

This report is a product of the distance learning course “Bioenergy Technology and Bioenergy Business”, supervised by Professor Björn Zethræus at the Linnæus University in Sweden, and auspiced by CHAF, 2011

Appendix Two – Regional Resources

Biomass and waste availability within Ballarat Municipality

Summary

The biomass and waste resources within the Ballarat Municipality are extensive enough to allow the development of a number of commercial options to convert various fractions of them into energy – as heat, electricity, or gas or liquid fuels. The most appropriate technologies to be used in the conversion options are detailed in Appendix Three. These are technologies that are in commercial use elsewhere in the world where these biomass and waste fractions are the accepted feedstocks.

Definition of terms

It is necessary to insert a brief definition of terms so that the lay person is better equipped to use the information. This appendix is a condensing of three reports that looked at

- Woody biomass - including straw and other agricultural dry stalk residues
- Putrescible or wet organic biomass – including sewage, manures, 'green' waste, and food waste
- 'Other' biomass and wastes – including mixed municipal solid wastes (MSW) from households and institutions, and commercial and industrial sources. This material is assumed to be non-recyclable, not containing toxic or hazardous material, and is relatively combustible. This sort of mixed-source MSW can be up to 70% biomass

Biomass	All material of an organic origin, including live and dead plant material, animal carcasses, outdated food
Municipal waste	Mixed household and other 'dry' combustible material. May contain plastics and other synthetic material of a fossil fuel origin, such as tyres, that cannot be recovered for recycling. Under 50% moisture content
Putrescible waste	Material that will rot or putrefy if left exposed to air at ambient temperature. Usually over 60% moisture content and may be almost 100% water, as with sewage (black water) or household waste water (grey water).

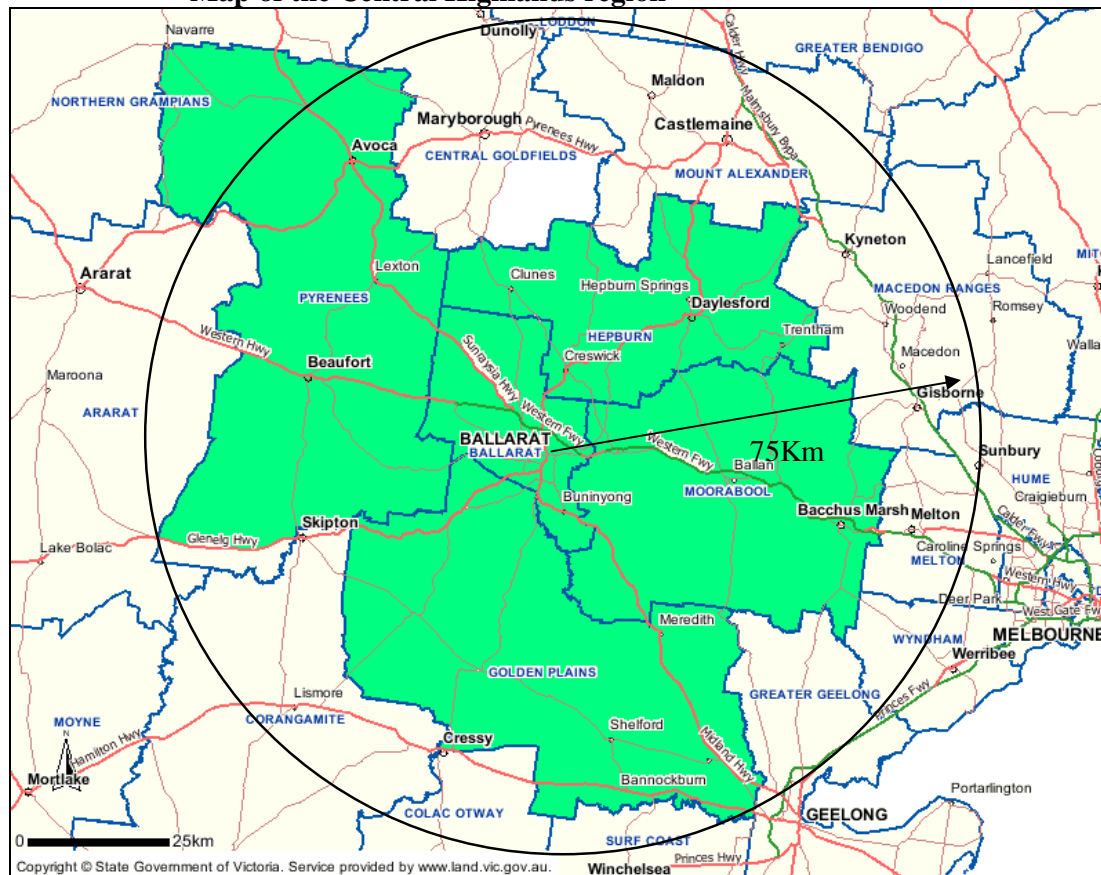
The region from which biomass is sourced

While the notional sourcing and audit of available biomass was from the 740 square kilometres within the boundary of the City of Ballarat, in practice the identifying or sourcing of biomass is also dictated by other factors. We used a notional radius of 80km direct distance and so a road distance of about 100 km. This was because it is an accepted radius beyond which it starts to become uneconomic to freight low-value high-volume material like wood chip or baled straw. However in some cases the radius of sourcing distance may be more or less than this depending on other factors.

- Urban size and density issues. Sewage is an example of a biomass form that is not feasible to transport large distances due to its high water content. However, where it is piped within a sizeable city like Ballarat to a treatment point the economics of energy recovery from this biomass form can be positive

- Alternative costs of disposal attached to biomass or waste. Where wastes such as MSW have a disposal fee then it can be economic to freight material a larger distance
- Ability to aggregate or gather some forms of biomass. Some useable forms of biomass do not have enough volume to warrant collection. Dairy manure and wash-down water is one example.
- Alternate transport. For example, use of rail freight may allow low value high volume material to be brought economically from a greater distance.

Map of the Central Highlands region



Woody biomass

Summary

The review of Ballarat Municipality's woody biomass resources suitable for combustion used resource information gathered from the sectors of cropping, horticulture, food manufacturing, forestry and wood manufacturing.

Within an approximate 75Km radius of the city, Ballarat's most affordable and abundant sources of biomass are;

- pulplogs from private plantations (softwood and hardwood combined), equivalent to 701 GWh/annum at \$0.10 per KWh,
- residues from forestry harvesting and management activities, equivalent to 226 GWh/annum at \$0.10 per KWh,
- oat husks from local oat processing facilities, equivalent to 47 GWh/annum at <\$0.01 per KWh, and
- grain cropping stubble, equivalent to 605 GWh/annum at \$0.27 per KWh.

Woody Biomass breakdown by source

Cropping

May & Feltrin (2011) report that within the Central Highlands region, the current area under grain and canola cropping is 163,600ha. The most common grain crops are wheat, barley and oats. Whilst strictly considered a woody plant, the stalk or blade of these grasses, following the harvest of the protein rich "head" can be baled into concentrated quantities of dry cellulosic material, known as stubble. Depending on the method used, this material can either be collected concurrent with the grain harvest or as a secondary operation.

Horticulture

The Central Highlands horticulture industry is predominately viticulture, with 1,290ha in grape production. Smaller areas contain olives (30Ha), apples, pears and stone fruit (total of 102ha).

Grain Processing

Oats from within this region and from surrounding areas are processed in two local grain mills. These facilities produce both animal feed and food for human consumption. The process requires dehulling of the outer coating of the oat grain, also known as the husks. The husk is a dry cellulosic material of little food value and is often disposed of at a cost to the mill. Husks are being used in other facilities around the world as a feedstock to generate bioenergy.

Forestry

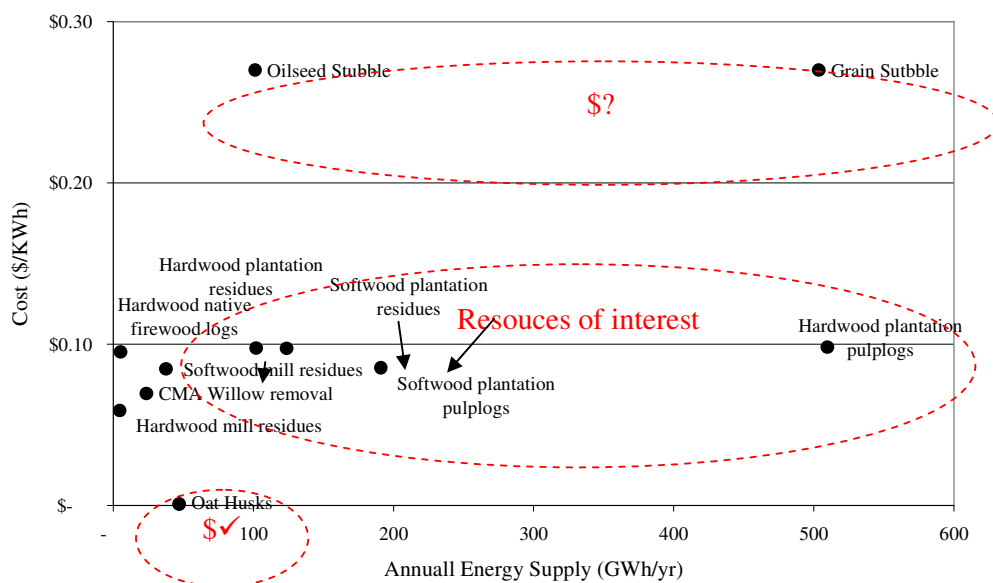
Forestry harvesting operations account for significant quantities of woody residues material which is either unsuitable for sale to local mills or marginally economic to transport to the nearest woodchip port in Geelong (see Appendix 1 for more information regarding companies competing for this fibre). Unwanted material is left behind to either

break-down naturally or to be burnt in-situ prior to replanting. The principal forestry owners currently harvesting in the region include Hancock Victoria Plantations, AKD Softwoods and Midway.

Timber Processing

Some 26,000 tonnes of logs (Crawford, 2009) are process in timber processing facilities within the Central Highlands region. Central Highlands Timber and Ballarat Timber Processors, are both based in Ballarat. The smaller Pyrenees Timber Mill at Chute processes both softwoods and native hardwood sawlogs.

Figure 2: Quantity and cost of woody biomass energy within Central Highlands



Conclusion

Based on the assumptions stated the lowest cost woody biomass energy can be supplied from local oat mills; however this is limited to only 47GWh/y. The more ample biomass resource comes from the forestry sector, which combined could provide around 1TWh/y at less than \$0.10KWh.

Opportunities exist to expand the quantity of lower cost woody biomass. The agricultural stubble appears to be costed with a margin for the farmer, rather than sharing in the benefit of avoiding additional costs from burning the material in-situ. Developing more efficient an integrated systems to collect this material should lead to a cost reduction.

Significant additional volumes of woody material could also be derived from integrating biomass collection with other existing land management activities. Thinning forests prior to or as an alternative to bushfire fuel hazard fires, capturing woody material during powerline maintenance and bringing roadside verge material into a facility, would all seem reasonable areas for future development.

Putrescible biomass

Summary

Putrescible waste is defined as biomass that will rot or putrefy due to microbial activity. The technologies for using this fraction of biomass to produce energy in a number of forms are quite mature and well known. The volumes available in the Ballarat municipality are considerable and are either already aggregated or are readily able to be aggregated.

In most cases this material would come to the site of a bioenergy plant with a 'gate fee' attached – which is either its previous cost of disposal, or its alternative landfill levy charge and gate fee. This income from receipt of putrescible waste can significantly improve the economics of production of energy from putrescible waste.

The forecast rapid growth in the population of the Municipality of Ballarat, the likely increase in volume of other types of putrescible wastes over the coming decades, and the increasing restrictions on options for disposal of putrescible wastes, makes it very timely to examine the alternative ways to manage putrescible waste, and particularly with the potential for recovery of energy. To assess these options it is important for this report as accurately as possible to identify volumes, qualities and economic availability of the putrescible waste generated at present within an 80 km radius of Ballarat city.

Our investigation establishes that approximately 60,000 'wet' tonnes (assumed 70-90% MC) of putrescible wastes are presently collected annually from commercial, industrial and residential sources in the municipality. A further estimated 6000 'wet' tonnes (mostly of 20% moisture content) of sewage biosolids and manure solids are produced each year in the municipality. In addition, a variable but potentially quite significant amount is produced of other putrescible material in the form of harvested weed from Lake Wendouree, and agricultural residues from the surrounding rural area.

This following sewage and biosolids section is shown in some detail as it is a fraction of putrescible biomass that is both significant by volume, traditionally already aggregated, and requires specific treatment.

Central Highlands Water provides water and sewerage services for the Ballarat region and beyond. CHW manages eleven sewage treatment plants from which biosolids are produced. While the majority of these plants harvest their biosolids approximately every twenty years, two larger treatment plants produce biosolids more frequently and one of these has excess biosolids stockpiled on-site. Biosolids in Victoria are classified by treatment grade (T1-T3; T1 being the purest and suitable for unrestricted use) and contaminant grade (C1-C3, with C1 suitable for unrestricted use and C3 not suitable for application to land).

Sewage treatment plants operated by Central Highlands Water currently reuse their biosolids via composting, primarily at an old land-fill site (Pinegro). The biosolids are classified as a treatment grade of T3 or T2, meaning they are only suitable for restricted use when applying directly to land. The biosolids have a contaminant grade of C2 again allowing for restricted use when applying directly to land. The material is blended with green waste to achieve a C1 contaminant rating (unrestricted use) before it is used at Pinegro.

The quantity of biosolids produced is a function of the treatment process and influent (quality and quantity) to the sewage treatment plants. Changes to the treatment process are largely driven by changes in regulation or end of asset life, changes to the influent are driven by changes in industrial, commercial and domestic composition of the sewage catchment, often commensurate with changes in population.

Conclusion

As can be seen in greater detail in the full report on Putrescible wastes, Ballarat municipality produces a significant amount of putrescible wastes annually. The main sources and fractions of this are -

handling sewage from its resident population of about 98,000, plus up to 20,000 students and tourists boarding in or visiting the municipality at any one time,

food waste, food processing waste and green waste from the approx 34,000 households, plus hospitality providers, institutions and food production industries,

green waste and other putrescible wastes from parks, agriculture and the Ballarat livestock centre.

Most of these fractions of putrescible waste are already aggregated via various systems for disposal – either with or without pre-treatment. In some cases the putrescible waste is enough for the industry to have installed its own anaerobic digester (McCain Foods and Berrybank piggery). However the greater part of this volume is presently either disposed of to landfill, handled through some composting process, or is otherwise aerobically treated in the case of sewage and greywater.

Where the disposal is to landfill or to composting businesses or worm farms there is a significant collection and disposal charge (with the landfill levy on putrescible waste making this the most expensive of the options and also the one with a proposed date of 2014 for disposal to landfill to cease).

Altogether the municipality produces enough putrescible wastes at potentially well over 60,000 m³ per year of 10% dry matter content, to provide adequate feedstock for a modern anaerobic digester.

With a forecast increase in population by 2050 of 50% (and some authorities suggest as much as 100%) it is almost certain that the production of putrescible waste will be closely correlated with this increase. In addition the alternatives for disposal of putrescible waste will continue to be ever more tightly regulated and thus limited in availability.

'Other' biomass and wastes

Waste can be roughly split into two categories: liquid and solid. Solid waste is further categorised into Municipal Solid Waste (MSW), Commercial and Industrial Waste (C&I) and Construction and Demolition Waste (C&D). Both liquid and solid waste streams can be described as hazardous and non-hazardous and combustible and non-combustible. For this study we shall only consider solid, combustible, non-hazardous wastes. (see figure below).

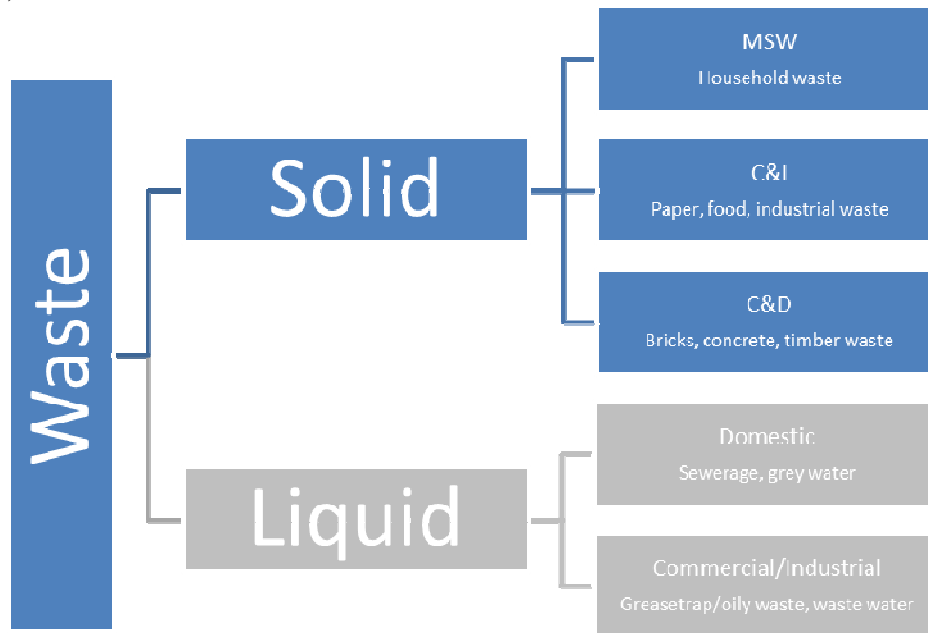


Figure 1: Simplified waste stream schematic

MSW:

Can be typically described as the waste that is collected in the bin at the kerbside, although the stream can be captured from a number of other sources such as:

- transfer station waste including green waste, general waste, timber waste
- recycling facility waste
- street sweepings; and
- public litter bin waste.

MSW for Ballarat city and region

Waste stream	Volume
Total waste to landfill (City of Ballarat only)	16,831 tonnes
Total waste to landfill (regional)	12,569 tonnes
Average weight per bin (City of Ballarat only)	7.6 kg
Total organics generated (City of Ballarat only)	12,757 tonnes
Total organics generated (regional)	24,447 tonnes

MSW typically has a calorific value of around 10 MJ/kg (assuming 40% MC).

C&I:

Typically the waste that is collected from bins and skips provided to shops, offices and public or municipal buildings.

C&I

	Food	Paper	Garden	Other	Total
CV	4.2	17	7	10	
Mass (tonnes)	23,782	195	12,037	80	36,094
MJ/year	99,884,400	3,315,000	84,259,000	800,000	188,258,400
MWh/year	27,746	921	23,405	222	52,294

Due to its makeup, the CV (energy content) for C&I waste can vary significantly, therefore individual values for different streams are tabulated (MJ/kg):

Food	Paper	Garden	Other
4	17	7	10

C&D:

Typically the waste collected from bins and skips provided to builders and demolition crews.

Estimated at 19,500 tonnes. Due to the makeup of C&D waste, it is assumed that 26% of this waste is combustible. Individual breakdowns are given below:

	Timber	Plastic	Paper and Card	Total
Percentage (%)	20	3	3	26
Mass (tonnes)	3,900	585	585	5070

C&D

	Timber	Plastic	Paper and Card	Total
CV	19.6	17	22.6	
Mass (tonnes)	3,900	585	585	5,070
GJ/year	76,440	9,945	13,221	99,606
MWh/year	21,233	2,763	3,673	27,668

Table 7

C&D waste can be split into two types:

- inert materials such as brick, soil, concrete and plasterboard; and
- combustible materials such as waste timber, paper and cardboard and plastic.

Timber has an estimated energy value of 19.6 MJ/kg, paper and cardboard a value of 17 MJ/kg and plastic film has a value of 22.6 MJ/kg.

A further category of waste in the region is the significant volumes generated annually of car and truck tyres. Using the available information on numbers of tyres, breakdown of type and weights per tyre type, there is an estimated amount of 12,601 tonnes of waste

tyres annually in Ballarat. In addition to this, there is currently an estimated three million tyres situated approximately 150km from Ballarat in the township of Stawell. These tyres are the remnants of a bankrupt re-treading facility. This represents some 1,727 GWh of energy.

Total energy available for Ballarat Municipality within ‘other’ categories of biomass and waste

The following tables provide figures (in MWh/ year) of the total energy available in each of the above categories:

Stream	Mass (tonnes/ year)	Gross Energy Available (GWh/ year)
MSW (City of Ballarat)	16,831	47
MSW (Regional)	12,569	35
C&I	36,094	52
C&D	5,070	28
Total	70,564	162

Conclusion

These relatively large volumes of ‘Other’ wastes can be converted to energy. This can be done at the regional level using various optional technologies, or they can be converted into an intermediate form (pelleted dry MSW or Refuse Derived Fuel - RDF) and transported elsewhere.

In either event one key outcome will be to reduce waste volumes going to landfill, reduce emissions from fossil fuels, produce some permanent regional jobs in plants and supply chains, and help move the City toward a reduced reliance on the various forms of imported energy.