



Firewood and Woody Biomass and their Role in Greenhouse Gas Reduction

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This note summarises some of the current research on the use of firewood and other woody biomass as an energy source to help reduce greenhouse gas emissions.

Introduction

About 11% of the world's energy comes from biomass; about half of this being wood. For approximately half of the world's population, wood or other biomass is the main source of energy, (IEA Bioenergy).

Burning of fossil fuels is a major cause of increasing atmospheric CO₂, which in turn is a major cause of global warming, (climate change). Burning firewood also releases greenhouse gases during combustion. However, burning firewood that has been grown in sustainable wood production systems can significantly reduce greenhouse gas emissions, compared to emissions from non-renewable energy sources. This is because unlike fossil fuels, biomass is a renewable resource and the CO₂ released from burning biomass can be re-sequestered in subsequent rotations.

Wood as a carbon sink

Tree plantations and sustainably managed forests can be efficient absorbers of carbon. Where they are grown and harvested, then regrown again in a continuous cycle, they essentially reabsorb the same amount of carbon that was released during and after the harvesting phase. This results in a cycle of carbon release and absorption, in a virtually carbon neutral process (minus the greenhouse gases released during the harvesting and transport stages).

When trees are harvested they have the added benefit of producing forest products that continue to store carbon in products such as timber and paper. Trees also store carbon in soils and in their roots acting overall as a "carbon sink". Recent work has shown that between 3.5 and 4.9 tonnes of carbon/ha/yr can be sequestered in the live biomass of plantations of sugar or spotted gums in regions where mean annual rainfall is between 500 and 750 mm (Paul, Jacobsen et al. 2008).

Over time, trees and forests that are left to grow free from disturbance from fire or harvesting, will reach equilibrium in terms of the amount of carbon they capture and the amount they release through death and decomposition.

How firewood works as a carbon sink

When used to generate energy, fossil fuels such as oil, coal and natural gas release carbon as carbon dioxide from sources that have taken millions of years to accumulate. They cannot be replenished in anything less than geological timescales. As we extract and burn fossil fuels we increase the levels of carbon dioxide in the atmosphere in what is, essentially, a one-way trip.

If wood is burnt to produce energy it usually displaces fossil fuels. Sustainably managed forests and plantations that are regrown have a dual benefit:

- they are effectively carbon neutral.
- the wood biomass used to generate energy eg. firewood, eliminates the greenhouse gas emissions that would have resulted from the alternative of burning fossil fuels.

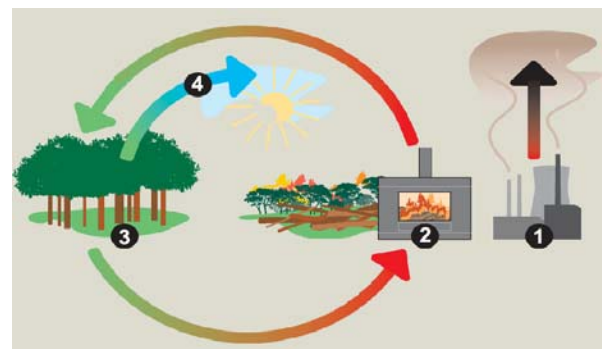


Figure 1. Firewood Association of Australia diagram

1. Fossil fuels such as oil, gas and coal fired electricity release carbon dioxide into the atmosphere during production and burning.
2. Carbon dioxide is also released when wood is burnt in fireplaces or wood heaters and during bushfires.
3. However, in sustainably grown and managed forests and plantations, growing trees absorb most of the carbon dioxide that is emitted during the harvesting, processing and burning of the firewood.
4. These trees then release oxygen into the atmosphere as well as storing carbon, resulting in a reduction in greenhouse gases and a virtually carbon neutral process.

Firewood study into domestic heating

A study into the greenhouse gas emissions of various firewood production systems was undertaken by CSIRO for the Australian Greenhouse Office (Paul et al). It examined CO₂ emissions from wood heating and compared it to emissions from other energy sources. One part of the study looked at firewood sourced from sustainably managed plantations, established on cleared agricultural land and burnt using a wood heater which was 62 per cent efficient. The study found that there was actually a positive net sequestration of carbon per unit of energy produced from burning firewood harvested from plantations. The two most favorable scenarios in terms of CO₂ emissions (Table 1) were:

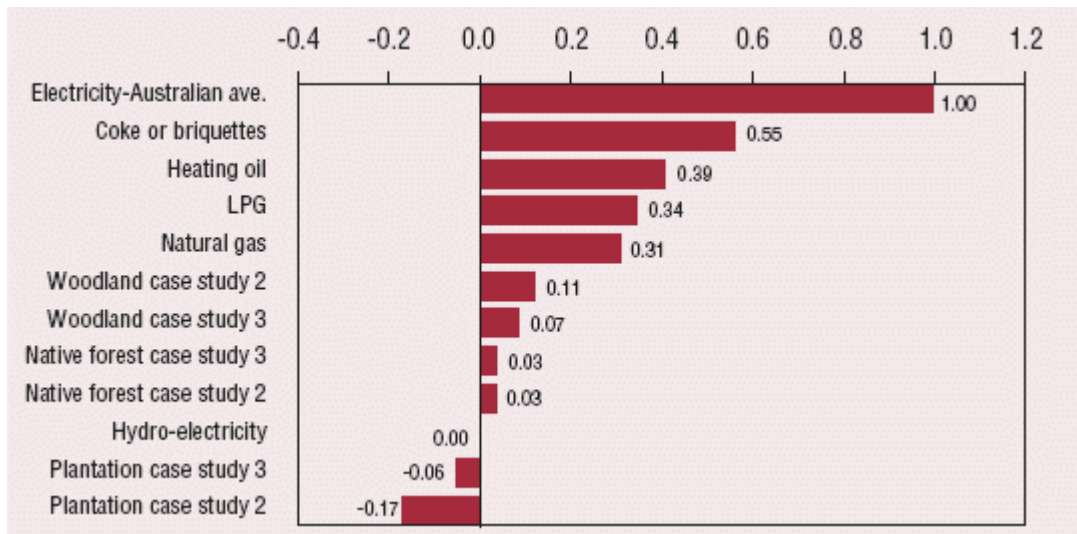
- Plantation case study 2 - where sugar gum firewood was collected from thinnings, slash and other debris from a plantation established primarily for sawlog production, and
- Plantation case study 3 - where a dedicated sugar gum plantation was harvested and regrown over three rotations.

Table 1 below shows a comparison of CO₂ released per unit of energy produced (kg CO₂ kWh⁻¹) for different sources of domestic heating. Data on non-firewood energy sources comes from AGO (2002). Note that it is assumed that: (i) firewood is burnt at 62% efficiency, (ii) electricity is used by a radiator or fan heater at 100% efficiency (use of a reverse-cycle air conditioner could reduce emissions per unit of heat delivered by about two-thirds), (iii) greenhouse gases generated by electricity supply are averaged across Australia except for Tasmania, where hydro-electricity is used, and (iv) greenhouse gases generated during the operation and construction of power plants are not included.

Table 1. Amount of greenhouse gas from different energy sources (kg CO₂ kWh⁻¹)

Source: <http://www.greenhouse.gov.au>

Life Cycle Assessment of Greenhouse Gas Emissions from Domestic Wood Heating (2003). AGO



Comparing energy emissions and costs from various energy sources

The Australian Greenhouse Office has stated, “in terms of limiting net greenhouse gas emissions, firewood is generally more favourable for domestic heating than other non-renewable fossil fuel sources of energy”.

Furthermore, using an energy efficient, slow combustion stove the cost of heating with firewood is competitive with gas or electric heating and can be one of the cheaper energy sources (SEA, 2006).

Type of Heat Source	Running Costs	Greenhouse Emissions
Slow Combustion Stove	LOW	LOW
Natural Gas	MEDIUM	LOW
Reverse Cycle Heat Pump	MEDIUM	MEDIUM
Off-Peak Electric Storage	LOW	HIGH
Electric Portable Heaters	HIGH	HIGH

Woody biomass for generating electricity

Like burning firewood for heating, hot water or cooking, woody biomass¹ is a renewable, low greenhouse gas emitting alternative to fossil fuels. Woody biomass, such as forest harvest and sawmill residues, have been used to generate electricity in numerous power plants around the world for decades. Unlike other renewable electricity sources such as solar and wind, biomass can be used to generate electricity on demand or provide a base-load electricity supply. There is also the advantage that woody biomass can be burnt in many existing coal-fired power stations; a process known as co-generation.

In Victoria, Murray Goulburn Cooperative use red gum woodchips to feed their boiler to produce steam for heating water and pasteurising milk at their Leitchville factory. The Visy pulpmill in Tumut, NSW utilises woody biomass to generate electricity to run its mill from a 19 MW power plant. This facility uses a wide range of wood wastes including sawdust, bark, and municipal wood waste; in fact any available waste wood fuel is used (Schuck, 2004).

A group of government and business organisations are developing an Integrated Wood Processing plant at Narrogin which will produce electricity, charcoal, activated carbon and eucalyptus oil from mallee tree plantations grown and coppiced every 4-5 years on farms in the Western Australian wheatbelt, (Oil mallee project).

In many parts of Sweden and Finland, small diameter thinnings and tree tops are chipped and used directly in combined heating and power plants in community heating plants. Some larger plants can directly use harvest waste in bundles of up to 500kg.

Net CO₂ emissions from the generation of electricity using biomass are typically only 5 to 10% of the emissions from fossil fuelled electricity generation (IEA Bioenergy, Task 38).

One of the disadvantages of using biomass such as wood residues is that it has a low density so, when compared to fossil fuels, large volumes are needed to produce the same amount of energy. Hence, if woody biomass is the main fuel to be used for a heating or power generation, the plant should be located close to the resource, e.g. near a sawmill or large plantation resource.

Other “wood to energy” conversion technologies

The technologies described above involve direct combustion of woody biomass. However there are a number of other technologies being developed that are improving the energy production from woody biomass. These technologies include: fast pyrolysis, gasification, liquid biofuels (eg. ethanol and methanol), briquetting and pelletisation.

¹ Biomass - any material which is recently derived from plants. The term woody biomass, as used in this Note, refers to biomass derived from trees.

Pollutants from firewood

As outlined above, burning firewood and other woody biomass can be greenhouse gas neutral or better. However, inappropriate use of wood heaters and firewood can create pollution.

Home heating using firewood results in air pollution due to incomplete combustion of volatiles released from the wood. Rapid release of volatile organic compounds occurs when combustion temperatures reach 250° C. Some of these unburnt VOC's condense as they cool to form the fine particles that we observe as wood-smoke. Some of the chemicals produced during combustion are known to be respiratory irritants and known or suspected carcinogens.

Pollutants from wood heaters can be minimized by;

- Always burning dry, untreated wood with a moisture content less than 20%.
- Ensure that the woodheater you purchase complies with the current Australian/New Zealand Standards AS/NZS 4012/4013 to ensure maximum efficiency emissions controls (AHHA).
- Get a hot fire going quickly. Keep the air controls set high enough to keep your fire burning brightly.
- Don't overload your wood heater with firewood.
- Never leave a wood heater to smoulder overnight. Doing this starves the fire of oxygen, producing more smoke and air pollution.

Further information

www.bioenergyaustralia.org.

www.climatechange.vic.gov.au

www.epa.vic.gov.au

www.firewood.asn.au

www.ffp.csiro.au

www.greenhouse.gov.au

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Firewood Association of Australia website:
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