Biomass energy from wood (woody biomass) is a clean and renewable energy source. Because fossil fuels are likely to become increasingly expensive, woody biomass can play an important role by providing energy in the form of heat, electricity or transport fuels.

Image courtesy of EnergyInfo

The concept

Woody biomass is a term used to describe wood, wood residue and by-products, and dedicated, fast growing trees, bushes and shrubs. Woody biomass has been used by humans as a source of energy in a relatively simple way, namely fires for heat and light, for thousands of years.

While this simple use remains popular, woody biomass can also be utilised as a source of energy for larger-scale commercial and industrial applications.

Why use wood for energy?

Woody biomass is effectively a store of solar energy. During tree growth, energy from the sun is captured using the process of photosynthesis. The wood stores this energy in the form of cellulose, a form of carbohydrate.

As a renewable energy source that can be grown and used sustainably, burning woody biomass has almost zero net greenhouse effect as the carbon dioxide given off during combustion is absorbed by the growth of the next crop of woody biomass.

Woody biomass can be used to generate heat and electricity, and can also be converted into liquid fuels similar to petrol and diesel. When used as a substitute for fossil fuels (coal, oil and gas) woody biomass reduces the amount of greenhouse gas emissions produced by New Zealand.

Using woody biomass can also be very cost effective, particularly when the wood residue being used is a by-product of an existing process. It can often be used to provide some of the energy for the production process itself.

Growing and harvesting woody biomass

Woody biomass is available from three main sources:

- **Wood residue**
  Small branches, thinnings, tops of trees (arisings) and other stemwood from harvested trees.
- **Wood processing residue**
  Bark, sawdust, shavings and off-cuts from processed wood such as panel board, construction timber and furniture.
- **Woody crop plantations**
  Short rotation crops grown specifically for energy purposes, possibly combined with the recycling of sewage and industrial effluent.

Wood residue results primarily from the harvesting of timber. In many plantations whole tree harvesting systems are now becoming common. The trees are felled, then skidded (dragged) to a central landing for processing. Arisings from tops and branches are gathered together rather than being scattered over the forest floor, and are easily collected for shredding into chips for use in a nearby wood-fired heat or electricity generating plant. This is already happening in some forests in the central North Island where the processed wood residue is delivered to large heat plant at pulp mills. The practice is expected to become more widespread as fossil fuel energy costs increase.

Image courtesy of EnergyInfo

Wood processing residue is a by-product of timber processing. This includes timber milling, and processes such as producing plywood and pulp and paper manufacturing.

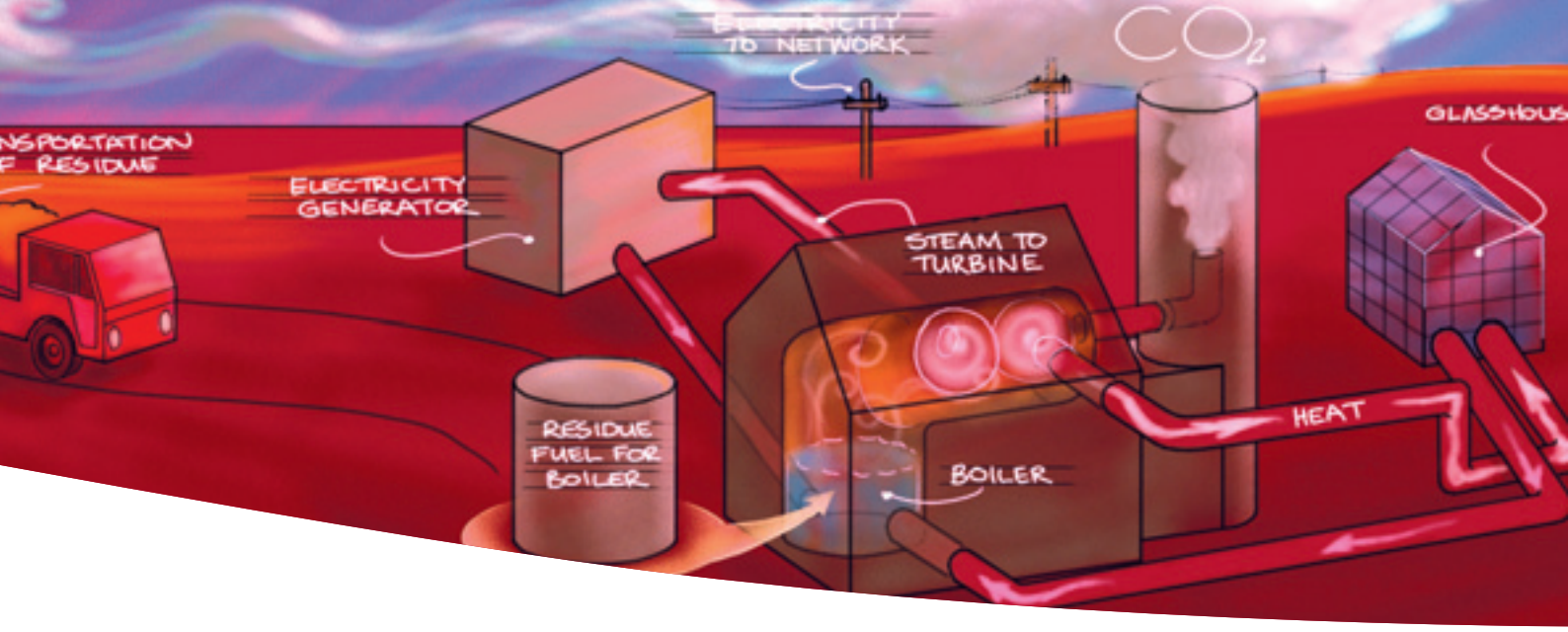
Woody crop plantations are specifically grown as energy sources. The species of trees are often chosen because of their 'coppicing' capability, meaning that they sprout from the cut stump. Species especially selected for local conditions can grow rapidly and are ready for harvest in four to eight years. After harvest, the site can be replanted or the stumps left to regrow. The coppice sprouts soon form three or four dominant stems which are ready for harvesting again within another four to eight years. For some species, this can be repeated several times before replanting becomes necessary.

Purpose grown short-rotation energy forests can also be combined with waste water disposal, as sewage and waste water from food processing factories and farms contain nutrients that can accelerate tree growth. Irrigating energy forests with this waste water helps avoid pollution of groundwater or waterways.

The potential for using woody biomass in New Zealand

In principle, woody biomass can be used as a substitute for coal, gas or oil in many energy supply applications.

In 2004, wood provided 6% of New Zealand's total energy needs in the form of heat for industry, firewood in our homes, and a small amount of electricity generation. However, our use of woody biomass has the potential to increase to 8% by around 2010 as plantation forests now reaching maturity are harvested and processed, making more wood residue available. Although woody crop plantations are common overseas, and have good future potential in New Zealand, it is expected to be some years before purpose-grown trees are planted on a large scale in New Zealand.



Conversion to usable energy

Converting wood into usable energy can be achieved using a number of alternative conversion processes.

- **Domestic heating**

  The efficiency of open fireplaces for domestic space heating is only around 20%. The high levels of air pollution emissions and low efficiency have led some local and regional authorities, such as those in Christchurch and Nelson, to ban open fires. They are now being replaced by low emission wood burners which, as well as providing about 70% efficiency, also meet air quality guidelines.

  New wood burners designed to burn wood pellets for heating are increasingly used in public and commercial buildings. These pellet burners are up to 86% efficient and are clean burning with low air pollution emissions. The wood pellet fuel is made from wood residue and sawdust waste.

- **Industrial heat**

  Wood-fired boilers and heat plant that produce either hot water or steam typically provide around 1 to 10MW (megawatts) in heating capacity, and are common in the wood processing industry. The steam can be used for drying and processing as well as for electricity production via a steam turbine. When both are done together this is called 'co-generation', and is sometimes referred to as a combined heat and power (CHP) plant.

  Improvements in efficiency are ongoing, and include cleaner burning boilers, reduced handling costs and overcoming problems with ash deposits.

  Co-firing woody biomass with coal is an effective way of replacing a portion of fossil fuels used, and minimises the cost of heat generation. It also provides security in case of a shortage of one source of fuel.

- **Other uses**

  A variety of other wood energy conversion processes are being evaluated. They include chemical processes to produce organic oils and gases, as well as transport fuel. None of these projects are yet at the commercial stage in New Zealand, but all have been shown to work overseas.

  Another conversion process is a wood gasification system, which researchers worldwide are continually developing. The woody biomass is turned into hydrogen, carbon monoxide and other gases, which can then be used to generate electricity by powering efficient gas turbines and diesel engines. Limitations at present include high costs and challenges in producing sufficiently clean wood gas.

The economics

As with any renewable energy source, the cost compared to non-renewable energy sources is crucial.

- **Residential**

  Firewood can vary in cost. For example collecting driftwood and wood residue from a local river bank or the backyard will minimise cost, while wood purchased in a city already cut, split and bagged will be expensive. Firewood bought from a local retailer and burned in a modern wood burner might supply heat at around 5 to 10 cents per kilowatt hour (c/kWh)[1] compared with the average retail electricity price of around 15 c/kWh. When considering the comparative costs of home heating, the capital cost of buying and installing an efficient wood burner, at around $1,800 to $2,800, must also be taken into account.

- **Industrial**

  On the larger industrial scale, heat supplied from wood fuel can range from 9 to 11 c/kWh. Wood residue ranges from zero cost where it is free on-site (or in a small number of cases where using the residue saves the cost of disposal) to more than the delivered price of coal. In most cases the transport cost, if any, is most significant, but the possible cost of converting existing equipment to utilise wood waste also needs to be considered.

  The cost of supplying fuel wood from forest arisings and short rotation forest plantations varies widely, depending on the harvesting, collection, transport and processing systems used. The distance that the residue needs to be transported before it is used tends to affect the economics the most.

  Liquid fuels such as ethanol and synthetic petrol or diesel can be produced from wood residue, but the processes are not yet commercialised, and costs are not yet known. The future potential for ethanol could be good given the increasing use internationally of ethanol-petrol blends.

  Electricity can be produced from woody biomass, but the process requires additional and often costly steam-turbine plant. This results in electricity generation at an additional 5 c/kWh on top of the heat cost. While the average electricity retail price remains around 15 c/kWh, wood-fired electricity generation will not be economically feasible unless also utilising the waste-heat through a co-generation system. These cost relativities are expected to change with the introduction of the carbon tax in 2007, and electricity generation is expected to become economic by the end of the decade.

1. Cost depends on region and proximity to firewood supplies.

Constraints to be addressed

In some situations, collection and processing costs are too high to warrant extraction of wood residue. Collecting and transporting bulky woody material from a forest is often expensive compared with using coal or natural gas.

Traditionally, harvesting trees in a forest would leave behind large volumes of woody biomass in the form of branches, tops and damaged stemwood pieces, which would eventually rot and provide nutrients for subsequent crops. If all this woody biomass is used as an energy source, the removal of nutrients in some regions could eventually reduce the soil fertility to an unacceptably low level. Spreading nutrient rich wastewater over the land could overcome this problem.

New Zealand coppicing energy forests have low economic land-use value compared with land used for growing food, timber or paper products. To keep costs down, energy forests must be grown with minimal applications of agrichemicals, fertiliser or irrigation. It is necessary to consider which tree species are best able to compete with weeds, resist pests and diseases, grow rapidly and produce biomass ideally suited for conversion to useful forms of energy.

Image courtesy of EnergyInfo

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Case studies

- A sawmill in the South Island adapted its 3MW coal boiler so that it could operate on wood residue as well as coal. Using only wood residue in the boiler saved $105,000 worth of coal a year, and saved $45,000 off the cost of disposing of wood residue in a landfill, giving an annual total saving of $150,000.

  The sawmill produced enough wood waste residue to meet the demand for heat in their wood drying kiln. When they expand their wood drying department they can supplement the wood residue with some coal.
- Replacing their gas boiler with a wood fuelled boiler to produce heat for timber drying enabled another company, Pan Pac Forest Products Ltd, to solve two problems at once. The new $18 million boiler met their increased energy needs and also used wood waste for which they would otherwise have had to find more landfill space.

  Pan Pac's project uses leading edge technology and meets increased energy demand in a sustainable way. We will see more of this technology in the future as wood processors look for sustainable solutions to their energy demands.

This fact sheet was produced by the Energy Efficiency and Conservation Authority (EECA). EECA is a Crown entity implementing the National Energy Efficiency and Conservation Strategy through improving energy choices.

For more information about EECA, the renewable energy target, and links to other information sources visit: **www.eeca.govt.nz**

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