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The Secretary
Senate Standing Committee on Environment, Communications and the Arts
PO Box 6100
Parliament House CANBERRA ACT 2600

Dear Secretary

Submission into the Management of Australia's Waste Streams

The purpose of this submission from Bioenergy Australia is to highlight energy recovery from municipal solid waste and other waste streams, and to provide information from Australia's participation in the International Energy Agency's Bioenergy Program. This submission is relevant to the terms of reference:

b. Effectiveness of existing strategies to reduce, recover or reuse waste from different waste streams
c. Potential new strategies to reduce, recover or reuse waste from different waste streams
d. The economic, environmental and social benefits and costs of such strategies
e. Policy priorities to maximise the efficiency and efficacy of efforts to reduce, recover or reuse waste from different waste streams

Bioenergy Australia is a nation-wide government-industry alliance of some 66 organisations, established to foster biomass as a source of sustainable energy and for value-added bio-products such as biofuels. Its broad objectives are to:

- Promote an awareness and understanding of the economic, social and environmental attributes of sustainable energy from biomass (including the biogenic component of urban waste streams).
- Broaden the market for biomass by enhancing opportunities, and by helping to reduce financial, regulatory, fuel supply, technical and institutional barriers to enable widespread adoption of biomass energy.
- Facilitate the development and deployment of biomass energy business opportunities and projects.

Bioenergy Australia is the vehicle for Australia's participation in the International Energy Agency's Bioenergy program, an international collaborative Research, Development and Demonstration agreement involving some 20 countries plus the European Commission. The Bioenergy Australia Manager represents Australia on the Executive Committee of IEA Bioenergy, which covers the broad spectrum of bioenergy, including bioelectricity and biofuels form diverse biomass resources including 'wastes'. Bioenergy Australia acts as a forum for general and authoritative information dissemination on bioenergy, including drawing on international best practice experiences through its IEA Bioenergy participation.

Please note that this submission may not necessarily reflect the views of individual member organisations.

Biomass refers to organic matter, derived in recent times, directly or indirectly, from plants, as a result of the photosynthesis. It includes a wide variety of materials, including organic waste by-products from various industries, municipal green waste, human sewage, and a significant fraction of domestic waste.

Bioenergy can be regarded as a form of solar energy, as photosynthesis combines atmospheric carbon dioxide with water in the presence of sunlight to form the biomass, while also producing oxygen. The energy bound into the biomass can be recovered through the variety of bioenergy processes and technologies. During the energy recovery process, the carbon dioxide bound in the biomass is released to the atmosphere. Bioenergy is regarded as renewable, when the biomass resource consumed in the energy conversion process is replenished by the growth of an equivalent amount of biomass. Under the Kyoto Protocol bioenergy is regarded as carbon dioxide neutral.

According to the International Energy Agency's data [1], renewable energy sources provide some 13.1% of the world's total primary energy supply. Of this, some 10.4 percentage points are from renewable combustibles and waste (i.e. biomass). In the OECD countries, renewable combustibles and waste provide 53.4% of the total renewable energy supply.

Figure 1 illustrates the range of energy processing paths for converting biomass to energy, chemical feedstocks and liquid biofuels.

Thermal (or thermo-chemical) energy conversion is generally applicable to drier biomass. The most familiar and commercially mature form of thermal energy conversion is combustion.

Combustion of biomass accounts for approximately 90 percent of the 44,000 MW of modern bioelectricity power plants world-wide, and is very similar to technology applied to solid fossil fuels such as brown coal. Excess air is applied for the combustion process to convert

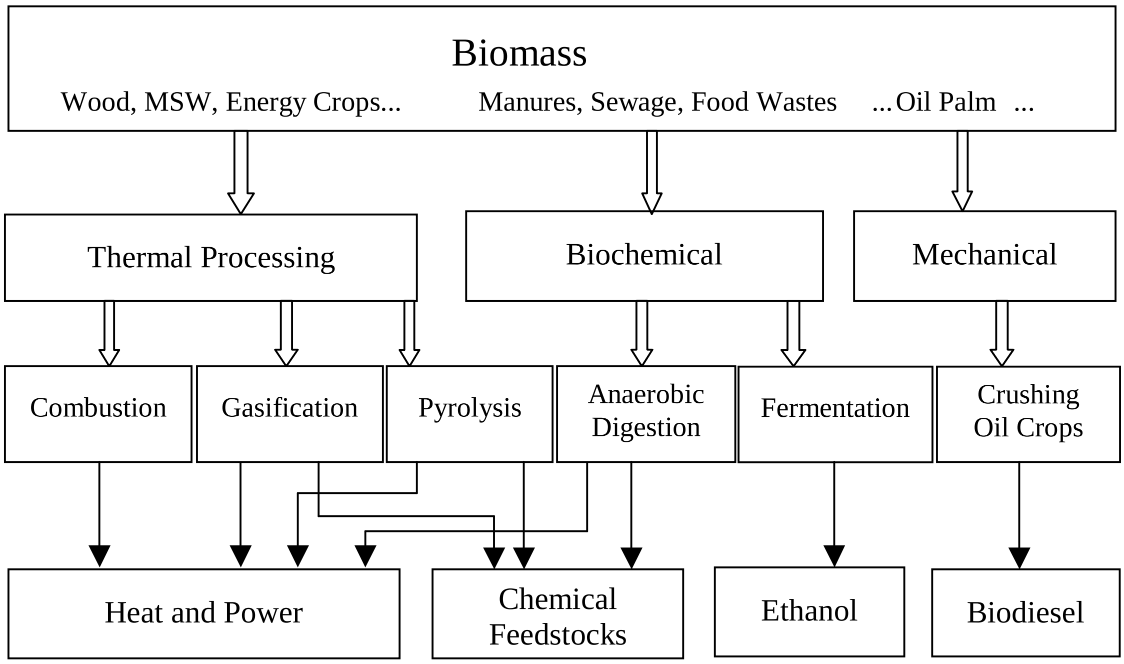


Figure 1: Bioenergy Conversion Routes

the biomass essentially to carbon dioxide and water vapour, liberating the stored energy in the biomass. Besides direct combustion, biomass can be co-combusted with coal in large utility boilers. Co-firing of biomass with coal is allowable under Australia's Mandatory Renewable Energy Target (MRET), and also under the NSW Greenhouse Gas Abatement Scheme, if the biomass source itself complies with the relevant Regulation administered by the Office of the Renewable Energy Regulator and under state legislation. Biomass co-combustion with coal is now well developed, with trials and commercial operation occurring in over 100 large power station units globally. Combustion technologies are mature technologies and have some advantages in terms of a low technological risk and cost.

Co-firing of biomass, including waste materials has been conducted at various Australian power stations, including at Liddell, Vales Point, Muja and Wallerawang power stations.

Gasification uses a reduced amount of air or oxygen. In gasification combustible gases are liberated from the biomass, to produce a fuel or chemical feedstock. This gas is rich in carbon monoxide and hydrogen gases and can be used to fuel gas engines, gas turbines, or act as a chemical feedstock for the production of chemicals such as methanol or other synthetic fuels. The product gas is very similar to that produced from coal and reticulated around Australian cities before the advent of natural gas.

Biomass gasification is not as advanced as combustion technologies, but has been deployed to a limited extent in Australia. Various wastes have been gasified at the Lahti power plant in Finland, with the product gas co-combusted with coal in an adjacent coal fired unit. Similarly woody wastes have been gasified at the Amer Centraal power station in The Netherlands, providing 83 MW of thermal energy into a adjacent coal fired power station boiler. Figure 2 shows the Amer Centraal gasifier, with the wood waste silo to the left and the gasifier to the right, from the roof of the coal fired power station unit.

Figure 2: Amer Centraal Gasifier

Pyrolysis of biomass takes two forms, slow pyrolysis as traditionally applied to charcoal making, or fast pyrolysis (flash pyrolysis), which mainly produces a combustible liquid fuel which can substitute for diesel or act as a chemical feedstock. Fast pyrolysis can convert up to 75% of the mass of the dry biomass to bio-oil. Pyrolysis occurs in the absence of oxygen under controlled conditions. Pyrolysis bio-oil is quite different to petroleum diesel, having a much higher specific gravity (1.2) and other physical and chemical properties. Bio-oil has approximately 60 percent the energy density of diesel on a volume for volume basis, and has been developed to the stage where commercial projects are beginning to emerge, after some 20 years of bio-oil development.

A leader in the pyrolysis bioenergy area has been Canadian company Dynamotive, who have built a 200 tonne/day biomass (input plant) in Ontario, Canada, where the bio-oil powers a 2.5 MW combustion turbine. Australian company, Renewable Oil Corporation has acquired a licence from Dynamotive and are working to develop projects in Australia to produce electricity from pyrolysis bio-oil.

Biochemical conversion of biomass uses microbes to convert the biomass into energy related intermediate products such as methane rich biogas. A common example of biochemical conversion occurs in landfills, where anaerobic organisms convert garbage into a mixture of methane and carbon dioxide, in roughly equal proportions. Often this combustible gas is captured and used for producing electricity in gas engines or turbines driving alternators. Half the automotive gas used in Sweden is derived from biogas. Biogas can also be purified and injected into natural gas pipelines, and sold as a 'green' product. At a Los Angeles landfill, biogas is purified and used to produce liquified bio-methane, which is used as a transportation fuel.

Australia has in excess of 140 MW of landfill gas power generation, which is a prime example of this technology. The largest plants are in excess of 10 MW per installation. An example of this technology is at the Lucas Heights 2 landfill gas power plant, which has 11 MW capacity. EarthPower Technologies (part owned by Veolia) have acquired a biodigester near Parramatta, NSW where they produce 3 MW of renewable electricity, plus a fertiliser co-product from the digestate.

Bioenergy has an advantage over other forms of renewable energy such as wind and direct solar energy. As the energy bound into the biomass provides inherent energy storage, bioelectricity can be dispatched, providing firm, base load capacity, unlike some other sources dispatched by nature. Additional energy storage is therefore not required for bioenergy. This allows excellent utilisation of the bioenergy plant's capacity. Many of the newer bioenergy plants have capacity factors in excess of 85 percent, on a par with coal fired units.

Industry Status

Table 1 lists operating renewable electricity projects in Australia at 31 December 2005, while Table 2 lists the capacities of projects under construction [2]. As of 31 December 2005 there were a total of 96 bioenergy projects in Australia with a combined capacity of 646 MW. In addition 144 MW of bioenergy capacity was under construction, consisting of 86 MW bagasse, 34 MW landfill gas, 13 MW wood waste and 11 MW from other sources. It is believed that the Clean Energy Council has more up to date information on bioenergy and other renewable energy plants in a more up to date plant register.

Table 1: Operating Bioenergy Projects

Biomass Source	**Number of Projects**	**Capacity (MW)**
Bagasse (waste sugar cane)	28	406.3
Paper Industry Wastes	3	76.5
Crop Wastes	1	1.5
Food Anaerobic Digestion	2	4,1
Landfill Gas	49	130.1

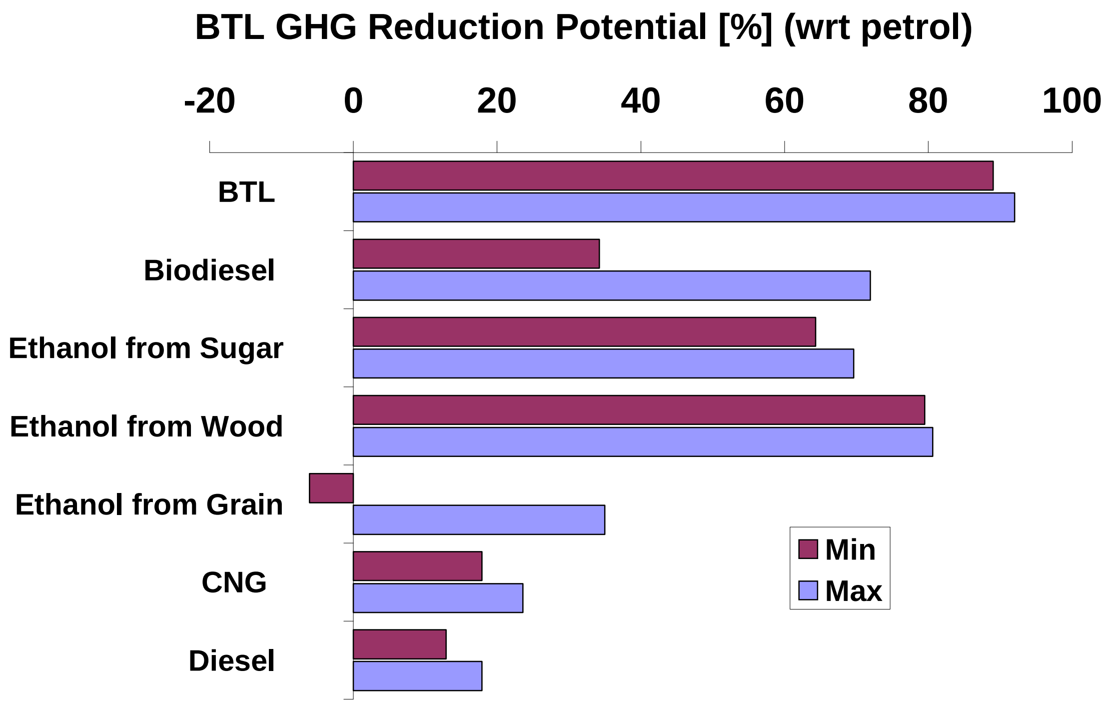
Municipal Solid Waste	1	1.4
Sewage Gas	10	17.9
Wood Waste	2	8.5
Total	96	646.2

Table 2: Bioenergy Plants Under Construction

Biomass Source	**Number of Projects**	**Capacity (MW)**
Bagasse/Wood	3	85.5
Energy Crops	2	1.1
Landfill Gas	8	33.8
Sewage Gas	2	10.8
Wood Waste	1	13.5
Total	16	144.7

Liquid Biofuels

Bioenergy Australia is a participant in the International Energy Agency's Bioenergy program and participates in Task 39 *Commercialising First and Second Generation Biofuels from Biomass*. There is currently much focus world-wide on establishing biofuels technologies that would not compete with food or fodder for resources. Promising technologies are ligno-cellulosic ethanol and also Biomass to Liquids (BTL) technologies which use thermal processing (gasification of the biomass and synthesis of mainly carbon monoxide and hydrogen into synfuels). Figure 3 below illustrates the very significant greenhouse gas reduction potential of BTL and other fuel technologies with respect to petrol. It illustrates that BTL and ethanol from wood are front runners for potential greenhouse gas mitigation.



Source: JRC/EURCAR/CONCAWE, Well-to-Wheels Report Jan 2004

Figure 3: Comparison of Various Biofuels for Greenhouse Gas Reduction.

Bioenergy Australia participated in the IEA Bioenergy Task 36 from 2004-2006. The end-of-Task report from this Task, consisting of a 20 page overview plus a CD of the final reports is attached to this submission. The 10 reports on the CD are:

- **Anon**. 2006. Waste Management Association of Australia. Energy from Waste Division: Stage 1 Report: Discussion Paper on the Theoretical Concepts and Potential Surrounding Extended Producer Responsibility and Product Stewardship.
- **Anon.** 2006. Waste Management Association of Australia. Energy from Waste Division: Stage 2 Report: Review and Assessment of the Performance of PS/EPR Schemes.
- **Anon**. 2007. Waste Management Association of Australia. Energy from Waste Division: Stage 3 Report: Infrastructure Requirements for Energy from Waste.
- **Bugge, M., Jonassen, O., Khalil, R., and Sørum l**. Options for the treatment of organic sludge: The move towards thermal processing. Sintef Energy Research, 2007
- **Jaitner, N.**, Mechanical Biological Treatment, Case Study 1: MBT in Ennigerloh, AEA Energy & Environment, 2007.
- **Lu, D.Y.**, Greenhouse Gas Implications of a Waste Management Strategy (Canada). CANMET Energy Technology Centre-Ottawa, February 2007
- **Wheeler, P.**, Mechanical Biological Treatment, Case Study 2: Eastern Creek UR 3R, Sydney, AEA Energy & Environment, 2007.
- **Wilén, C., Moilanen A., Hokkinen J., Jokiniemi J.**, Fine Particle Emissions of Waste Incineration. VTT Finland, March 2007.
- **Vehlow, J.,** Biogenic Waste to Energy: An Overview Forschungszentrum. KarlsruheGmbH, Karlsruhe, Germany
- **Vehlow, J.**, Dioxins in Waste Combustion: Conclusions from 20 years of research. Forschungszentrum. KarlsruheGmbH, Karlsruhe, Germany

These reports are also downloadable from:
http://www.ieabioenergytask36.org/publications_2004_2006.htm

The above overview on utilising waste streams as an input for energy and energy related products such as transportation fuels has been provided as input to address the Committee's terms of reference b,c,d,e. It is hoped that the Committee will afford due recognition to energy recovery as one of its key findings.

Thank you for the opportunity of providing this submission. I would be most pleased to provide follow-up information and assistance.

Yours Sincerely

Dr Stephen Schuck
Bioenergy Australia Manager

Attachment: IEA Bioenergy Report- Accomplishments from IEA Bioenergy Task 36: Energy recovery from Municipal Solid Waste.
References:

[1] International Energy Agency, *Renewables Information*. IEA Statistics 2006. Paris, France, 2006.
[2] Business Council for Sustainable Energy, *Renewable Energy Plant Register*, 31 December 2005. http://www.bcse.org.au/default.asp?id=172