



FACT SHEET 12: ENERGY FROM WASTE

What is Waste?

In the natural world, there is no such thing as waste. Nature efficiently recycles materials within a very complex ecological process. Our industrial processes have not yet been developed to this level of efficiency or complexity. There are many new and exciting developments however which reduce the environmental, social and financial costs of waste treatment and disposal. In the words of Dr. Amory Lovins of The Rocky Mountains Institute:

"Now the reason it is extremely profitable to wring out waste.. is that there is so much waste, and quite an astonishing amount... worldwide this resource flow is in the order of a half-trillion tonnes per year. And what happens to it? Well, only about 1% of it ends up in durable goods, the rest is wasted first; the system is about 99% waste. That's a business opportunity."

Waste produced by the domestic, industrial and commercial sectors of the community can broadly be classified into two streams: Solid Wastes and Liquid Wastes. Here we examine the potential for energy generation from both streams. In addition, gaseous by-products of industries associated with the extraction and refining of fossil fuels are also used to produce energy, yielding both financial and environmental benefits. Heat, another by-product of many industrial processes, can also represent a pollutant when released into the environment, such as when river water is used for cooling. In some instances there is the potential for some of this heat to be captured and "recycled" to increase process efficiency, it may also be profitably used for local heating needs, or even converted into electricity for on-site use such as in fertiliser manufacturing plants.

Generating Energy from Waste

Waste organic materials have an energy value and hence can be used as a source of renewable biomass. In Australia alone, wastes with approximately 100PJ of energy content are discarded every year. Using conversion systems and techniques already commercially available or being demonstrated, around 20PJ could be economically extracted from this waste at current energy prices. Wastes generally have a low energy density and therefore they are bulky and can be difficult to handle and process. Also they are often some distance away from where they can be processed and transporting them from one place to another uses energy.



Treatment of these wastes and their management can also affect the release of greenhouse gases in several ways by:

- reducing emissions of methane from landfill and decomposition of wastes
- reducing fossil fuel use by substituting energy recovery from waste combustion
- reducing energy consumption and released gas in mining and manufacturing industries, due to recycling
- maintaining carbon stocks in forests due to decreased demand for virgin paper as a result of recycling
- reducing the energy used in the transport of wastes for disposal or recycling. Except for the long-range transport of glass for either reuse or recycling, emissions from transport of waste materials are usually one or two orders of magnitude smaller than emissions from the other four factors listed above.

Australia is one of the few developed nations that does not have a well-established waste to energy industry, unlike the U.S., Japan, U.K., much of continental Europe, Canada and Singapore. There are four main issues, which may have prevented wide scale adoption of waste to energy technologies to date:

- Waste-to-energy schemes promote the generation of rubbish and discourage the philosophy of "Reduce, Reuse and Recycle"
- Combustion of waste products for direct generation of power is perceived as environmentally unsound, particularly the management of emissions, ash and smoke
- Communities have heard of the concerns about waste incinerators in other localities, even though these are often older inefficient designs not the state-of-the-art technologies which could be used

Good communication, careful planning and education relating to overseas experiences and the performance of modern conversion equipment will be needed to overcome these concerns.

Potential for Australia

In 1998 emissions from decomposition of landfill and wastewater matter alone accounted for 3.4% of national net greenhouse gas emissions - almost all of which was methane. It is estimated that wastes of approximately 100PJ of energy content are thrown away every year.

The "Waste Management Policy" of any nation should ensure that, as far as is practical, people and processes that produce waste should meet the costs of disposing of the waste they produce. They should also be encouraged to reduce, reuse and recycle waste, recover as much energy out of what is left and dispose of the remainder sensibly.



MUNICIPAL SOLID WASTE

Using existing international projects as a guide, approximately 80% of Australia's Municipal Solid Waste is available for the production of energy. This represents a resource of approximately 50 GJ annually, without looking at what can be obtained from existing landfill sites. Whilst this is a very small part of Australia's annual primary energy use (3223 million GJ), it is an important resource. Especially important is the reduction of greenhouse gas emissions because less fossil fuel will be used and less natural methane will be produced by decomposing waste.

The installed electricity generating capacity from landfill gas in Australia was about 72MW in 1997 (DPIE 1997). Landfill gas projects are a recent but growing development, from 15 projects operating in Australia in 1998 (Australian Greenhouse Office) to 29 at the beginning of 2004 (<http://www.rec-registry.com/public/stations.main>).

By using the gas to run gas engines driving generators, electricity can be produced for around \$40/MWh which is one of the cheapest sources of bioenergy. The availability of this resource is limited by the number of suitable sites and the need to try and minimise waste production in future by recycling it. As the majority of landfill sites do not have gas recovery systems, there is significant scope for the expansion of landfill gas utilisation, but since many sites are too small to be used, it will be unlikely to reach more than 300MWe total installed capacity.

Waste to energy facilities offer very substantial opportunities. An example of potential long term development of liquid and solid waste for materials, chemicals, fuels and power is shown below.

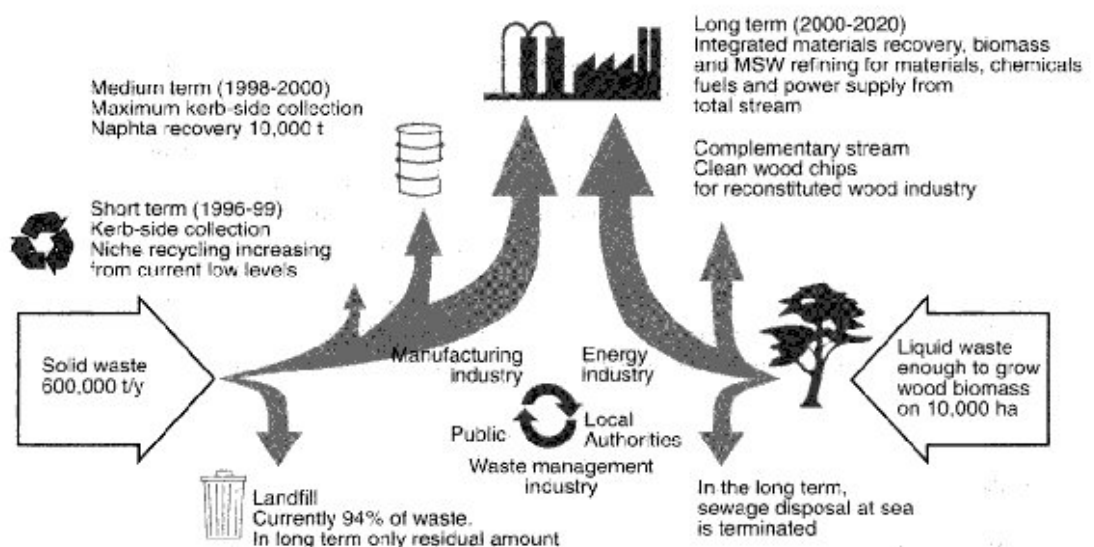


Figure 1.

An integrated waste treatment solution for a mixed urban/rural region.
Source: EECA/Centre for Advanced Engineering 1996 Report



LIQUID AND GASEOUS WASTE

The use of sewage gas for electricity production is increasing in Australia. In 1997, the installed sewage gas electricity generation capacity was about 7MW, which represents a 59% recovery of methane from wastewater treatment plants (Australian Greenhouse Office 1998). The capacity is expected to treble by the year 2010.

GREEN WASTE

Bagasse (sugar industry waste) currently represents about 2% of Australia's total primary energy consumption (Bush, Harris & Ho Trieu 1997). The steam produced is used to drive sugar cane mills, for process heating, and for grid-connected electricity production. The sugar mills in Queensland, NSW and WA have a combined capacity of about 300MW (DPIE 1997).

Wood (including forestry residue) represents 2.4% of Australia's total primary energy consumption (Bush, Harris & Ho Trieu 1997). About 75% of the heat energy produced from this wood is consumed as firewood in the residential sector, with about 22% of homes using wood for primary heating (DPIE 1997). The remaining heat energy is used in the wood products, paper and food industries.

Benefits of Waste to Energy Schemes

- The volume of waste sent to landfill can be reduced by up to 90%
- Sterilisation of waste is possible
- By combining the extraction of energy and useful products from waste with the recycling of materials, particularly ones that result from energy intensive processes, significant reductions in greenhouse gas emissions can be made, particularly carbon dioxide and methane.
- Waste in landfill which would release methane into the atmosphere has the methane used to produce energy which releases CO₂ instead. A molecule of methane has a global warming potential 21 times that of carbon dioxide over a 100 year lifetime.
- In general, waste products have lower sulphur contents than fossil fuels and therefore produce less acid rain when used as fuel substitutes.
- Burning organic waste results in ash which can be use in the agricultural sector as a soil enhancer, reducing the need for phosphate fertilisers and mineral supplements
- Concentration and safe disposal of heavy metals can be achieved
- Reduction of dioxin emissions to almost zero levels is possible
- Less land is required for landfill and other disposal methods for the remaining, non-convertible waste.

- Local use of the waste-to-energy resource reduces the need to import fuels for electricity. The electricity is therefore not subject to changes in price and currency.
- The ash left over in some processes can be used to make construction materials
- Producing energy from solid waste that would otherwise go to landfill could reduce groundwater contamination.
- Producing energy from waste water that would otherwise be pumped into the sea will reduce ocean and beach pollution.

Things that Limit the Use of Waste to Produce Energy

- Waste typically has a lower energy density (energy available per unit mass) than fossil fuels. So if it needs to be moved at any stage during the process, the cost of energy production is increased, and the energy efficiency is reduced. Locating the waste processing plant near the waste resources would reduce this problem.
- Incomplete burning of waste can result in the production of noxious gases, such as carbon monoxide and nitrogen oxides. The solution is to strictly control the process to minimise their production.
- In countries where a waste-to-energy industry is not established, the cost of converting waste to energy is higher than in other countries because all the initial expertise and technology has to be imported.
- Relatively cheap domestic electricity and natural gas fuel tariffs, as well as political and institutional barriers to waste use (such as increased scrutiny by environmental agencies) decrease the cost competitiveness of waste-to-energy technologies.
- Legal complexities can slow things down.

Abbreviations

MW – mega watts

MWe – mega watts electricity

DC – direct current

PJ – petajoules

GJ – gigajoules



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Further Information

For more information about “Waste Streams”, “Waste to Energy Technologies”, “Refuse derived fuels”, “Gassification”, “Solid waste to Energy Recycling Facility”, “Endersludge” and “Emerging Processes” see the [RE-Files](#)

Below are some useful links for additional information, and a list of references. Some of these links require Acrobat reader which is available free [here](#)

[Energy Developments](#)

Environmental Solutions

[Australian Biomass](#)

[The Veggie Van](#): From the Fryer to the Fuel Tank

[Food Waste Disposal Using Anaerobic Digestion](#), Korea

Municipal Waste Incineration Plant in the Republic of Korea

[CADDET Technical Brochures](#)

[Rocky Mountain Institute](#)

[Natural Capitalism: Creating the Next Industrial Revolution](#), Amory Lovins and Hunter Lovins

Combined Landfill Projects

[Cooperative Research Centre for Waste Management and Pollution Control](#)

[The Septic Information Website](#): Inspecting, Designing and Maintaining Residential Septic Systems.

Club de Ville Diester: French Biodiesel

WA Water Corporation

Australian Energy News

[New South Wales Department of Mineral Resources](#)

Kobe Steel Refuse Derived Fuel in Japan

[ETSU](#) Centre of Excellence in energy efficiency and sustainable energy

Sustainable Development International

[Seghers Multiwaste](#) - Industrial system for multiwaste combustion

[Energy Products of Idaho](#) : Gasifiers and fluidised bed systems for waste to energy systems.

[National Biofuels Program](#) US Department of Energy

[Peter Brotherhood Ltd](#) : Engineering a new environment

[Lahmeyer International Consulting Services](#) for energy, water resources and hydropower, transportation and project management



[Alternative fuels data centre](#) US Department of energy

[Juniper Waste-Energy Technology](#)

[Juniper: Pyrolysis and Gasification](#) of Waste A Worldwide Technology and Business Review

[Plastics Resource Information](#) on Advanced Recycling Technology

[Toshiba](#) PKA Pyrolysis and Gasification Process

[EnerTech](#) Waste Conversion and Energy Technology (May be difficult to access)

Australian Greenhouse Office International Case Studies

[Babcock Borsig Power](#) A world leader in environmental technology (May be difficult to access)

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