisions around renewable energy will be informed by robust scientific evidence.

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References

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