BALLARAT RENEWABLE ENERGY AND ZERO EMISSIONS

Ararat Aquatic Center Biomass Heating Feasibility Study

Daryl Scherger
13/06/2019

Ararat Aquatic Centre

Ararat Aquatic Center Biomass Heating Feasibility Study

Executive Summary

This study looks at the potential of biomass heating to reduce the operating costs of the Ararat Aquatic Centre. The 2018 natural gas use was 7192.72 GJ with monthly energy use and costs set out in Attachment 1. The suggested option is a 400 kW dual boiler system manufactured by Granpal Boilers in Poland and supplied by Dragon NRG. The suggested fuel is primarily locally produced straw pellets supplemented by processed green and timber waste from the Ararat Transfer Station. There may be lower cost fuel options such as processed wood waste from Ballarat or plantation residues from nearby Blue Gum plantations but these sources may not be available long term. The estimated total capital cost for the system is $441,300 with an expected annual return on investment of 9.3%.

Part of the study included looking at the potential of integrating solar PV, solar hot water and heat pumps into the proposed biomass heating system. Using a recent report by Wood & Greive Engineers on energy use at the Centre as a guide, it appears that installing 100 kW of solar PV would reduce energy costs by $27,217 and have a ROI of 14.7%. Installing 100 kW of PV would require approval from the relevant electricity distributor and this is no guaranteed. Installing both 100 kw solar PV and a heat pump system would reduce energy costs by $24,848 and have a ROI of up to 6.5% but additional heating would reduce this figure. Solar hot water has the lowest capital cost but also has a low ROI of 4%.

Background

The Ararat Aquatic Centre is located on the north side of High Street adjoining the town's CBD. The Centre comprises an indoor 25m swimming pool, spa and toddlers pool; gymnasium hall; cardio and weights areas; squash courts; two indoor basketball courts; staff administration areas; and change room amenities. It is mostly over a single level with the addition of a mezzanine area over the squash courts, mezzanine level over the gymnasium area, and lower ground floor storage areas at the back of the gymnasium under the lounge/foyer area. It has an estimated gross floor area of approximately 4800m² and a conditioned area of approximately 1315m².

The recent increases in natural gas prices has significantly increased the operating costs of the Centre and Ararat Rural City Council engaged Ballarat Renewable Energy And Zero Emissions (BREAZE) to undertake a brief study on the suitability of using biomass heating as an alternative to natural gas. Any biomass heating option should use locally produced biomass as fuel and, as Ararat is located in a major cereal growing area, wheat straw is a readily available fuel. Another lower cost option that is of interest to council staff is to use green and/or timber waste from the town's waste transfer station as fuel.

Ararat Aquatic Centre main pool

Project scope:

- Assess suitability of a biomass heating system for the center with due consideration to size, location, access for fuel delivery and storage, and capacity of the contracted center management and Council's facilities management to operate and maintain the system.
- Cost estimates for all capital elements of the project and sources of supply.
- Proposed source(s) of biomass feedstock with indicative costs for supply and delivery.
- Costs of maintenance and programmed replacement components for the proposed system
- Any recommendations for integration of existing or additional PV, Solar Hot Water or heat pumps to the proposed system.

Heating Demand

Total energy use figures for the Aquatic Centre were obtained from 2018 gas and electricity invoices for the site as provided by Ararat Rural City staff. The 2018 natural gas use was 7192.72 GJ and electricity consumption was 177,988 kWh. Monthly energy use and costs are set out in Attachment 1.

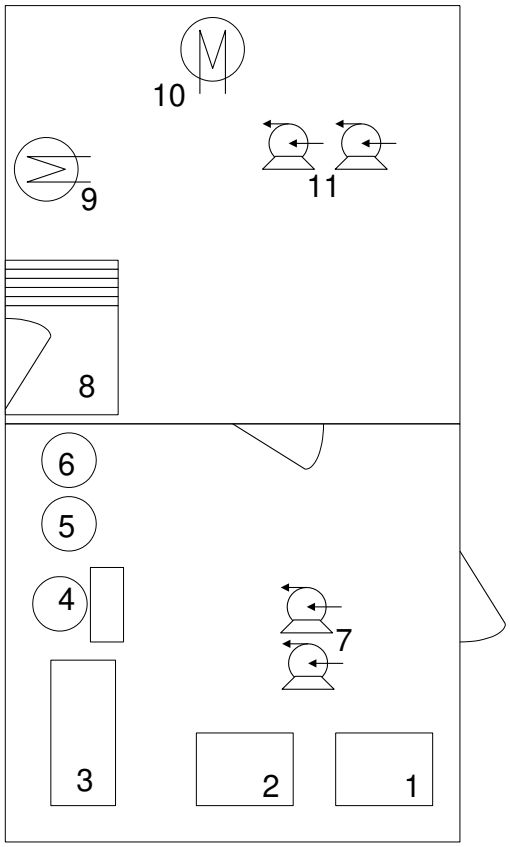
The pool water is currently heated with two 120 kW gas fired Raypak boilers via an Alfa Laval plate heat exchanger. The pool hall is heated by an air handling unit located on the roof. Hot water is supplied to coils in the air handling unit by a gas fired 380 kW Raypak 1722 boiler. The pool hall heating systems operate continuously to maintain conditions within the pool hall.

Hot water needs of the change rooms are met with two gas fired Rheem storage units, and a 54.2 kW Edwards boiler with and storage cylinder. One of the Rheem units does not appear to be

functional. Hot water for the basketball and multipurpose stadium changerooms is provided by a local indoor gas fired storage unit located in a small plantroom between the male and female change rooms.

Based on gas consumption figures, the peak heating demand including pool water, hall heating and hot water for the site is 406 kW. The minimum demand was 46 kW with an average demand of 228 kW. Biomass boilers are generally most efficient when operating at close to peak output and not able to operate effectively below around one third of their rated capacity. The recommended boiler configuration for the site is two 200 kW units operating in a cascade. One boiler would act as the primary heating source and the second only operating during the cooler months. Containerised systems are recommended as they have a lower installation cost and are easier to relocate or sell if needed. The Polish boiler manufacturer Granpal is the recommended boiler supplier as they produce containerised, multifuel boilers that are made to EU specifications. The advantage of a multifuel boiler is they allow the owner to use a range of fuel types meaning they can source fuel from a number of suppliers minimising both cost and supply issues.

Plant Room Layout



Number	Unit Description
1	Pool water heater #1 (set point 50°C)
2	Pool water heater #2 (set point 50°C)
3	Air heating (set point 70°C)
4	Auxiliary hot water heating (set point 70°C; 250 MJ/hr)
5	Auxiliary hot water heater; (turned off) tank used as storage for above
6	Backup auxiliary hot water heater (off)
7	Circulating water pumps to circulate heating water between pool heaters (1) and (2) and heat exchangers (9), (10) and spa heater (not shown)
8	Entry stairwell
9	Main pool water plate heat exchanger (Alfa Laval)
10	Toddler pool heat exchanger (Sondex)
11	Pool water pumps

Courtesy John Sanderson

Fuel Supply

According to council staff, the Ararat transfer station receives 1,800 to 2,000 cubic metres of green waste each year. Timber waste received at the transfer station currently goes to landfill but transfer station staff estimate up to 200 cubic metres could be diverted each year. A 2018 study undertaken by the Grampians Central West Waste and Resource Recovery Group (GCWWRRC) titled Woody Garden Organics Report indicated that this material can be processed to produce approximately 92 kg of boiler fuel per cubic metre of waste. This would equate to around 202 tonne of fuel per annum. Approximately 300 tonnes of additional fuel would be required to achieve the estimated 499 tonnes needed to meet sites heating needs.

Ararat Rural City Operational Services Coordinator, Norm Woodhams, reported that council paid $7.70 per cubic metre this year for green waste shredding. This works out at $61.60 per tonne for both shredding and screening using the processing cost from the GCWWRRG report. After deducting the current receival charge of $15 per cubic metre (approximately $60 per tonne) the net fuel cost is $1.60 per tonne at the transfer station. Assuming a nominal handling and delivery cost of $10 per tonne would give a net fuel cost of around $11.60 per tonne for process green/timber waste.

Pyrenees Shire and a group of local farmers has conducted a study on producing wheat straw pellets and bales for energy production. The group intends to commence producing straw pellets next year and their representative, Nick Patterson, has provided me with an indicative delivered price of $135 per tonne. If we assume an annual fuel consumption of 500 tonnes comprising 200 tonnes of green/ timber waste and 300 tonnes of straw pellets then the annual fuel cost for a biomass heating system would be around $42,820.

Other sources of fuel include wood chips from Pyrenees Timber which would cost around $150 per tonne delivered and shredded timber waste from KKC Recycling at around $80 per tonne delivered. Another unconfirmed source could be Blue Gum plantation in southwestern parts of the municipality. A recent report produced by Southern Grampians Shire titled *Bioenergy Industrial Development Feasibility Study* by Enecon Pty Ltd indicated that plantation residues could have a delivered price of around $45 per tonne or less.

Biomass Heating System Suppliers and Costs

The proposed heating system installation is comprised of four main activities: supply and install the biomass system, site works, plumbing connection from the boiler system to the existing heating system including heat exchangers and electrical connection to the boiler system. The first is supply and installation of the boiler system. The suggested technology is Granpal Boilers from Poland. Granpal is the recommended boiler supplier as they produce containerised, multifuel boilers that are made to EU specifications. The advantage of a multifuel boiler is they allow the owner to use a range of fuel types meaning they can source fuel from a number of suppliers minimising both cost and supply issues. Dragon NRG from Bendigo supply and install biomass boilers and provided the cost estimate for the boiler system proposed in this study.

The site works required for the boiler installation are significant due to the chosen site. The carpark area is on fill which batters off at the end. To minimise the loss of carparks, the containers will be located as close as possible to the property boundary above the battered fill. This will require extended footings and cross beams to securely support the containers. Ararat Rural City Operational Services Coordinator, Norm Woodhams, has suggested that Council could do the siteworks in-house and has suggested a cost of $15,000.

Due to the distance between the proposed boiler site and the pool plant room, the plumbing connection costs will be significant. An initial estimate was obtained from Poole Plumbing for the proposed pipework. The electrical supply and control system would be a relatively minor installation and an estimate for this service was obtained from Bondys Contractors.

The contact details for each potential supplier are listed in attachment 2.

Below is an indicative budget for a 400 kW biomass heating system.

Indicative Budget for Ararat Aquatic Centre 400 kW Heat Only System

ITEM	CAPITAL COST	INCOME	EXPENDITURE
2 x 200kW Granpal containerised hot water boilers	$290,000.00		
Ash removal system	included		
Fuel Storage	included		
Buffer tanks	included		
Flue	included		
Controller	included		
Coolant additive	$500.00		
Freight/shipping	$20,000.00		
Delivery Melbourne to destination	$3,000.00		
Fumigation	$500.00		
Crane/lifting equipment hire	$5,000.00		
Overseas currency charges	$100.00		
Site works and installation	$15,000.00		
Electricity connection	$12,000.00		
Heat delivery system	$50,000.00		
Commissioning	$2,000.00		
Insurance	$500.00		
Import duties	$1,000.00		
Import processing charge	$200.00		
Contingency Amount - 10% of capital cost	$40,100.00		
Plant foot print up to 80 m2			
Fuel - 500 tonnes of biomass - 300 tonne of straw pellets @ $135/tonne & 200 tonne of processed green/timber waste @ $11.60/tonne net			$42,820.00
Plant & Equipment Maintenance (2% of capital)			$8,224.00
Heating replacement value - 1,997,178 kWh @ $0.0468/kWh		$92,157.53	
TOTALS	**$441,300.00**	**$92,157.53**	**$51,044.00**
Profit	**$41,113.53**	**ROI**	**9.3%**

NB - Costings are indicative only and should not be used for investment purposes.

Site Plan of Proposed Biomass Heating Installation

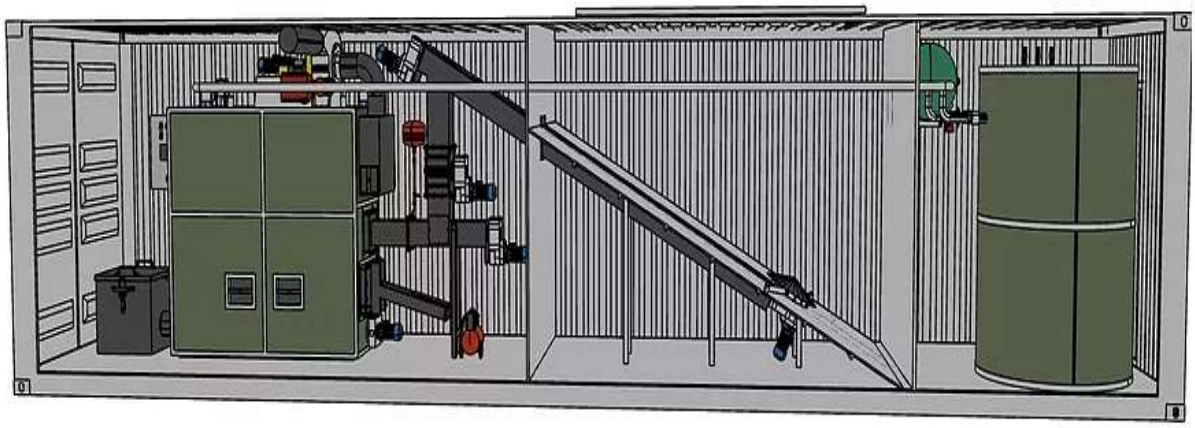
Proposed boiler installation site — Existing pool plant room

Connecting pipes - exposed ——— underground - - - - - - - 75mm I.D. insulated pipe.

Proposed installation site

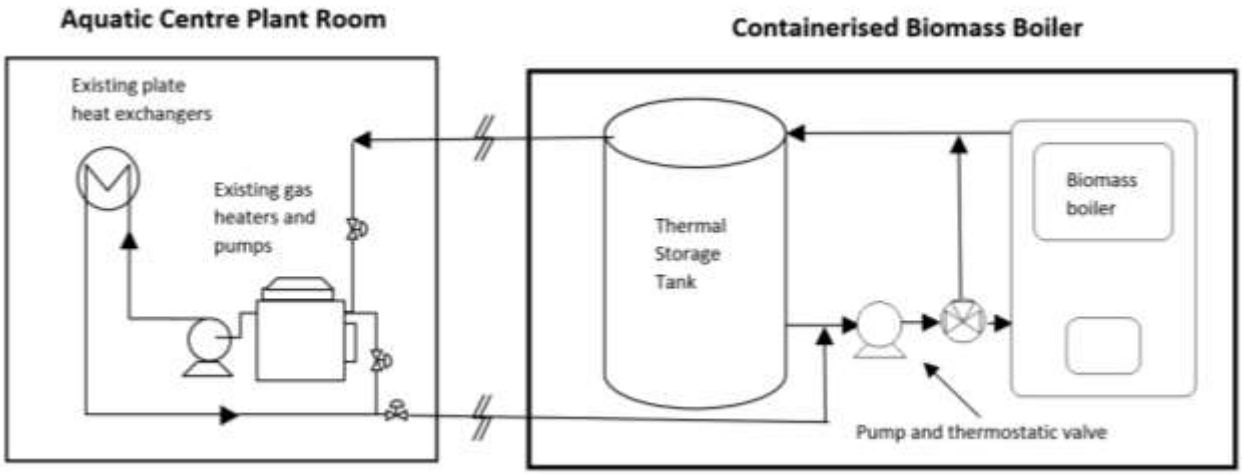
Battered fill at the eastern end of the proposed installation site.

Diagram of the proposed containerised biomass boiler system



The proposed installation will require two of these units connected in parallel.

Schematic for the integration of the biomass heating system to the pool water heating circuit.



Boiler Maintenance and Servicing Requirements

Biomass boilers require regular inspection, maintenance and servicing. Below is a table setting out a recommended inspection, maintenance and service schedule for the proposed boiler system.

Interval	Activity	Typical time required
Daily	Check boiler operation, back burn dousing system water level, fuel storage level and ash level in ash container	5 minutes
Monthly	Check heat exchanger tubes and clean if needed. Fly ash and soot can be hazardous so use PPE. Check hydraulic oil level and top up if needed.	2 to 4 hours
Annually	Full boiler service carried out by installer, usually prior to winter.	2 days
As required	Arrange and supervise fuel delivery	30 minutes to 1 hour
As required	Empty ash container and dispose of ash appropriately	15 minutes

Routine boiler maintenance normally requires the equivalent of 12 person days per year. Annual service cost is $2,000 to $4,000 plus parts/lubricants. If properly maintained, biomass boilers will last for over 20 years however the main fire box components, the grate and fire bricks, will need repair/replacement every 5 to 10 years depending on fuel type and service level.

Integrating Solar PV, Solar Hot Water or Heat Pumps

Earlier this year Ararat Rural City obtained a report on the energy use of the Aquatic Centre produced by Wood and Grieve Engineers. This report suggested installing 25 kW or 65 kW of solar PV to offset the electricity used in water pumping. The Centre currently uses 337,945 kWh of electricity per annum at a total cost of $81,444. Around three quarters of this usage is for water pumping, mainly for the pool filtrations system. This amounts to an average electricity use for pumping of 30 kW. The biomass boiler system would add up to 6 kW to this demand giving an annual pumping demand of 315,576 kWh. The 25 kW solar PV system suggested by Wood & Greive would produce up to 32,421 kWh of electricity and produce annual savings of $5,916. The 65 kW system would produce 84,296 kWh and annual savings of $15,105. There is enough roof space on the site to locate up to 100 kW of solar PV which would produce up to 129,686 kWh. Based on the

Wood & Greive report figures, the installed cost for the 100 kW system would be $185,077 and the annual saving around $27,217. This gives a ROI of 14.7%. Their report did warn that installing 100 kW of PV would require approval from the relevant electricity distributor and this is not guaranteed.

If heat pumps were used instead of a biomass boiler it would require a 400 kW system costing around $200,000 installed. Using a heat pump Coefficient of Performance of 5, the annual electricity use of such a system would be 399,596 kWh. At the current average electricity price of $0.24/kWh this option would cost $95,903 per annum. Combined with a 100 kW solar PV installation, the total cost would be around $385,077. Gas and electricity savings would amount to around $24,848 with the net energy cost being around $150,130. The ROI on this option is up to 6.5% but heat pumps require a supplementary heating system when temperatures drop below 7 degrees, which happens regularly during winter in Ararat, so the ROI is likely to be lower.

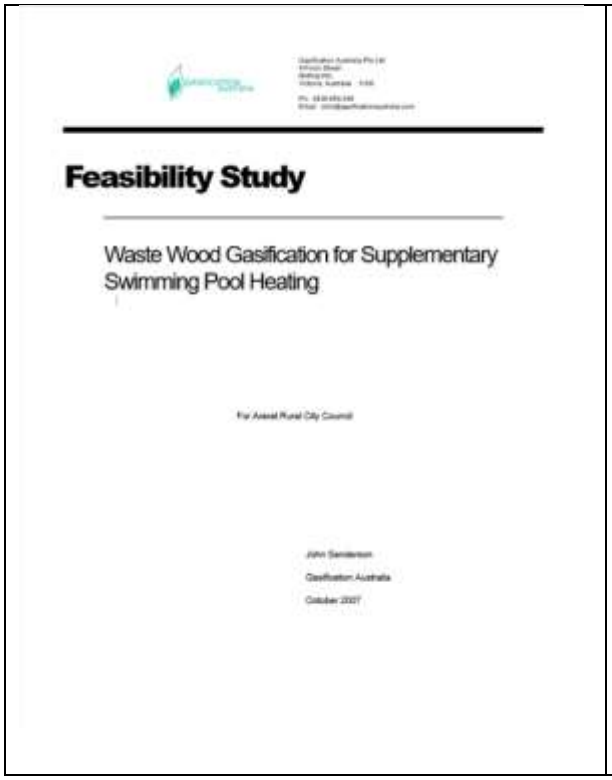
Based on information from the Apricus Solar Hot Water web site, Ararat receives around 5.8kWh of thermal insolation per square metre per day in summer. At this level of insolation around 300 square metres of solar collector would be required to meet summer pool heating needs which is estimated to cost between $30,000 and $40,000 to install. At an average fuel cost of $20/tonne, the reduction in boiler fuel use over summer would be up to $1,200. This gives a return on investment of up to 4% which is likely to be less than the life of the installation.

Attachment 1

Ararat Aquatic Centre Energy Usage

	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Total
Electricity Peak - kWh	15,782	16,423	13,426	15,093	14,954	13,627	14,524	13,676	14,442	14,062	16,865	15,114	177,988
Cost - Power only	$ 4,781.95	$ 3,673.83	3,003.40	$4,850.89	$4,804.72	4,378.36	4,434.18	$4,175.28	$3,971.55	3,867.05	$ 5,145.51	$4,617.33	$51,704.03
Electricity Off Peak - kWh	13,538	13,242	13,657	14,104	12,714	14,099	12,609	12,508	13,558	13,355	13,233	13,340	159,957
Cost - Power only	$ 2,626.37	$ 1,941.28	2,002.12	$2,692.45	$2,427.10	2,691.50	2,465.06	$2,445.31	$2,646.52	$2,606.90	$ 2,584.40	$ 2,610.64	$29,739.65
Total Electricity	29,320	29,665	27,083	29,197	27,668	27,726	27,133	26,184	28,000	27,417	30,098	28,454	337,945
Total Electricity Cost	$ 7,408.32	$ 5,615.10	$5,005.51	$7,543.34	$7,231.82	7,069.85	6,899.24	$6,620.60	6,618.07	6,473.95	$ 7,729.92	$ 7,227.97	$81,443.69
Average Electricity Use - kW per hour	39	40	38	39	38	37	36	39	38	38	40	40	
Pool Gas Use - GJ	836.38	922.22	802.82	631.36	692.46	124.24	429.73	179.84	319.54	681.70	520.08	1,052.35	7192.72
Pool Gas Only Cost	$11,316.22	$12,477.64	$7,498.34	$8,359.21	$9,168.17	1,644.94	5,814.25	$2,433.24	4,323.38	9,223.40	$ 7,036.68	$14,238.30	$93,533.75
Heating - kWh per Month	232,328	256,172	223,006	175,378	192,350	34,511	119,369	49,956	88,761	189,361	144,467	292,319	1,997,978
Hours per Month	744	744	720	744	720	744	744	672	744	720	744	720	
Heating - Average kW per Hour	312	344	310	236	267	46	160	74	119	263	194	406	**2,733**
Biomass Required - tonnes	58	64	56	44	48	9	30	12	22	47	36	73	499

References:



Feasibility Study

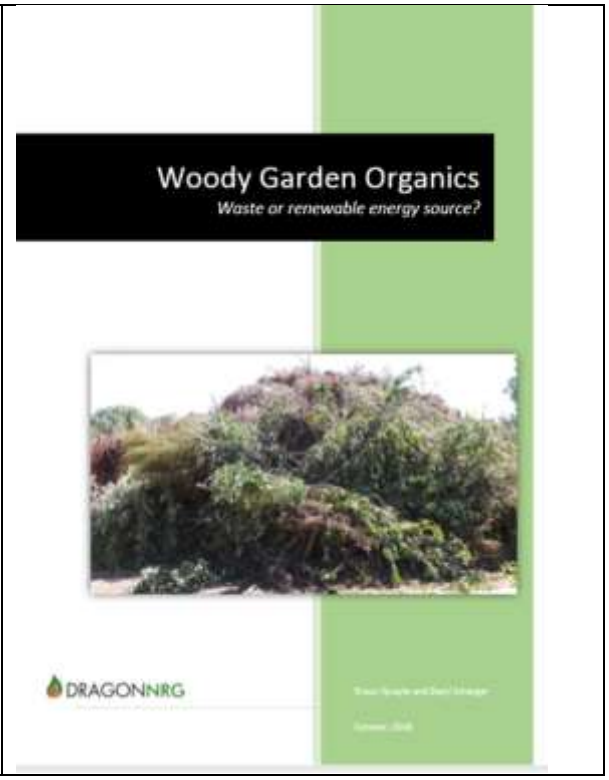
Waste Wood Gasification for Supplementary Swimming Pool Heating

For Axwell Rural City Council

John Sanderson

Gasification Australia

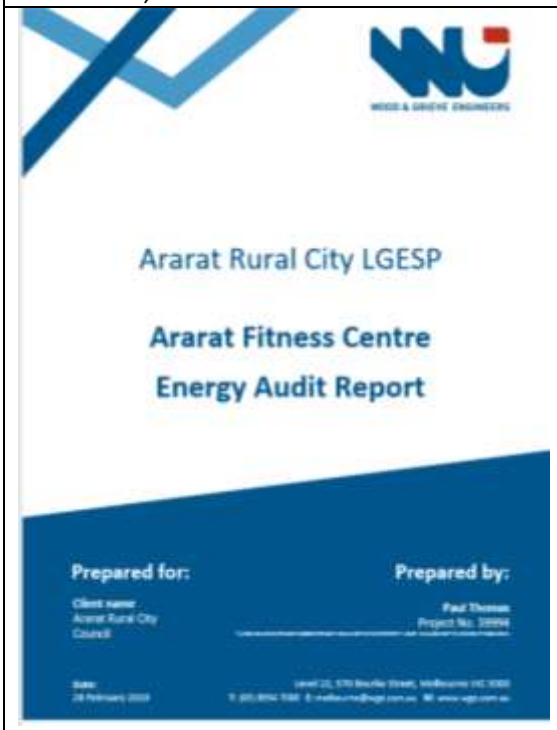
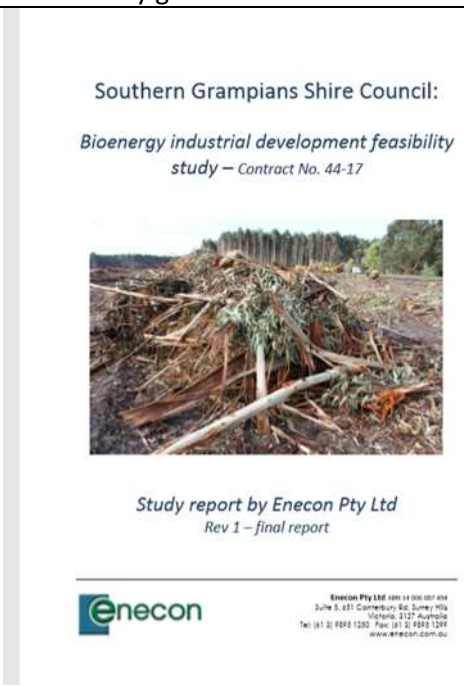
October 2007



Woody Garden Organics

Waste or renewable energy source?

DRAGONNRG

2007 feasibility study for Ararat Rural City on using wood waste gasification for supplementary swimming pool heating by John Sanderson, Gasification Australia.	2018 study by Dragon NRG for Grampians Central West Waste and Resource Recovery Group on the feasibility of producing boiler fuel from woody green waste.
 2019 Ararat Fitness Centre Energy Audit by Wood and Greive Engineers	 2019 feasibility study for Southern Grampians Shire on biomass heating/CHP by Enecon P/L