

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

December 2011

Appendix 1: Market Prospects

Ballarat Energy Services

**Domestic and commercial
Industrial
Transport**

Central Highlands Agribusiness Forum Inc.

December 2011

Executive Summary

Ballarat, like all communities in Australia, is faced with a changing situation of energy consumption, costs and supply. Supply and legislated constraints affecting availability and pricing of fossil transport fuels – as well as changing availability and costs of other forms of energy – will stimulate significant changes in energy use and sourcing. This appendix is derived from the reports prepared as part of the requirements of the Central Highlands Agribusiness Forum-facilitated Bioenergy Technology course. This course investigates the opportunity for the City of Ballarat to take a leadership position in this energy use transition. Given the abundance of a number of forms of biomass in close proximity to this agricultural and food manufacturing regional city, energy from biomass (bioenergy) will be one of the key alternative forms of energy, and it is the focus of this study.

This document, Appendix 1, presents information on current energy services. The document is a compilation of three reports focussing on energy services. Other project appendices focussing on Regional Biomass Resources (Appendix 2), Technology Options (Appendix 3) and Future Projections (Appendix 4).

The reports making up this document, Appendix 1, focus on the following three areas of Ballarat's energy services for the year 2011:

- Domestic and commercial
- Industrial
- Transport

Collectively, the first three reports:

- quantified and described the demand for energy services across the local domestic and commercial, industrial, and transport sectors;
- provided a technical summary designed to inform a range of businesses and government bodies with interest in developing economic activity, alternative energy supplies and environmental mitigation for rural Victoria.

While this Appendix provides a *summary* of the energy services associated with the three sectors, full details – including information sources, methods and data – are provided within the original three group reports making up Report One.

Introduction

At the 2009 National Conference the current Australian Government pledged to reduce its emissions by between 5% and 15% below 2000 levels by 2020, and at least 60% below 2000 levels by 2050. They have also set a target of 20% of electricity coming from renewable sources by 2020 (ALP 2009).

The City of Ballarat is well placed to contribute to these emission reduction and renewable energy targets by substituting fossil fuels with renewable energy sources. Being an agricultural and forested region of about 740 km² with 20,000 km² within an 80 km radius, large volumes of biomass residues are being generated annually. Only miniscule amounts of this are currently being utilised, producing predominately thermal energy.

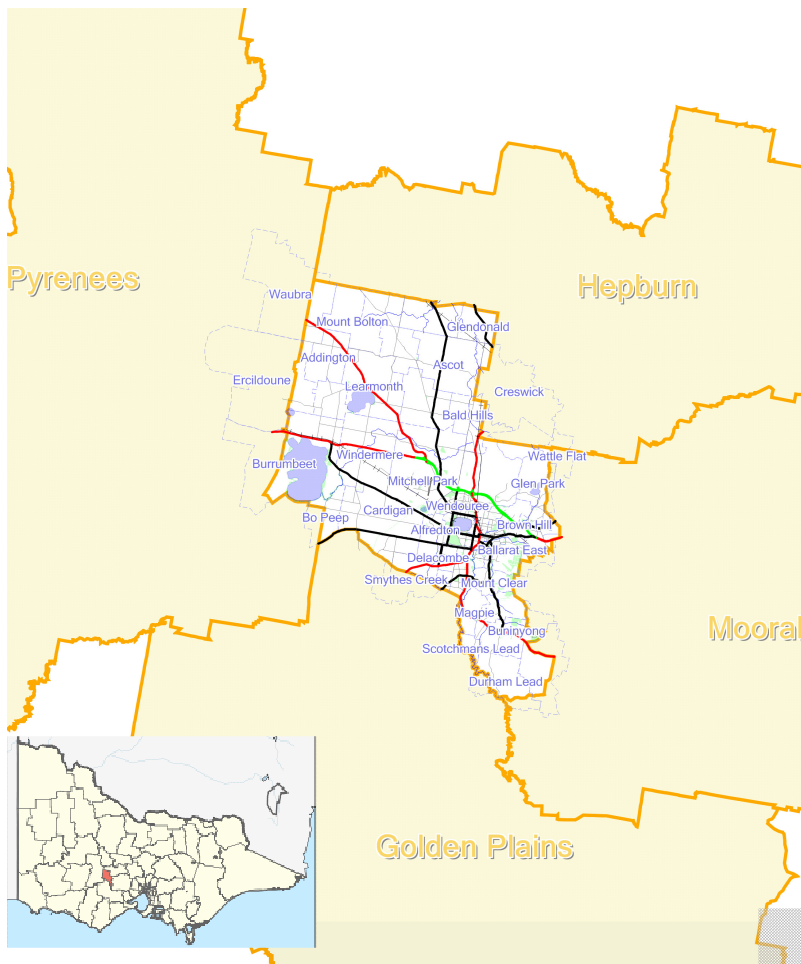


Figure 1: Municipality of City of Ballarat, and adjacent local government areas

Explanation of energy terms

This study looks at energy services and the forms of supply of those energy services. An energy service is, as the name indicates, a service involving energy supplied to or needed by a user that is produced or provided by one or other energy forms –electrical energy (electricity), thermal energy (heat), or chemical energy (transport fuels).

Examples of Energy Services

As an example, domestic space and water heating may be produced by electricity, by burning of gas or firewood, or by other systems including solar thermal collectors.

Movement of goods or people may be by energy from liquid or gas transport fuels, or by electricity via some system including (for goods) by conveyor or elevator over a short distance, or for people and services by electric train or other vehicle.

Some industrial energy services such as joining or forming metal, or cooking or refrigeration, may require significantly higher or lower temperatures, or far larger amounts of energy, than needed by the domestic, commercial or retail sectors. Examples may be welding, forging, firing of bricks, production of steam for food processing etc.

Energy

Measurement of energy produced, used or stored (in fuels) is conventionally in units of megawatt hours (MWh) or kilowatt hours (kWh). Energy in liquid and gas fuels like diesel, LPG and natural gas can be converted to these units, as can energy ‘stored’ in wood, straw, or municipal solid waste.

The relation between these units is that 1000 kWh equals one MWh, 1000 MWh equals one gigawatt-hour (GWh), and so on through terrawatt-hours and petawatt-hours.

So an average household might over a year use about 5000 kWh (5 MWh) of electricity, and possibly 15,000 kWh (15 MWh) of heat energy. The average family with one car and driving 15,000 km per year might use 1500 litres of fuel, and this is also approximately 15,000 kWh (15 MWh) of energy.

Collectively in 2011 the 98,000 residents of the Ballarat municipality in their nearly 37,000 households will use – very approximately - about 200 GWh of electrical energy, 550 GWh of heat from natural gas, and 500 GWh of chemical energy in liquid transport fuels. The total of this is about 30% of the overall energy used across all sectors.

Greenhouse Gas Emissions (GHG)

Different forms of energy use release different amounts of emissions per MWh or GWh of energy utilised. Emissions from our electricity use are very high as the electricity is only about 30% of the energy produced from our brown coal-fired plants, with the other 70% being wasted heat.

Transport fuels release about 240-250 tonnes of CO₂ per GWh of fuel consumed (petrol is 240, diesel is about 250). Emissions from burning of natural gas are of the same order per GWh as for liquid fuels.

The aggregate total for the municipality divided by the population is one relevant figure. This includes all industry and other emissions and is in the order of 15-18 tonnes CO₂-equivalent/person/year. Other emissions from supplying all the goods and services to the population of Victoria on a per capita basis are added to this. This include things like the postal service, water supply, infrastructure maintenance, mining and refining – a myriad of energy-consuming activity. This will add a further 5-8 tonnes CO₂-equivalent/person.

Energy use for the domestic and commercial sector

The 2006 census figures gave Ballarat a population of 88,137, with numbers per household forecast to fall from 2.5 people/household in 2006 to approximately 2.3 people/household by 2021. The population in mid-2011 is estimated to be about 98,000, with the number of households estimated at about 36,790.

Energy overview

The City of Ballarat is a significant user of energy, including natural gas, LPG (liquified petroleum gas), electricity, petrol and diesel. Overall the annual consumption of electricity is about 638 GWh or 75 MW (Powercor). Natural gas use for provision of energy services including domestic heating and cooking is about 1257 GWh (equivalent to about 144 MW) (SP Ausnet). The City of Ballarat is on the natural gas grid but the outlying towns and all farms are reliant on either electricity and/or bottled LPG for cooking, and space and water heating.

Domestic and commercial energy services

These energy services users in this energy use sector include households, retail businesses and other commercial businesses; social, recreational and municipal services, and the institutional sector that is accessible to the public, i.e. hospitals, schools, universities. These all require similar energy services. These include water and space heating, space cooling, cooking, heating, refrigeration and freezing of foods, pumping of liquids and heated or cooled air, lighting, data and IT access, and delivery of goods and services.

Total energy consumption

- SP Ausnet estimated total natural gas consumption for the City of Ballarat for 2010 at 1257 GWh (or 144 MW).
- Electricity consumption by the domestic and commercial sector is estimated for 2011 at 638 GWh or (74 MW) (Powercor).
- Domestic household electricity useage is estimated to make up about 30% of the total energy used in the City of Ballarat.
- Business and other commercial use accounts for about 19% and industry for about 50% of the total use of electricity.

Conclusion

Use of energy by the domestic and commercial sectors is assumed to continue to grow with increasing population and number of households. However there are other rates of possible energy growth and emissions that are demonstrated elsewhere. Projects proposing some of these will be based on the information gathered in the project's nine reports, of which this Appendix summarises the first three.

Transport energy services

Provision of transport energy services primarily uses road and rail, with a future potential for some growth of air transport. The provision of transport energy services is mainly fuelled by fossil fuels of diesel, petrol and LPG, with potential for far greater use of liquid and gas biofuels and electricity.

Road transport

The transport energy services provided within the City of Ballarat's road network can be broken down into the following categories:

- Movement of goods – by road and rail
- Provision of services – principally by road
- Movement of people – to and from work, to and from school, for leisure, recreation, shopping and social activity; principally by road with some by rail.

The total fuel consumption for road transport-provided energy services within and servicing the Ballarat LGA for the 2009 year was approximately 153 million litres, with about 94.2 million litres as petrol and 72 million litres being diesel (this does not include non-transport-use fuel as used in agriculture, forestry or mining, or special services – ambulances, crane trucks, fire units, etc.).

The consumption of fuel by freight vehicles:

- Articulated trucks (about 390) are estimated to use about 18.9 million litres (MI) of diesel. Although the Ballarat LGA-based articulated trucks will frequently cart to well beyond the LGA region we will use this figure as they would fuel in the region, and other articulated trucks based elsewhere will be coming into and through the region.
- Light commercial vehicles: consumption by the 11,460 in the LGA of 20.85 MI of diesel.
- The 1880 light and heavy rigid trucks consumed about 13.53 MI of diesel in 2009
- The 470 buses include city route buses (Davis Bus Lines), country route service buses (V-Line and several companies with regular services to other regional cities) and charter and school route buses. Total annual consumption is therefore 7.05 MI of diesel.

Passenger vehicle fuel consumption in the Ballarat municipality for 2009 was 94.2 MI, with 88% or 82.88 MI being petrol and 12% or 11.3 MI being diesel.

'Other' vehicle classes (the 2726 motorcycles and 188 non-freight specialist-purpose trucks) are either low annual kilometre specialist vehicles or low fuel consumption and probably seasonal-use vehicles, and are assumed to contribute only minor additional consumption to the overall figures, so their use and emissions contribution is ignored for this study.

About 1365 of the registered petrol passenger vehicles may have been converted to LPG but applying this different fuel type will make no significant difference (and most conversions will have occurred after 2009).

Figure 2 below shows registered motor vehicles per thousand residents for the Ballarat municipality over the four year period to 2009.

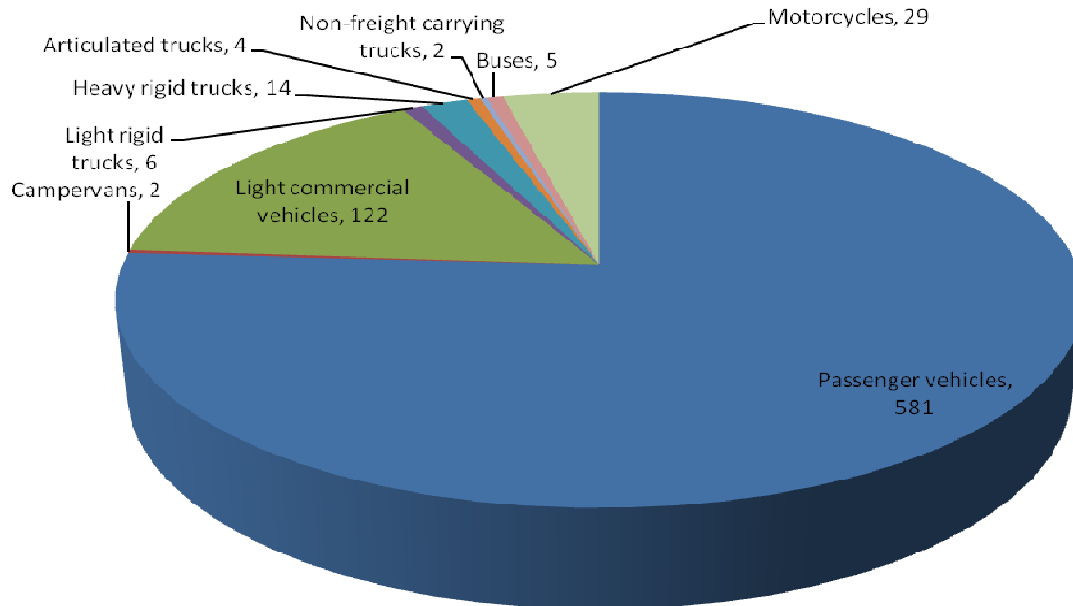


Figure 2: Registered motor vehicles at 31 March 2005–2009

Note: Rate per 1,000 of population of Ballarat municipality

Total registered motor vehicles: 765 per 1,000 population;
 extrapolated total for a 2011 population of 94,088 is 71,977 vehicles.

Rail

The diesel passenger train service from and to Ballarat as well as the rail freight services add to fuel consumption totals. The estimate for the combined diesel use by these two forms of energy services using rail that can be attributed to the Ballarat LGA is of the order of 2.5 million litres/year. This is derived from a government statistic that the emissions from diesel rail are 1.5% of the total transport emissions for the State (Victorian Government 2011).

Air

The aviation sector based at Ballarat aerodrome provides energy services including agricultural services (applications of fertiliser and agricultural sprays), flight training and business travel charters, as well as medical evacuation and aircraft servicing. The approximate figure for aviation fuel currently sold from the aerodrome is between 100,000 and 200,000 l/year, and so is not significant to our totals.

Main findings

The total fuel consumption for road transport-provided energy services within and servicing the Ballarat municipality for the 2011 was approximately 153 million litres, with about 94.2 million litres as petrol and 72 million litres being diesel.

Total energy of petrol used, at 34.7 megajoule per litre (MJ/l), is 3.27 million gigajoule (GJ), which equals 908 gigawatt hour (GWh). Total energy of diesel consumed at 37.9 MJ/l is 2.78 million GJ or 772 GWh. Aggregate energy for provision of transport services using road vehicles is 6.05 million GJ or 1,680 GWh.

Note - The report on transport energy services did not include fuel used in agriculture, forestry or mining. It also did not include specialist vehicles (crane trucks, fire engines etc.) or motorbikes. It can be assumed that the inclusion of all these sectors will add between 20 and 40 million litres to the total fuel used in 2011.

It should also be noted that to move this volume of fuel to the municipality from the Shell Refinery in Geelong using B-Doubles carrying 50,000 litres a trip would require 3700 loads a year or 14 loads every weekday. The 3700 round-trips of 120 km at 54 l/100km means that at least 240,000 litres a year is consumed just to keep the Ballarat municipality supplied with road transport fuels.

CO₂-equivalent emissions are 240 tonnes/GWh for petrol and therefore 200,000 tonnes CO₂, and 250 tonnes/GWh for diesel, and so 194,000 tonnes CO₂.

Total estimated CO₂ emissions from Ballarat municipality for energy services supplied using road transport for the 2011 year on this fuel consumption figure will be approximately 394,000 tonnes CO₂. It can be assumed this will continue to rise in step with increase in population numbers if the Ballarat municipal population continues to rely on this present pattern of supply of transport energy services.

This emission figure from energy services supplied *by road alone* (based on the data from 2009 and the given population increase of 2.1% pa) is 4 tonnes per person; already over half a tonne per head more than the world average.

Industrial energy services

Summary

Industry in Ballarat is highly diverse, and includes many enterprises that have evolved from Ballarat’s heavily industrialised past, when it was a centre for foundries, locomotive manufacture, mining and other heavy machinery. Energy services presently required by industry include provision of heating for cooking and other food processing, cooling, high temperature firing of bricks kilns and foundries, powering of lighting and electric motors for conveyors, grinders, lifts and elevators. Energy is needed for all types of welding and industrial cutting and shaping, for compressors and for freezing of large volumes of processed foods.

Energy requirements

Due to the difficulty of finding figures for industry that were as accessible and accurate as for transport totals and for domestic and commercial sectors, it has been necessary to derive industrial energy use by the difference between these two.

| Energy type | Total | Transport | Residential | Commercial & institutional | Industrial component*** |
|-------------|---------------|-----------|-------------|----------------------------|--------------------------------|
| Electricity | 72.9 MW-e* | - | 22.1 MW-e | 14.5 MW-e | 36.4 MW-e |
| Natural gas | 143.5 MW-th** | - | 62.5 MW-th | 11.4 MW-th | 69.7 MW-th |
| | | | | | |

* Source: Powercor (639 GWh [2009/10 supply])

** Source: SP Ausnet (4525.7 PJ [2010 supply])

*** Derived by subtraction

The figures shown here for the City of Ballarat tally acceptably with similar breakdown figures for the State of Victoria generally.

A good indicator of sectoral energy consumption is provided by ABARE who estimate that manufacturing and construction consumes 23.5% of final energy in Victoria. Assuming that Ballarat’s manufacturing base is roughly in line with Victoria's overall manufacturing base, the ABARE data can be used as a guide to estimate the sectoral split in Ballarat. However it is strongly recommended that a better survey be done by bringing together the major energy providers and the representative industry bodies. Obviously this sort of information is important for any planning or development.

Ballarat’s work force increased in number by 7,800 between 1986 and 2006, with much of this growth occurring in 1996 with the economic recovery following the recession of the early 1990s. During this period Ballarat experienced significant changes in workforce composition, with a decline in the proportion of employees in the manufacturing sector (from 18% in 1986 to 13% in 2006). Despite this, the number of employees in manufacturing has remained relatively stable over this period due to strong performance in specific sectors such as food processing. Examples of large manufacturing employers in Ballarat include the food sector companies Mars and McCain.

Some generalisations can be made about the types of energy used, and patterns of use, within particular industrial sectors. In the food production sector, for instance, an

approximately 30:70 split between electricity and gas use is a consistent energy consumption pattern:

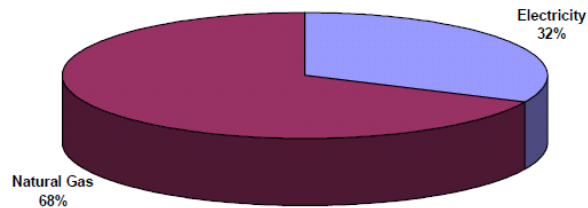


Figure 1 – Food production energy split (Sustainability Victoria 2007)

Estimates for energy uses within the food production sector are presented below:

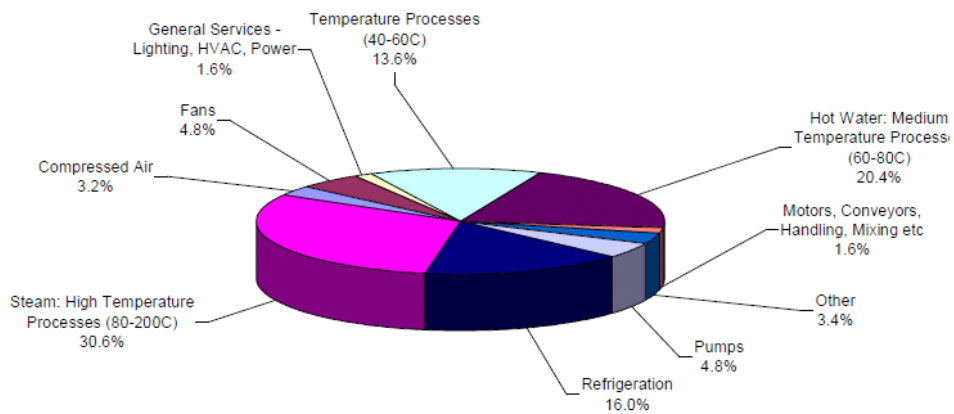


Figure 2 – End energy uses split within the food production sector (Sustainability Victoria 2007)