What technologies can be used to produce energy from wood waste?

National Association of Forest Industries

Wood Waste Bioenergy Information Sheet No. 10

New technologies are improving the prospects of using wood waste from timber harvesting and timber processing plants for efficient, small and large-scale renewable energy production. By promoting the use of wood waste, these new technologies will allow the timber industry to deliver some permanent replacement of fossil fuels, in addition to providing environmental and economic benefits.

If a larger proportion of the timber processing wastes were used to generate renewable energy instead of ending up in landfill or burnt without any energy production, Australia's total greenhouse gas emissions would be lower and forestry and timber companies could reduce their costs of waste disposal.

How much power can be generated from wood waste?

The amount of energy produced from one tonne of wood waste will depend on the energy conversion technology employed and the scale of the operation[1]. However, in general terms for electricity generation, each tonne of dry wood waste (which is equivalent to approximately 2 green tonnes of wood waste) can generate between 0.9 and 1.3 MWh of electricity[1]. Alternatively, to produce 1 MWh of electricity it takes between 0.75 and 1.1 dry tonnes of wood waste[3].

How do we turn wood waste into electricity?

Numerous technologies are currently available for generating energy from wood waste. The six most widely-used technologies are:

Direct combustion of biomass – Direct combustion is the process used by over 90% of the world's bioenergy plants. Boilers are designed to utilise heat transfer from the processes of radiation, conduction and convection. In general, the hot gases derived from burning the biomass flow over a set of tube banks, heat the water in the tube banks to produce steam, with the steam driving a turbine to generate electricity.

This is an extension of the technology used by many mills where wood waste is used to produce heat and steam for drying or to operate fibreboard presses. By adding a steam turbine to the direct combustion processes, these mills could also produce electricity to be used on site or sold into the grid.

Key Points:

- *A broad range of energy conversion technologies can be employed to provide renewable energy from wood waste[1]:*
  - *Direct combustion*
  - *Co-firing with coal or bagasse*
  - *Pyrolysis*
  - *Gasification*
  - *Pelletisation and briquetting*
  - *Production of liquid fuels.*
- *Around the world, over 90% of commercial renewable energy generation is associated with combustion or co-firing[2].*
- *A broad range of capital costs are associated with each of these technologies and apart from direct combustion or co-firing, a significant level of research is required before the other technologies become commercially viable[1].*

Co-firing – Co-firing is the combustion of wood waste with coal and/or bagasse (from sugar refineries) to generate electricity. Wood waste can be supplied in multiple forms – woodchips, wood gas (from gasification) or bio-oil (from pyrolysis). In its most simple form, the capital costs of co-firing coal and wood waste may be as low as $200,000 per MWh[4].

Pyrolysis - The heating of wood waste in the absence of oxygen in a controlled environment to produce varying quantities of oil, gas and charcoal. The gas can be burnt to produce electricity and the bio-oil can be used as a chemical feedstock or as a substitute for diesel fuel in stationary power generating plants.

Gasification - The heating of wood with a small amount of oxygen under conditions that turn a high proportion of the wood into a gas. It is a high efficiency process and some early commercial applications of this technology are now available. Some technical difficulties associated with the integrated combined cycle gas power plants are still to be overcome. However, it is possible to use the wood gas for co-firing in coal furnaces.

Pelletisation / briquetting - Engineered fuels such as pellets and briquettes are made by compressing fine wood particles and resinous compounds in the presence of heat to produce small blocks that can be co-fired in coal fired power stations or used directly in home heating units. Over a million tonnes of wood pellets are produced in Denmark each year as a commercial and home heating resource[1], and over 300,000 tonnes per annum of wood pellets are used in a Copenhagen energy plant (the Avedore 2 CHP plant)[2].

Chemical-biological production of liquid fuels - Production of liquid fuels, such as ethanol, from wood waste is based on a series of chemical reactions and biological processes that convert wood into chemically-simple sugars and then into ethanol. No commercial applications of this technology are currently available.

Capital investment costs

Each of these technologies can be used to generate renewable energy under different circumstances, from small-scale production in rural or remote areas where the cost of electricity is high, through to large-scale power generation.

The relative capital costs of these technologies for producing electricity are provided in the table below[5]:

Technology	Capital cost per $m/MW installed capacity
Direct combustion	1.5-2.5
Co-firing	0.2-0.7
Pyrolysis	3-5
Gasification	2.5-3.5

How much wood waste would it take to meet the needs of an average home?

Each dry tonne of biomass fuel can produce around 0.9 to 1.3 MWh of electricity. Australia has around 3 million dry tonnes of wood waste potentially available each year, which could be used to generate clean, green power[6].

It is therefore possible that just 35 kg of wood waste per day (less than 6.5 tonnes of dried wood waste per house per year) would be enough to meet a typical household's average electricity demand, based on the average household electricity consumption of 7MWh/annum[7].

By effectively utilising one third of the total wood waste resources already available, Australia could produce enough electricity for over 400,000 homes, and reduce the nation's greenhouse gas emissions by 2 million tonnes per annum[8].

1. Report 4 – Converting wood waste into renewable energy – a summary of biomass energy conversion technologies.
2. Schuck (2005) Bioenergy technology status and development, Bioenergy Australia Conference (Melbourne).
3. Cowie (2005) Greenhouse gas balance of bioenergy systems based on integrated plantation forestry in northeast New South Wales, Bioenergy Australia Conference (Melbourne).
4. Report 4 – Converting wood waste into renewable energy – a summary of biomass energy conversion technologies (p.14). IEA Bioenergy (2005) Co-firing biomass with coal: a success story.
5. Report 4 – Converting wood waste into renewable energy – a summary of biomass energy conversion technologies (Appendix A).
6. Fung, Kirschbaum, Raison and Stucley (2002) The potential for bioenergy production from Australian forests, its contribution to national greenhouse targets and recent developments in conversion processes, Biomass and Bioenergy 22: 223-236; Report 3 – potential wood flows, technical and scale issues and identification of sustainable management criteria.
7. Country Energy Website (2006). Calculation of wood waste requirements per household: average household consumption of electricity = 7MWh per annum; 2 tonnes of green wood waste produces 1.1MWh of electricity; 12.7 tonnes green wood waste (or 6.5 tonnes green wood waste) produces 7MWh of electricity = 17.8kg green wood waste (or 35kg dry wood waste) per household per day.
8. The Review of the Renewable Energy (Electricity) Act 2000 (National Association of Forest Industries and Australian Forest Growers, 2003) submission into the review of the Renewable Energy (Electricity) Act 2000.

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