Final

Energy-from-waste micropower station network - proof of concept

11 DECEMBER 2017

PREPARED FOR

Central Victorian Greenhouse Alliance Incorporated

Report title	Energy-from-waste micropower station network - proof of concept
Client	Central Victorian Greenhouse Alliance Incorporated
Status	Final
Author(s)	Christine Wardle, Luke Richmond
Reviewer(s)	Bill Grant, Christine Wardle
Project number	P809
Report date	11 December 2017
Contract date	21 February 2017
Information current to	11 December 2017
Copyright	Central Victorian Greenhouse Alliance

Disclaimer

Blue Environment prints on 100% recycled paper

Blue Environment Pty Ltd
ABN 78 118 663 997
Suite 208, 838 Collins St, Docklands Vic 3008
Email: blue@blueenvironment.com.au
Web: www.blueenvironment.com.au
Phone: +61 3 9081 0440 / +61 3 5426 3536

Contents

Figures

Tables

Abbreviations and glossary

AD	Anaerobic digestion
AEMO	Australian Energy Market Operator
BAU	Business-as-usual
BWEZ	Ballarat West Economic Zone
CO_2e	Carbon dioxide equivalent
CPI	Consumer price index
CVGA	Central Victorian Greenhouse Alliance
DELWP	Department of Environment, Land, Water and Planning
EFTE	Equivalent full time employee
EfW	Energy-from-waste
EPA	Environment Protection Authority
ESV	Energy Safe Victoria
GHG	Greenhouse gas
kWh	Kilowatt hour
LGC	Large-scale Generation Certificate
MJ	Megajoule
MW	Megawatt
T	turbine
ViCSPA	Victorian Certified Seed Potato Authority

Summary

This report, prepared for the Central Victorian Greenhouse Alliance (CVGA), investigates the feasibility of implementing an energy-from-waste (EfW) micropower station network by six CVGA member councils: Central Goldfields, Ballarat, Hepburn, Macedon Ranges, Mount Alexander and Pyrenees. The network is predicated on expanding a small-scale anaerobic digestion (AD) facility currently being developed by Hepburn Shire Council into a regional facility.

It is proposed to develop the Hepburn AD facility on the site of the Daylesford Consolidation Facility (adjoining the transfer station), initially processing around 2,000 tonnes/year of food waste from commercial sources. Under the CVGA regional model, the Hepburn facility would process additional waste from participating councils, returning energy in the form of either gas, electricity or slurry (as a fuel for onsite AD processing) for use at nominated council buildings.

Participating councils provided data on potential waste feedstocks and energy demand at various council buildings. Sites with the highest energy consumption were identified and inspections undertaken to identify any siting issues for the three proposed infrastructure options (gas, slurry or electricity). Council buildings utilised a variety of electricity only or gas and electricity, and not all had a use for heat energy.

Waste feedstocks across the six participating councils varied by type, quantity and availability over time. Garden waste was the predominant type of feedstock available, with additional quantities of food waste, animal manure and mixed food/garden waste. Total feedstock identified ranged between 25,420 tonnes/year in 2018 and 29,080 tonnes/year by 2028. Most of the feedstock (78%) was garden waste already being recycled.

Detailed modelling was undertaken for each of the three proposed infrastructure options (gas, slurry or electricity scenarios). The feasibility outcomes summarised in Table ES1 show that:

- both the gas and slurry scenarios are only feasible for three of the six councils (Ballarat, Hepburn and Macedon Ranges)
- the electricity scenario is feasible for four councils (Ballarat, Hepburn, Macedon Ranges and Pyrenees)
- for Central Goldfields and Mount Alexander, participation is not feasible under any scenario.

Table ES1 Scenario feasibility

Council	Gas	Slurry	Electricity	Available waste (tonnes/year)
Ballarat	Feasible	Feasible	Feasible	15,100
Central Goldfields	Not feasible	Not feasible	Not feasible	500
Hepburn	Feasible	Feasible	Feasible	2,600
Macedon Ranges	Feasible	Feasible	Feasible	6,500
Mount Alexander	Not feasible	Not feasible	Not feasible	400
Pyrenees	Not feasible	Not feasible	Feasible	300

There are also differing degrees of feasibility between infrastructure options for those councils where feasibility has been identified. A regional consensus on the preferred technology would need

to be reached between participating councils; this may be at the cost of the individual benefit to some councils.

Further site investigations, central plant siting and infrastructure issues, and the strategic impact on regional arrangements were also considered and the following conclusions reached:

- To operate as a central regional facility, the Hepburn AD facility would be subject to a number of sizing and technology impacts, including additional receival infrastructure, increased throughput (from 2,000 tonnes/year to over 25,000 tonnes/year) and increased processing time as a result of the high percentage of garden waste.
- As a regional facility generating over 1 MW, the proposed Daylesford location of the central plant is unlikely to receive EPA works approval. Relocation near the Creswick transfer station may be more likely to receive approval, however this would be subject to a range of issues being addressed to the satisfaction of the EPA. The suitability of the Creswick site would also need to be further explored with additional investigations on the extent of filled land, site access, gas/electricity distribution infrastructure, available utilities and other issues.
- Proceeding with the gas scenario would require meeting regulatory approvals which are not yet in place, resulting in a significant lead time in establishing the appropriate regulatory framework (including significant time and resource costs).
- The Australian energy market is currently volatile and highly politicised; the level of future costs and feed-in tariffs/supply contracts are therefore uncertain.
- Most of the waste feedstock identified as available for processing in the proposed AD facility is already diverted from landfill. It is not eligible for renewable energy credits and avoided landfill costs do not contribute to any material degree to cost savings.
- An appropriate administrative, management and financial framework would need to be developed among participating councils.

In summary, the concept has not been demonstrated to be advantageous to all nominated councils, although the electricity scenario may provide benefit to Ballarat, Hepburn, Macedon Ranges and Pyrenees. However there is a range of regulatory, technical, financial and other risks that would need to be considered by councils in deciding whether to proceed with a regional network.

1. Introduction

The Central Victorian Greenhouse Alliance (CVGA) is an incorporated association comprising 13 local governments and works to address sustainability issues for its member councils. CVGA developed a concept to replicate initial investigations undertaken by Hepburn Shire Council on the feasibility of an energy-from-waste (EfW) facility, and implement an EfW micropower network across six member councils (Central Goldfields, Ballarat, Hepburn, Macedon Ranges, Mount Alexander, Pyrenees). CVGA commissioned Blue Environment, in association with Wood & Grieve Engineers and EnergyConsult, to explore the proof of this concept; this report outlines the findings of this investigation.

The objective of the project was to develop a business case for each of the six participating councils that would allow each council to make an informed decision on the potential for implementing an EfW micropower station in their municipality using the Hepburn EfW facility as a basis.

Investigations undertaken to develop the business case for each council included:

- consultation with participating councils and other relevant stakeholders
- analysis of waste and energy data
- assessment of relevant technology impacts
- site inspections and assessment of siting and logistical issues
- consideration of environmental, planning and regulatory requirements
- detailed financial analysis
- risk assessment
- consideration of regional framework and other related issues.

2. Project context

This section outlines the base concept developed by Hepburn Shire Council, together with additional options for participation by CVGA member councils. It also explores the regulatory and planning context to the project.

2.1 Hepburn concept

Hepburn Shire Council has undertaken previous investigations to consider the applicability of EfW to the municipality. These investigations (Wood and Grieve Engineers 2016) recommended anaerobic digestion as the most feasible EfW process for the Shire, and Hepburn is currently considering development of an anaerobic digestion (AD) facility.

The concept developed by Hepburn Shire Council proposes to establish AD technology at their Daylesford Consolidation Facility (adjacent to the Daylesford Transfer Station) to transform organic waste into energy which can help meet the electricity and heating needs of a redeveloped community hub at the Daylesford Town Hall.

The AD technology proposed to be used incorporates the following infrastructure:

- organic waste processing plant, including receiving bunker, hammer mill, macerator and slurry storage tanks
- AD cogeneration plant, incorporating a digester, methane storage tank and two micro-turbines.

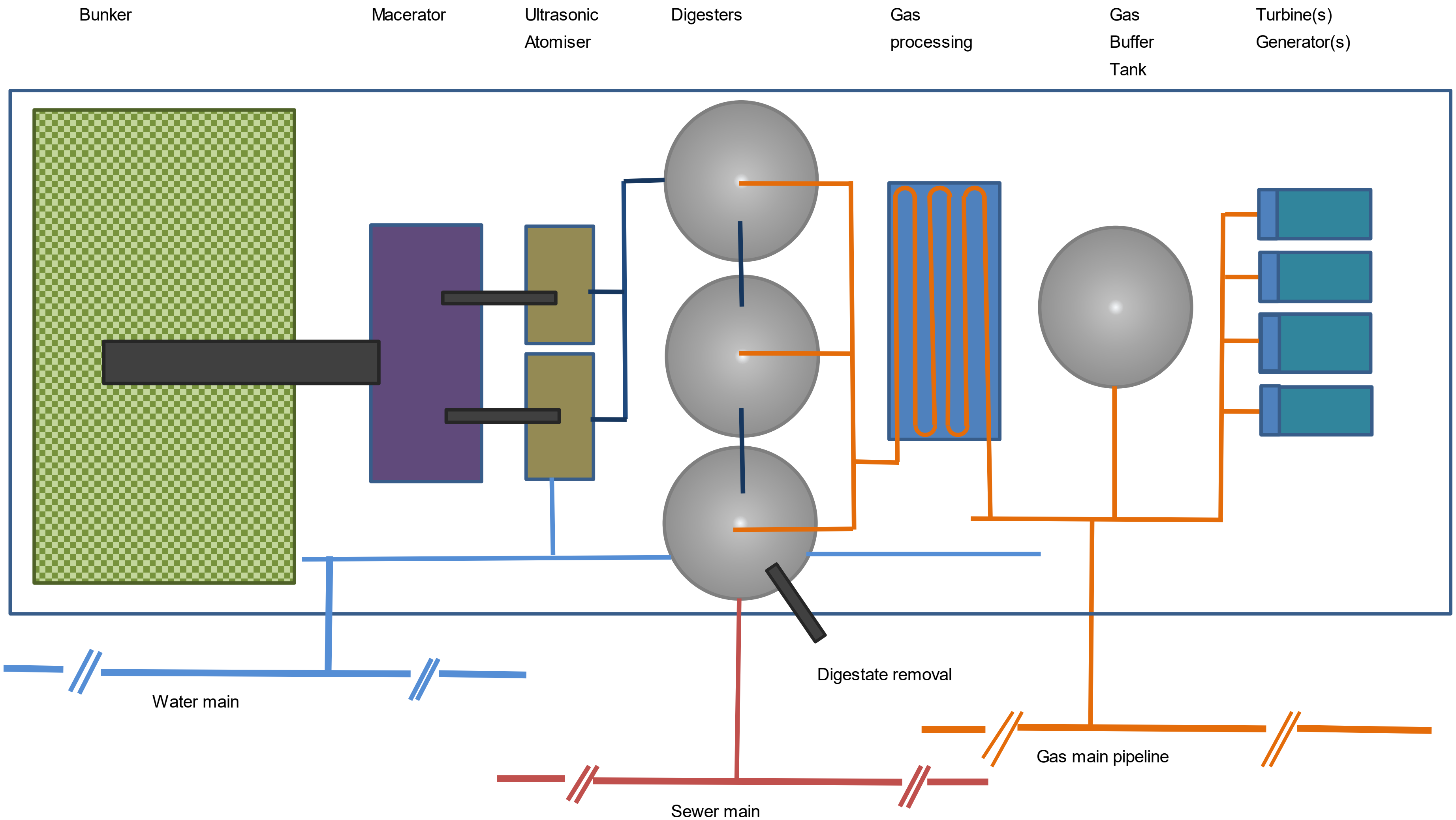
Pre-treatment of the waste feedstock would also need to ensure removal of gross contaminants such as metals and other non-organic materials, for example through the use of a magnet and trommel.

It is envisaged that the AD infrastructure would be contained within the plant room of the redeveloped community hub with additional plant situated at the Daylesford Consolidation Facility for waste sorting, treatment and slurry generation.

The AD facility would (initially) process around 2,000 tonnes/year of food waste from commercial sources. With added water, the food waste would be turned into a slurry; the slurry would be fed into the digester to produce 'biogas' (mainly methane and carbon dioxide) and digestate. The biogas would fuel the micro-turbines to produce electricity and heat, and the digestate would be processed for sale as a soil amendment.

A process flow chart for an anaerobic digestion plant in line with that proposed for Hepburn is shown in Figure 1 overleaf. Note that the process can be split depending on the configuration chosen, e.g. for a centralised facility or site-located turbine. The different configuration options are included in discussion of potential scenarios in Section 2.2.

Figure 1: Anaerobic digestion process flow chart



Note: The plant would export either electricity or gas to the main grid/pipeline but not both

2.2 Potential regional model

Under the proposed regional model, the base concept developed by Hepburn would be expanded to process additional waste from participating councils in the region. This model assumes that councils would transport their waste to a central plant in the Hepburn Shire, where pre-treatment of the waste feedstock and post-treatment of the digestate would occur.

The Hepburn model is premised on a small scale facility (2,000 tonnes/year) to handle food waste from commercial sources. The facility would utilise existing buildings at the Daylesford Consolidation Facility (currently also used by a Council contractor for consolidation of kerbside recyclables prior to transport to markets); additional infrastructure to be developed under the regional scenario includes a weighbridge (for weighing incoming loads from each council), gatehouse/site office, enclosed storage areas (for pre-treatment of waste feedstock) and traffic management/access works. However there are a number of siting, infrastructure and other issues that need to be considered to scale up the facility to meet regional needs:

- Most organic waste available from neighbouring councils is garden waste from municipal sources. This is generally higher in contaminants than food waste and requires more pre-treatment to remove metals, plastics and other non-organic waste.
- Garden waste will also require a longer residence time than food waste in the digester to optimise gas recovery. The longer residence time is likely to increase the need for storage of waste feedstock on site; together with pre-treatment and post-treatment (of digestate) requirements, the site area needed is likely to be greater than the area available at the Daylesford Consolidation Facility.
- Environment Protection Authority (EPA) planning requirements means the proposed site in Daylesford (including the consolidation facility and the neighbouring transfer station) is unlikely to be suitable for a larger regional facility (discussed further in Section 2.4).

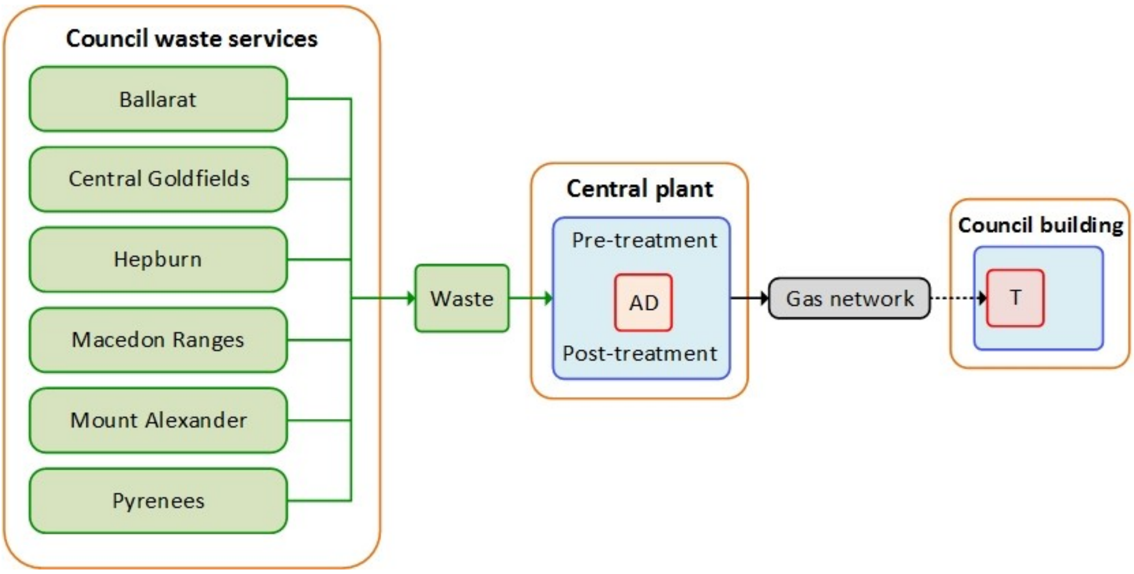
Under the regional model, the location of the AD facility and turbine may differ according to three different potential scenarios, delivering either gas, slurry or electricity as a fuel for energy production. These three scenarios are discussed below.

Scenario 1: Gas

Under this scenario, participating councils would transfer waste to the central facility in Hepburn Shire where it would be aggregated and pre-treated. The digester would be located at the central plant; biogas generated by the AD facility would go through a cleaning process to ensure it meets the requisite quality standards for direct injection into the natural gas distribution network. Each council would have a separate turbine located onsite at a council building and gas would be extracted from the distribution network in order to generate power from the turbine. This scenario is summarised in Figure 2.

It is understood that direct injection of gas from an AD facility has been undertaken before in Europe, but this project would be a first for Victoria. Direct injection was utilised by the Wingfield landfill (in South Australia) some years ago, but it ceased due to issues around gas quality and pressure.

Figure 2: Gas scenario

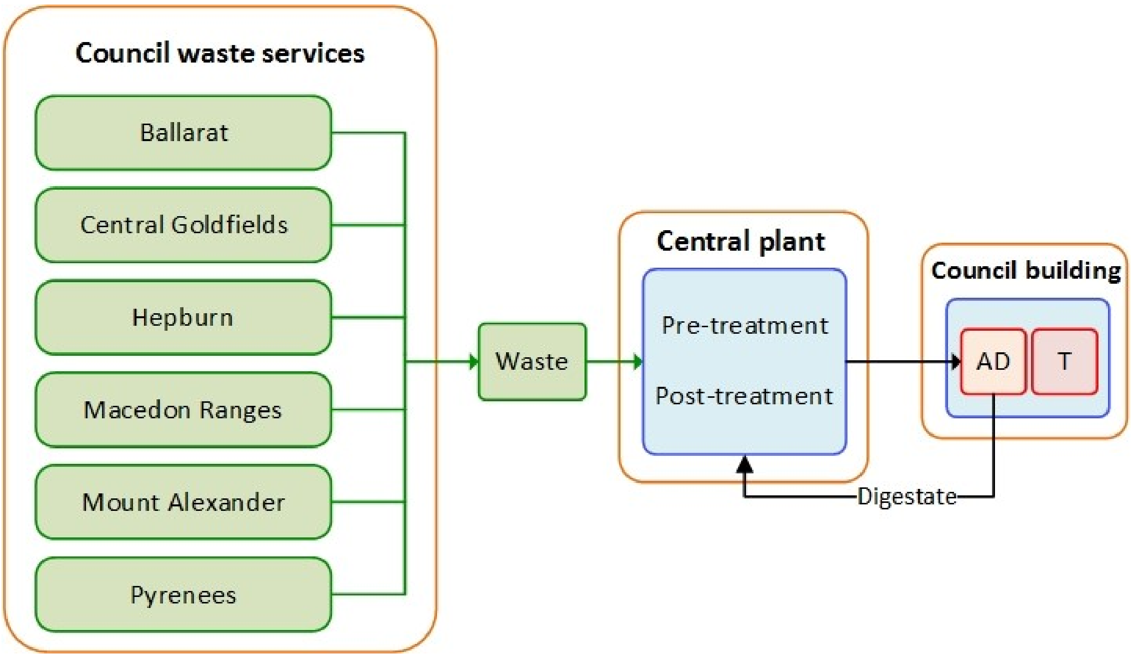


Note: AD = anaerobic digester, T = turbine

Scenario 2: Slurry

Under this scenario, participating councils would transfer waste to the central facility in Hepburn Shire where it would be aggregated and pre-treated. The output from the central plant would be a slurry which is delivered to council buildings via the road network. Each council would have an AD facility and turbine located onsite at a council building with electricity generated by the turbine used directly by the building. Digestate from the AD process would be returned to the central plant via the road network for post-treatment. This scenario is summarised in Figure 3.

Figure 3: Slurry scenario

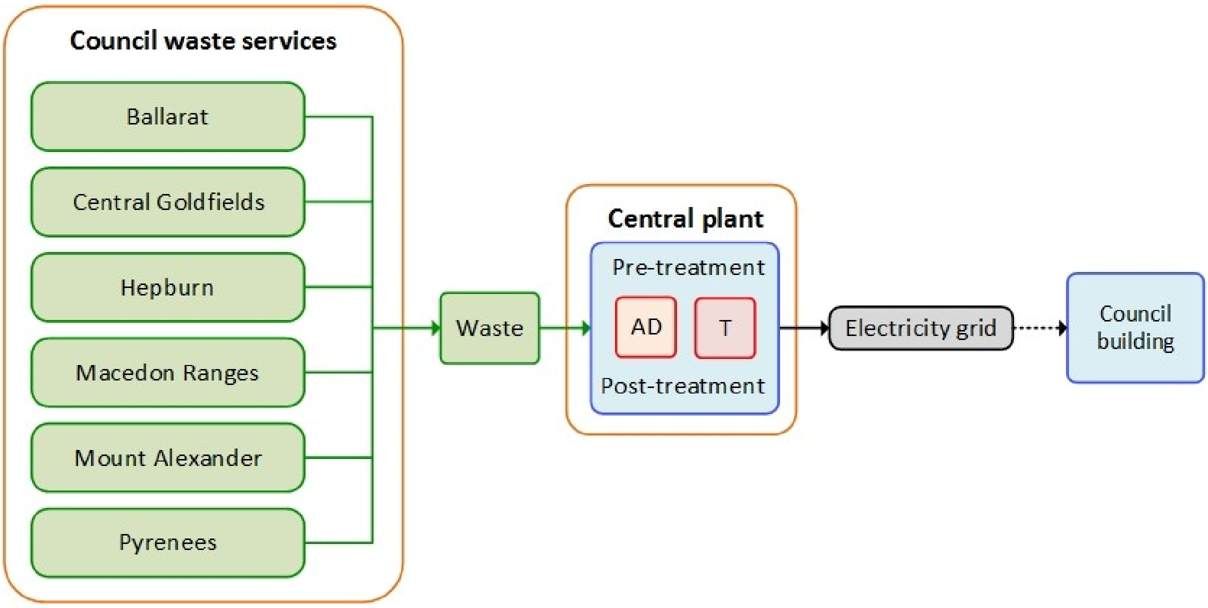


Note: AD = anaerobic digester, T = turbine

Scenario 3: Electricity

Under this scenario, participating councils would transfer waste to the central facility in Hepburn Shire where it would be aggregated and pre-treated. The AD facility and turbine would be located at the central plant and electricity generated at the plant would be feed in to the electricity distribution network. Councils would then use an equivalent share of their generation from the central plant. No onsite plant equipment would exist at council buildings. This scenario is summarised in Figure 4.

Figure 4: Electricity scenario



Note: AD = anaerobic digester, T = turbine

These three scenarios have been explored for each participating council.

2.3 Regulatory and planning issues

The EPA's *Energy from Waste Guideline* (EPA 2013a) outlines the key environmental regulatory requirements relevant to AD facilities. As the regional AD facility is expected to have a capacity of at least 1 MW, development will require EPA works approval.

Note the capacity of the Hepburn base concept is expected to fall below the 1 MW threshold and not require EPA works approval, although this would limit future growth of the facility. Similarly, if the slurry option (Scenario 2 above) was developed at each council building, the 1 MW threshold is not likely to be exceeded at each site and EPA works approval would not be required.

EPA works approval will be subject to demonstrating to the EPA's satisfaction that the facility meets best practice in a range of environmental criteria. There is an expectation that the technology is proven, and demonstrates outcomes through reference to other local or international plants that use the same technology and treat comparable waste streams on a similar scale. Based on previous experience, EPA is likely to require specific examples of the particular system, process or branded technology to be used: they are unlikely to accept generic outcomes from other AD facilities which utilise different processing systems or treat different waste streams.

The potential odour impact of organic processing facilities is generally a key concern, with food waste and garden waste classified as medium to high risk depending on source and type. Site-specific evidence based on air, noise, odour and dust modelling is likely to be required. This would need to demonstrate that surrounding land users would not be adversely impacted and that there are no off-site impacts (including impacts on groundwater and surface waters); an environmental protection and management regime would need to be established.

One key criteria to be addressed relates to siting of the facility, and the buffer distances required between the AD facility and other sensitive land uses, including residential premises. The *Energy from Waste Guideline* does not specify a required buffer distance for AD facilities and notes that EPA will assess each facility on a case-by-case basis. The nearest residence to the Daylesford Consolidation Facility is just 40 m away, and there are a number of houses within 500 m of the site. While EPA would not make a determination until presented with a works approval application, initial consultation with the EPA indicated they would be unlikely to approve a facility with a buffer distance of just 40 m.

The likely buffer distance required will be subject to a range of circumstances (including pre- and post-treatment processes and infrastructure). The EPA guideline on *Recommended separation distances for industrial residual air emissions* (EPA 2013b) also refers to a case-by-case consideration, however, in the absence of specific guidelines, indicative distances for a similar sized compost facility outlined in the *Designing, constructing and operating composting facilities* (EPA 2017) guideline range between 500 m and 1,500 m.

Digestate from the AD facility would also need to be managed in accordance with the *Environment Protection (Industrial Waste Resource) Regulations 2009.* Subject to EPA works approval for its end-use, handling of the digestate would fall within the regulated transport and tracking requirements of prescribed industrial waste. If the slurry option is used (Scenario 2), its transport and handling would also need to conform to these regulations.

The Victorian Planning Provisions note the variable threshold of different types of organic processing technologies, and refer approval back to the EPA. However other local planning requirements may apply (particularly for Scenarios 1 and 2) and these may differ for each council depending on which scenario is implemented. For example, the slurry option may involve regular truck movements to a council site, with consequent impacts of traffic, noise and potentially odour on surrounding residents and businesses. Development of an environmental management plan to address potential community impacts would demonstrate the best practice credentials of councils, regardless of planning requirements.

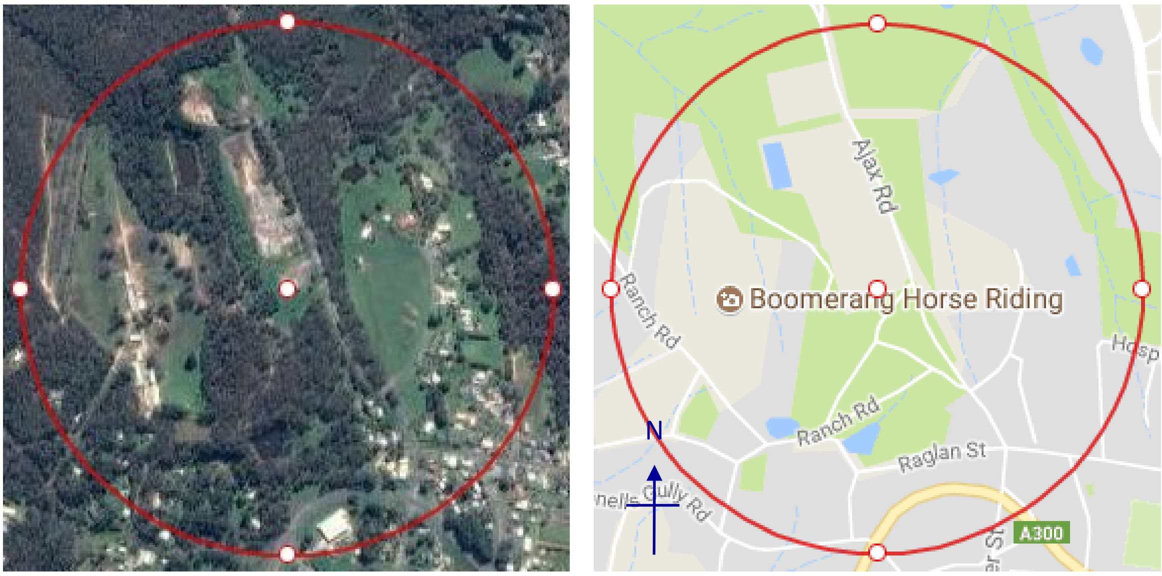
If the gas option (Scenario 1) is used, there are a number of additional requirements around cleaning and pressurising the gas for direct injection to the gas distribution network. The *Gas Safety (Gas Quality) Regulations 2007* sets out minimum safety standards for gas quality and testing of natural gas conveyed through transmission pipelines. The regulations specify gas quality standards set by Australian Standard AS4564 *Specification for general purpose natural gas*.

The *Gas Industry Act 2001* outlines the framework for gas producers, including the requisite licence for access to the distribution network, but does not specifically address the circumstances which would apply to CVGA member councils. As a Victorian first, it is understood there is no established protocol for CVGA to follow. Numerous telephone and email requests for further information and clarification from Energy Safe Victoria met with no response, however it is likely that, in the absence of an approved framework, the time and process involved in gaining the consent of Energy Safe Victoria for the gas scenario is likely to be lengthy.

2.4 Site of central plant

The expansion of the Hepburn central plant would increase the throughput from 2,000 tonnes per year of mainly high-quality food waste to over 25,000 tonnes of a waste mix that is largely dominated by garden waste (see Table 1). Daylesford Consolidation Facility or the adjacent Daylesford Transfer Station is not likely to be suitable for a regional facility with the anticipated throughput. Figure 5 shows the 500 m buffer zones around the centre of the proposed Daylesford facility. A 500 m buffer zone contains approximately 46 houses, a school holiday camp and a light commercial/industrial building. The number of residential properties within the 500 m buffer distance (with the nearest as close as 40 m) means the site is unlikely to receive EPA works approval (refer Section 2.3).

Figure 5: 500 m buffer zones around the proposed Daylesford site



Hepburn Shire has indicated that in the event that the Daylesford site is unsuitable, they will consider locating the central facility adjacent to the Creswick Transfer Station, on Ring Road, Creswick. The Creswick site was also inspected to gauge its likely suitability.

Figure 6 shows a 500 m zone around the centre of the proposed Creswick facility. There are approximately 45 residential properties and one commercial building within the zone while a light industrial building and a caravan park is located on the border of the 500 m radius.

Most of the residential properties are around 300 m away and for the most part are visually screened by vegetation and the topography of the site. There is also a creek (Creswick Creek) around 135 m from the proposed site.

There are a number of environmental protection and management issues that would need to be addressed, including protection of Creswick Creek water quality, community amenity and prevention of any other off-site impacts. Nevertheless, if fully enclosed and with appropriate environmental protection measures in place the Creswick site has greater potential to meet EPA works approval requirements than the Daylesford site.

Figure 6: 500 m buffer zone around the alternate Creswick site

The site is situated at a former putrescible landfill which closed in 2005 and is currently undergoing on-going monitoring and maintenance. The area of filled land is not currently known but inspection indicated a preferred location at the site (shown by the blue rectangle in Figure 6 above) due to limitations of the topography of other areas of the site. If the central plant is built on filled land, infrastructure stability concerns may lead to higher construction costs; there may also be limitations on the depth to which excavations (e.g. for roads, weighbridge and storage bunkers) can be made, as these may adversely impact on the integrity of the landfill cap.

Development of the central plant in this location would also entail significant costs to establish utilities at the site (e.g. electricity, water, sewerage) as these are not currently in place.

Suitable access to the site would also be limited to the north-west, as access from the north incorporates a causeway over Creswick Creek which may be underwater for part of the year and would not be suitable for large trucks.

The feasibility of the site for Scenario 1 and Scenario 3 is also uncertain, as the distance to the nearest gas and electricity transport networks is not known.

More detailed site investigations would need to be undertaken by Hepburn Shire Council to determine the feasibility of establishing an AD facility at this site, however for the purposes of this project we have assumed that the central plant would be located at the Creswick site.

3. Methodology

This section outlines the methodology of the project investigations and modelling undertaken.

3.1 Input data

Waste feedstock

From each participating council, waste data was requested covering:

- the type and monthly quantity of organic waste collected from kerbside services
- the type and monthly quantity of organic waste deposited at transfer stations
- the type and quantity of organic waste from other council managed sources or from known commercial generators
- the short and long-term availability of those waste quantities including current contractual arrangements (term and expiry dates)
- planned service introductions or expansions (for example, adding food organic collections to existing garden organics collections)
- current material pathways and management/disposal points
- current per tonne costings for:
  - waste disposal to landfill (gate fees)
  - collection, transport and reprocessing of kerbside organic waste
  - reprocessing of transfer station organic waste (including any income received on reprocessed material sale).

The main types of organic waste available nominated by councils was animal manure, separated food waste, separated garden waste and mixed food and garden waste. The quantities of these wastes available over time are presented in Table 1.

Table 1: Total waste type and quantities available from participating councils

Waste type	2018	2023	2028
Animal manure	260	260	260
Food waste	2,000	2,000	2,000
Garden waste	19,800	21,330	22,920
Mixed food and garden waste	3,350	3,620	3,900
Total	**25,420**	**27,210**	**29,080**

Quantities of waste collected from municipal sources (garden waste and mixed food and garden waste) are estimated to increase in line with population projections (as sourced from *Victoria in Future,* DELWP 2016). Quantities of animal manure are sourced from stock sale yards and separated food waste from commercial generators and so are unlikely to change.

We note that all garden waste (around 78% of total waste identified) was diverted for mulching and not deposited to the region's landfills.

Energy demand

Participating councils were asked to examine historical energy demand at council managed buildings and provide a prioritised list (and the accompanying data) based on those with the largest electricity and/or gas usage. Each council provided data for at least one building and at least a full year's worth of data. Table 2 shows the number of facilities and the type of data that was provided by each council.

Table 2: Number of facilities for which councils provided data

Council	Type of energy data provided			
	Electricity only	Gas only	Electricity & gas	Total
Ballarat	-	10	2	12
Central Goldfields	1	2	1	4
Hepburn	4	-	4	8
Macedon Ranges	4	-	4	8
Mount Alexander	-	-	2	2
Pyrenees	1	-	-	1
Total	**10**	**12**	**13**	**35**

In total, data for 35 buildings were provided by participating councils with a combined average annual energy demand of 5,999,000 kWh (or 5.99 GWh) and 60,806,000 MJ (or 60.81 TJ). Using the information and data provided, we examined which buildings had the highest average annual energy demand which would be appropriate for further consideration in project analysis. Table 3 shows the average annual energy consumption for electricity and gas at each council's highest consumers of energy.

Table 3: Annual energy consumption at highest consumer sites

Council	Building	Annual consumption	
		Electricity (kW/year)	Gas (MJ/year)
Central Goldfields	Maryborough Recreation Centre	302,200	5,643,900
Ballarat	Ballarat Aquatic Centre	1,671,300	21,400,600
Hepburn	Town Hall	62,700	410,700
Macedon Ranges	Kyneton Aquatic Centre	1,357,300	8,158,800
Mount Alexander	Civic Centre	89,100	594,300
Pyrenees	Beaufort Shire Office	110,600	No gas

Several councils nominated recreation or aquatic centres as their highest consumers of energy, reflecting the large energy loads required to maintain air and particularly water temperature at these facilities.

Site inspections

Each of the sites in Table 3 was inspected in May-June 2017 to check site logistics, energy connections, access and general feasibility of either of the gas or slurry scenarios. This included the potential placement of one or two shipping containers (which would contain the AD and/or turbine).

The site inspections identified the approximate distance between gas meter and potential container locations, aiming to minimise the distance and connection costs where practicable. Key changes required to existing infrastructure (e.g. for access or security purposes) were also identified.

Note under the electricity scenario (refer Figure 4) no site infrastructure would be required at the council building, as electricity would be purchased from a retailer using existing electrical connections.

3.2 Modelling

A Microsoft Excel spreadsheet was developed to model the business case for participation by each council. The spreadsheet accompanies this report.

Analysis of waste data

The data received from each council varied in format and where necessary was converted to provide standardised figures. Where organic waste data was provided on a monthly basis, we conducted analysis to estimate the seasonal variation of waste tonnages throughout the year. This figure was used in considerations for sizing of plant equipment.

Projections of future waste quantities for kerbside and drop-off tonnes were based on population projections included in *Victoria in Future* (DELWP 2016). Projections for waste from other council operations or commercial sources were based on a waste-by-waste basis. For each council, future waste projections were summarised between 2018 and 2028 for each waste type. The total waste types and quantities available for input from each council to a central facility were also summarised.

Total waste quantities and types for each council were used in modelling, in conjunction with estimated biogas yield, to estimate cost-sharing arrangements associated with the central plant capital and ongoing costs and income. As a result, each council's share is not only dependent on the quantity but also the type of materials they contribute to the central plant. The potential biogas yield from different material types was based on standard values and presented in Table 4.

Table 4: Standard waste type reference values used in modelling

Waste type	Biogas yield m³/tonne waste	Emission factor $kgCO_2$/kg waste	Waste densities	
			kg/m³	m³/t
Animal waste slurry	20	0.5	720	1.4
Animal manure	60	0.5	870	1.1
Cafe/restaurant waste	140	1.9	500	2.0
Fats	1,000	1.5	610	1.6
Food waste	135	1.9	500	2.0
Garden waste	130	1.4	240	4.2
Lawn clippings	125	1.6	300	3.3
Leaves	420	1.5	100	10.0
Mixed organic waste	133	1.7	800	1.3
Municipal organic waste	160	1.2	340	2.9
Processed slurry	160	0.0	800	1.3
Straw	290	1.5	100	10.0
Used grease	250	1.5	610	1.6

Analysis of energy data

Monthly electricity and gas consumption data was requested from councils for a minimum time period of one year for the highest consuming council owned buildings. Data was provided by councils across a range of time periods and combinations of electricity only, gas only or electricity and gas together (see Table 2). Where data was provided for multiple years, the average monthly and yearly consumption was calculated. The average yearly consumption was then used to compare council buildings and identify the highest consumers of gas and electricity.

Collation of reference values

A range of reference values were collated to provide consistent data for each council's analysis. These included:

- **Central and on-site plant costs.** Provided by Wood & Grieve Engineers on a per kW, per m² of plant area, per tonne per day, per m³ of material holding volume or as fixed figures. Figures were provided for individual items in a waste processing plant, gas production plant, electrical generation plant and for labour and design works.
- **Waste type biogas yield.** Used to estimate the volume of biogas expected from individual waste types based on m³ of gas per tonne of waste. Some figures provided by Wood & Grieve Engineers and others collated from external references (as noted in the model) (see Table 4).
- **Waste type emission factors.** Used to estimate expected greenhouse gas emissions from individual waste types based on $kgCO_2$-e per kilogram of waste. Some figures provided by Wood & Grieve Engineers and others collated from external references (as noted in the model) (see Table 4).

- **Waste density factors.** Used to convert waste volume data into tonnes and tonnes into volumes for different individual waste types. Some figures provided by Wood & Grieve Engineers and others collated from external references (as noted in the model) (see Table 4).
- **Central plant gate fee.** The "default" central plant gate fees were based on estimates provided by Hepburn Shire Council which they used in modelling of the small scale central plant. An alternate gate fee (called "break-even") was calculated in modelling as the per tonne cost payable by each participating council (Hepburn included) to ensure that the central plant is operated on a cost neutral break-even basis.
- **Electricity cost and feed-in tariff.** The future projected cost of electricity, in dollars per kWh, is highly variable and dependent on wholesale prices, network prices and assumptions of future generation sources. In projecting future unit costs we used the Australian Energy Market Operator (AEMO) publication *Retail electricity price history and projections* (2016), in particular "Figure 20: Comparison of Victorian retail prices by scenario and market" and the commercial neutral scenario. In order to highlight the uncertainty associated with electricity unit costs we also modelled the effect of using a projection from the recent *Report to the Independent Review into the Future Security of the National Electricity Market* (Jacobs 2017), in particular "Figure 33: Average NEM retail prices by customer class, BAU". This projection was released as part of the Independent Review into the Future Security of the National Electricity Market, also known as the Finkel Review. Although more recently published, this projection predicts lower electricity prices into the short and long-term which, in reality, may already be surpassed by short-term price increases as publicised by electricity distributors. For this reason, the AEMO (2016) projection was assessed as being more accurate.
- The future expectation for **Large-scale Generation Certificates** (LGCs) and income received from feed-in tariffs was based on assumptions used by Hepburn Shire Council in modelling of the small-scale plant. These were sourced from Powershop Australia, who have indicated an interest in purchasing electricity (and potentially gas) from the proposed facility. According to EnergyConsult, these projected figures are reasonable given future supply and demand and energy market projections.
- **Gas cost and supply contract.** The future projected cost of gas, in dollars per megajoule (MJ), was based on information from councils on the retail cost of gas in their most recent billing period and projected into the future based on an index of projected wholesale gas prices as presented in Jacobs (2017) (see Figure 14 on page 40 of that report). As advised by EnergyConsult, wholesale gas prices contribute around one-third to the total retail gas price and is a good indicator for price changes in the retail market. Future projections of a hypothetical supply contract for gas proved difficult to estimate as there is a lack of data available around current arrangements (where they exist). However, it is expected that the per unit income received from a gas supply contract would be equal to a proportion (assumed to be around 80%) of the projected wholesale gas price (used above to project retail gas prices).
- **Transport costs.** Transport costs were based on cost per minute, average speed, average load (tonnes) and average loading and unloading times for different waste handling vehicles.
- **Digestate yield volume.** The expected yield of digestate following anaerobic digestion is dependent on the mix of material type entering the digestion plant. A brief literature review was conducted to estimate the percentage yield of digestate following anaerobic digestion.

Estimate of central plant expansion costs

The original plan for a central facility slated by Hepburn Shire was for a plant that would accept around 2,000 tonnes of mainly food waste for slurry generation or anaerobic digestion to gas or electricity. Studies into the feasibility of the small central plant have largely been completed and any expansion of the central plant would need to be funded by external parties wishing to make use of the infrastructure.

In order to estimate the capital costs associated with expanding the central plant to accept waste from other councils it was first necessary to estimate the costs associated with the small central plant based on waste volumes of 2,000 tonnes per year. The capital costs associated with the expanded central plant were then estimated based on 2018 waste quantities (around 25,400 tonnes) with a seasonality factor applied, estimated to be 127% of average waste figures (effectively a plant sized to accept around 32,200 tonnes per year). The total estimated capital cost of the Hepburn only central plant was then subtracted from the total estimated capital cost of the expanded central plant in order to calculate the costs associated solely with expanding the central plant to accept waste from other councils. This estimate was used along with the estimate of each council's share of costs and income (based on waste quantity, type and biogas yield) to apportion the capital cost to each participating council. Capital costs are either paid by each council on a total upfront or a cost per tonne per year basis (separate to ongoing management gate fees).

For both the small and expanded central plant, capital costs were estimated for:

- Waste processing plant: including processing enclosure (building); waste delivery storage hopper; waste pre-processing sorting equipment (filters and grates); waste handling augers, hoists and conveyors; mechanical macerator or compactor; ultra-sonic waste processor; general waste buffer storage; liquid "fuel" holding tank (no digestion); liquid pumping station; and digestate post-treatment.
- Gas production plant: including digester tanks (holding tanks); control system, sensors and instrumentation; miscellaneous pipework, valves, safety devices; methane storage; natural gas connection and metering (importing only); flueing and flaring; aborted fuel management (dumping and pumping); digestate processor and auger; gas export pressurisation equipment; gas export safety; and miscellaneous and gas export network approvals.
- Electrical generation plant (microturbine): including microturbine or reciprocating engine; switchboards and electrical infrastructure; transformers; control systems; electrical approvals; heat exchanger or dump radiator (where heat energy will be retained).
- Labour and design works: including design works; design contingency; miscellaneous labour; project management; commissioning works; and tuning, verifications, modification and handover.

Costs were based on a cost per kW, per m^2 of plant area, per tonne per day, per m^3 of material holding volume or as fixed figures. The majority of costs associated with labour and design works were based on a percentage of the capital expenditure or size of plant. All plant cost data was provided by Wood & Grieve Engineers.

Ongoing costs were estimated for individual line items which cover each aspect of the expanded central plant's operation. These were assessed as:

- Staffing, estimated as a proportion of an effective full-time employee and a set salary per year. Staffing requirements were estimated to be different for each central plant configuration.
- Maintenance, estimated as a percentage of the total capital costs.
- Treatment or disposal of digestate, estimated as either:
  - the cost of disposal of digestate to landfill
  - treatment of digestate to a soil amendment product for sale (estimated as cost and potential income)
  - sale of digestate without treatment (this option is unlikely due to EPA regulations).

- Disposal of contamination, estimated as the cost to dispose of waste to landfill based on an assumed proportion of all incoming materials to the central plant.

The total ongoing costs for each plant type were summed and divided by the total waste entering the plant to estimate a "break-even" gate fee which would allow the central plant to be run at cost-neutral. This gate fee can be interchanged in place of the "default" gate fee estimated in initial Hepburn Shire modelling.

Ongoing income/offsets were estimated for individual line items which cover aspects of the central plants output. These were assessed as:

- External capital funding: input was allowed if the central plant were to receive external funding (for example from the Victorian Government) for plant capital costs.
- Gate fee received on incoming waste: estimated as the fee councils would pay per tonne of waste entering the plant. The gate fee can be selected as either the "default" or "break-even".
- Sale of processed digestate (split amongst councils). The income from the sale of processed digestate would not be attributed directly to the central plant but shared between councils based on the cost-sharing arrangements noted earlier.
- Feed-in tariff and LGCs for electricity generation export (split amongst councils). The income from feed-in tariffs and LGCs would not be attributed directly to the central plant but shared between councils based on the cost-sharing arrangements. The income for this item was calculated as the estimated electrical output of the plant (kWh/year) multiplied by the combined estimated value of feed-in tariffs and LGCs on a dollar per kWh basis.
- Supply contract for gas generation and export (split amongst councils). The income from the supply contract would not be attributed directly to the central plant but shared between councils based on cost-sharing arrangements. The income for this item was calculated as the estimated gas output of the plant (MJ/year) multiplied by the estimated value of a gas supply contract on a dollar per MJ basis.

Estimating onsite plant outputs

An initial estimate of potential onsite plant sizing was conducted based on the maximum outputs for each council from the central plant. This provided a value for maximum possible engine capacity and annual electricity production. Using this data, an estimate of the required inputs needed to maintain a turbine (or multiple turbines) of a particular size were derived. Turbine sizing for each council was based on the potential outputs from the central plant and the energy requirements for selected buildings. Turbines were allocated based on multiples of 65 kW microturbines (65 kW for one turbine, 130 kW for two turbines, etc).

The potential electricity generation of an onsite plant was then compared with electricity consumption at council buildings in order to determine the most appropriate site. Council sites were selected based on their total energy consumption.

For the gas and slurry scenarios, a range of assumed values around plant operational abilities (recommended by Wood & Grieve Engineers) were applied to material/energy supply figures to estimate the total energy output of onsite plant, the most relevant figures being daily and annual electricity generation. This data was then used to estimate the costs associated with each of the alternate scenarios.

Estimating the alternate scenario: gas

The capital costs, ongoing costs, offsets and income were estimated for the alternate scenario involving a central waste processing and AD plant exporting gas to the network with a microturbine situated on-site at a council facility.

Onsite plant capital costs were estimated for:

- Electrical generation plant (microturbine): including grid connection; turbine; switchboards and electrical infrastructure; transformers; control systems; electrical approvals; heat exchanger or dump radiator; and heat reticulation (where heat energy will be retained). Costs were estimated on a per kW basis so that the total cost of different scales of plant could be assessed at different councils. All plant costings data were provided by Wood & Grieve Engineers.
- Labour and design works: including design works; design contingency; miscellaneous labour; project management; commissioning works; and tuning, verifications, modification and handover. The majority of costs associated with these items are based on a percentage of the capital expenditure or size of plant.

Ongoing costs and income/offsets were estimated for individual items covering each aspect of the alternative business case for gas. The ongoing costs associated with the on-site gas turbine option were assessed as:

- Contribution to central plant capital, either as a single year lump sum fee or a per tonne per year fee charged in addition to a separate gate fee.
- Cost of replacement material, estimated as the purchase cost required to replace reprocessed organic material used by council in council operations.
- Waste transport costs, estimated as the cost of transporting kerbside waste (once a collection truck is full) from major town centres to the central plant plus the cost of transporting transfer station drop-off waste to the central plant. Transport costs were based on cost per minute, average speed, average load (tonnes) and average loading and unloading times for different vehicle types as well as estimated distances and tonnage quantities.
- Gate fees charged for use of central plant, charged as either the “default” gate fee value used in modelling by Hepburn Shire or as the “break-even” gate fee to ensure that ongoing costs at the expanded central plant are shared equally between all parties involved.
- Cost of gas from network, estimated as the total cost of gas required to operate the onsite turbine.
- Cost of electricity to cover shortfall in generation, estimated as the total cost of electricity to cover the shortfall between on-site turbine generation and the total requirements of the building (for example, if a building uses 100 kWh per year and an on-site turbine will generate 75 kWh per year, a council would still be required to pay for electricity to cover the remaining 25 kWh per year).
- Staffing, estimated as a proportion of an effective full-time employee and a set salary per year.
- Maintenance, based on estimates provided by Hepburn Shire that a single microturbine has annual maintenance costs of $15,000.

The ongoing income and offsets associated with the on-site gas turbine option were assessed as:

- External capital funding for plant. Input was allowed if any councils were to receive external funding (for example from the Victorian Government) for plant capital costs.
- Offset cost of business-as-usual (BAU) waste management. Estimated as the offset cost of avoided waste to landfill, avoided transport and reprocessing (gate fee) costs for kerbside waste

and avoided cost of reprocessing transfer station drop-off waste (income from reprocessed materials was also considered to estimate a net cost).

- Offset cost of energy use. Estimated as avoided electricity cost (as a result of turbine generation), income from surplus electricity generation and share of income from central plant gas generation.
- Share of income from processed digestate. Estimated as the share of income received from the reprocessing of digestate into a saleable product at the central plant.

Estimates of ongoing costs and ongoing income/offsets where combined to provide a year-by-year net estimate of costs/benefit. Where this figure was negative, the ongoing costs were estimated to be greater than the income/offsets and vice versa. Combined with the initial capital cost, the estimated payback period was calculated.

Estimating the alternate scenario: slurry

The capital costs, ongoing costs, offsets and income were estimated for the alternate scenario involving a central waste processing plant with slurry transported to an AD plant and turbine situated on-site at a council facility. On-site capital costs were estimated for:

- Gas production plant: including liquid pumping station; liquid "fuel" holding tank (no digestion); digester tanks (holding tanks); control system, sensors and instrumentation; miscellaneous pipework, valves, safety devices; methane storage; natural gas connection and metering (importing only); flueing and flaring; aborted fuel management (dumping and pumping); and digestate processor and auger.
- Electrical generation plant (microturbine): including turbine; switchboards and electrical infrastructure; transformers; control systems; electrical approvals; heat exchanger or dump radiator; and heat reticulation (where heat energy will be retained). Costs were estimated on a per kW basis so that the total cost of different scales of plant could be assessed at different councils. All plant costs were provided by Wood & Grieve Engineers.
- Labour and design works: including design works; design contingency; miscellaneous labour; project management; commissioning works; and tuning, verifications, modification and handover. The majority of costs associated with these items are based on a percentage of the capital expenditure or size of plant.

Ongoing costs and income/offsets were estimated for individual items which cover each aspect of the alternative business case for slurry. The ongoing costs associated with the on-site AD plant and gas turbine option were assessed as:

- Contribution to central plant capital, either as a single year lump sum fee or a per tonne per year fee charged in addition to a separate gate fee.
- Remaining BAU costs. Under the slurry model, all waste generated by council may not be sent to the central plant to be converted into a slurry as on-site digestion and turbines may not require a quantity of slurry that is matched by waste inputs. That is, only the quantity of waste required to produce enough slurry to ensure continuous energy generation at the on-site plant would be sent to the central plant. Excess waste would be managed via current BAU methods.
- Cost of replacement material, estimated as the purchase cost required to replace reprocessed organic material used by council in council operations.
- Waste transport costs, estimated as the cost of transporting kerbside waste (once a collection truck is full) from major town centres to the central plant plus the cost of transporting transfer station drop-off waste to the central plant. Also included is the cost of transporting slurry from the central plant to the on-site plant at a council facility. Transport costs were based on cost per

minute, average speed, average load (tonnes) and average loading and unloading times for different vehicle types as well as estimated distances and tonnage quantities.

- Gate fee charge for use of central plant. Charged as either the default gate fee value used in modelling by Hepburn Shire Council or as the break-even fee to ensure that ongoing costs at the expanded central plant are shared equally between all parties involved.
- Cost of electricity to cover shortfall in generation, estimated as the total cost of electricity to cover the shortfall between on-site turbine generation and the total requirements of the building. For example, if a building uses 100 kWh per year and an on-site turbine generates 75 kWh per year, a council would still be required to pay for electricity to cover the remaining 25 kWh per year.
- Staffing, estimated as a proportion of an effective full-time employee and a set salary per year.
- Maintenance, based on estimates provided by Hepburn Shire Council that a single microturbine has annual maintenance costs of $15,000.
- Treatment or disposal of digestate, estimated as the cost of transport and gate fee for reprocessing (at the central plant) or disposal (to landfill) of digestate originating from the on-site plant.

The ongoing income and offsets associated with the onsite AD plant and gas turbine option were assessed as:

- External capital funding for plant. Input was allowed if any councils were to receive external funding (for example from the Victorian Government) for plant capital costs.
- Offset cost of BAU waste management. Estimated as the offset cost of avoided waste to landfill, avoided transport and reprocessing (gate fee) costs for kerbside waste and avoided cost of reprocessing transfer station drop-off waste (income from reprocessed materials was also considered to estimate a net cost).
- Offset cost of energy use. Estimated as avoided electricity cost (as a result of turbine generation), income from surplus electricity generation and share of income from central plant gas generation.
- Share of income from processed digestate. Estimated as the share of income received from the reprocessing of digestate into a saleable product at the central plant.

Estimates of ongoing costs and ongoing income/offsets were combined to provide a year-by-year net estimate of costs/benefit. Where this figure was negative, the ongoing costs were estimated to be greater than the income/offsets and vice versa. Combined with the initial capital cost, the estimated payback period was calculated.

Estimating the alternate scenario: electricity

The capital costs, ongoing costs, offsets and income were estimated for the alternate scenario involving a central waste processing, AD and turbine plant exporting electricity to the network. This option does not require on-site infrastructure and as a result the only capital costs attributed to the scenario are those associated with the central plant. These costs are either paid as a single year lump sum fee or a per tonne per year fee charged in addition to a separate operational gate fee.

Ongoing costs and income/offsets were estimated for individual items which cover each aspect of the alternative business case for electricity. The ongoing costs associated with the central plant electricity option were assessed as:

- Cost of replacement material, estimated as the purchase cost required to replace reprocessed organic material used by council in council operations.
- Waste transport costs, estimated as the cost of transporting kerbside waste (once a collection truck is full) from major town centres to the central plant plus the cost of transporting transfer station drop-off waste to the central plant. Transport costs were based on cost per minute, average speed, average load (tonnes) and average loading and unloading times for different vehicle types as well as estimated distances and tonnage quantities.
- Gate fee charge for use of central plant, charged as either the default gate fee value used in modelling by Hepburn Shire Council or as the break-even fee to ensure that ongoing costs at the expanded central plant are shared equally between all parties involved.
- Cost of electricity from network, estimated as the total cost of electricity required at the selected council facility.

The ongoing income and offsets associated with the onsite gas turbine option were assessed as:

- Offset cost of BAU waste management, estimated as the offset cost of avoided waste to landfill, avoided transport and reprocessing (gate fee) costs for kerbside waste and avoided cost of reprocessing transfer station drop-off waste (income from reprocessed materials was also considered to estimate a net cost).
- Offset cost of energy use, estimated as avoided electricity cost (as a result of turbine generation), income from surplus electricity generation and share of income from central plant gas generation.
- Share of income from processed digestate, estimated as the share of income received from the reprocessing of digestate into a saleable product at the central plant.

Estimates of ongoing costs and ongoing income/offsets were combined to provide a year-by-year net estimate of costs/benefit. Where this figure was negative, the ongoing costs were estimated to be greater than the income/offsets and vice versa. Combined with the initial capital cost, the estimated payback period was calculated.

Estimating high and low range

Given the uncertainty associated with future cost and income variables that impact on the outcome of the projected cost/income balance, we estimated a high and low range for projections. This provides an estimated range for which we are reasonably confident the true value will fall. We also estimated the expected scenario based on electricity price projections as provided by the Finkel Review (Jacobs 2017) in order to highlight the impacts of uncertain future electricity prices. In figures provided for each council showing 10-year projected costs/income (Figure 10, Figure 15, Figure 21, Figure 26, Figure 31 and Figure 36), four lines are presented, summarised as:

- the solid green (gas), red (slurry) or blue (electricity) lines as the expected projection, using electricity projections as provided by AEMO (2016)
- the dashed green, red or blue lines as the potential range of projected values
- the dashed purple line as the expected projection, using electricity projections as provided by the Finkel Review (Jacobs 2017).

Estimating avoided emissions

Avoided greenhouse gas emissions were estimated for each council based on:

- Avoided electricity generation, estimated as the annual generation of electricity achieved by each alternate system (and therefore avoided under the BAU system), in kWh, multiplied by greenhouse gas (GHG) emissions factors for kg CO_2-e per kWh as detailed in *National Greenhouse Accounts Factors* (Department of the Environment and Energy 2016, Table 41).

- Additional waste diversion from landfill, estimated as the type and quantity of waste avoided from landfill (above the BAU case) multiplied by GHG emissions factors for kg CO_2-e per tonne of waste material as detailed in *National Greenhouse Accounts Factors* (Department of the Environment and Energy 2016, Table 42) (see Table 4).

Note the majority of waste identified in this project was already diverted from landfill; it would not be eligible for renewable energy credits and as a result was not considered in calculations of GHG avoidance.

Assumptions used in modelling

A number of assumptions were made in modelling the costs associated with the BAU and alternate cases. Some of these assumptions apply to the analysis conducted for each scenario and council, and are outlined in Table 5.

Table 5: Data and central plant assumptions applicable to all councils

Ref	Assumption
1	Councils sending waste to the central plant include: Ballarat City Council, Central Goldfields Shire Council, Hepburn Shire Council, Macedon Ranges Shire Council, Mount Alexander Shire Council, Pyrenees Shire Council.
2	The central plant would be established adjacent to the Creswick transfer station (Ring Road, Creswick).
3	Central plant capacity estimates are based on all waste from participating councils being available in 2018 with a seasonality multiplier of 1.24 applied (this is based on seasonality of waste generation as assessed from each council's monthly waste data).
4	For modelling purposes, the share of generation from the centralised plant is based on the estimated yield of biogas from the quantity of materials entering the plant from each council (final arrangements will be subject to contractual agreements between involved parties).
5	Slurry generation quantity is estimated to be equal to the quantity of waste entering the plant plus 20% (added water).
6	For the central AD plant, a fast reaction time (that is, an ultra-sonic waste processor is included in waste pre-treatment) is assumed with a 5-day residence time, yielding up to 76% of available gas from input material.
7	The central plant uses seven micro turbines (a single micro turbine has a maximum size of 200 kw).
8	Electrical efficiency for the central plant engine is assumed to be 35%, running for 12 hours per day at 80% capacity.
9	Heat generated by the turbine is retained and used in other building processes.
10	The value of heat, in MJ, is based on a calculated heat rate of 10.3 MJ/kWh of electricity generated multiplied by the turbine's assumed thermal efficiency of 55% and a heat utilisation factor of 75%.
11	Staffing at the central plant would be at a rate of 0.3, 0.5 and 0.5 EFTE/year for the slurry, gas and electricity plant respectively, based on a labour cost (salary plus indirect costs) of $80,000 per year.
12	Maintenance costs of the central plant are estimated to be 5% per year of the initial capital cost, then increasing with CPI.
13	Digestate yield is estimated to be 85% of material feedstock entering the plant.
14	Digestate (either from the gas/electricity plant or returned to the central plant site from on-site council plant) is treated to produce a soil amendment product fit for wholesale to the agricultural market.
15	Material feedstock is assumed to contain 5% contamination (material not appropriate for bio-digestion) and will be disposed of at standard landfill gate fees.

<table>
<tr><th>Ref</th><th>Assumption</th></tr>
<tr><td>16</td><td>Total income from gate fees at the central plant are calculated based on the estimated break-even gate fee according to annual on-going plant costs and expected tonnes.</td></tr>
<tr><td>17</td><td>Transport distances are based on the fastest travel distance between two points as provided by Google maps.</td></tr>
<tr><td>18</td><td>Average transport costs are based on distance and tonnes and the following values (red values are assumed figures and black values are calculations using those assumed figures):
<table>
<tr><td>Vehicle type</td><td>Collection</td><td>Haulage/skip</td><td>Tanker</td><td>Tanker</td><td></td></tr>
<tr><td>Waste type handled</td><td>Kerbside</td><td>Trans. stat.</td><td>Slurry</td><td>Digestate</td><td></td></tr>
<tr><td>Running cost</td><td>$90</td><td>$80</td><td>$90</td><td>$150</td><td>$/hr</td></tr>
<tr><td>Avg speed</td><td>80</td><td>80</td><td>80</td><td>80</td><td>km/hr</td></tr>
<tr><td>Avg load</td><td>12</td><td>9</td><td>20</td><td>20</td><td>t</td></tr>
<tr><td>Estimate travel cost</td><td>$0.09</td><td>$0.11</td><td>$0.06</td><td>$0.09</td><td>$/t.km</td></tr>
<tr><td>Avg loading/unloading time p</td><td>20</td><td>30</td><td>30</td><td>30</td><td>Minutes</td></tr>
<tr><td>Estimated loading cost</td><td>$2.50</td><td>$4.44</td><td>$2.25</td><td>$3.75</td><td>$/loaded t</td></tr>
</table></td></tr>
<tr><td>19</td><td>The minimum size for a single turbine is 65 kW with multiples of 65 kW thereafter where councils have enough feedstock. On-site plant costings are based on the total kW output of the turbine(s) regardless of whether a council has the required waste feedstock to service the plant to maximum output. All on-site turbines will be situated inside a shipping container.</td></tr>
<tr><td>20</td><td>Future electricity costs are based on projections sourced from the Australia Energy Market Operator (AEMO) (2016) Retail electricity price history and projections, Figure 20.</td></tr>
<tr><td>21</td><td>Future electricity feed-in tariffs and LGCs are based on data supplied to the model by Hepburn Shire Council. These were developed as part of Council's modelling of costs for the development of a Hepburn only AD plant.</td></tr>
<tr><td>22</td><td>Future gas costs are based on data supplied by councils for 2016/17 and an indexation of the projected future wholesale gas price (which contributes approximately 1/3 of the retail gas prices) as sourced from Jacobs (2017) (see Figure 14, page 40, produced as part of the recent Independent Review into the Future Security of the National Electricity Market, also known as the Finkel Review).</td></tr>
<tr><td>23</td><td>Future gas supply contracts are based on a proportion of the projected future wholesale gas price as sourced from Jacobs (2017) (see Figure 14, page 40). It is assumed that gas market suppliers would pay 80% of this cost as a supply contract to generators.</td></tr>
<tr><td>24</td><td>The avoided electricity cost from an on-site turbine is calculated based on the value of electricity on a $/kWh basis.</td></tr>
<tr><td>25</td><td>The income from surplus electricity is calculated based on the value of electricity feed-in tariffs plus the value of LGCs on a $/kWh basis.</td></tr>
</table>

Ref	Assumption
26	The income from surplus gas is calculated based on the value of gas a hypothetical supply contract on a $/MJ basis.
27	Included in ongoing costs would be the requirement of Councils to purchase electricity to cover the shortfall between alternate case generation and total BAU consumption at a chosen facility.
28	Councils would only purchase electricity or gas equal to the amount required by an on-site turbine (for gas) or the total electricity consumption at a facility (if total consumption is less than total generation). The income, in the form of LGCs and/or feed-in tariffs, from excess gas or electricity generation are credited to the Council. Not included in modelling is the cost of purchasing the excess generation to offset other consumption in Council facilities.
29	All costs are considered to be 'real' costs and increase with CPI at a 10-year historical average rate of 2.5%.
30	It is estimated that actual cost and income values will be within a range of 25% of those estimated in the model.

4. Ballarat

The results of the modelling, site inspections and feasibility of participation for the City of Ballarat are discussed below.

4.1 Waste feedstock and energy demand

Waste type and availability

Ballarat introduced a universal kerbside garden organics collection service to approximately 33,700 households in July 2016. From July 2016 to May 2017, around 8,470 tonnes of garden organics were collected as part of the service (extrapolated to be approximately 9,400 tonnes for all of 2016/17). As this service is relatively new, its expansion to include food waste in the short-term is not being considered by council. In addition to the kerbside service, separated garden waste is accepted at Council's waste transfer station (located at 119 Gillies St South, Ballarat) and in 2015 approximately 2,000 tonnes were deposited. Due to the introduction of the universal kerbside service it is likely that the quantity deposited at the transfer station will decrease, however, up-to-date transfer station data that matches data from the kerbside collection was not available.

Kerbside collected organic waste is transported to Ballarat's reprocessor in Mount Wallace where it is reprocessed into compost. The transport and reprocessing component of the service is estimated to cost Council $879,700 per year. Drop-off garden waste is reprocessed into mulch at the transfer station, stockpiled and used in council operations, costing approximately $68,400 per year. The short-term availability of these feedstocks is probable (according to council, the kerbside reprocessing contract is on a year-by-year basis), however the long-term future availability is less certain and is largely dependent on Council investigations around the development of a waste to energy facility in the Ballarat West Employment Zone.

To date, monthly tonnages collected from the kerbside service have ranged from 542 tonnes in July (the first month of the service) to 1,256 tonnes in November. For drop-off tonnes, monthly figures are available from mid-2012 to the end of 2015 to provide a pattern of seasonal variability in waste quantities. This long-term monthly average shows a decrease in waste quantities from May to September followed by a sharp increase and peak to November. Using five-year month-by-month data, the seasonal peak for waste quantities was estimated to be 119% of the average tonnages.

An additional source of organic waste feedstock was also identified. Approximately 3,000 tonnes (wet weight) of aquatic weed removed from Lake Wendouree would be available as feedstock. Table 6 summarises the waste types, quantities and availability of waste in the City of Ballarat.

Table 6: Waste feedstock in Ballarat

Waste type	Source	Availability	Tonnes/year	Seasonality
Garden waste	Kerbside collections	Yes	9,900	
Garden waste	Drop-off	Yes	2,100	
Aquatic weed	Council operations	Yes	3,000	
Total available	**15,000 tonnes (garden waste)**			**119%**

Council building energy consumption

Council provided electricity and gas consumption data for 12 council facilities including:

- Ballarat Aquatic Centre and Ballarat Library (electricity and gas)
- Art Gallery of Ballarat, Eureka Centre (Museum of Australian Democracy at Eureka, or MADE), Her Majesty's Theatre, Ballarat Town Hall, Phoenix Community College, Mining Exchange, Rubicon Street, Kohinoor Community Centre, Robert Clark Centre and Botanic Gardens (all gas only).

Data was provided based on monthly consumption between July 2014 and January 2017. The Ballarat Aquatic Centre had by far the highest average annual consumption for both electricity (1,671,300 kWh) and gas (21,401,600 MJ) for the facilities supplied by council.

Monthly average electricity consumption throughout the year at the Ballarat Aquatic Centre is relatively consistent, ranging between 108,400 kWh in February to a peak of 144,600 kWh in June. Monthly average gas consumption throughout the year is much more seasonal, with the lowest in February of 1,098,200 MJ up to a peak of 2,251,200 MJ in June. The annual cost of electricity and gas consumption at the facility is estimated to be $267,000 and $362,000 respectively (or $629,000 per year).

The next highest consumer of electricity was the Ballarat Library (379,600 kWh) however it ranked fifth for gas consumption (1,293,400 MJ). The second and third highest gas consumers were the Art Gallery of Ballarat and the Eureka Centre at 3,673,000 MJ and 1,650,500 MJ respectively.

4.2 Council site

As the largest energy consumer among council-nominated sites, the Ballarat Aquatic Centre was selected as the most appropriate site for further investigation. The centre is located at Prince of Wales Recreation Reserve, Gillies Street North and includes four indoor heated swimming pools, spa, steam room, fitness centre, gymnastics hall, children's centre, creche, café and other amenities.

Inspection of the site identified placement of existing connections to the electricity grid and gas networks with sufficient area at the facility for on-site plant (Figure 19 shows an aerial view of the aquatic centre).

Figure 7: Aerial view of Ballarat Aquatic Centre

There is a services compound at the south-eastern corner of the aquatic centre which is enclosed by secure fencing and a lockable gate. The gas connection and other services are located within this compound.

Figure 8 shows the location of the gas connection just inside the services compound. While there is insufficient space for placement of a shipping container inside the compound, there is potentially space adjacent to the gas connection but outside the fence for placement of a container (required under the gas scenario). This would involve minimum connection distance (less than 5 m) from the container to the gas meter. However we note access is difficult due to sloping land to the adjacent creek, and placement of the container is likely to require use of a crane.

Figure 8: Ballarat Aquatic Centre gas connection

Placement of two shipping containers (as required under the slurry scenario) would need to utilise area closer to the south-western end of the site. This would involve a connection distance of around 20 m and would likely involve loss of some staff car parking space. Additional fencing would be required to secure the containers against public access; this may involve extending the services compound. Access by trucks bringing slurry to the site would also involve some potential for conflict with pedestrians and vehicles, as the only available access is via the centre's car park and cuts directly across pedestrian walkways to the site entrance. This is potentially high risk, particularly given the large number of children using the facility.

Of the two scenarios, the logistics of the site indicate that the gas scenario is likely to be more practicable than the slurry scenario. The gas scenario would involve fewer changes to existing infrastructure (at lower cost) and less disruption to existing activities at the aquatic centre.

4.3 Modelling

Assumptions used in modelling that are applicable to each scenario for Ballarat only are presented in Table 7.

Table 7: Data and plant assumptions applicable to Ballarat

Ref	Assumption
General assumptions applicable to each option	
1	Council currently provide a kerbside collection service for garden organic waste; an expansion to include food waste is not likely in the near future.
2	Ballarat Aquatic Centre is selected as the project site as it is the largest consumer of electricity and gas based on average annual consumption data.
3	For scenarios with an on-site turbine, the site will have 2 turbine(s) with a capacity of 13 0kW. On-site turbine(s) capacity does not exceed potential outputs from waste feedstock. On-site turbine(s) exceed building energy requirements.
4	Combined BAU total collection and transport costs for kerbside garden waste were provided. It is assumed that the proportion of BAU costs attributed to waste transport is 10% of total collection and transport costs.
5	Where BAU management of drop-off organic waste involves mulching and use of materials in council operations, a cost will be incurred to source a similar quantity of materials to replace those diverted under the alternate business case.
6	It is assumed that 100% of drop-off materials are used in council operations (based on conversations with council officers) and bulk replacement materials would cost $20 per tonne.
7	Kerbside garden waste would be hauled directly following collection to the central plant facility. Drop-off garden waste would be transported when sufficient quantities are stockpiled at transfer station sites.
8	Ballarat will contribute to central plant capital costs on an annualised per tonne basis over 5 years.
Assumptions applicable to the gas option	
9	Staffing requirements at an on-site plant would be 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
10	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
11	All waste is sent to the central plant and excess gas generation is credited to council.
12	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
13	Heat generated by the turbine is retained and used in other building processes.
Assumptions applicable to the slurry option	
14	Staffing requirements at an on-site plant would be 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
15	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
16	Maintenance of the small scale AD plant is estimated to be $20,000 per year (in year 1 based on estimated received by Hepburn Shire Council) and then increasing with CPI.
17	Additional waste not required for slurry production to meet engine demand is sent to the central plant to be converted to slurry and sold as a low quality product at $5/tonne.

Ref	Assumption
18	For the on-site AD plant, a fast reaction time is assumed with a 5-day material residence time, yielding up to 76% of available gas from input material.
19	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
20	Heat generated by the turbine is retained and used in other building processes.
21	Digestate generated at the on-site plant is returned to the central plant for further treatment and sale.
Assumptions applicable to the electricity option	
	None

Results

Table 8 presents the results of modelling the capital costs, on-going costs and on-going income and offsets for each scenario in Ballarat. Also presented is the yearly balance in year one, five and ten (if this figure is negative then council is paying money to maintain the alternative option), the feasibility of each option and the estimated payback period in the number of years and the expected year.

From a financial point of view, each option has been assessed as being feasible with payback for gas, slurry and electricity after 6, 8 and 11 years respectively. For all scenarios, the year one balance is negative however for gas and slurry this is minimal. This pattern is a reflection of the five-year payback contributions made by Ballarat towards central plant capital. Once this payback period is complete the yearly balance increases to $463,300 for gas, $303,000 for slurry and $466,700 for electricity with further increases to the ten-year balance period.

Figure 9 presents a comparison of the year one costs and income for each scenario. For the gas and slurry options, up to 80% of the ongoing costs are associated with the:

- gate fee at the central plant
- contribution to central plant capital (for the first five years)
- cost of electricity from the network to meet energy needs at the building not covered by the on-site generator.

Up to 66% of income is attributed to the avoided costs of BAU kerbside organic waste transport and reprocessing. A further 19% is attributed to Ballarat's share of income from the sale of value-added products derived from treated digestate.

For the electricity option, around 81% of the on-going costs are associated with Ballarat's contribution to central plant capital (for the first five years) and the gate fee at the central plant, reflecting the large quantities of waste diverted to the central plant from Ballarat. Up to 60% of income is attributed to avoided costs of BAU kerbside organic waste transport and reprocessing, while a further 35% is attributed to Ballarat's share of income from central plant electricity generation (LGCs and feed-in tariffs) and from the sale of treated digestate.

Figure 10 presents the expected balance of cost and income for each option as well as potential high and low scenarios and an alternate expected projection using electricity prices as projected by the Finkel Review (Jacobs 2017). In each option, the expected scenario experiences a plateau or decline over the first five years due to Ballarat's early contribution to central plant capital. Once this period is finished all options show the income is greater than costs and an increase in the expected balance.

A comparison of the expected cost or income per tonne of waste is presented in Figure 11. This shows that, in the long run, the most cost-effective scenario is likely to be the central plant gas option. Both the gas and electricity options provide similar income per tonne of waste (after the payback of central plant capital over the first five years) however the initial cost of central plant capital under the electricity scenario means that Ballarat would have to pay approximately $40 per tonne more than the gas option which is close to cost neutral during the same period.

Table 8: Modelling results for Ballarat

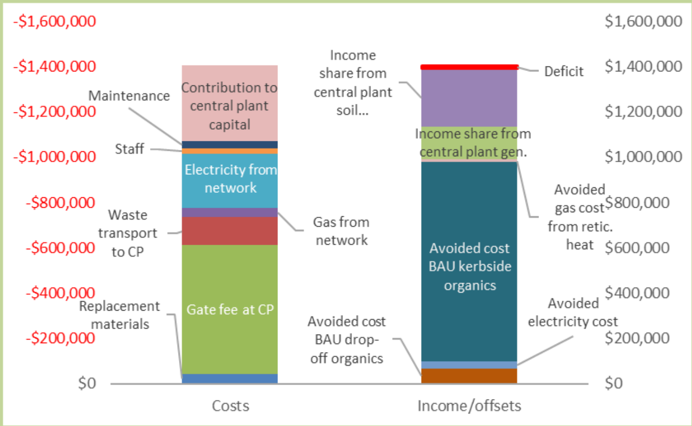
Cost/income item		Gas	Slurry	Electricity
Capital costs				
On-site plant capital		-$ 1,136,900	-$ 1,291,100	
On-going costs				
Contribution to central plant capital (per t, 5 years)		-$ 334,700	-$ 228,900	-$ 1,077,700
Remaining BAU				
Replacement materials		-$ 42,900	-$ 42,900	-$ 42,900
Waste transport to central plant		-$ 122,100	-$ 139,100	-$ 122,100
Gate fee at central plant		-$ 570,400	-$ 605,000	-$ 779,000
Gas from network		-$ 41,300		
Electricity from network		-$ 240,400	-$ 240,400	-$ 271,200
Staff		-$ 24,000	-$ 24,000	
Maintenance		-$ 30,000	-$ 50,000	
Disposal of digestate			-$ 16,700	
Total ongoing costs		**-$ 1,405,800**	**-$ 1,347,000**	**-$ 2,295,100**
On-going income/offsets				
Avoided landfill gate fees from waste div.				
Avoided cost BAU kerbside organics		$ 879,700	$ 879,700	$ 879,700
Avoided cost BAU drop-off organics		$ 68,400	$ 68,400	$ 68,400
Avoided electricity cost		$ 30,800	$ 30,800	
Surplus electricity income				
Avoided gas cost from reticulated heat use		$ 13,600	$ 13,600	
Income share from central plant gen.		$ 143,300		$ 257,300
Income share from central plant soil amendment		$ 256,100	$ 256,100	$ 256,100
Value of excess slurry			$ 87,800	
Total on-going income/offsets		**$ 1,391,900**	**$ 1,336,400**	**$ 1,461,500**
Balance and viability				
Balance at end of year:	1 (2018)	-$ 13,900	-$ 10,600	-$ 833,600
	5 (2023)	$ 463,300	$ 300,400	$ 466,700
	10 (2028)	$ 614,600	$ 375,700	$ 540,200
Feasibility		**Feasible**	**Feasible**	**Feasible**
Estimated payback period (number of years)		6	8	11
Estimated payback year		2024	2026	2029

Note: All figures are estimates rounded to the nearest hundred.

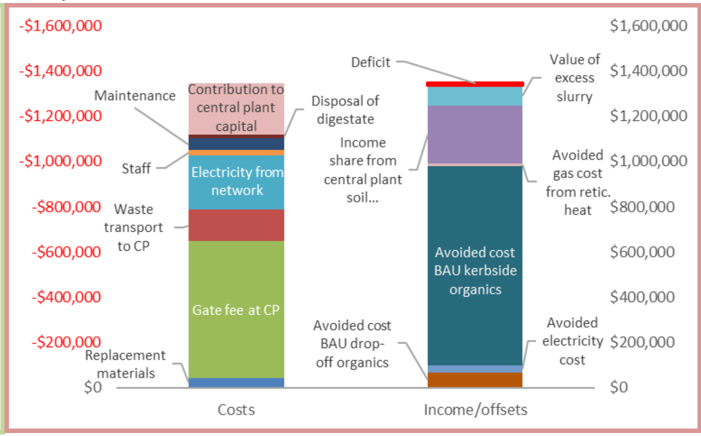
blue environment pty ltd

Figure 9: Year 1 cost and income comparison for Ballarat

Gas



Slurry



Electricity

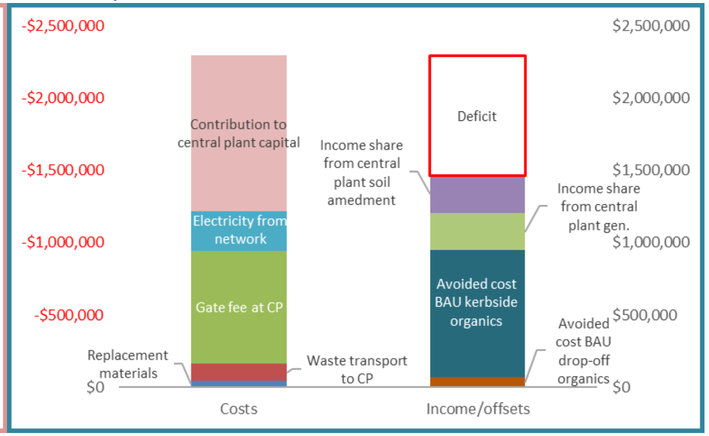
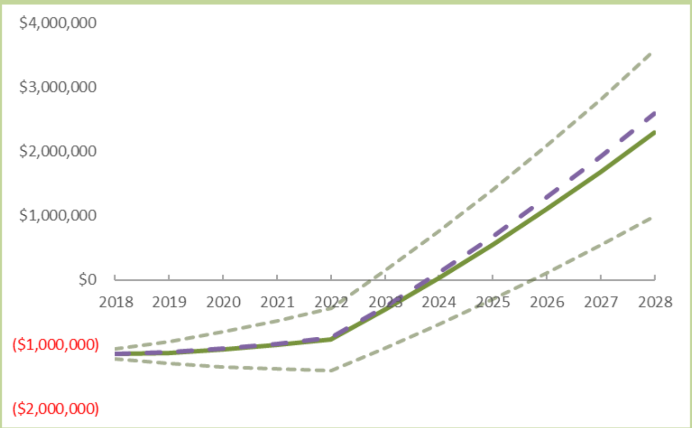
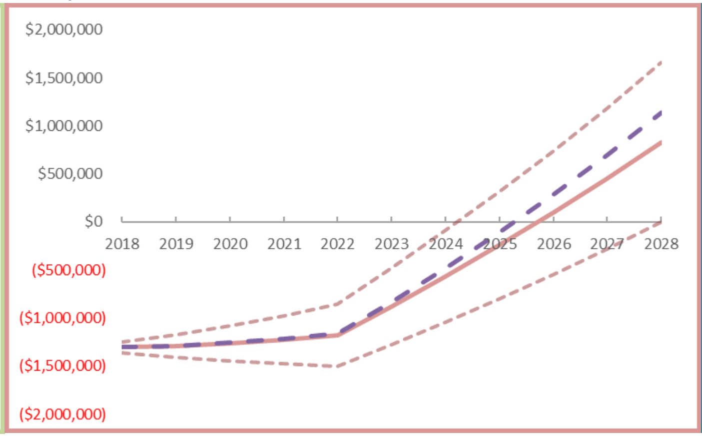


Figure 10: 10-year timeseries of the cost/income balance for Ballarat

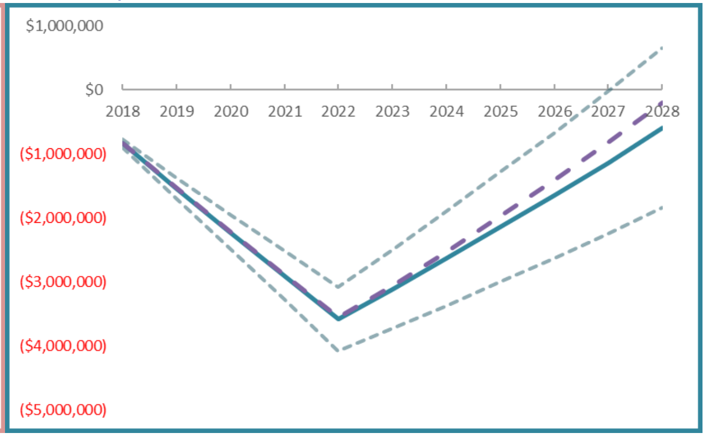
Gas



Slurry

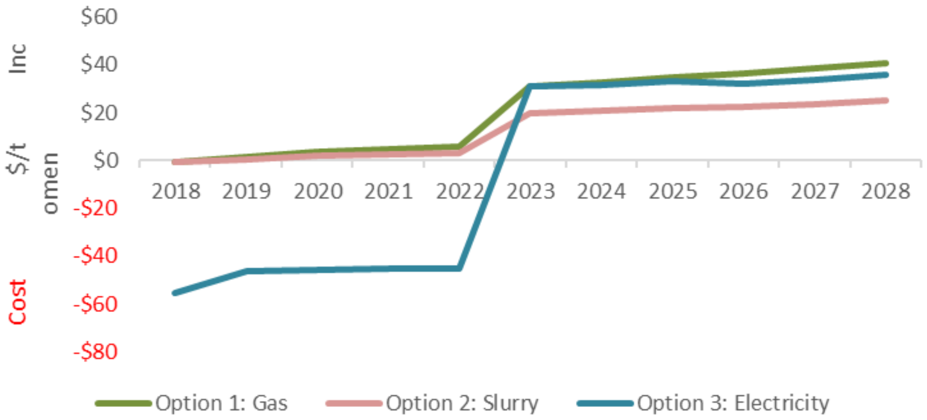


Electricity



Note: The purple dashed line shows the expected cost/income balance using electricity cost ranges projected by the Finkel Review (see Section 3.2)

Figure 11: Cost/income per tonne of waste for each scenario



4.4 Summary

All options for Ballarat are projected to be feasible with the gas option having the fastest estimated payback as well as the highest likely income in dollars per tonne of waste. Site inspections of the Ballarat Aquatic Centre also indicate the gas scenario is feasible for implementation at the site.

Table 9 summarises the current BAU costs for electricity consumption, gas consumption, kerbside waste transport and reprocessing and transfer station waste reprocessing. Also summarised is the feasibility for each option, the one, five and ten-year balance (yearly cost minus yearly income) and the expected payback period.

Table 9: Summary of BAU and alternate case costs

BAU energy and waste costs	$/year
Electricity consumption	-$ 271,200
Kerbside organics transport and reprocessing	-$ 879,700
Transfer station organics reprocessing	-$ 68,400
Total BAU costs per year	**-$ 1,219,300**

Balance at end of year (income - cost)	Gas	Slurry	Electricity
	Feasible	**Feasible**	**Feasible**
1 (2018)	-$ 13,900	-$ 10,600	-$ 833,600
5 (2023)	$ 463,300	$ 300,400	$ 466,700
10 (2028)	$ 614,600	$ 375,700	$ 540,200
Payback period (years)	6	8	11

5. Central Goldfields

The results of the modelling, site inspections and feasibility of participation for Central Goldfields Shire Council are discussed below.

5.1 Waste feedstock and energy demand

Waste type and availability

Central Goldfields Shire Council currently operate a voluntary kerbside food organics and garden organics collection service for residents. The service is used by approximately 1,100 households with a further 5,000 that could potentially be included in the service in the future. In 2016, approximately 350 tonnes of food and garden organics were collected as part of the service. Collected waste is reprocessed into compost at a council facility (which has a maximum throughput capacity of 1,000 tonnes), located at Carisbrook Transfer Station and operated by Council's transfer station contractor. Composted materials are then bagged and provided to service participants free of charge. Expansion of the service is likely to occur as additional residents opt-in to the service, however given Council has invested in equipment to reprocess the kerbside collected materials, it is highly unlikely that this quantity of waste would be available for input to a central facility.

Separated garden waste is accepted at Council's waste transfer stations (located at Carisbrook, Talbot, Dunolly and Bealiba) and in 2015 approximately 500 tonnes were deposited. Drop-off garden waste is not currently reprocessed together with kerbside food and garden organics due the waste being woodier in nature. Instead, drop-off garden waste is shredded/mulched and stockpiled at Carisbrook Transfer Station for use in council operations with a small quantity sold to the public. Given the majority of this waste is currently stockpiled and used in council operations, it is likely that this waste would be available for input to a central facility. Monthly data on the quantity of garden waste deposited at transfer stations was not available.

In 2016, monthly tonnages in the kerbside service ranged from 18 and 24 tonnes between January and July. From August to December, tonnes ranged from 32 to 51 tonnes with peak quantity in October, which is consistent with the long-term average from five years of data. Using five-year month-by-month data, the seasonal peak for waste quantities was estimated at 137% of the average tonnages.

Additional sources of organic waste, either from council operations or commercial operators, were not identified in discussions with council officers. Table 10 summarises the waste types, quantities and availability in Central Goldfields.

Table 10: Waste feedstock in Central Goldfields

Waste type	Source	Availability	Tonnes/year	Seasonality
Mixed food and garden waste	Kerbside collections	No	350	
Garden waste	Drop-off	Yes	500	
Total available	**500 tonnes (garden waste)**			**137%**

Council building energy consumption

Central Goldfields provided electricity and gas consumption data for four council facilities including:

- Maryborough Recreation Centre (electricity and gas)
- Central Goldfields Shire Office (electricity only)
- Maryborough Town Hall and Princes Park Complex (gas only).

Data was provided based on monthly or bi-monthly consumption between February 2016 and February 2017. The Maryborough Recreation Centre had by far the highest consumption for both electricity (303,300 kWh) and gas (5,643,900 MJ) for the facilities nominated by council. Electricity consumption throughout the year is relatively consistent, ranging from between 21,900 kWh in October to 29,100 kWh in January. Gas consumption throughout the year is much more seasonal with the lowest monthly consumption in February of 200,000 MJ up to 742,200 MJ in July. The annual cost of electricity and gas consumption at the facility is estimated to be $48,000 and $95,000 respectively (or $143,000 per year).

The next highest consumer of electricity was the Central Goldfields Shire Office (206,640 kWh, no gas data provided). The second and third highest gas consumers were the Maryborough Town Hall (173,000 MJ) and Princes Park Complex (59,900 MJ).

5.2 Council site

As the consumer of the largest quantity of energy in the Council, the Maryborough Recreation Centre was selected as the most appropriate site for further investigation. The centre is located at 40 Gillies Street, Maryborough and contains a gymnasium, three indoor heated swimming pools and two indoor sport courts (Figure 12 shows an aerial view of the recreation centre).

Figure 12: Aerial view of Maryborough Recreation Centre

Inspection of the site identified the gas meter towards the northern corner of the building, located almost half-way between the corner and the entrance to the recreation centre. The gas meter is shown on the right-hand side of the photo in Figure 13.

Figure 13: Maryborough Recreation Centre

While there is sufficient space in the car park for a shipping container close to the gas meter (within approximate connection distance of 5 m), placement in front of the corner windows would impact on amenity and light entering the building.

An alternative location for one or two shipping containers (for both the gas and slurry scenarios) exists in the same car park area but adjacent to the amenity building, involving a connection distance of closer to 20 m. This location is indicated in Figure 12. Trenching of gas/electricity connections to the relevant meters below the gravel car park would involve relatively minor disruption to existing activities.

For the slurry scenario, truck access to the AD shipping container would need to use the public entrance to the site. Interaction between trucks and light vehicles could be reduced by restricting public use of the north-east car park; this could be off-set by establishing an alternative car park to the west of the recreation centre. Alternatively, public access to the site could be changed to Majorca Road, however the realignment of roads and parking would involve significant cost outlay.

A further issue for the slurry scenario is the proposed location for the shipping containers along the rear boundary of a residence adjoining the recreation centre, as well as other houses in Gillies Street. The potential for odour arising from the slurry would need to be carefully managed to minimise any impact on residents.

Of the two scenarios, the site characteristics would indicate the gas scenario as the most practicable and involving lower costs.

5.3 Modelling

See Section 3.2 for a detailed description of the methods used in modelling the business case for Central Goldfields. Table 5 in the same section provides a summary of the assumptions used in modelling that are applicable to all councils.

Assumptions used in modelling that are applicable to each scenario for Central Goldfields only are presented in Table 11.

Table 11: Data and plant assumptions applicable to Central Goldfields

Ref	Assumption
General assumptions applicable to each option	
1	Central Goldfields Shire Council currently have a kerbside collection of food and garden organic waste.
2	Maryborough Recreation Centre is selected as the project site as it is the largest consumer of electricity and gas based on average annual consumption data.
3	For scenarios with an on-site turbine, the site will have 1 turbine with a capacity of 65 kW. On-site turbine capacity does not exceed potential outputs from waste feedstock. On-site turbine does not exceed building energy requirements.
4	Combined BAU per tonne collection and transport cost for kerbside food and garden waste was provided. It is assumed that the proportion of BAU costs attributed to waste transport is 30% of total collection and transport costs.
5	Kerbside food and garden organics collected in Central Goldfields would not be available as council have invested in their own composting facility for this waste.
6	Where BAU management of drop-off organic waste involves mulching and use of materials in council operations, a cost will be incurred to source a similar quantity of materials to replace those diverted under the alternate business case.
7	It is assumed that 10% of drop-off materials are used in council operations (based on conversations with council officers) and bulk replacement materials would cost $20 per tonne. The majority of mulched material is currently stockpiled.
8	Drop-off garden waste would be transported when sufficient quantities are on site.
9	Central Goldfields will contribute to central plant capital costs on an annualised per tonne basis over 5 years.
Assumptions applicable to the gas option	
10	Staffing requirements at an onsite plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
11	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
12	All waste is sent to the central plant and excess gas generation is credited to council.
13	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
14	Heat generated by the turbine is retained and used in other building processes.
Assumptions applicable to the slurry option	
15	Staffing requirements at an on-site plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
16	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
17	Maintenance of the small scale AD plant is estimated to be $20,000 per year (in year 1 based on estimated received by Hepburn Shire Council) and then increasing with CPI.

Ref	Assumption
18	Additional waste not required for slurry production to meet engine demand is sent to the central plant to be converted to slurry and on sold as a low quality product at $5/tonne.
19	For the on-site AD plant, a fast reaction time is assumed with a 5-day material residence time, yielding up to 76% of available gas from input material.
20	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
21	Heat generated by the turbine is retained and used in other building processes.
22	Digestate generated at the on-site plant is returned to the central plant for further treatment and sale.
Assumptions applicable to the electricity option	
	None

Results

Table 12 presents the results of modelling the capital costs, on-going costs and on-going income and offsets for each scenario in Central Goldfields. The yearly balance in year one, five and ten (if this figure is negative then council is paying money to maintain the alternative option), the feasibility of each option and the estimated payback period in the number of years and the expected year is also presented.

From a financial perspective, each option has been assessed as not feasible as none will achieve a payback on investment. For all scenarios the year one, five and ten-year balance is negative suggesting that costs from the start, and into the future, are larger than the estimated income/offsets received.

Figure 14 presents a comparison of the year one costs and income for each scenario. Immediately evident is the large difference between project costs and expected income and the resulting deficit between the two (in all cases, costs are more than double, and close to triple, the expected income). For the gas scenario, costs associated with electricity from the network (to cover building consumption not covered by the on-site generator), staff and gas from the network make up nearly 60% of the total cost. For the slurry scenario, costs associated with on-site plant maintenance (of the AD plant and generator), electricity from the network and staff also make up nearly 60% of total costs. For the electricity scenario, the cost of electricity from the network, five year per tonne contribution to central plant capital and the gate fee at the central plant contribute over 90% of total costs. The main sources of income in the gas and slurry scenarios is from the avoided BAU cost of reprocessing drop-off organics and from avoided electricity costs. The main source of income in the electricity scenario is from the avoided BAU cost of reprocessing drop-off organics.

Figure 15 presents the expected balance of cost and income for each option as well as potential high and low scenarios and an alternate expected projection using electricity prices as projected by the Finkel Review (Jacobs 2017). In each option, the expected scenario starts and continues on a downward trend.

A comparison of the expected cost or income per tonne of waste for each scenario is presented in Figure 16. This shows that, for all scenarios, Central Goldfields would need to supplement on-going costs in order to make any option feasible. Of all of the scenarios, the electricity option would provide the least cost strain to council, however this would still be a minimum of $120 per tonne.

Table 12: Modelling results for Central Goldfields

Cost/income item		Gas	Slurry	Electricity
Capital costs				
On-site plant capital		-$ 662,800	-$ 782,600	
On-going costs				
Contribution to central plant capital (per t, 5 years)		-$ 11,200	-$ 7,600	-$ 35,900
Remaining BAU				
Replacement materials		-$ 1,000	-$ 1,000	-$ 1,000
Waste transport to central plant		-$ 9,000	-$ 13,600	-$ 9,000
Gate fee at central plant		-$ 18,500	-$ 19,600	-$ 25,300
Gas from network		-$ 20,200		
Electricity from network		-$ 34,000	-$ 26,800	-$ 49,000
Staff		-$ 24,000	-$ 24,000	
Maintenance		-$ 15,000	-$ 35,000	
Disposal of digestate			-$ 21,400	
Total ongoing costs		**-$ 132,900**	**-$ 149,000**	**-$ 120,200**
On-going income/offsets				
Avoided landfill gate fees from waste div.				
Avoided cost BAU kerbside organics				
Avoided cost BAU drop-off organics		$ 13,100	$ 13,100	$ 13,100
Avoided electricity cost		$ 15,000	$ 22,200	
Surplus electricity income				
Avoided gas cost from reticulated heat use		$ 6,700	$ 9,800	
Income share from central plant gen.		$ 4,700		$ 8,300
Income share from central plant soil amendment		$ 8,300	$ 8,300	$ 8,300
Value of excess slurry				
Total ongoing income/offsets		**$ 47,800**	**$ 53,400**	**$ 29,700**
Balance and viability				
Balance at end of year:	1 (2018)	-$ 85,100	-$ 95,600	-$ 90,500
	5 (2023)	-$ 84,300	-$ 97,700	-$ 59,500
	10 (2028)	-$ 100,200	-$ 108,900	-$ 78,400
Feasibility		**Not feasible**	**Not feasible**	**Not feasible**
Estimated payback period (number of years)		-	-	-
Estimated payback year		No payback	No payback	No payback

Note: All figures are estimates rounded to the nearest hundred

Figure 14: Year 1 cost and income comparison for Central Goldfields

Gas *Slurry* *Electricity*

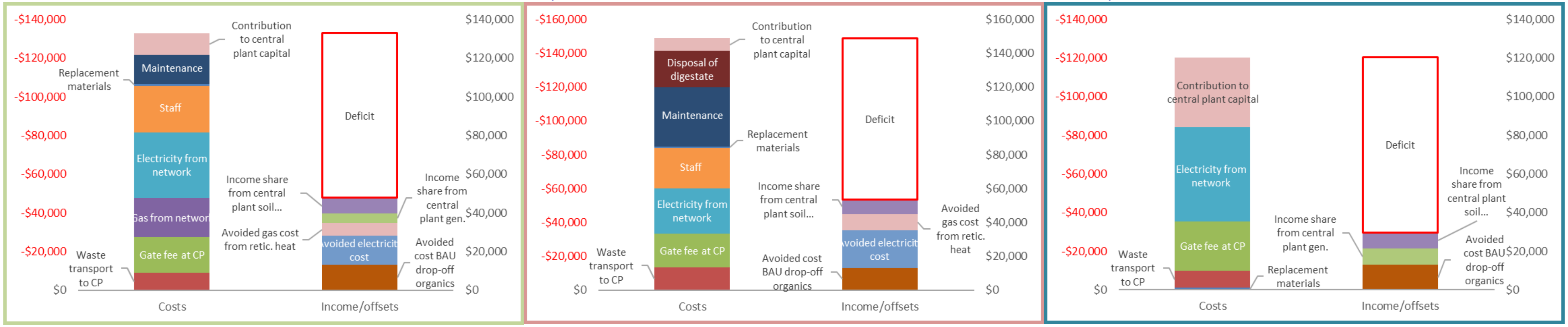
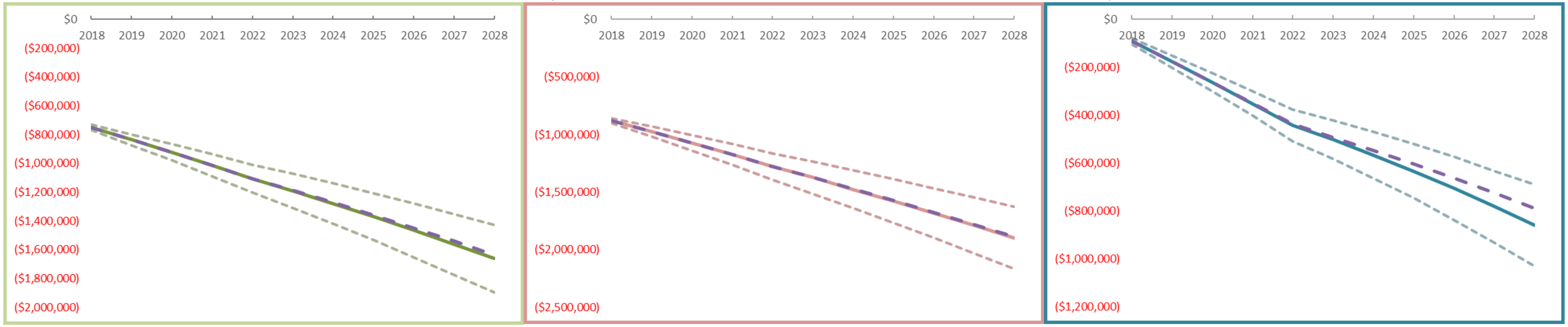


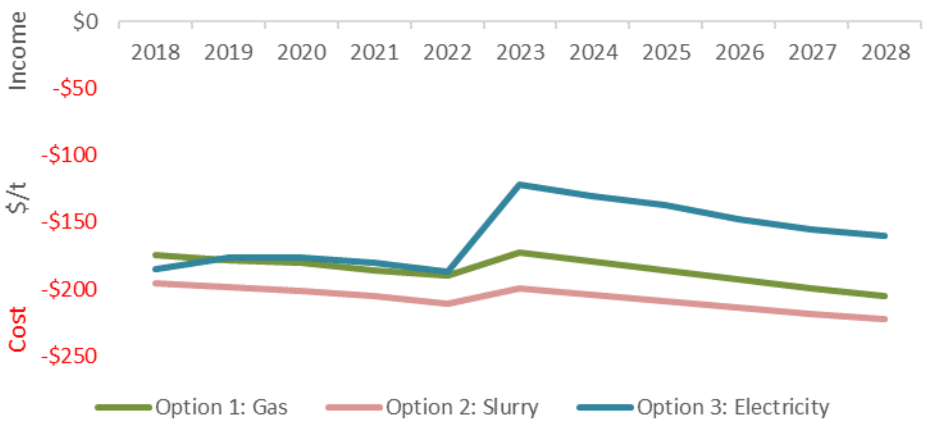
Figure 15: 10-year timeseries of the cost/income balance for Central Goldfields

Gas *Slurry* *Electricity*



Note: The purple dashed line shows the expected cost/income balance using electricity cost ranges projected by the Finkel Review (see Section 3.2)

Figure 16: Cost/income per tonne of waste for each scenario for Central Goldfields



5.4 Summary

All options for Central Goldfields are projected to be not feasible based on modelling of costs and expected income and offsets. Table 13 summarises the current BAU costs for electricity consumption, kerbside waste transport and reprocessing and transfer station waste reprocessing. Also summarised is the feasibility for each option and the one, five and ten-year balance (yearly cost minus yearly income).

Table 13: Summary of BAU and alternate case costs for Central Goldfields

BAU energy and waste costs		$/year	
Electricity consumption		-$ 48,000	
Kerbside organics transport and reprocessing		Not estimated (waste under BAU arrangement)	
Transfer station organics reprocessing		-$ 13,100	
Total BAU costs per year		**-$ 61,100**	
Balance at end of year	Gas	Slurry	Electricity
(income - cost)	Not feasible	Not feasible	Not feasible
1 (2018)	-$ 85,100	-$ 95,600	-$ 90,500
5 (2023)	-$ 84,300	-$ 97,700	-$ 59,500
10 (2028)	-$ 100,200	-$ 108,900	-$ 78,400
Payback period (years)	-	-	-

The yearly cost associated with each alternate scenario is more than the current BAU cost for electricity consumption and transfer station organics reprocessing (the cost of kerbside organics transport and reprocessing was not considered as this waste source is currently being used in a council owned and operated reprocessing plant).

6. Hepburn

The results of the modelling, site inspections and feasibility of participation in the regional model for Hepburn Shire Council are discussed below.

6.1 Waste feedstock and energy demand

Waste type and availability

Hepburn does not currently offer a kerbside collection service for any organic waste and Council is not considering introducing such a service. Separated garden organic waste is accepted at Council's waste transfer stations (located in Creswick, Daylesford and Trentham) and in 2016 around 630 tonnes were deposited. This material is mulched at the Daylesford Transfer Station and is stockpiled for use in council operations or provided to residents for free, although council officers advise very little is taken; as a result, this feedstock is immediately available.

Monthly data for this waste is unavailable, however discussions with council officers suggests that peak volumes occur in November and December each year. During this period, 53% of annual volumes are received, as council offers free drop-off services to residents in the lead up to the bushfire season. From January to October, garden organic waste quantities received are consistent. Based on these figures, it is estimated that the seasonal peak of waste quantities is 168% of the average tonnages.

From preliminary investigations carried out by Hepburn in developing the base concept (refer Section 2.1), Council has identified 2,000 tonnes of food waste feedstock available from commercial sources.

Table 14 summarises the waste types, quantities and availability of waste in Hepburn.

Table 14: Waste feedstock in Hepburn

Waste type	Source	Availability	Tonnes/year	Seasonality
Garden waste	Drop-off	Yes	630	
Food waste	Commercial	Yes	2,000	
Total available	**2,630 tonnes (food and garden waste)**			**168%**

Council building energy consumption

Hepburn provided electricity and gas consumption data for eight council owned facilities including:

- The Warehouse (Clunes), Daylesford Depot, Creswick Works Depot and Creswick Service Centre (all electricity only)
- Daylesford Town Hall, Duke Street Offices, Daylesford Regional Visitor Information Centre and Daylesford Library (all electricity and gas).

Data was provided based on monthly consumption between July 2014 and June 2016.

The Warehouse (at Clunes) (64,100 kWh) had the highest average annual consumption of electricity followed closely by Daylesford Town Hall (62,700 kWh). The Warehouse is not connected to gas mains and therefore does not have gas consumption data while Daylesford Town Hall (410,700 MJ) had the highest gas consumption data for all facilities in Hepburn. Average monthly consumption for both electricity (7,000 kWh) and gas (83,700 MJ) at Daylesford Town Hall is highest in July and is lowest for electricity (4,200 kWh) in February and for gas (2,400 MJ) in January. The annual cost of electricity and gas consumption at the facility is estimated to be $10,000 and $7,000 respectively (or $17,000 per year).

The next highest consumers of electricity were the Daylesford Depot (42,900 kWh, no gas data) and the Duke Street council offices (37,800 kWh) which ranked third in gas consumption (118,600 MJ).

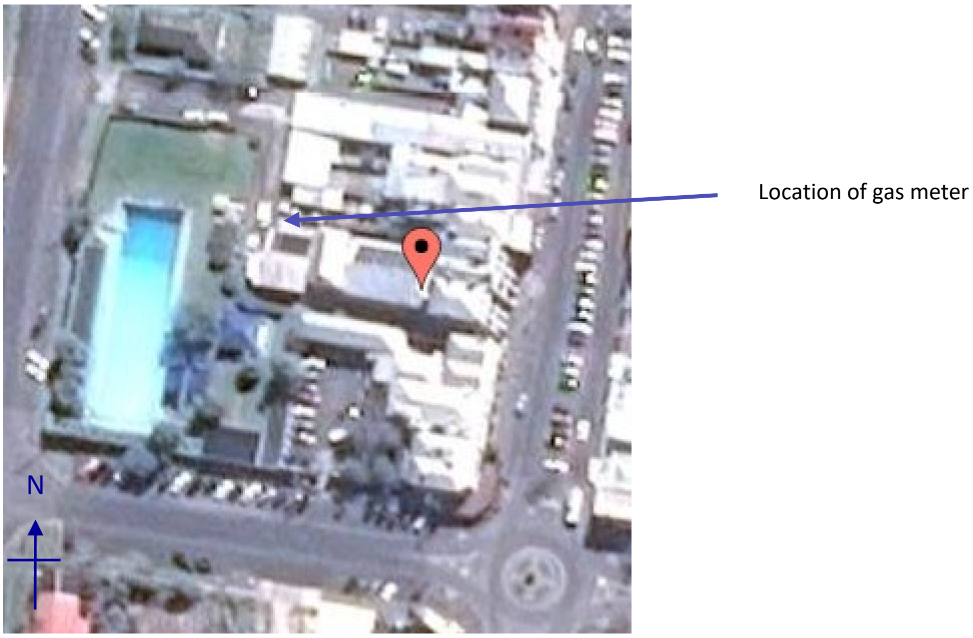
6.2 Council site

The Warehouse at 36 Fraser Street, Clunes (see Figure 17) is a multifunction visitor information centre, museum, library and council services centre, and is the highest electricity consumer of those nominated by Council. It is bound by a heritage hotel and community gardens on the main shopping street in Clunes. There is no space available for placement of a shipping container near the building, and consequently neither the slurry nor gas scenarios are practicable for this building.

Figure 17: The Warehouse, Clunes

The Daylesford Town Hall at 76 Vincent Street, Daylesford was the proposed recipient of energy in initial investigations undertaken by Hepburn Shire Council under the base concept (refer Section 2.1). As the consumer of the second largest quantity of electricity and largest consumer of gas, this site was also investigated. Figure 18 shows an aerial view of the site.

Figure 18: Aerial view of Daylesford Town Hall



The gas meter at the Town Hall is currently located on the north-west corner of the building (as shown in Figure 19). The adjoining space is very limited; it is used for casual car parking by visitors to the Town Hall as well as providing access to the rear of neighbouring businesses. The only Council-owned land that has potentially unused space is a lawned area incorporated in the adjacent swimming pool. However appropriation of this space for placement of a shipping container would severely impact current activities at the pool. There is also current space for only one container, not two; consequently the slurry scenario is not an option.

Figure 19: Daylesford Town Hall - rear view

Given the site limitations, neither the gas nor slurry scenario are considered currently feasible without severe impacts on the use of the public pool. However as explored in the initial concept investigations (Wood & Grieve Engineers 2016), the use of energy by the Daylesford Town Hall was predicated on the proposed redevelopment of the Town Hall and adjoining swimming pool into an expanded community hub. 2016 plans for the proposed community hub show the AD equipment incorporated into a basement level situated between the existing Town Hall buildings and the adjacent pool.

Should this redevelopment occur, the cost and feasibility of implementing the gas scenario at the Daylesford Town Hall are likely to markedly improve. However given the large number of truck movements and potential for odour in the central business district of Daylesford, the slurry scenario is likely to be more problematic to implement.

6.3 Modelling

See Section 3.2 for a detailed description of the methods used in modelling the business case for Hepburn. Table 5 in the same section provides a summary of the assumptions used in modelling that are applicable to all councils.

Assumptions used in modelling that are applicable to each scenario for Hepburn only are presented in Table 15.

Note the modelling does not include any consideration of issues arising from the proposed change in siting of the central plant from Daylesford to Creswick (including EPA works approval, planning, utilities connection and site stability considerations); it has been assumed that these costs have been included in figures for construction and development of the central plant provided by Hepburn Shire Council.

Table 15: Data and plant assumptions applicable to Hepburn

Ref	Assumption
General assumptions applicable to each option	
1	Council does not currently have a kerbside collection of organic waste; introduction of a food or garden waste collection service is not likely.
2	Daylesford Town Hall is selected as the project site as it is the largest consumer of energy (electricity and gas) based on average annual consumption data.
3	The site will have one turbine with a capacity of 65 kW. On-site turbine capacity does not exceed potential outputs from waste feedstock. On-site turbine exceeds building energy requirements.
4	Where BAU management of drop-off organic waste involves mulching and use of materials in council operations, a cost will be incurred to source a similar quantity of materials to replace those diverted under the alternate business case.
5	It is assumed that 10% of drop-off materials are used in council operations (based on previous conversations with council officers) and bulk replacement materials would cost $20 per tonne. The majority of mulched material is currently stockpiled and a small proportion provided to residents.
6	Like other participating councils, Hepburn will contribute to central plant capital costs on an annualised per tonne basis over 5 years for the portion of plant additionality they utilise.
Assumptions applicable to the gas option	
7	Staffing requirements at an onsite plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary and indirect costs) of $80,000/year.
8	Maintenance of the microturbine plant is estimated to be $15,000 per 65kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
9	All waste is sent to the central plant and excess gas generation is credited to council.
10	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
11	Heat generated by the turbine is retained and used in other building processes (e.g. swimming pool).
Assumptions applicable to the slurry option	
12	Staffing requirements at an onsite plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary and indirect costs) of $80,000/year.
13	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
14	Maintenance of the small scale AD plant is estimated to be $20,000 per year (in year 1 based on estimated received by Hepburn Shire Council) and then increasing with CPI.
15	Additional waste not required for slurry production to meet engine demand is sent to the central plant to be converted to slurry and sold as a low quality product at $5/tonne.
16	For the on-site AD plant, a fast reaction time is assumed with a 5-day material residence time, yielding up to 76% of available gas from input material.
17	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
18	Heat generated by the turbine is retained and used in other building processes (e.g. swimming pool).

Ref	Assumption
19	Digestate generated at the on-site plant is returned to the central plant for further treatment and sale.
Assumptions applicable to the electricity option	
	None

Results

Table 16 presents the results of modelling the capital costs, on-going costs and on-going income and offsets for each scenario in Hepburn. The yearly balance in year one, five and ten (if this figure is negative then council is paying money to maintain the alternative option), the feasibility of each option and the estimated payback period in the number of years and the expected year is also presented.

From a financial perspective, each option has been assessed as being feasible, with payback for gas and slurry after 9 and 16 years respectively. The electricity scenario is profitable from the initial year of construction due to no on-site plant capital expenditure (the same for all councils) combined with a relatively small contribution to central plant capital (apportioned according to the quantity and quality of additional waste they contribute to the central plant). The cost and income comparison for Hepburn is slightly different than for other participating councils. The amount of capital that Hepburn is required to contribute to the expanded plant is calculated based on the additional 630 tonnes of garden organic waste deposited at their transfer stations. However, Hepburn will receive the income (and benefit) associated with this waste plus the initial 2,000 tonnes of food waste that is already committed to the Hepburn concept central plant from commercial sources. As a result, the year one, five and ten balances (cost minus income) are positive for all scenarios.

Figure 20 presents a comparison of the year one costs and income for each scenario. For the gas scenario, up to 65% of costs are associated with the gate fee at the central plant, staffing at the on-site plant and the cost of gas from the network to run the turbine. For the slurry scenario, up to 75% of the costs are associated with the gate fee at the central plant and staffing and maintenance of the AD and turbine at the on-site plant. For the electricity scenario, over 80% of costs are associated with Hepburn's contribution to central plant capital (for the first five years) and the gate fee at the central plant. Conversely, 70% and 76% of the expected income, for gas and slurry respectively, is from the avoided cost of BAU transfer station organics processing and Hepburn's share of income from the sale of products from treated digestate. The income for the electricity scenario is divided relatively evenly between the avoided cost of BAU transfer station organics processing, Hepburn's share of income from central plant generation (LGCs and feed-in tariffs) and their share of income from the sale of treated digestate.

Figure 21 presents the expected balance of cost and income for each option as well as potential high and low scenarios and an alternate expected projection using electricity prices as projected by the Finkel Review (Jacobs 2017).

In each option, the expected scenario experiences a plateau or decline over the first five years due to the contribution to central plant capital. Once this period is finished all options show the income is greater than costs and an increase in the expected balance. In each option, the expected scenario starts and continues on an upward trend. The slurry scenario remains below the break-even point beyond the ten year projection. This is due to the increased capital associated with on-site plant and equipment.

A comparison of the expected cost or income per tonne of waste is presented in Figure 22. This shows that, in the long term, the most cost-effective scenario is likely to be the central plant electricity option. All scenarios provide a positive income per tonne of waste, however the electricity option means that Hepburn would receive approximately $20 per tonne more than the gas option by year ten.

Table 16: Modelling results for Hepburn

Cost/income item		Gas	Slurry	Electricity
Capital costs				
On-site plant capital		-$ 638,200	-$ 804,800	
On-going costs				
Contribution to central plant capital (per t, 5 years)		-$ 14,500	-$ 9,900	-$ 46,600
Remaining BAU				
Replacement materials		-$ 1,300	-$ 1,300	-$ 1,300
Waste transport to central plant		-$ 6,700	-$ 8,100	-$ 6,700
Gate fee at central plant		-$ 24,200	-$ 25,700	-$ 33,200
Gas from network		-$ 20,600		
Electricity from network				-$ 10,200
Staff		-$ 24,000	-$ 24,000	
Maintenance		-$ 15,000	-$ 35,000	
Disposal of digestate			-$ 8,700	
Total on-going costs		**-$ 106,300**	**-$ 112,700**	**-$ 98,000**
On-going income/offsets				
Avoided landfill gate fees from waste div.				
Avoided cost BAU kerbside organics				
Avoided cost BAU drop-off organics		$ 62,400	$ 62,400	$ 62,400
Avoided electricity cost		$ 10,200	$ 10,200	
Surplus electricity income		$ 2,900	$ 2,900	
Avoided gas cost from reticulated heat use		$ 6,800	$ 6,800	
Income share from central plant gen.		$ 25,900		$ 46,400
Income share from central plant soil amendment		$ 46,200	$ 46,200	$ 46,200
Value of excess slurry			$ 15,000	
Total on-going income/offsets		**$ 154,400**	**$ 143,500**	**$ 155,000**
Balance and viability				
Balance at end of year:	1 (2018)	$ 48,100	$ 30,800	$ 57,000
	5 (2023)	$ 77,300	$ 46,700	$ 140,300
	10 (2028)	$ 96,000	$ 54,300	$ 153,600
Feasibility		**Feasible**	**Feasible**	**Feasible**
Estimated payback period (number of years)		9	16	0
Estimated payback year		2027	2034	2018

Note: All figures are estimates rounded to the nearest hundred.

Figure 20: Year 1 cost and income comparison for Hepburn

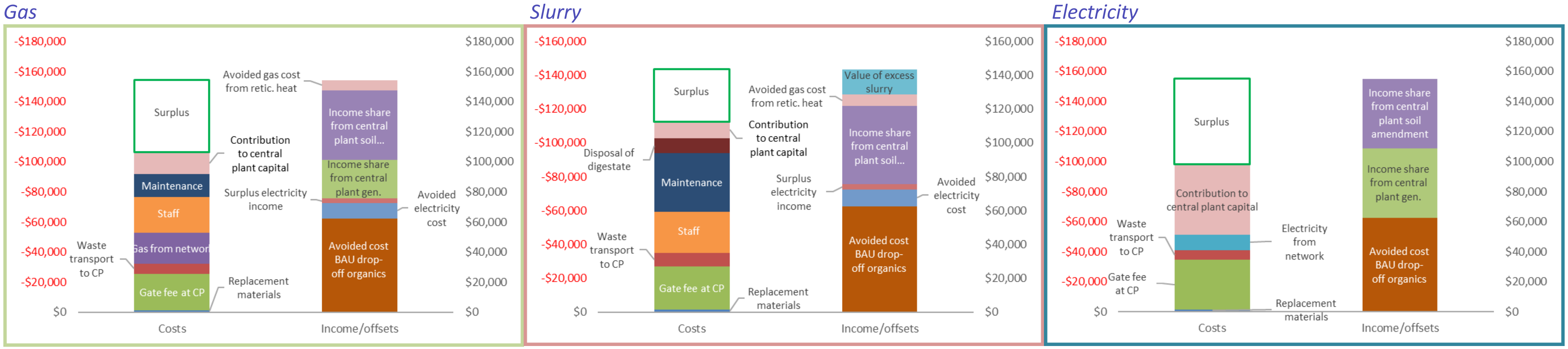
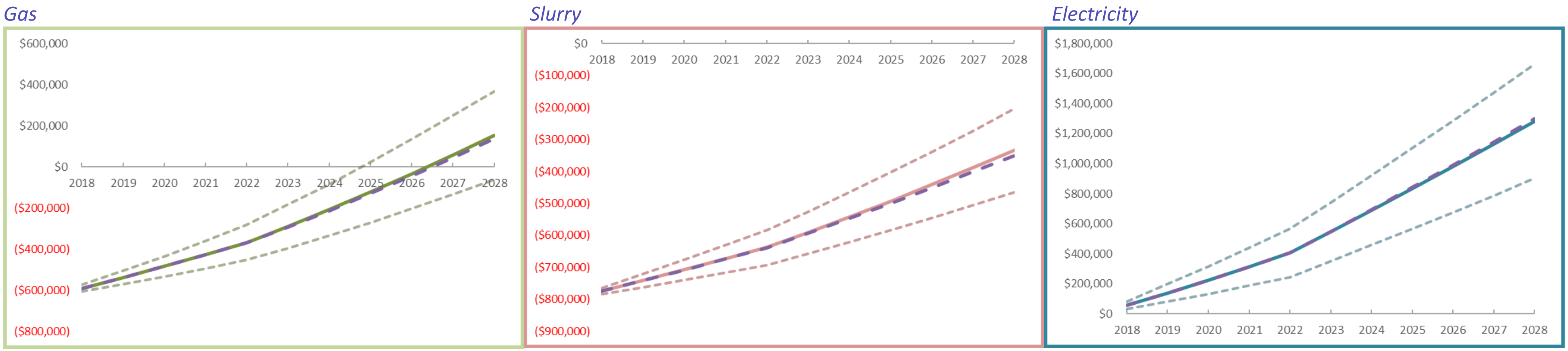
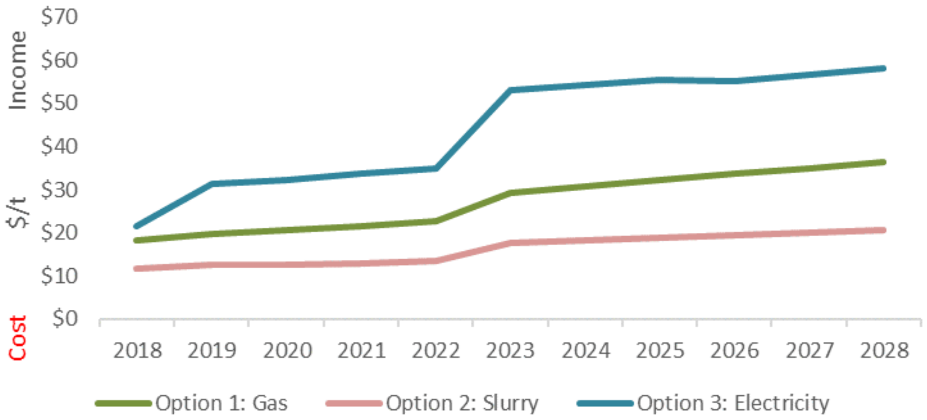


Figure 21: 10-year timeseries of the cost/income balance for Hepburn



Note: The purple dashed line shows the expected cost/income balance using electricity cost ranges projected by the Finkel Review (see Section 3.2)

Figure 22: Cost/income per tonne of waste for each scenario for Hepburn



6.4 Summary

All options for Hepburn are projected to be feasible based on modelling of costs and expected income and offsets. Table 17 summarises the current BAU costs for electricity consumption, kerbside waste transport and reprocessing and transfer station waste reprocessing. Also summarised is the feasibility for each option and the one, five and ten-year balance (yearly cost minus yearly income).

Table 17: Summary of BAU and alternate case costs for Hepburn

BAU energy and waste costs		$/year	
Electricity consumption		-$ 10,200	
Kerbside organics transport and reprocessing		No service	
Transfer station organics reprocessing		-$ 62,400	
Total BAU costs per year		**-$ 72,600**	
Balance at end of year	Gas	Slurry	Electricity
(income - cost)	**Feasible**	**Feasible**	**Feasible**
1 (2018)	$ 48,100	$ 30,800	$ 57,000
5 (2023)	$ 77,300	$ 46,700	$ 140,300
10 (2028)	$ 96,000	$ 54,300	$ 153,600
Payback period (years)	9	16	0

Note the determination of feasibility is subject to the redevelopment of the Daylesford community hub proceeding as proposed (with all grid connection costs incorporated into development costs); without this redevelopment, the logistics of the proposed site are not favourable for either the gas or slurry scenario.

7. Macedon Ranges

The results of the modelling, site inspections and feasibility of participation for Macedon Ranges Shire Council are discussed below.

7.1 Waste feedstock and energy demand

Waste type and availability

Macedon Ranges currently provide a universal kerbside collection of garden organic waste in major townships. The service is provided to approximately 10,300 households and in 2015/16 collected around 2,600 tonnes. Waste collected from the kerbside service is currently deposited at a depot of Macedon Range's collection contractor and consolidated into bulk haul vehicles for transport to their organics reprocessor in Camperdown. Discussions with Council officers have indicated that Macedon Ranges is considering adding food organics to their garden organics collection contract when this expires in 2018. Council have estimated that of the approximate 9,000 tonnes of garbage currently sent to landfill from MSW collections, 25% is food waste (or 2,250 tonnes). Based on previous experience with other Victorian councils, we estimate that a maximum of 50% of this waste would be captured in an expanded system, resulting in an additional 1,125 tonnes diverted from landfill and available as feedstock. The availability of the mixed food organics and garden organics would be from October 2018 onwards.

Separated garden waste is accepted at Council's waste transfer stations (located at Kyneton, Romsey and Woodend) and in 2016 approximately 2,800 tonnes were deposited. Drop-off garden waste is not reprocessed together with kerbside garden organics. Instead, drop-off garden waste is shredded/mulched and stockpiled at Kyneton Transfer Station for use in council operations (a small quantity is sold to the public). Given the majority of this waste is currently stockpiled or used in council operations, it is likely that it would be immediately available for input to a central facility.

Based on average monthly data, collections of kerbside waste tend to peak in October at around 360 tonnes with the lowest quantities collected in February and July (160 tonnes). For transfer station waste, average monthly drop-off tonnes tend to peak in January at 390 tonnes with the lowest quantities collected in June (150 tonnes). Using month-by-month data, the seasonal peak for waste quantities was estimated to be 127% of the average tonnages.

Macedon Ranges identified additional waste generated from within the region that could be sent to a centralised facility. Council currently manages around 260 tonnes per year of livestock manure from the Kyneton Saleyards which would be immediately available for input to a central facility. Table 18 summarises the waste types, quantities and availability of waste.

Table 18: Waste feedstock in Macedon Ranges

Waste type	Source	Availability	Tonnes/year	Seasonality
Mixed food and garden waste	Kerbside	Oct 2018	3,400	
Garden waste	Drop-off	Yes	2,900	
Livestock manure	Council operations	Yes	260	
Total available	**6,500 tonnes (food, garden, manure waste)**			**127%**

Council building energy consumption

Macedon Ranges provided electricity and gas consumption data for eight council owned facilities, including:

- Kyneton Aquatic Centre, Gisborne Aquatic Centre, Kyneton Council Office and Kyneton Mechanics Institute (all electricity and gas)
- Gisborne Town Office, Woodend Depot, Romsey Community Centre and Woodend Community Centre (all electricity only).

Data was provided for a range of periods with a minimum of one full year of data between November 2014 and February 2017. Based on average annual consumption, the Kyneton Aquatic Centre was by far the highest consumer of electricity (1,357,300 kWh) and the second highest consumer of gas (8,158,800 MJ), second to the Gisborne Aquatic Centre (8,994,800 MJ). Average monthly consumption for electricity was highest in August and for gas in June/July, with both being lowest in January/February. The annual cost of electricity and gas consumption at the Kyneton Aquatic Centre is estimated to be $217,000 and $138,000 respectively (or $355,000 per year).

The next highest consumers of electricity were the Gisborne Aquatic Centre (553,300 kWh, and highest gas consumer as mentioned above) and the Kyneton Council Offices (371,600 kWh) which also ranked third for gas consumption (1,072,600 MJ).

7.2 Council site

As the consumer of the largest quantity of electricity and second largest consumer of gas, the Kyneton Aquatic Centre was selected as the most appropriate site for further investigation. The Centre is located at 8 Victoria Street, Kyneton and contains a gymnasium, three indoor heated swimming pools and indoor sports courts. Figure 23 shows an aerial view of the aquatic centre.

Figure 23: Aerial view of Kyneton Aquatic Centre

Inspection of the aquatic centre identified the location of the existing gas meter on the northern edge of the building. This location is indicated on the aerial view, and shown in Figure 24 overleaf.

Figure 24: Kyneton Aquatic Centre

Figure 24 shows sufficient space for a shipping container adjacent to the gas meter, although it would require reconfiguration of the existing paving, fence line and landscaping both for greater usability and maintaining staff access to that part of the centre. Some reduction in the garden area will likely be needed.

There is some potential for locating two shipping containers (required under the slurry scenario), however this would impact on current site activities to a much greater degree. The two shipping containers would need to be located in the same area shown in Figure 24, due to lack of space elsewhere. Under this scenario, the reconfiguration of the area needed would be much greater, with additional reduction of the garden area. The portable tennis building (to the left of the photo) may also need to be moved due to traffic and odour impacts, and there would be some loss of car parking spaces. Trucks transporting slurry to the site currently could only access the site via the public car park. As a minimum this would need to be modified to reduce the number of tight turns that trucks would need to make transiting the car park. However it is preferable for safety reasons for trucks to have separate entrances and exits from public vehicles, and this would entail much greater changes to the existing entrance and parking areas.

Of the two scenarios, the gas scenario is more favourable due to lower impact on existing activities and lower costs in reconfiguring the existing improvements.

7.3 Modelling

See Section 3.2 for a detailed description of the methods used in modelling the business case for Macedon Ranges. Table 5 in the same section provides a summary of the assumptions used in modelling that are applicable to all councils.

Assumptions used in modelling that are applicable to each scenario for Macedon Ranges only are presented in Table 19.

Table 19: Data and plant assumptions applicable to Macedon Ranges

Ref	Assumption
General assumptions applicable to each option	
1	The quantity of waste captured by the introduction of food waste collections is based on current waste to landfill (9,000 tonnes) and waste composition audit results for food of 25% (approximately 2,250 tonnes of food waste). It is assumed that 50% of this waste will be captured as a result of the new service.
2	Kyneton Aquatic Centre is selected as the project site as it is by far the largest consumer of electricity and the second largest consumer of gas based on average annual consumption data.
3	For scenarios with an on-site turbine, the site will have 2 turbines with a capacity of 130 kW. On-site turbine capacity does not exceed potential outputs from waste feedstock. Onsite turbines do not exceed building energy requirements.
4	A combined BAU per tonne kerbside cost for collection and transport of organic waste was provided. It is assumed that the proportion of BAU costs attributed to waste transport is 25% of total collection and transport costs.
5	Where BAU management of drop-off organic waste involves mulching and use of materials in council operations, a cost will be incurred to source a similar quantity of materials to replace those diverted under the alternate business case.
6	We have assumed that 20% of drop-off materials are used in council operations (based on discussion with council officers) and bulk replacement materials would cost $20 per tonne.
7	The current BAU method used of hauling collected kerbside organics to the Wheelie Waste depot in Kyneton for bulking before transportation to a reprocessor would continue under the alternate case.
8	Macedon Ranges will contribute to central plant capital costs on an annualised per tonne basis over 5 years.
Assumptions applicable to the gas option	
9	Staffing requirements at an on-site plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
10	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
11	All waste is sent to the central plant and excess gas generation is credited to council.
12	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
13	Heat generated by the turbine is retained and used in other building processes.
Assumptions applicable to the slurry option	
14	Staffing requirements at an on-site plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
15	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
16	Maintenance of the small scale AD plant is estimated to be $20,000 per year (in year 1 based on estimated received by Hepburn Shire Council) and then increasing with CPI.

Ref	Assumption
17	Additional waste not required for slurry production to meet engine demand is sent to the central plant to be converted to slurry and on sold as a low quality product at $5/tonne.
18	For the on-site AD plant, a fast reaction time is assumed with a 5-day material residence time, yielding up to 76% of available gas from input material.
19	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
20	Heat generated by the turbine is retained and used in other building processes.
21	Digestate generated at the onsite plant is returned to the central plant for further treatment and sale.
Assumptions applicable to the electricity option	
	None

Results

Table 20 presents the results of modelling the capital costs, on-going costs and on-going income and offsets for each scenario in Macedon Ranges. The yearly balance in year one, five and ten (if this figure is negative then council is paying money to maintain the alternative option), the feasibility of each option and the estimated payback period in the number of years and the expected year is also presented.

From a financial perspective, each option has been assessed as being feasible with payback for gas, slurry and electricity after 8, 11 and 6 years respectively. For all slurry and electricity scenarios, the year one balance is negative, however this is minimal for slurry. The gas scenario is marginally positive. This pattern is a reflection of the five-year payback contributions required towards central plant capital. Once this payback period is complete, the yearly balance increases to $221,100 for gas, $144,100 for slurry and $436,900 for electricity with further increases to the ten-year balance period.

Figure 25 presents a comparison of the year one costs and income for each scenario. For the gas and slurry options, 71% and 76% (respectively) of the ongoing costs are associated with the:

- gate fee at the central plant
- cost of electricity from the network to meet the energy needs of the building not covered by the on-site generator
- cost of transporting waste to the central plant.

For the same scenarios, up to 86% and 88% (gas and slurry respectively) of expected income is attributed to the:

- avoided cost of BAU kerbside organics waste transport and reprocessing
- avoided landfill gate fees from additional waste diversion (service expansion of the kerbside garden waste bin to include food waste collections planned for late 2018)
- share of income from the sale of products derived from treated digestate.

For the electricity scenario, around 85% of costs are associated with Council's contribution to central plant capital (for the first five years), the gate fee at the central plant and the cost of electricity from the network to cover the building's energy needs not met by the on-site generator. Conversely, around 73% of expected income is attributed to the avoided cost of BAU kerbside organics waste transport and reprocessing and the avoided landfill gate fees from additional waste diversion.

Figure 26 presents the expected balance of cost and income for each option as well as potential high and low scenarios and an alternate expected projection using electricity prices as projected by the Finkel Review (Jacobs 2017). In each option, the expected scenario experiences a plateau or decline (especially for the electricity scenario) over the first five years owing to Macedon Ranges' contribution to central plant capital. Once this period is finished, all options show the income is greater than costs and an increase in the expected balance.

A comparison of the expected cost or income per tonne of waste is presented in Figure 27. This shows that, in the long run, the most cost-effective scenario is likely to be the electricity option; this would see income received per tonne of waste in the order of $76 by 2028 (compared to around $44 for the gas scenario).

Table 20: Modelling results for Macedon Ranges

Cost/income item		Gas	Slurry	Electricity
Capital costs				
On-site plant capital		-$ 1,138,900	-$ 1,291,100	
On-going costs				
Contribution to central plant capital (per t, 5 years)		-$ 143,100	-$ 97,900	-$ 461,200
Remaining BAU				
Replacement materials		-$ 11,500	-$ 11,500	-$ 11,500
Waste transport to central plant		-$ 175,900	-$ 180,800	-$ 175,900
Gate fee at central plant		-$ 236,200	-$ 260,000	-$ 323,500
Gas from network		-$ 41,300		
Electricity from network		-$ 189,400	-$ 189,400	-$ 220,200
Staff		-$ 24,000	-$ 24,000	
Maintenance		-$ 30,000	-$ 50,000	
Disposal of digestate			-$ 20,200	
Total on-going costs		**-$ 851,500**	**-$ 834,800**	**-$ 1,192,300**
On-going income/offsets				
Avoided landfill gate fees from waste div.		$ 193,600	$ 193,600	$ 193,600
Avoided cost BAU kerbside organics		$ 426,700	$ 426,700	$ 426,700
Avoided cost BAU drop-off organics		$ 27,900	$ 27,900	$ 27,900
Avoided electricity cost		$ 30,800	$ 30,800	
Surplus electricity income				
Avoided gas cost from reticulated heat use		$ 13,600	$ 13,600	
Income share from central plant gen.		$ 61,100		$ 109,700
Income share from central plant soil amendment		$ 109,200	$ 109,200	$ 109,200
Value of excess slurry			$ 35,900	
Total on-going income/offsets		**$ 862,900**	**$ 837,700**	**$ 867,100**
Balance and viability				
Balance at end of year:	1 (2018)	$ 11,400	$ 2,900	-$ 325,200
	5 (2023)	$ 221,100	$ 144,100	$ 436,900
	10 (2028)	$ 284,000	$ 179,400	$ 489,800
Feasibility		**Feasible**	**Feasible**	**Feasible**
Estimated payback period (number of years)		8	11	6
Estimated payback year		2026	2029	2024

Note: All figures are estimates rounded to the nearest hundred.

Figure 25: Year 1 cost and income comparison for Macedon Ranges

Gas Slurry Electricity

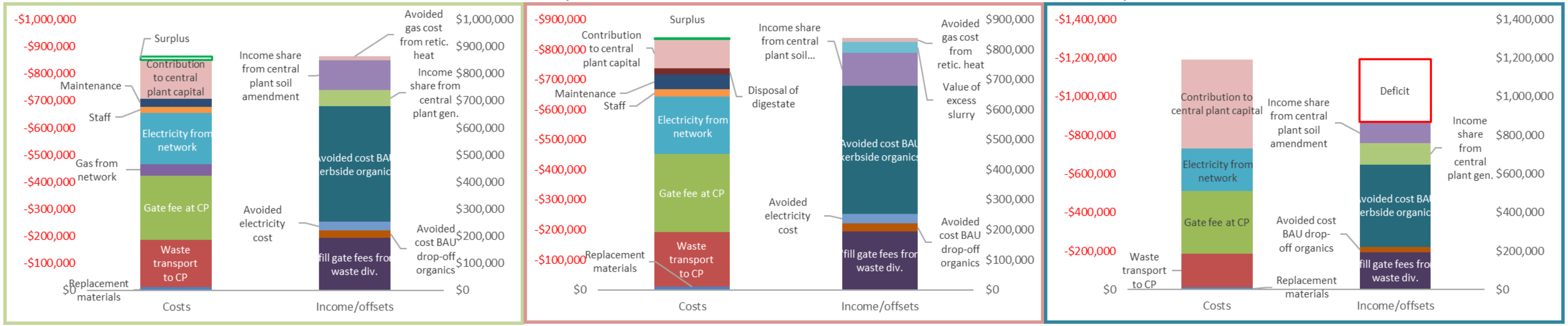
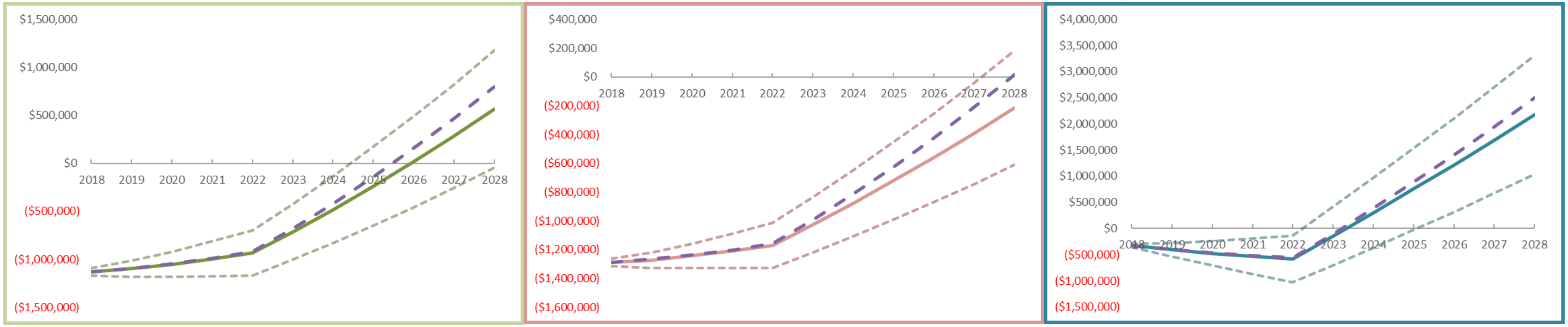


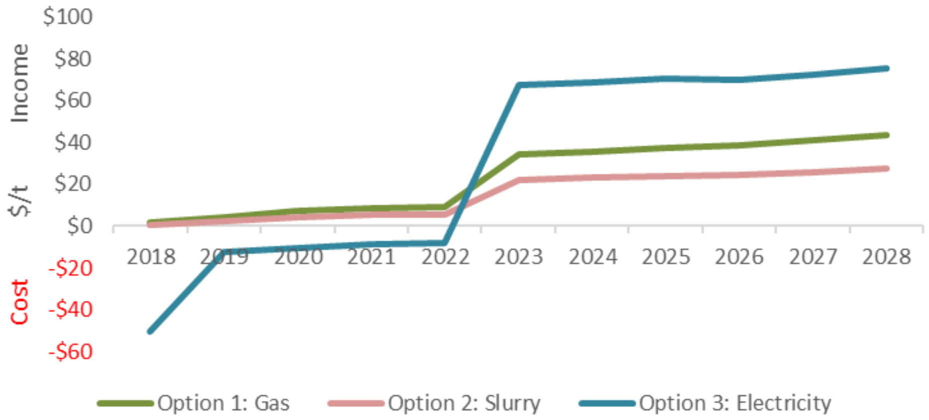
Figure 26: 10-year timeseries of the cost/income balance for Macedon Ranges

Gas Slurry Electricity



Note: The purple dashed line shows the expected cost/income balance using electricity cost ranges projected by the Finkel Review (see Section 3.2)

Figure 27: Cost/income per tonne of waste for each scenario for Macedon Ranges



7.4 Summary

All options for Macedon Ranges are projected to be feasible based on modelling of costs and expected income and offsets, although the electricity option provides better long term financial outcomes. Table 21 summarises the current BAU costs for electricity consumption, kerbside waste transport and reprocessing and transfer station waste reprocessing. The feasibility for each option and the one, five and ten-year balance (yearly cost minus yearly income) is also summarised.

Table 21: Summary of BAU and alternate case costs for Macedon Ranges

BAU energy and waste costs		$/year	
Electricity consumption		-$ 217,000	
Kerbside organics transport and reprocessing		-$ 426,700	
Transfer station organics reprocessing		-$ 15,000 (cost minus income received)	
Total BAU costs per year		**-$ 658,700**	
Balance at end of year	Gas	Slurry	Electricity
(income - cost)	**Feasible**	**Feasible**	**Feasible**
1 (2018)	$ 11,400	$ 2,900	-$ 325,200
5 (2023)	$ 221,100	$ 144,100	$ 436,900
10 (2028)	$ 284,000	$ 179,400	$ 489,800
Payback period (years)	8	11	6

8. Mount Alexander

The results of the modelling, site inspections and feasibility of participation for Mount Alexander Shire Council are discussed below.

8.1 Waste feedstock and energy demand

Waste type and availability

Mount Alexander does not currently offer a kerbside collection service for any organic waste and Council is not considering introducing such a service. Separated garden organic waste is accepted at Council's waste transfer stations (located at Castlemaine and Maldon) and in 2016 around 400 tonnes were deposited. This material is mulched at the Castlemaine facility and is stockpiled for use in council operations or sold to residents (although in discussion with council staff, very little is bought); as a result, this feedstock is immediately available. Monthly data for this waste is unavailable due to council recording systems. Table 22 summarises the waste types, quantities and availability of waste in Mount Alexander.

Table 22: Waste feedstock in Mount Alexander

Waste type	Source	Availability	Tonnes/year	Seasonality
Garden waste	Drop-off	Yes	400	
Total available	**400 tonnes (garden waste)**			**Unknown**

Council building energy consumption

Mount Alexander provided electricity and gas consumption data for two council owned facilities, Castlemaine Civic Centre and Castlemaine Town Hall (both electricity and gas). Consumption data was provided between January 2015 and December 2016 for electricity and July 2009 and March 2017 for gas. Based on average annual consumption, the Civic Centre (89,100 kWh) and Town Hall (88,800 kWh) had similar electricity usage profiles. For average annual consumption of gas, the Civic Centre is by far the largest consumer (594,300 MJ). Average monthly consumption of electricity in the Civic Centre was reasonably consistent throughout the year but highest in February and lowest in September while in the Town Hall it was highest in August and lowest between November and February. Average monthly consumption of gas was similar in both facilities with lowest consumption in January and definitive peaks in the June to September period. The annual cost of electricity and gas consumption at the facility is estimated to be $14,000 and $10,000 respectively (or $24,000 per year).

8.2 Council site

The facilities nominated by Mount Alexander are relatively similar in energy consumption. In addition to this they are located adjacent to each other (at 25 and 27 Lyttleton Street, Castlemaine) but separated by a small lane-way used for outgoing vehicle access from the car park behind the civic centre (Figure 28 shows an aerial view of both the Town Hall and Civic Centre).

Figure 28: Aerial view of Castlemaine Town Hall (A) and Civic Centre (B)

Both sites were inspected to identify relevant site issues. While three different gas meters were located around the Town Hall, suitable access to all of them was constrained by adjacent roadways or buildings. However the gas connection at the Civic Centre (indicated in Figure 28 above) had an adjacent staff car park that could potentially provide space for one or more shipping containers.

The staff car park was located on a raised platform at the rear of the Civic Centre, the corner of which is shown in Figure 29).

Figure 29: Castlemaine Civic Centre car park

This location could be used for one or two shipping containers for the gas or slurry scenario, although we note the following issues would need to be considered:

- there could be a loss of up to six car parking spaces available to staff (depending on the scenario)
- as the platform is raised the profile of the shipping containers would also be raised, increasing the visual impact and potentially reducing the amenity of the small garden/recreation area at the rear of the Civic Centre
- there is a storage building located between the car park and the gas meter on the rear of the Civic Centre building; connection between the meter and the shipping container could not be done by trenching alone, but would be more complex (and potentially more costly)
- security of the area containing the shipping containers (e.g. by fencing) may also be problematic without further impacting on the availability of car parking.

While there may be space for the two shipping containers of the slurry scenario, truck access would be more constrained by the current configuration of the car park. There may also be concerns regarding the potential odour impacts of the slurry given the central business district location.

Consequently the gas scenario is likely to be more practicable at this site than the slurry scenario, although we note the gas scenario may also be problematic to implement given the site constraints. It is therefore likely that the electricity scenario may be more feasible at this location.

8.3 Modelling

See Section 3.2 for a detailed description of the methods used in modelling the business case for Mount Alexander. Table 5 in the same section provides a summary of the assumptions used in modelling that are applicable to all councils.

Assumptions used in modelling that are applicable to each scenario for Mount Alexander only are presented in Table 23.

Table 23: Data and plant assumptions applicable to Mount Alexander

Ref	Assumption
General assumptions applicable to each option	
1	Mount Alexander Shire Council does not currently have a kerbside collection of organic waste. In discussion with council officers, a service introduction for food or garden waste collections is not likely.
2	The Castlemaine Civic Centre is selected as the project site as it is the largest consumer of electricity and gas based on average annual consumption data.
3	Where BAU management of drop-off organic waste involves mulching and use of materials in council operations, a cost will be incurred to source a similar quantity of materials to replace those diverted under the alternate business case.
4	We have assumed that 95% of drop-off materials are used in council operations (based on previous discussion with council officers) and bulk replacement materials would cost $20 per tonne. Very little mulch is sold to residents and the majority is used in council operations.
5	Mount Alexander Shire Council will contribute to central plant capital costs on an annualised per tonne basis over 5 years.
Assumptions applicable to the gas option	
6	Staffing requirements at an onsite plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
7	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
8	All waste is sent to the central plant and excess gas generation is credited to council.
9	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
10	Heat generated by the turbine is retained and used in other building processes.
Assumptions applicable to the slurry option	
11	Staffing requirements at an onsite plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
12	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
13	Maintenance of the small scale AD plant is estimated to be $20,000 per year (in year 1 based on estimated received by Hepburn Shire Council) and then increasing with CPI.
14	Additional waste not required for slurry production to meet engine demand is sent to the central plant to be converted to slurry and on sold as a low quality product at $5/tonne.
15	For the on-site AD plant, a fast reaction time is assumed with a 5-day material residence time, yielding up to 76% of available gas from input material.
16	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
17	Heat generated by the turbine is retained and used in other building processes.
18	Digestate generated at the on-site plant is returned to the central plant for further treatment and sale.

Ref	Assumption
Assumptions applicable to the electricity option	
	None

Results

Table 24 presents the results of modelling the capital costs, on-going costs and on-going income and offsets for each scenario in Mount Alexander. The yearly balance in year one, five and ten (if this figure is negative then council is paying money to maintain the alternative option), the feasibility of each option and the estimated payback period in the number of years and the expected year is also presented.

From a financial perspective, each option has been assessed as not feasible as none will achieve a payback on investment. For all scenarios the year one, five and ten-year balance is negative suggesting that costs from the start, and into the future, are larger than the estimated income/offsets received.

Figure 30 presents a comparison of the year one costs and income for each scenario. Immediately evident is the large difference between project costs and expected income and the resulting deficit between the two (in all cases, costs are more than three times the expected income).

For the gas scenario, costs associated with staff, gas from the network (to be used by the generator) and the gate fee at the central plant are the largest contributors to overall costs making up 55% of the total. For the slurry scenario, costs associated with on-site plant maintenance (of the AD plant and generator), staff and disposal of digestate make up 65% of total costs. For the electricity scenario, the five year per tonne contribution to central plant capital, the gate fee at the central plant and the cost of electricity from the network contribute over 90% of total costs.

The main sources of income in the gas and slurry scenarios is from avoided electricity costs, Mount Alexander's share of income from the sale of products derived from treated digestate and the avoided BAU cost of transfer station waste reprocessing which contribute 76% and 81% respectively to total income. The main source of income in the electricity scenario is split relatively evenly between the avoided BAU cost of transfer station waste reprocessing, Council's share of income from the sale of treated digestate and their share from central plant generation (LGCs and feed-in tariffs).

Figure 31 presents the expected balance of cost and income for each option as well as potential high and low scenarios and an alternate expected projection using electricity prices as projected by the Finkel Review (Jacobs 2017). In each option, the expected scenario starts and continues on a downward trend.

A comparison of the expected cost or income per tonne of waste for each scenario is presented in Figure 32. This shows that, for all scenarios, Mount Alexander would need to supplement on-going costs in order to make any option feasible. Out of each of the scenarios, the electricity option would provide the least cost strain to council, however this would still be a minimum of $70 per tonne.

Table 24: Modelling results for Mount Alexander

Cost/income item		Gas	Slurry	Electricity
Capital costs				
On-site plant capital		-$ 678,900	-$795,400	
On-going costs				
Contribution to central plant capital (per t, 5 years)		-$ 9,200	-$ 6,300	-$ 29,600
Remaining BAU				
Replacement materials		-$ 7,700	-$ 7,700	-$ 7,700
Waste transport to central plant		-$ 7,400	-$ 12,000	-$ 7,400
Gate fee at central plant		-$ 15,300	-$ 16,300	-$ 21,000
Gas from network		-$ 16,700		
Electricity from network		-$ 2,000		-$ 14,500
Staff		-$ 24,000	-$ 24,000	
Maintenance		-$ 15,000	-$ 35,000	
Disposal of digestate			-$ 18,800	
Total on-going costs		**-$ 97,300**	**-$ 120,100**	**-$ 80,200**
On-going income/offsets				
Avoided landfill gate fees from waste div.				
Avoided cost BAU kerbside organics				
Avoided cost BAU drop-off organics		$ 9,600	$ 9,600	$ 9,600
Avoided electricity cost		$ 12,500	$ 14,500	
Surplus electricity income			$ 500	
Avoided gas cost from reticulated heat use		$ 5,500	$ 6,800	
Income share from central plant gen.		$ 3,900		$ 6,900
Income share from central plant soil amendment		$ 6,900	$ 6,900	$ 6,900
Value of excess slurry				
Total on-going income/offsets		**$ 38,400**	**$ 38,300**	**$ 23,400**
Balance and viability				
Balance at end of year:	1 (2018)	-$ 58,900	-$ 81,800	-$ 56,800
	5 (2023)	-$ 55,600	-$ 83,000	-$ 27,700
	10 (2028)	-$ 61,200	-$ 89,200	-$ 34,600
Feasibility		**Not feasible**	**Not feasible**	**Not feasible**
Estimated payback period (number of years)		-	-	-
Estimated payback year		No payback	No payback	No payback

Note: All figures are estimates rounded to the nearest hundred.

Figure 30: Year 1 cost and income comparison for Mount Alexander

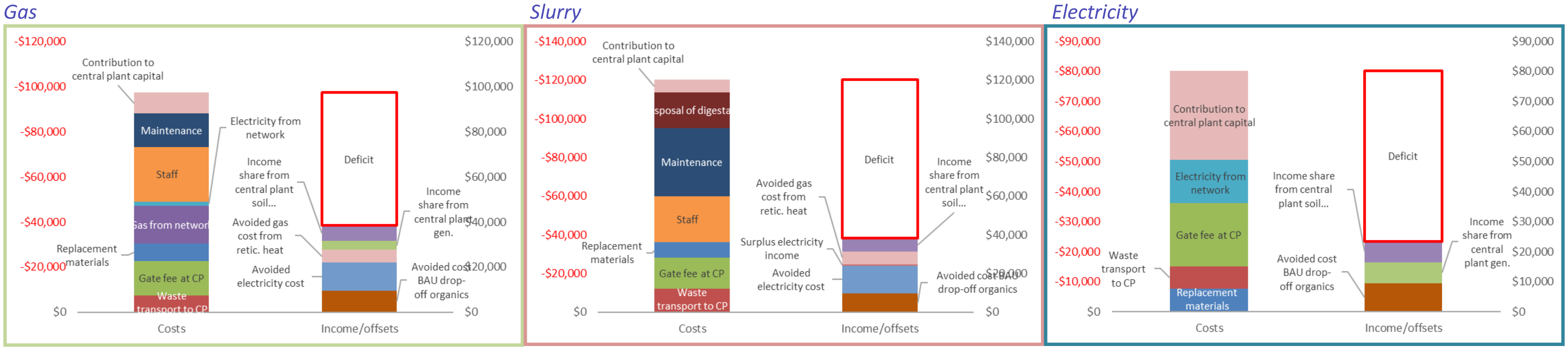
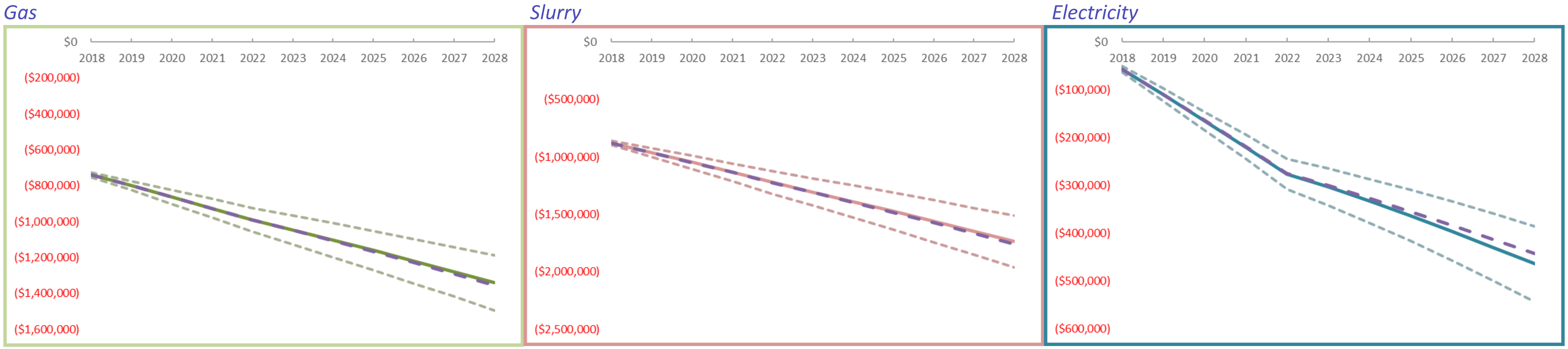
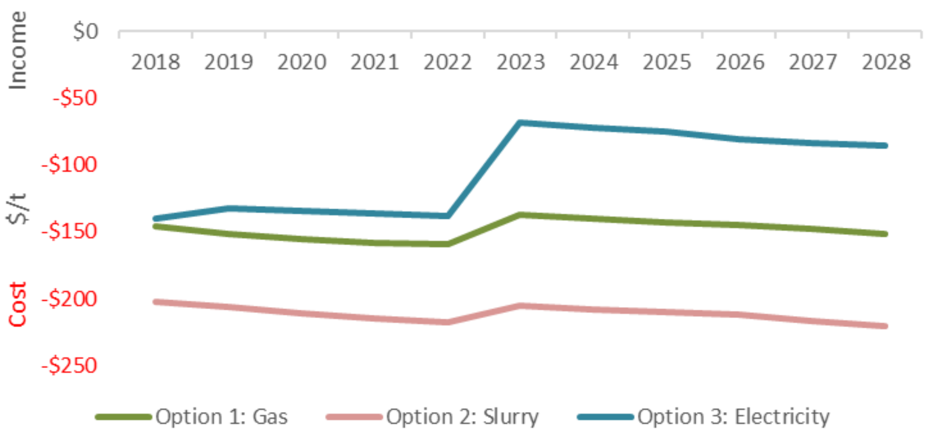


Figure 31: 10-year timeseries of the cost/income balance for Mount Alexander



Note: The purple dashed line shows the expected cost/income balance using electricity cost ranges projected by the Finkel Review (see Section 3.2)

Figure 32: Cost/income per tonne of waste for each scenario for Mount Alexander



8.4 Summary

All options for Mount Alexander are projected to be not feasible based on modelling of costs and expected income and offsets. Table 25 summarises the current BAU costs for electricity consumption, kerbside waste transport and reprocessing and transfer station waste reprocessing. The feasibility for each option and the one, five and ten-year balance (yearly cost minus yearly income) is also summarised.

Table 25: Summary of BAU and alternate case costs for Mount Alexander

BAU energy and waste costs		$/year	
Electricity consumption		-$ 14,000	
Kerbside organics transport and reprocessing		No service	
Transfer station organics reprocessing		-$ 9,600 (cost minus income received)	
Total BAU costs per year		**-$ 23,600**	
Balance at end of year	Gas	Slurry	Electricity
(income - cost)	Not feasible	Not feasible	Not feasible
1 (2018)	-$ 58,900	-$ 81,800	-$ 56,800
5 (2023)	-$ 55,600	-$ 83,000	-$ 27,700
10 (2028)	-$ 61,200	-$ 89,200	-$ 34,600
Payback period (years)	-	-	-

9. Pyrenees

The results of the modelling, site inspections and feasibility of participation for Pyrenees Shire Council are discussed below.

9.1 Waste feedstock and energy demand

Waste type and availability

Pyrenees currently provide a kerbside collection of garden organic waste in the townships of Avoca and Beaufort. The service collected around 120 tonnes in 2016. Separated garden waste is also accepted at Council's waste transfer stations (located at Avoca, Beaufort, Landsborough and Snake Valley) and in 2016 around 200 tonnes were deposited. Waste from the kerbside service and drop-off locations are combined at Snake Valley Transfer Station and mulched, with materials used in the rehabilitation of former Council-owned landfill sites and other Council operations. It is likely that this material would be immediately available for input to the central plant.

Based on monthly data for waste quantities in 2016, both kerbside collections and drop-off tonnages peaked in October with the lowest quantities in January. Using month-by-month data, the seasonal peak for waste quantities was estimated to be 122% of the average tonnages.

Additional sources of organic waste, either from Council operations or commercial operators, were not identified in discussions with Council officers. Table 26 summarises the waste types, quantities and availability in Pyrenees.

Table 26: Waste feedstock in Pyrenees

Waste type	Source	Availability	Tonnes/year	Seasonality
Garden waste	Kerbside	Yes	120	
Garden waste	Drop-off	Yes	200	
Total available	**320 tonnes (garden waste)**			**122%**

Council building energy consumption

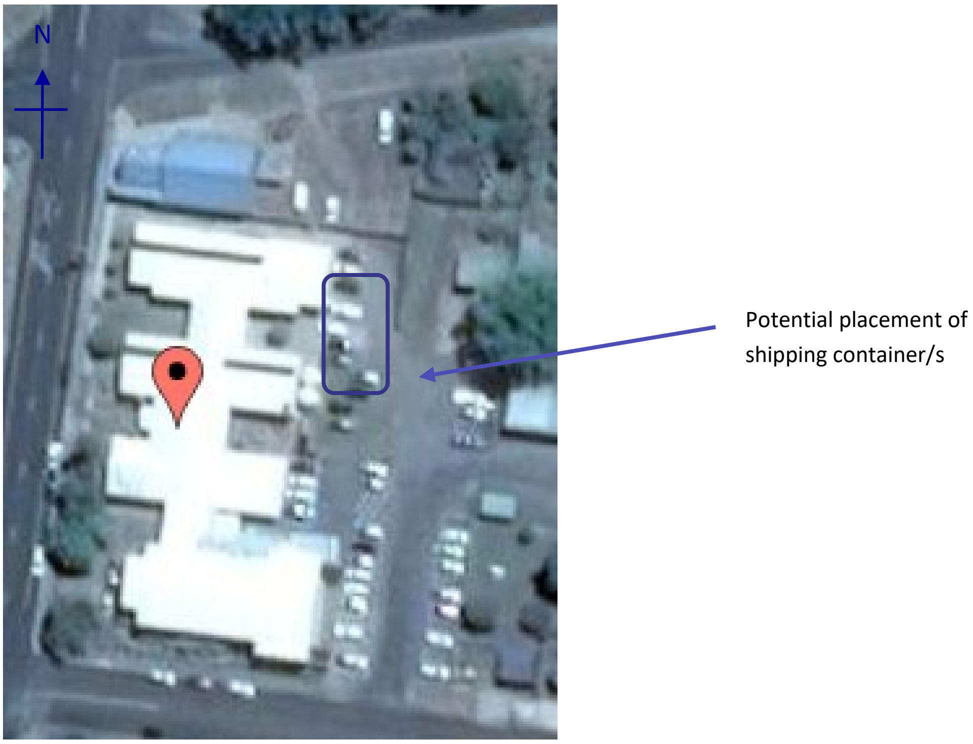
Pyrenees provided electricity consumption data for one Council-owned facility, Beaufort Shire Office, and consumption data was provided between July 2013 and June 2015. Average annual electricity consumption is approximately 110,600 kWh per year with monthly consumption highest in July and lowest in January and February (forming a definitive peak), costing council around $17,900 per year.

Council officers noted that no Council facilities in Pyrenees are connected to the gas distribution network; where gas is used, it is supplied via gas cylinders as needed.

9.2 Council site

The only facility nominated by Pyrenees was the Beaufort Shire Office, at 5 Lawrence Street, Beaufort. Figure 33 shows an aerial view of the site.

Figure 33: Aerial view of Beaufort Shire Office



There is a large area at the rear of the Beaufort Shire Office currently used for car parking which offers potential for locating one or more shipping containers. In order to maintain clear access to the depot area (to the east of the site in Figure 33), any container/s should be placed at the northern end of the car park (indicated above).

Within the potential placement area, there are currently generators in one location (see Figure 34). While the specifications of the generators are not known, there may be some potential for reconfiguration for tandem use with the gas or slurry scenarios. This would need to be further investigated.

Figure 34: Beaufort Shire Office car park

As the building is not currently connected to the gas distribution network, siting of the turbine container is not constrained by the location of a gas meter. However this means that implementing the gas scenario would require gas connection and distribution infrastructure to be developed, adding to the cost of implementation.

There is potentially access available at this location for trucks servicing the slurry scenario, although given the area's use for staff car parking it is not ideal. The amenity of the location may also be impacted by truck movements, as well as potential odour issues.

9.3 Modelling

See Section 3.2 for a detailed description of the methods used in modelling the business case for Pyrenees. Table 5 in the same section provides a summary of the assumptions used in modelling that are applicable to all councils.

Assumptions used in modelling that are applicable to each scenario for Pyrenees only are presented in Table 27.

Table 27: Data and plant assumptions applicable to Pyrenees

Ref	Assumption
General assumptions applicable to each option	
1	Pyrenees Shire Council currently provide a kerbside collection service for garden organic waste. In discussion with council officers, a service expansion to include food waste is not likely.
2	Beaufort Shire Office is selected as the project site as it is the largest consumer of electricity based on average annual consumption data.
3	A combined BAU per tonne kerbside cost for collection and transport of organic waste was provided. It is assumed that the proportion of BAU costs attributed to waste transport is 25% of total collection and transport costs.
4	Where BAU management of drop-off organic waste involves mulching and use of materials in council operations, a cost will be incurred to source a similar quantity of materials to replace those diverted under the alternate business case.
5	It is assumed that 100% of drop-off materials are used in council operations (based on discussion with council officers) and bulk replacement materials would cost $20 per tonne. All material is used in rehabilitation of old landfill sites, council operations or stockpiled.
6	Pyrenees Shire Council will contribute to central plant capital costs on an annualised per tonne basis over 5 years.
Assumptions applicable to the gas option	
7	Staffing requirements at an on-site plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
8	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
9	All waste is sent to the central plant and excess gas generation is credited to council.
10	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
11	Heat generated by the turbine is retained and used in other building processes.
Assumptions applicable to the slurry option	
12	Staffing requirements at an onsite plant would be at a rate of 0.3 EFTE/year based on a labour cost (salary plus indirect costs) of $80,000/year.
13	Maintenance of the microturbine plant is estimated to be $15,000 per 65 kW turbine per year (in year 1 based on estimates received by Hepburn Shire Council) and then increasing with CPI.
14	Maintenance of the small scale AD plant is estimated to be $20,000 per year (in year 1 based on estimated received by Hepburn Shire Council) and then increasing with CPI.
15	Additional waste not required for slurry production to meet engine demand is sent to the central plant to be converted to slurry and on sold as a low quality product at $5/tonne.
16	For the on-site AD plant, a fast reaction time is assumed with a 5-day material residence time, yielding up to 76% of available gas from input material.
17	Electrical efficiency for the central plant engine is assumed to be 35%, running for 5 hours per day at 80% capacity.
18	Heat generated by the turbine is retained and used in other building processes.

Ref	Assumption
19	Digestate generated at the on-site plant is returned to the central plant for further treatment and sale.
Assumptions applicable to the electricity option	
	None

Results

Table 28 presents the results of modelling the capital costs, on-going costs and on-going income and offsets for each scenario in Pyrenees. The yearly balance in year one, five and ten (if this figure is negative then council is paying money to maintain the alternative option), the feasibility of each option and the estimated payback period in the number of years and the expected year is also presented.

From a financial perspective, the gas and slurry scenarios have been assessed as not feasible as they will not achieve a payback on investment, while the electricity scenario is assessed as feasible. For the gas and slurry scenarios the year one, five and ten year balance is negative suggesting that costs from the start, and into the future, are larger than the estimated income/offsets received. For the electricity scenario, the year one balance is negative, however the year five and ten year balance is positive. This suggests that once the central plant capital payback is complete (after five years), the expected income is greater than the estimated costs.

Figure 35 presents a comparison of the year one costs and income for each scenario. Immediately evident in all scenarios is the deficit between project costs and expected income in year one. For the gas scenario, costs associated with staff, maintenance and gas from the network (to be used by the generator) contribute nearly 60% to overall costs. For the slurry scenario, maintenance, staff and treatment of digestate make up 68% of total costs. For the electricity scenario, the five year per tonne contribution to central plant capital, the cost of electricity to cover the shortfall in generation and the gate fee at the central plant contribute 86% to total costs.

The main sources of income in the gas and slurry scenarios is from avoided costs of transfer station organics reprocessing, avoided costs of kerbside organics transport and reprocessing and avoided electricity costs which contribute 82% and 84% respectively. The main source of income in the electricity scenario is from the avoided costs of transfer station organics reprocessing and the avoided costs of kerbside organics transport and these contribute 82% to overall income.

Figure 36 presents the expected balance of cost and income for each scenario as well as potential high and low scenarios and an alternate expected projection using electricity prices as projected by the Finkel Review (Jacobs 2017). In the gas and slurry scenarios, the expected case starts and continues on a downward trend. In the electricity scenario, the initial five year period is reasonably level before starting on an upward trend.

A comparison of the expected cost or income per tonne of waste for each scenario is presented in Figure 37. This shows that for the electricity scenario, Pyrenees would need to supplement on-going costs for the first five years, however after this period would receive an income per tonne that is greater than the initial cost per tonne in order to make any option feasible. Both the gas and slurry scenarios would require Pyrenees to supplement on-going costs beyond the ten year period modelled.

Table 28: Modelling results for Pyrenees

Cost/income item		Gas	Slurry	Electricity
Capital costs				
On-site plant capital		-$ 689,200	-$ 811,000	
On-going costs				
Contribution to central plant capital (per t, 5 years)		-$ 7,400	-$ 5,000	-$ 23,700
Remaining BAU				
Replacement materials		-$ 4,000	-$ 4,000	-$ 4,000
Waste transport to central plant		-$ 5,400	-$ 8,700	-$ 5,400
Gate fee at central plant		-$ 12,200	-$ 13,000	-$ 16,800
Gas from network		-$ 13,300		
Electricity from network		-$ 8,000	-$ 3,200	-$ 17,900
Staff		-$ 24,000	-$ 24,000	
Maintenance		-$ 15,000	-$ 35,000	
Disposal of digestate			-$ 14,500	
Total on-going costs		**-$ 89,300**	**-$ 107,400**	**-$ 67,800**
On-going income/offsets				
Avoided landfill gate fees from waste div.				
Avoided cost BAU kerbside organics		$ 24,200	$ 24,200	$ 24,200
Avoided cost BAU drop-off organics		$ 24,800	$ 24,800	$ 24,800
Avoided electricity cost		$ 9,900	$ 14,700	
Surplus electricity income				
Avoided gas cost from reticulated heat use		$ 4,400	$ 6,500	
Income share from central plant gen.		$ 3,100		$ 5,500
Income share from central plant soil amendment		$ 5,500	$ 5,500	$ 5,500
Value of excess slurry				
Total on-going income/offsets		**$ 71,900**	**$ 75,700**	**$ 60,000**
Balance and viability				
Balance at end of year:	1 (2018)	-$ 17,400	-$ 31,700	-$ 7,800
	5 (2023)	-$ 9,800	-$ 27,200	$ 21,300
	10 (2028)	-$ 9,700	-$ 25,000	$ 21,500
Feasibility		**Not feasible**	**Not feasible**	**Feasible**
Estimated payback period (number of years)		-	-	5
Estimated payback year		No payback	No payback	2023

Note: All figures are estimates rounded to the nearest hundred.

Figure 35: Year 1 cost and income comparison for Mount Alexander

Gas *Slurry* *Electricity*

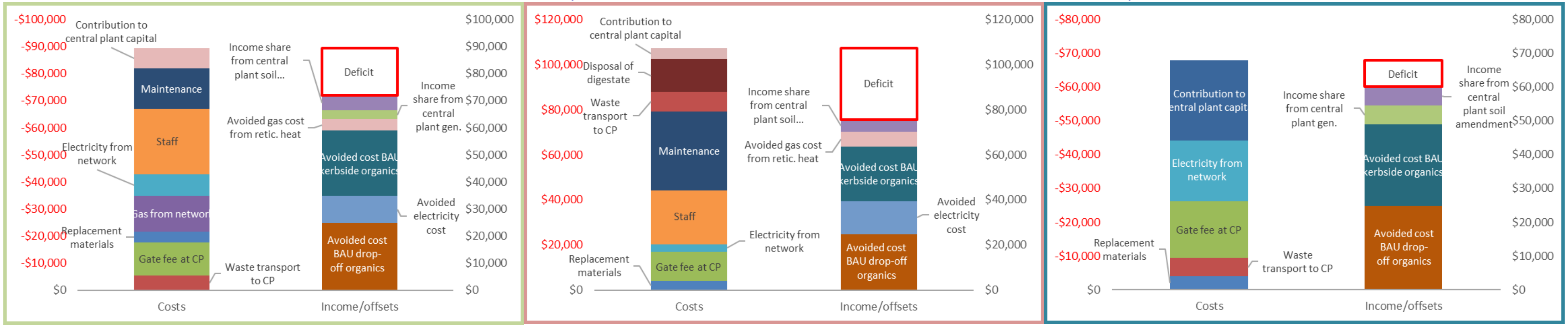
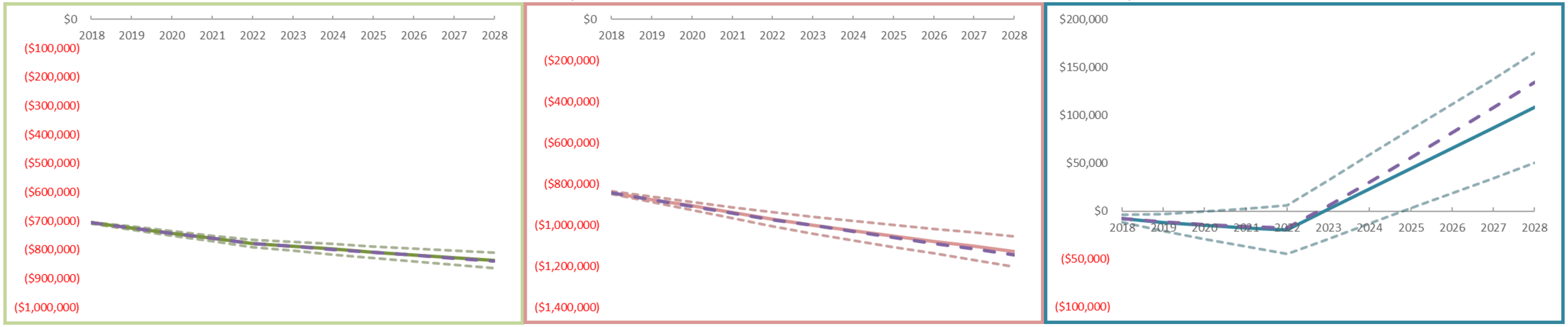


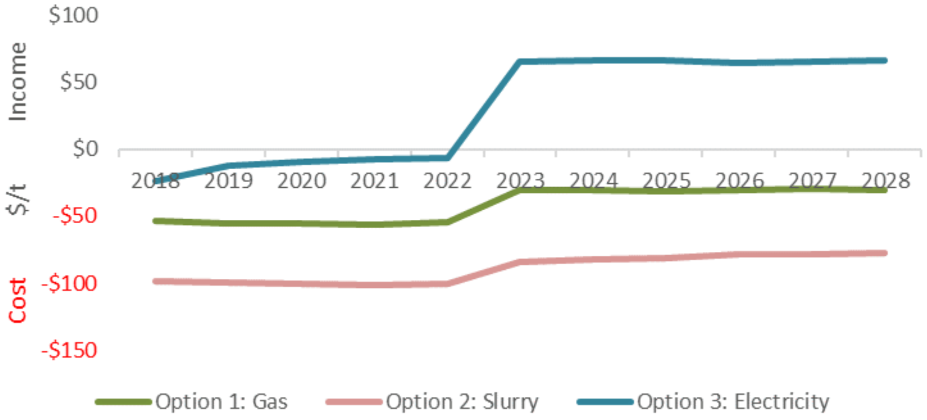
Figure 36: 10-year timeseries of the cost/income balance for Mount Alexander

Gas *Slurry* *Electricity*



Note: The purple dashed line shows the expected cost/income balance using electricity cost ranges projected by the Finkel Review (see Section 3.2)

Figure 37: Cost/income per tonne of waste for each scenario for Pyrenees



9.4 Summary

The gas and slurry options for Pyrenees are projected to be not feasible based on modelling of costs and expected income and offsets, however are less than the current estimated per year costs of electricity consumption, kerbside organics transport and reprocessing and transfer station organics reprocessing. The electricity option is projected to be feasible with payback in five years. Table 29 summarises the current BAU costs for electricity consumption, kerbside waste transport and reprocessing and transfer station waste reprocessing. The feasibility for each option and the one, five and ten-year balance (yearly cost minus yearly income) is also summarised.

Table 29: Summary of BAU and alternate case costs for Pyrenees

BAU energy and waste costs		$/year	
Electricity consumption		-$ 17,900	
Kerbside organics transport and reprocessing		-$ 24,200	
Transfer station organics reprocessing		-$ 24,800	
Total BAU costs per year		**-$ 66,900**	
Balance at end of year	Gas	Slurry	Electricity
(income - cost)	Not feasible	Not feasible	Feasible
1 (2018)	-$ 17,400	-$ 31,700	-$ 7,800
5 (2023)	-$ 9,800	-$ 27,200	$ 21,300
10 (2028)	-$ 9,700	-$ 25,000	$ 21,500
Payback period (years)	-	-	5

10. Strategic assessment

The financial modelling and site assessment undertaken for each council's circumstances, and summarised in the previous sections, are not the only issues in determining the feasibility of each Council's participation in the proposed scheme. There are a number of other considerations in assessing the viability of the overall concept and the framework in which it would operate; these are examined below.

10.1 Governance and administrative framework

Given the potential participation of different Councils, it is important that a framework for project governance and on-going administration is established to account for the different responsibilities and financial impacts on each organisation.

As the owner of the proposed site for the central plant and technology proponent, Hepburn Shire Council is expected to be responsible for development of the AD facility; this would include complementary activities including site investigations, obtaining the necessary planning and regulatory approvals, ensuring utilities and ancillary equipment are available at the site (e.g. weighbridge, electricity/gas connection), technology selection, facility design and construction, and commissioning of the facility.

However before proceeding further, clear parameters need to be established between Hepburn Shire and other participating councils on the distinction between the base concept (small scale facility accepting only 2,000 tonnes/year of food waste) and the additionality required for the facility to meet the needs of other councils (over 25,000 tonnes/year of garden and food waste). This would allow a financial distinction to be easily made on apportioning development and operating costs to be borne only by Hepburn or spread across other participating organisations.

The framework could be established in a number of different ways (including execution of a memorandum of understanding between Hepburn Shire Council and each participating council, or establishing a joint local government authority) but should be transparent. The methodology chosen should have sufficient flexibility to allow for staged implementation (e.g. councils joining at different times, including more council buildings in future stages), as well as additional participation (e.g. additional councils outside the initial participants, potential C&I sources of waste feedstock).

The framework should establish what each party's rights and responsibilities are in relation to matters such as:

- the level of capital investment required to participate (base concept versus additionality of the larger facility)
- the level of contribution to operating costs from each council
- how the share of outputs is derived (e.g. the relativity to waste feedstock contributed)
- responsibility for maintenance and operating costs (including any differentiation between commissioning and fully operational stages)
- operating benchmarks (e.g. % operating time, penalties for non-performance)
- participation by non-CVGA councils and other businesses
- timing and protocols for future changes to cost/revenue sharing arrangements
- on-going administrative responsibility (including potential for contracting out facility operations).

10.2 Regional scenarios

The viability of the network at a regional scale may be affected by the participation of key municipalities and the scenarios which are feasible for them. This can be shown in the outcomes estimated for each council and scenario presented in Table 30.

Table 30: Estimated viability for each scenario in participating councils

Council	Gas	Slurry	Electricity	Waste tonnes
Ballarat	Feasible	Feasible	Feasible	15,100
Central Goldfields	Not feasible	Not feasible	Not feasible	500
Hepburn	Feasible	Feasible	Feasible	2,600
Macedon Ranges	Feasible	Feasible	Feasible	6,500
Mount Alexander	Not feasible	Not feasible	Not feasible	400
Pyrenees	Not feasible	Not feasible	Feasible	300

The table shows that feasibility is lower for councils with small quantities of waste feedstock, and greater for those with larger waste feedstocks. This reflects the economies of scale that could potentially be delivered by a regional facility.

However there may be a contradiction in the scenarios which are feasible or provide the best financial outcome for different councils, and this could affect the participation of some councils in the regional network. For example:

- The electricity scenario is the only scenario deemed feasible for Pyrenees. However this scenario is predicated on a central plant incorporating both the digester and turbine, and feeding electricity to the grid. This scenario is only valid for Pyrenees if all other participating councils decide to implement the electricity scenario as well; Pyrenees could not participate if other councils preferred to implement either the gas or slurry option.
- While all scenarios are deemed feasible for Ballarat, Hepburn and Macedon Ranges, there are varying degrees of financial outcomes for different councils. For both Hepburn and Macedon Ranges, the most financially advantageous long-term outcome is delivered by the electricity scenario. Alternatively for Ballarat, while all scenarios deliver relatively equal long-term financial outcomes, the gas scenario can be delivered over a shorter payback period. As the gas and electricity scenarios are mutually exclusive in terms of the central plant infrastructure required, there may be competing tensions among councils on determining the best scenario outcome on a regional level.

Given the different outcomes for different infrastructure scenarios, there would need to be a consensus built between councils around the regional benefits (not just the benefits to each individual council) for the preferred technology option.

10.3 Risk analysis

As with many innovative approaches to waste management, there are a number of project and proponent risks that need to be considered.

Technology risk

New process

In any new process, early adopters can often face technology risks that are not applicable to systems with a proven track record. Evidence from local plants is not available to show the viability of the slurry, gas or electricity scenarios under operational conditions. Risks identified in relation to this include:

- the proposed system is new and untested, potentially resulting in commissioning delays or problems when infrastructure components are 'bolted on' and not specifically designed to work in tandem with each other
- the digester relies on optimising bacterial growth and this can require significant fine-tuning when different feedstocks are introduced
- the application of regulatory controls and whether receiving the necessary approvals will take significant time (particularly for the gas scenario)
- the availability of skilled personnel with the expertise to operate and maintain plant and equipment at both the central plant and on-site facilities at council buildings (e.g. the gas and slurry scenarios).

Large proportion of garden waste

In March and April 2017, Hepburn contracted testing of high quality food waste in an anaerobic digestion process in order to examine the resulting digestion time, gas yield and gas quality. The results showed that biogas quality was high for relatively short digestion periods (less than 24 hours) and of a consistent quality. However, adding household collected and transfer station waste will drastically change the waste mix to be predominately garden waste and will increase contamination and potentially decrease the ability of waste pre-treatment equipment to produce a consistent and reliable slurry for anaerobic digestion.

In discussions with Central Goldfields, who run their own composting facility in order to process kerbside food and garden waste, it was noted that including transfer station waste (woodier garden waste) meant that waste processing equipment was not able to function as required. As a result, Central Goldfields does not include garden waste from transfer stations in their composting process. If a similar issue were to occur at the central plant, around three-quarters of the waste identified as part of this project would not be able to be processed and additional plant/equipment may be required. Furthermore, the increased mix of garden waste will impact negatively on gas generation and yield rates from the anaerobic digestion process.

Site access

Increased traffic at the potential central plant and council buildings has potential to impact on the amenity of surrounding land-users and increase site safety risks. It is envisaged that all infrastructure (at both the central plant and council buildings) would need to be secured to prevent unauthorised access; this would likely involve security fencing and lockable gates.

Locating the central plant near the Creswick Transfer Station will see increased traffic from waste transport vehicles to the area. This is especially an issue at the potential Creswick site as truck access will be restricted to one road (the site can only be accessed from the western end of Ring Road as the northern end would require vehicles to cross a causeway) and the majority of traffic will have to pass through the residential streets of Creswick in order to reach the site. It is likely that traffic management plans will need to be developed to minimise potential traffic incidents and reduce the impact on local residents.

For the slurry option, vehicle access to on-site equipment will contribute to site safety risks as it may mean that industrial vehicles (for slurry delivery and digestate collection) will operate in areas with regular pedestrian access (for example, at council recreation centres). This would need to be carefully managed at council sites and may require additional traffic management measures (e.g. provision of new site entrances/exits, additional paving and landscaping) to provide separation between heavy vehicle traffic and pedestrians.

Contingency options (short-term) and plant failure (long term)
In the short-term, failure or breakdown of equipment can lead to premature dumping of digestate (if microbes in the anaerobic digester die) or stockpiling of materials either at council sites or at the central plant. This may result in increased levels of odour or pests (especially if food waste is stockpiled) and noise from increased management of materials on site. It may be necessary for councils to have appropriate contingency measures in place to appropriately manage their materials in the event of a short-term failure or breakdown of plant equipment.

The long-term failure of the plant could result in:

- return on investment not being realised
- needing to find alternative recovery pathways for organic waste (this may be difficult without a reprocessing contract)
- stockpiling of organic waste
- disposing of recoverable organic waste to landfill
- having idle equipment at council sites
- paying more for energy consumption than currently incurred under BAU.

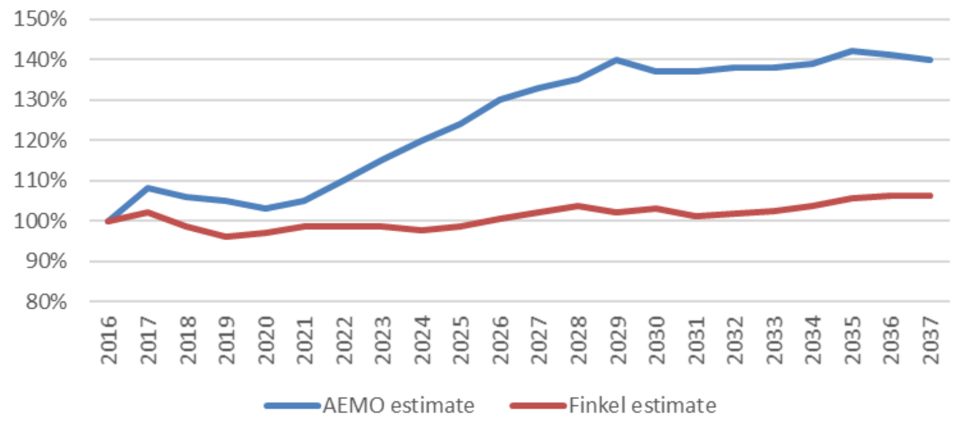
Financial risk

Energy cost and income uncertainty
Significant uncertainty exists around the projected cost of electricity and gas prices and potential income. Electricity prices are difficult to forecast as a number of variables will impact on the price, including:

- electricity wholesale prices
- electricity network prices
- assumptions around future electricity generation source mix.

Two recent projections of future electricity price index changes were assessed as part of the modelling undertaken. The Australian Energy Market Operator (AEMO) projection (from *Retail electricity price history and projections*, AEMO 2016) was considered to be more accurate than the projection from the recently released Finkel Review (from *Report to the Independent Review into the Future Security of the National Electricity Market,* Jacobs 2017). A comparison of the two index projections is provided in Figure 38. This shows that the AEMO estimate projects a higher price in the short term followed by a small decrease and then a longer-term increase. The Finkel Review estimate shows a smaller short-term increase (one that is likely to understate the expected increases already slated by energy companies) followed by a relatively stable plateau of pricing. This is not considered to be a likely outcome for future electricity pricing.

Figure 38: Comparison of projected indexed electricity costs



The future expectations for LGCs and income received from feed-in tariffs is also largely uncertain. As part of the modelling, we used assumed values provided by Hepburn Shire Council and developed as part of their modelling of costs associated with the small scale centralised plant. These are considered to be reasonable estimates of future potential income, however, given the political nature of the electricity market, are highly uncertain.

The future price of gas is based on estimates of current per unit cost and projected based on an index of the wholesale gas price as presented in Jacobs (2017). As advised by EnergyConsult, wholesale gas prices contribute around one-third to the total retail gas price and is a good indicator for price changes in the retail market. Future projections of hypothetical supply contracts for gas proved difficult to estimate as there is a lack of data available around current arrangements (where they exist). As a result, projections are based on a proportion (assumed to be 80%) of the estimated wholesale price used in projecting costs. While the reasoning used to estimate the cost and potential income are sound, the overall gas market is highly unpredictable and therefore uncertainty exists around these projections.

Additional costs and regulatory approvals

Every attempt has been made to consider all costs and income/offsets associated with BAU and the alternate options, however there are likely to be additional items that were not fully estimated as part of this project as they require detailed site assessment and planning investigations or were out of scope. For example, the potential central plant site at Creswick is located at a former landfill site. Depending on the exact location of filled land and the proposed location of the facility, additional engineering and construction measures may be required in order to ensure building stability without comprising landfill management and monitoring.

There is also likely to be an additional time and cost impost for obtaining the necessary regulatory approvals from both EPA and ESV.

Additional avoidance from landfill

Landfill gate fee avoidance, from diverting waste from landfill, has the potential to increase the cost offset achieved by each council and decrease payback periods. Macedon Ranges was the only council to identify additional waste diversion, in the form of an expanded kerbside organic service to include food waste. The avoided cost of diverting this food waste from landfill contributes just over one-fifth to the total expected income and without this, it is likely that the alternate scenarios would not be feasible. If participating councils were able to identify additional waste, for example from commercial and industrial sources, then the benefits of avoided waste to landfill may improve or increase the profitability of the alternate business cases.

Lack of markets for treated products
The estimated income from the sale of value-added product derived from treatment of digestate and from excess slurry is highly dependent on finding suitable markets for these products. Based on council waste quantities entering the plant it is estimated that around 20,800 tonnes of digestate would be available for sale. If markets cannot be found for this waste, a potential income stream could become an additional cost in managing and disposing of materials. For some councils, this change could impact on the feasibility of alternate scenarios.

Regional biosecurity

The transportation of food and garden organic material presents a biosecurity risk associated with the potential spread of a range of plant and animal pests and diseases. Strict regulations are in place throughout much of Victoria for different threats in order to control the movement and spread of potentially damaging materials. In the study region, a number of industries exist that could be negatively impacted by one of these biosecurity issues, including urban and commercial crops (in particular potatoes, grapes and cereals), livestock and forestry. The tourism industry may also be impacted by the loss of amenity at tourist sites or from quarantine restrictions on the movement of people or organic materials. Examples of specific threats identified for the region include:

- Aquatic weed from Lake Wendouree: Ballarat currently undertake a program of aquatic plant removal from Lake Wendouree to maintain the amenity value of the lake (City of Ballarat 2017). The dominant species targeted as part of removal works is water-milfoil (*Miriophyllum salsugineum*) and while the plant is native and provides an important role in ecosystem maintenance, is considered to be a weed due to its ability to dominate and spread. Other water bodies that currently do not contain water-milfoil, including agricultural dams, town water supplies and recreational lakes/rivers, are potentially at risk if this weed is transported through the region.
- Grape phylloxera, an aphid pest that feeds by sucking fluids from the grapevine roots, causing a progressive decline in the vigour of infested vines (Agriculture Victoria 2017a): High risk vector materials include grapevines, fresh grapes, grape marc and must, vineyard soil, packages and equipment used for harvesting and vehicles, machinery, clothing and footwear used in vineyards. Most of the region is considered to be a phylloxera exclusion zone and is bordered by phylloxera risk zones, however there is a small pocket labelled as a phylloxera infested zone in Macedon Ranges Shire Council (Agriculture Victoria 2017b).
- Potato cyst nematode, a microscopic organism that feeds on the root of potatoes and can reduce crop yields, increase production costs and may result in restrictions of trade: According to the Victorian Certified Seed Potato Authority (ViCSPA) areas around Ballarat had the largest area assigned to potato seed production in Victoria (2015).

In order to reduce the impacts and likelihood associated with potential biosecurity risks, a range of controls would need to be implemented, including:

- covering material loads during transportation to prevent wind-blown spread of materials
- handling and storage (prior to anaerobic digestion) of incoming materials in bunkers and enclosures
- strict site hygiene protocols to prevent the possibility of cross-contamination between incoming and outgoing materials.

Sustainability risk

Contamination of the environment
The proposed central plant site at Creswick is a former landfill site (now closed) and post-closure management and monitoring of the site is ongoing. Depending on construction planning requirements, more likely than not it will be necessary to build structures on top of land previously used as a landfill. This comes with a range of technical engineering and planning approval issues as well as safety issues with the potential release of gas or leachate and ground depression post construction.

Treatment of digestate and waste water/leachate following anaerobic digestion will form an important component of the controls around preventing contamination to the environment. Material coming out of the anaerobic digestion process will need to be dewatered so that the remaining solids can be further processed into a useful product for sale while it is likely that the separated liquid fraction will require further treatment to reduce negative impacts prior to disposal.

Waste availability
The waste identified by councils for input to the central plant is either available now or will be available by mid to late 2018. The current reprocessing arrangements for Ballarat's 9,900 tonnes of kerbside collected waste is on a year-by-year contract basis. This reflects the uncertainty of organics management in Ballarat, where council is investigating their own EfW facility as part of the Ballarat West Employment Zone (BWEZ) development. If Ballarat were to commission this facility it would be expected that the total amount of waste identified from Ballarat (around 15,000 tonnes) would be diverted from either BAU or the alternate option under this project in order to provide sufficient feedstock to the BWEZ development. This amounts to almost 60% of the waste identified in this project and represents a significant risk to the long-term guaranteed waste feedstock.

Risk to councils

Local amenity
Aside from the issues previously identified with the locality of the central plant, local amenity issues at council buildings also present a potential risk to participating councils. It is proposed that any on-site plant would be housed inside a locked shipping container, the size of which is dependent on the scenario chosen and number of turbines used at each council building; security fencing would also surround the container(s). On-site plant would be placed as close as practicable to existing electricity or gas grid connections in order to minimise the works in establishing suitable connections.

Depending on the alternate scenario chosen, local amenity considerations at each site include odour and gas dispersion, increased heavy vehicle traffic, noise, building access for vehicles and pedestrians, required site works to install plant equipment and the heritage value of proposed council buildings. Detailed site assessments were not included in the scope of this project and it is expected that such investigations would provide further input and potential mitigation strategies to manage public amenity issues.

10.4 Avoided emissions and landfill benefits

The avoided emissions and landfill benefits associated with implementing an EfW plant have the potential to be significant and a main driver in delivering councillor and community support. However, over 95% of the waste nominated by councils for the project is already being diverted from landfill with the only new diversion originating from plans by Macedon Ranges to introduce food waste to their garden waste collections (estimated to be 1,125 tonnes of food waste). As a result, very little landfill diversion or emission avoidance is achieved from waste diverted from landfill. The main avoided emissions for the project come from avoided electricity consumption at council buildings (presented in Table 31). It is estimated that the gas, slurry and electricity scenarios would achieve 2,940 tonnes, 3,049 tonnes and 7,841 tonnes of avoided CO_2 emissions respectively.

Table 31: Avoided emissions estimate, kgCO_2-e

Council	Offset from	Gas	Slurry	Electricity
Ballarat	Energy use	110,400	163,100	110,400
Central Goldfields	Energy use	225,900	225,900	3,402,300
Hepburn	Energy use	112,900	112,900	613,600
Macedon Ranges	Energy use	225,900	225,900	1,450,700
	Landfill avoidance	2,100,000	2,100,000	2,100,000
Mount Alexander	Energy use	91,400	112,900	91,400
Pyrenees	Energy use	73,000	107,800	73,000
Total	Energy use	839,500	948,500	5,741,400
	Landfill avoidance	2,100,000	2,100,000	2,100,000
	Total	**2,939,500**	**3,048,500**	**7,841,400**

Avoided emissions are estimated based on the current emissions from electricity use for the consumption of purchased electricity by end users in Victoria on a kgCO_2 per kWh multiplied by the estimated generation (in kWh) for each council and scenario. Consequently, the avoided emissions for each council are highly dependent on the quantity and quality of waste sent to the central plant and overall emissions for some councils may not provide sufficient incentive to commit to the project.

10.5 Implementation strategy

Implementation of the preferred scenario would be undertaken by a number of staged activities, outlined in an implementation strategy for CVGA in Table 32. A number of actions may be dependent on actions completed by Hepburn Shire Council and where this is the case, we have noted the potential trigger for the action by CVGA.

Table 32: Implementation strategy for CVGA

#	Action	Potential trigger for action
1.	Reach agreement with participating councils as to their commitment to the project and scenario type	
2.	If decision is to gas scenario, establish ESV framework for approval	
3.	Develop, with committed councils, the governance framework to be used throughout the project and in assigning costs or income to project participants once operational	
4.	Assess potential external funding opportunities	
5.	Conduct detailed site assessments at each council site (gas or slurry option only)	
6.	Prepare planning and development documents for each council site (gas or slurry option only)	
7.	Submit planning and development documents for approval for each council site (gas or slurry option only)	Hepburn submit planning and development documents for approval
8.	Facilitate discussions with electricity/gas network providers on feed-in tariffs/supply contracts	
9.	Facilitate discussion with councils on waste feedstock and confirm timing of availability	Hepburn receive planning approval for central plant
10.	Facilitate discussion with council site facility managers to prepare sites for on-site plant (gas or slurry option only)	
11.	Monitor construction timelines of central plant	Hepburn begin construction of central plant
12.	Facilitate construction management of plant equipment at council facilities (gas or slurry option only)	
13.	Provide selected waste streams for testing and commissioning at central plant	Commissioning of central plant to commence
14.	Develop markets for value add product and excess slurry (slurry option only)	Hepburn begin accepting materials at central plant
15.	Manage the feed-in of council waste feedstock to the central plant	Hepburn plant gradually increases tonnage throughput
16.	Assess additional waste feedstock opportunities from committed councils, especially for organic waste that could be diverted from landfill	Hepburn accepting all committed councils waste feedstock
17.	Assess additional council sites for implementation of onsite plant equipment (gas or slurry option only)	

11. Conclusions

The proposed concept of a regional micropower network brings together six councils in the CVGA with varying characteristics of waste feedstock and energy demand. Participating councils have available waste feedstocks which vary between 300 and 15,100 tonnes/year, while their council buildings utilise a variety of electricity only or gas and electricity, and may or may not have a use for heat energy. This variation contributes to the differing determination of feasibility for the participating councils.

Detailed modelling (provided in the accompanying Microsoft Excel spreadsheet) was undertaken for each of the three proposed infrastructure options (gas, slurry or electricity scenarios). Further site investigations, central plant siting and infrastructure issues, and the strategic impact on regional arrangements were also considered and the following conclusions reached:

- To operate as a central regional facility, the Hepburn AD facility would be subject to a number of sizing and technology impacts, including additional receival infrastructure, increased throughput (from 2,000 tonnes/year to over 25,000 tonnes/year) and increased processing time as a result of the high percentage of garden waste.
- As a regional facility generating over 1 MW, the proposed Daylesford location of the central plant is unlikely to receive EPA works approval. Relocation near the Creswick transfer station may be more likely to receive approval, however this would be subject to a range of issues being addressed to the satisfaction of the EPA. The suitability of the Creswick site would also need to be further explored with additional investigations on the extent of filled land, site access, gas/electricity distribution infrastructure, available utilities and other issues.
- Proceeding with the gas scenario would require meeting ESV regulatory approvals which are not yet in place, resulting in a significant lead time in establishing the appropriate regulatory framework (including significant time and resource costs).
- Both the gas and slurry scenarios are only feasible for three of the six councils (Ballarat, Hepburn and Macedon Ranges).
- The electricity scenario is feasible for four councils (Ballarat, Hepburn, Macedon Ranges and Pyrenees).
- For Central Goldfields and Mount Alexander, participation is not feasible under any scenario.
- The Australian energy market is currently volatile and highly politicised; the level of future costs and feed-in tariffs/supply contracts are therefore uncertain.
- Most of the waste feedstock identified as available for processing in the proposed AD facility is already diverted from landfill. It is not eligible for renewable energy credits and avoided landfill costs do not contribute to any material degree to cost savings.
- An appropriate administrative, management and financial framework would need to be developed among participating councils.

In summary, the concept has not been demonstrated to be advantageous to all nominated councils, although the electricity scenario may provide benefit to Ballarat, Hepburn, Macedon Ranges and Pyrenees. However there is a range of regulatory, technical, financial and other risks that would need to be considered by councils in deciding whether to proceed with a regional network.

References

Agriculture Victoria (2017a) *Viticulture Biosecurity*, accessed 10 July 2017, available from: http://agriculture.vic.gov.au/agriculture/horticulture/wine-and-grapes/viticulture-biosecurity

Agriculture Victoria (2017b) *Phylloxera management zones*, accessed 10 July 2017, available from: http://agriculture.vic.gov.au/agriculture/pests-diseases-and-weeds/pest-insects-and-mites/grape-phylloxera/management-zones

Australian Energy Marker Operator (AEMO) (2016) *Retail electricity price history projections*, available from: www.aemo.com.au/-/media/Files/Electricity/NEM/Planning_and_Forecasting/NEFR/2016/Retail-electricity-price-history-and-projections.pdf

Australian Government Department of the Environment and Energy (2016) *National Greenhouse Accounts Factors – Australian National Greenhouse Accounts*, August

City of Ballarat (2017) *Lake Wendouree Master Plan Preliminary Draft*, accessed 10 July 2017, available from: http://www.ballarat.vic.gov.au/media/4284669/lakewendoureemasterplanprelimdraft.pdf

DELWP (2016) *Victoria in Future, Individual years from 2011 to 2031: Geographic area: LGAs and VIFSAs*, prepared by the Victorian Government Department of Environment, Land, Water and Planning, July

EPA (2013a) *Energy from Waste Guideline,* publication no. 1559, EPA Victoria, Carlton

EPA (2013b) *Recommended separation distances for industrial residual air emissions,* publication no. 1518, EPA Victoria, Carlton

EPA (2017) *Designing, constructing and operating composting facilities,* publication no. 1588.1, EPA Victoria, Carlton

Jacobs (2017) *Report to the Independent Review into the Future Security of the National Electricity Market*, Melbourne, June

Standards Australia Limited (2012) *AS 4454-2012: Composts, Soil Conditioners and Mulches*, available from SAI Global, Sydney

Victorian Certified Seed Potato Authority (ViCSPA) (2015) *Victorian Potato Industry Strategic Plan 2015-2020*, accessed 10 July 2017, available from: http://www.vicspa.org.au/f.ashx/Strategic-Plan-Victorian-Potato-Industry-Final.pdf

Wood and Grieve Engineers (2016) *Energy from Waste Implementation and Evaluation Review,* prepared for Hepburn Shire Council