Dairy Australia
Your Levy at Work

Opportunities for Reducing Greenhouse Gas Emissions Intensity in the Australian Dairy Processing Sector

Study Report

Prepared for:

Mr Ian Olmstead
Program Manager - Manufacturing Innovation & Sustainability - Trade & Industry Strategy
Dairy Australia, Level 5, IBM Centre, 60 City Road, Southbank, Victoria, 3006

Prepared by:

Infotech Research

Infotech Research
Melbourne
www.infotechresearch.org

Contributing authors:

Mr Mark Barber
Energy & Carbon Consultant
Melbourne
mark@northmoregordon.com, or
markbarber9@yahoo.com.au
mobile 0458 400 411

Dr John Cumming
Director
Infotech Research
john@infotechresearch.org
mobile 0418 125 688

Acknowledgments

Thanks to the following key contributors to study

- Kevin Joyce
- Jeremy Osborne
- Ian Olmstead
- Craig Morgan
- Mike Weeks
- Gary Ridout
- Sandra Kentish
- Mikel Duke
- Todor Vasiljevic

Disclaimer

The information provided in this report is intended to inform the reader and provide additional information to complement and extend presented materials. Data about energy efficient technologies was sought from the technology suppliers as well as from independent researchers and the open literature. It is presented herein without prejudice or bias and no benefit to Infotech Research is sought from its use. While Infotech Research has endeavoured to provide a complete and balanced report, we take no liability for omissions or the accuracy of the information provided and recommend that the reader confirms this information before proceeding to use it for any purpose.

Contents

1.	Executive Summary	4
2.	Background / Context	6
3.	Emerging Technologies	7
4.	Low Carbon Technology Alternatives for Hot water Generation	22
5.	Government Policy Developments related to Carbon Abatement	28
6.	Government Financial Support/Incentive Schemes	30
Appendices		40

1. Executive Summary

The Australian government has placed considerable pressure on manufacturing industry to increase its "energy productivity" as a component of Australia's target for Greenhouse Gas (GHG) Emission Reduction targets of 5% to 2020 and 26 to 28% to 2030 from 2005 levels. The dairy processors have a significant role in achieving these targets primarily through energy efficiency improvements and renewable energy uptake.

This study is intended to assist dairy processors in this task by providing information about emerging technologies that have potential to assist dairy processors in this pursuit of energy efficiency, renewable energy uptake and GHG emission intensity reduction.

A large quantity of technologies and techniques were considered for their potential to save energy or deliver renewable energy and thereby reduce GHG emissions. These were then filtered to produce a list of seventy potentially promising technologies. Sixteen technologies were then short-listed based on a set of commercial criteria and examined further within this report. These technologies are commercially available and save energy over common good practice. Each of these technologies has been evaluated in terms of simple payback period (years) based only on energy cost savings.

Each technology has been profiled in the report to give further details of the technology benefits and risks that may be encountered.

Refrigeration Compressors and Refrigerants

Refrigeration systems have increased in efficiency so that the cooling effect is now 5 or 6 times that of the energy input. This is 3 to 4 times that of older refrigeration systems in common use.

Membrane Concentration

Evaporation is a process which consumes large amounts of energy. It currently relies on heating via steam and pumping off the water vapour. The use of multiple effect evaporators is good practice to recover most of the heat for the next stage of evaporation and mechanical vapour recompression also recovers heat, but the newer membrane technologies such as forward osmosis and membrane distillation can use either waste saline streams or waste heat respectively to draw water through the membrane at a much lower temperature also saving energy.

Processing Efficiency Improvement

Efficiency improvements in processing and waste treatment will give energy savings as less treatment is necessary, or processing is achieved at a lower pressure. This is the case with homogenizer Nino Soavi "nano" valves that operate at a pressure typically 50 bar below that of conventional systems. Pressure and energy are directly proportional so that energy is saved by homogenising at a lower pressure.

Spray drying can benefit from air intake that is less humid and increases the rate of water vaporisation. Modifications to the dryer impeller design can also improve efficiency of air throughput.

Heat Recovery

Hot waste streams that can be utilised for energy recovery abound at dairy processing sites. Flash steam can be recovered from high pressure steam condensate, boiler blow down wastes, compressor condensate and air compressor exhausts.

Insulation

Removable hot surface insulation covers presented a simple but highly effective method for reducing heat losses with a short payback.

Biomass, Solar Energy & Heat Pumps

Of the heating systems available, waste heat source heat pumps run at a potential energy efficiency in heating that is many times the actual electrical energy input, so an efficiency far greater that of steam is achievable for heating purposes.

Biomass fuels such as saw dust and wood chips provide a low GHG and renewable alternative to natural gas for producing hot water/steam in boilers.

Solar energy can be used to save conventional fuels and GHG emissions. Ground mounted flat plate solar panels were examined as a system for water heating.

With gas prices now elevated (and potentially climbing further), and the capital cost and performance of alternative methods for the generating of hot water improving, heat-pumps, flat plate solar collectors, and wood residue combustion can now be considered as contenders for the production of hot water.

Other Processing Technologies

There were many other processing technologies that showed promise in improving energy efficiency by improving process efficiency and providing other processing improvements through the use of low temperatures in high pressure pasteurising and plasma treatments. RF heating, pulsed electric fields and ohmic heating were also considered to have promise, but were not pursued in this report.

Risks Assessed

Some consideration of the risks associated with the introduction of emerging technologies was included in the individual profiles. A location dependent risk is that an energy saving in gigajoules may lead to an increase in GHG emissions at some locations. Notably in

Victoria, where the carbon intensity of electricity from the grid is high (1.17 kg CO_2(eq) / kWh), the use of a heat pump to save natural gas proved to increase GHG emissions even though the total energy use was much reduced.

The location of the facility, its size and the process technology currently employed will be factors that will vary the energy savings and paybacks for the technologies profiled.

It is important to note that the Study has assessed the cost-effectiveness of technologies in the absence of government funding (with exception of solar collection which has accounted for the capex offsetting effect of renewable energy certificates).

2. Background / Context

The Australian dairy processing sector uses significant amounts of energy at processing sites, mainly in the form of electrical power and heat. The majority of heat is derived from reticulated natural gas. A small proportion of primary heat needs are also derived from electricity, biomass, diesel, LNG and LPG.

By-products of this energy use are greenhouse gases (GHG) such as carbon dioxide, nitrous oxide and methane. Transport of process inputs (raw milk, ingredients, chemicals, packaging etc.) and production outputs (intermediate and finished product, solid waste streams etc.) result in the combustion of transport fuels which contribute to further GHG production, as does the biological degradation of organic waste streams produced by the dairy processors.

Because of their participation in the Australian Dairy Industry Council's Sustainability Framework, a number of the largest dairy processors in Australia have committed to manufacturing-based reduction targets with respect to greenhouse gas emissions intensity.

Specifically, the target is a reduction of greenhouse gas emissions intensity by 30%

The dairy processors who have made commitments to this target report on progress each year and substantial in-roads have been made towards achievement of the goal set. Further work needs to be done, however, and the industry continues to monitor and act upon evolving risks and opportunities which might hinder or support progress.

One vehicle for industry support towards meeting the manufacturing-based Framework targets is the Dairy Manufacturer's Sustainability Council (DMSC). The DMSC is a membership based community of practice which includes nine core dairy processor members. These members include; Devondale Murray Goulburn, Lion Dairy and Drinks, Parmalat Australia, Warrnambool Cheese and Butter, Bega Cheese, Burra Foods, Bulla Dairy Foods, Norco Foods, and Fonterra Australia. Most of these DMSC members contribute data to the Framework and all of them have an interest in improving the environmental performance of their businesses as well as the overall sustainability of the industry.

In bringing together the environmental, sustainability and energy managers from the member companies to discuss progress, evaluate technologies and share knowledge/experiences with respect to environmental compliance or performance, the DMSC acts as a technical working group for the manufacturing related aspects of the Sustainability Framework. Dairy Australia supports and manages the DMSC on behalf of its members.

To support the DMSC and the Australian dairy processing sector in achieving its environmental reduction targets 9 through to 11, Dairy Australia is commissioning an annual series of study reports which provide a summary brief to DMSC members on the global risks and opportunities which are arising which might hinder or support progress.

The scope of this study and report is the three main areas of influence on the greenhouse target; emerging technology, policy developments, and funding availability. It outlines current and emerging technologies, funding avenues, and policy/regulatory changes which provide opportunities for reducing GHG emissions intensity in the Australian dairy processing sector.

3. Emerging Technologies

3.1. Technology Selection Criteria

The study conducted a global scan to identify 'emerging' technologies with potential to save energy and reduce GHG emissions for dairy processors. 'Emerging' was defined as commercially available but with no or low level of take-up by the Australian dairy sector. Technologies were selected to meet the following criteria, within the Australian context:

- Judged as being beyond current typical good practice in Australia,
- Assessed as being potentially cost-effective now or in the near term[1],
- Commercially available[2],
- Demonstrated as applicable to Australian dairy milk processors,
- Will result in materially fewer GHG emissions, either through 'fuel switching', use of renewable energy sources, or improved energy efficiency, and
- Practical to implement.

3.2. Identified Technologies (and Techniques)

The approach taken to identifying emerging technologies involved consultation with a body of dairy industry technology developers and equipment suppliers. Data was collected from:

- Dairy Australia
- Industry analysts
- Technology suppliers to the industry
- Research institutions
- Overseas technology suppliers
- Technical literature and
- Publicly available literature.

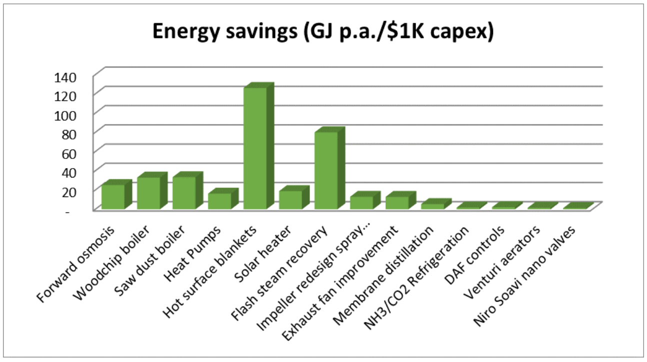
Over 70 technologies and techniques with potential to reduce GHG emissions intensity within a dairy processing facility were identified and considered for a more detailed analysis. These technologies were split into two main categories - those associated with milk processing unit operations and those associated with delivering utilities services. A summary of technologies considered is provided in the Table 1 and Table 2 on page 9.

The technologies considered for further assessment in this study are shaded in green and the full list of technologies identified through the course of this study is provided in the Appendix.

A profile of each of the technologies that fitted the selection criteria is given in the tables that follow.

Energy savings for each of the technologies studied were calculated using data supplied by technology suppliers.

Figure 1 Cost effectiveness of energy saved



When the cost of the plant was taken into consideration some technologies proved to be more cost efficient than others. For example, the simple measures of insulating steam valves and recovering flash steam losses proved to give better savings per dollar spent.

This rating also reflected the return on investment which was calculated for energy savings only and is given in the individual technology profiles.

It should be noted that some of the technologies studied had cost benefits other than energy savings and may have good returns on investment despite a low ranking in Figure 1.

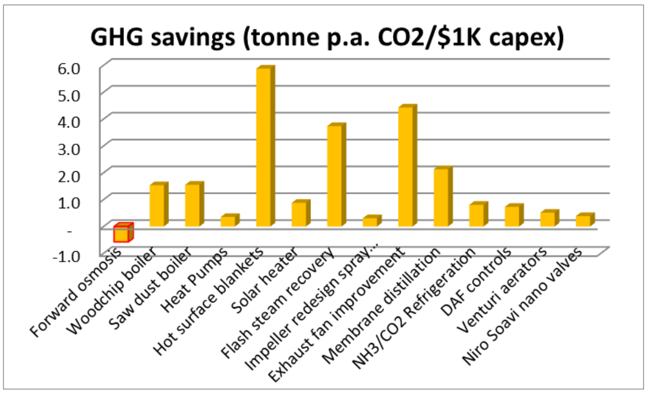
Energy savings were generated as steam-based fuel savings in some cases and electrical energy in others. There is a significant cost per GJ difference from natural gas to electricity and this can also affect the return on investment.

Greenhouse Gas (GHG) emission reductions depend on the energy savings, the type of energy saved and the location at which it is saved. The technology analysis used Victoria as the plant location and therefore placed larger GHG reductions for electricity than it would elsewhere. This GHG analysis will vary with time also as renewable energy is introduced into the grid and states take power from different sources.

[1] Applied threshold of 7 years simple payback, without government financial assistance.

[2] Already proven, or post-pilot, but possibly novel within Australia.

Figure 2 Cost effectiveness of GHG emission reductions



Natural gas savings are discounted in terms of GHG emission reductions due to the lower GHG intensity of each GJ of natural gas compared to electricity in Victoria.

One of the significant energy saving technologies, Forward Osmosis acts by replacing steam with an electrically run membrane system saving energy but increasing GHG emissions due to the higher GHG intensity of the electricity used in Victoria.

List of technologies (ranked from top to bottom)

The technologies chosen for evaluation were:

1. Forward osmosis
2. VSD controlled screw compressor Model HMR-H1830T-28 R717 High Stage Thermosiphon refrigeration unit
3. Advanced efficiency impellors for dryer exhaust fans
4. Membrane distillation
5. CO2 refrigerant systems, including combined low charge ammonia and CO2 cascades to replace/ supplement ammonia and other systems.
6. DAF dosing control systems.
7. Venturi-based water aerators to reduce energy intensity of lagoon aeration.
8. High efficiency homogenisation by NanoValve from NiroSoavi
9. Removable steam valve and header covers
10. Drying of dryer intake air to boost dryer efficiency and productivity (in certain climates)
11. High Pressure Processing
12. Dehumidification of dryer air intake

In addition to the technologies listed above, a number of water heating technologies were also evaluated for their potential to provide energy and GHG savings (assuming a set model process requirements)

Alternatives for Hot Water Generation[3]

1. Solar thermal (flat plate)
2. Heat pump
3. Woody waste fuelled hot water boiler

3.3. Evaluated & Costed Technologies

For each technology evaluated the following information is provided below:

a) Technology name & description
b) Typical Applications
c) Indicative potential energy efficiency and/or carbon footprint improvement
d) Pros & Cons
e) Apparent ease of implementation
f) Potential Relevant government support schemes
g) Vendor or agent details
h) Example installation, or case study (either actual or hypothetical)
   - Estimated CAPEX cost
   - Estimated Savings
   - Estimated typical ROI expressed as simple payback

3.4. Assumptions & Factors

The cost-effectiveness of investments based on energy savings is sensitive to gas and electricity tariffs. The prices applied under this study (11c/GJ natural gas and 12c/kWh electricity delivered) were chosen by the authors based on their knowledge of prevailing industry pricing, informal interviews with industry members, and allowance for further increases expected in the near future.

[3] Compared to the common practice of using gas-fired steam via heat exchanger to heat water.

Table 1 Milk processing elements

Heat treatment	Refrigeration	Pasteurising	Separation	Drying	Homogenisation	Clean-in-place (CIP)
Plasma (cold)	2 stage Ammonia systems	Ohmic heating	Membrane distillation	Advanced impeller design	EC motors	Ultrasonics
RF heating	Mini heat exchangers	Pulsed electric fields	Multistage pumps with VSDs	Microwave heating	Ultrasound	
Solar heating	Floor slab insulation	High pressure processing	Improved membrane systems	Dehumidification of air intake	Niro Soavi Nano valves	
Heat pumps	Solar absorption chillers			RF heating		
	Low-charge reciprocal compression chillers			Forward osmosis		

Table 2 Utilities in dairy processing

Boilers	Air compressors	Water heaters	Chillers	Electricity	Wastewater treatment
Direct solar + bio gas boiler	Dehumidifiers for compressed air systems	Direct solar thermal	High efficiency screw compressors	Low grade heat generators	Membrane Bio Reactors (MBR)
Wood chips and saw dust fuels		Heat pumps	Ammonia 2 stage chillers	Co-generation	Bio gas generators
Condenser heat recovery				Tri generation	Venturi system aerators
Removable steam valve blankets				Solar PV panels with battery systems	Dosing control systems
Spray condenser					

Table 3 Assessment snapshot of advanced efficiency impellors for dryer exhaust fans

Name: Advanced efficiency impellors for dryer exhaust fans						
Technology Description	Replace existing dryer fan impellors with a more energy efficient design.					
Application(s)	Dryer exhaust fans on older dryer fleet. The motors that drive these fans are very large, typically ranging from 150 to 350KW.					
Potential Energy efficiency and/or carbon footprint improvement	Large reduction in electricity consumption and a proportional reduction in electricity-related carbon emissions					
Pros (Other benefits & advantages over common practice)	Reduced noise emissions and longer fan bearing life					
Cons (and technical risks)	Can cause faster build-up of milk powder on blades and hence require more frequent cleaning					
Apparent ease of implementation	Moderate. Requires custom engineered solution. May require crane.					
Potential Relevant government support schemes	Circumstance dependent. Vic VEET, NSW ESC. Refer to Section 6 for more options. Financials shown below **excludes** any gov support.					
Other Remarks	Impellors custom designed in each application. Aerovent commonly supply into new dryer projects. Savings shown below are not only from impellors.					
Vendor or agent details	**Aerovent.** Melbourne, t: (03) 9720 8088 www.aerovent.com.au e: Robert@aerovent.com.au					
Example installation (actual)						
Description:		Capital cost	Energy Savings	Payback period[4]	GHG savings tonnes Co2e	Key Assumptions
MG Koroit Site. APV Dryer 2011. Replaced impellors on APV exhaust fans (2 off) plus changed from indirect to direct motor drive. Delivered reduced electricity use, reduced downtime, reduced noise.		$194K	$60K p.a. 700MWh p.a.	3.2 years on energy only. 5.5 months including all benefits	860 tonnes p.a.	Costs and tariffs as @ 2011

[4] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 4 Assessment snapshot of Ammonia coupled with CO2 refrigeration system - NewTon

Name: Ammonia coupled with CO2 refrigeration system - NewTon	
Technology Description	The NewTon system from Mayekawa (Mycom) uses a coupled ammonia refrigerant with a screw compressor and VFD control with a cooling heat conduction using carbon dioxide. These systems are linked with a heat exchanger
Application(s)	Cool stores and ice plant temperature control.
Potential Energy efficiency and/or carbon footprint improvement	Energy savings are recorded at an average of 30% for the NewTon 3000 and up to 59% for the NewTon C over older R22 refrigeration systems. The carbon footprint is another 5% lower due to a lack of direct emissions from refrigerant leaks.
Pros (Other benefits & advantages over common practice)	Safety - A low compressor load of ammonia which is contained to the machine room, while conventional systems use the same refrigerant in evaporator fans. Variable speed control to save cool store cooling energy Efficient IPM motor technology Australian service network
Cons (and technical risks)	Cost. ($280,000 NewTon 3000 and $345,000 NewTon C) These are not as efficient as the new continuous refrigeration systems due to split system cooling.
Apparent ease of implementation	Modular units that can be linked depending on the cool store demand.
Potential Relevant government support schemes	Circumstance dependent. Refer to Section 6 for options. Financials shown below **excludes** any gov support.
Other Remarks	The NewTon as with other ammonia based systems will comply with the R22 phase out in new equipment by 2016. Technology is mature. (8 years old)
Vendor or agent details	Mayekawa (Mycom) Peter O'Neill (Sales Manager) Sydney 02) 9695 7000

Hypothetical case study

Description:	Capital cost	Energy Savings	Payback period[5]	GHG savings	Key Assumptions
A 10,000 m^3 cool store running a refrigeration system with a COP of 1.5 is upgraded with a NewTon 3000 with a COP of 2.2 (30% energy savings).	$280,000 Plus, site specific costs	140 MWh 504 GJ $16,800	at 12c/kWh 17 years (not including savings due to low refrigerant NH_3 loads)	Energy 164 Tonne Refrigerant Direct 62 Tonne Total 226 T	Assume energy consumption reduced from 42 to 28 kWh/m3/y

[5] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 5 Assessment snapshot of Flash Steam recovery from high pressure condensate

Name: Flash Steam recovery from high pressure condensate						
Technology Description	The energy content in flash steam is high and can be recovered using a custom designed condensate and flash recovery system. This consists of Flash vessel, Safety Valve, Condensate recovery pump, Back Pressure valve and other ancillary valves.					
Application(s)	Recover Flash Steam from High Pressure condensate and reuse for a wide range of applications that are site specific. Pre-heating of feed water tank for the boiler or generating hot water is examples. This steam also can be used in whole or as a supplement to any low-pressure steam using devices.					
Potential Energy efficiency and/or carbon footprint improvement	Reductions in Boiler Fuel consumption and a proportionate reduction in boiler fuel-related carbon emissions.					
Pros (Other benefits & advantages over common practice)	Reduced load on Effluent Treatment plant, lower water consumption, reduced boiler water treatment chemicals, reduced visible steam plumes.					
Cons (and technical risks)	Backpressure on Steam Traps. Orifice changes might be necessary.					
Apparent ease of implementation	Moderate. Requires custom engineered solution. New piping and machinery to be considered.					
Potential Relevant government support schemes	Circumstance dependent. Refer to Section 6 for options. Financials shown below **excludes** any gov support.					
Other Remarks	The approximate prices below are for supply, installation and commission of Flash vessel, safety valves, back pressure valve, controls, isolation and non-return valves. The pumping, reticulation, and control of recovered hot water or steam to point of usage will be an additional cost.					
Vendor or agent details	**TLV Pty Ltd.** Melbourne, t: (03) 9873 5610 mob 0488 102 340 www.tlv.com.au e: sales@tlv.com.au					
Hypothetical example						
Description:	Capital cost	Energy Savings	Payback period[6]	GHG savings	Key Assumptions	
Hypothetical Scenario for savings calculation. Multiple processes connected to a common condensate recovery line. Condensate Pressure after losses = 8bar(g). Combined Condensate Flow rate = 5000kg/hr Flash Steam Recovery Pressure = 2bar(g). Quantity of Flash Steam Recovered after 10% loss- 375kg/hr	$50K	$56K p.a. Approx. 6,000GJ p.a	11 months	Approx. 300 tonnes p.a.	Cost of Steam $25/tonne Annual working hours -6000 Losses-10%	

[6] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 6 Assessment snapshot of Screw compressor refrigeration system – High Stage Thermosiphon

Name:	**Screw compressor refrigeration system – High Stage Thermosiphon**
Technology Description	GEA high efficiency screw compressor refrigeration system with variable speed drive running ammonia refrigerant throughout the system. .
Application(s)	Cool stores and ice plant temperature control.
Potential Energy efficiency and/or carbon footprint improvement	Energy savings estimated at 73% over older refrigeration systems with a COP of 1.5 using R22 refrigerant. The carbon footprint is another 5% lower due to a lack of direct emissions from refrigerant leaks.
Pros (Other benefits & advantages over common practice)	Energy efficiency Variable speed control to save cool store cooling energy No direct GHG emissions from refrigerant losses Australian service network
Cons (and technical risks)	Ammonia used in cool stores may cause safety issues
Apparent ease of implementation	Modular units that can be linked depending on the cool store demand.
Potential Relevant government support schemes	Circumstance dependent. Refer to Section 6 for options. Financials shown below **excludes** any gov support.
Other Remarks	The ammonia refrigerant based systems will comply with the R22 phase out future requirements.
Vendor or agent details	GEA refrigeration division, Carrum Downs VIC Greg Clements (Sales Manager) 03) 88779963

Example installation, or case study (either actual or hypothetical)

Description:	Capital cost	Energy Savings	Payback period[7]	GHG savings	Key Assumptions
A 30,000 m^3 cool store running a refrigeration system with a COP of 1.5 is upgraded with a GEA 103 kW Thermosiphon system with a COP of 5.65 (73% energy savings).	\$80,000 (compressor set)	1,028 MWh 3,700 GJ	At 12c/kWh 0.65 years	Energy 1,200 Tonne Refrigerant Direct 62 Tonne Total 1,262 T	COP from a base of 1.5 to 5.65

[7] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 7 Assessment snapshot of Streamwise DAF control system

Name:	Streamwise DAF control system
Technology Description	Dosing controls for DAF chemical additions that self-optimize dosing using a system learning function that measures output water quality.
Application(s)	Wastewater treatment DAF system to remove fats and floating matter from wastewater.
Potential Energy efficiency and/or carbon footprint improvement	The DAF output is improved and the chemical additions are minimized. DAF output of BOD and suspended solids are reduced lowering the energy required to remove these at a later stage of wastewater treatment.
Pros (Other benefits & advantages over common practice)	Chemical savings over manual DAF dosing adjustment Labour savings in manual dosing controls Reduced downstream wastewater treatment required Victorian supplier with local know how at hand.
Cons (and technical risks)	Early technology adoption may have some pitfalls yet to be identified.
Apparent ease of implementation	Simple replacement of existing manual dosing pumps and quality monitoring. Done by the supplier who maintains the system.
Potential Relevant government support schemes	Nil.
Other Remarks	STREAMWISE is an intelligent system that learns from experience and then maintains the optimum chemical dosing regime for DAF plant operation. Each site is unique in the DAF feed stream, its variation and physical condition
Vendor or agent details	Dr. Sharmen Rajendran (Eng.) Alastair Lockey (Managing Director) WATERWERX (Braeside)

Hypothetical case study

Description:	Capital cost	Energy Savings	Payback period[8]	GHG savings	Key Assumptions
A 1000 m3/day wastewater treatment plant removing BOD of 300kg/d and SS of 500 kg/d from the DAF effluent will save the use of 1,200 kg of O2 in WWTP.	Leasing cost per year $120,000	240 kWh/d 864 MJ/d 259 GJ/y $8,640	13.7 y (energy only) 0.5 y (chemical savings)	88 TPA	at 0.2 kWh/kg O2 generated in bioreactor

[8] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 8 Assessment snapshot of Andzac (Venturi) Aerator

<table>
<tr><th colspan="7">Name: Andzac (Venturi) Aerator (for wastewater treatment)</th></tr>
<tr><td>Technology Description</td><td colspan="4">Venturi aeration is achieved by pumping water through a venturi jet and sucking air into the water stream. The Andzac Aerator uses four Venturi jets and pumps aerated water back into the water body.</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Application(s)</td><td colspan="4">Wastewater aeration ponds both bio-reactor aerobic -ponds and maturation (polishing) ponds.</td></tr>
<tr><td>Potential Energy efficiency and/or carbon footprint improvement</td><td colspan="6">An electrical efficiency improvement of 22% may be achieved in electrical energy used per kg of oxygen dissolved into the water system.</td></tr>
<tr><td>Pros (Other benefits & advantages over common practice)</td><td colspan="6">The pumping system mixes the oxygenated water in the pond</td></tr>
<tr><td>Cons (and technical risks)</td><td colspan="6">Jet fouling (prevented by inlet screens)
Small electrical capacity (2.2 and 5 kW units) so more than one aerator may be needed.</td></tr>
<tr><td>Apparent ease of implementation</td><td colspan="6">These units operate in a similar manner to pontoon surface aerators with simple replacement possible.</td></tr>
<tr><td>Potential Relevant government support schemes[9]</td><td colspan="6">Circumstance dependent. Refer to Section 6 for options.
Financials shown below excludes any gov support.</td></tr>
<tr><td>Other Remarks</td><td colspan="6">The efficacy of the Andzac aerators should be compared on the basis of oxygenation efficiency, O_2kg/kWh, with other systems to inform purchasing decisions.</td></tr>
<tr><td>Vendor or agent details</td><td colspan="6">Andrew Nicol
Andzac Water Treatment 330 Gooch Street, Thornbury Victoria 3071
Tel: 03) 9484 9944 email: enquiries@andzac.com</td></tr>
<tr><td colspan="7">Hypothetical case study</td></tr>
<tr><td colspan="2">Description:</td><td>Capital cost</td><td>Energy Savings</td><td>Payback period</td><td>GHG savings</td><td>Key Assumptions</td></tr>
<tr><td colspan="2">Base case = 22kW aerator operating 12 hours per day for a year gives 1.8 kg O_2/kWh, running at 60% motor load uses 57.8 MWh for 80.9 T O_2.
Andzac 2.2 kW aerator x 5 operating 12 hours per day uses 31.5 MWh and gives 73 Tonne O_2.</td><td>$60,000 per unit</td><td>26.3 MWh
(calc. over 5 units)</td><td>>15 years</td><td>30.8 Tonne</td><td>Andzac offers a 22% energy saving</td></tr>
</table>

[9] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 9 Assessment snapshot of Niro Soavi NanoVALVE

Name:	**Niro Soavi NanoVALVE - Homogenisation**
Technology Description	An optimized fluid dynamic nano valve that runs at a lower pressure, has less wear and requires less maintenance. 
Application(s)	It has an advantage in homogenizing milk, UHT milk, milk for yoghurt and drinking yoghurt.
Potential Energy efficiency and/or carbon footprint improvement	Pressure savings translate to energy savings up to maximum of 50 bar gives an energy saving of 5.9 kW for a 30 kW homogenizer, or up to 16% of homogenizer electricity usage.
Pros (Other benefits & advantages over common practice)	Maintenance is reduced by a factor up to 5. Lower pressure gives less wear Kevlar type seals give the seals a longer lifetime
Cons (and technical risks)	The nano valves will only run to a maximum of 250 bar pressure
Apparent ease of implementation	Retro fits of the nano valves are rare. The change usually involves the purchase of a new homogenizer.
Potential Relevant government support schemes[10]	Circumstance dependent. Refer to Section 6 for options. Financials shown below **excludes** any gov support.
Other Remarks	The nanoVALVE technology has been in the marketplace for over ten years.
Vendor or agent details	GEA – Peter Tracey – Business Development Manager – Components Tel: 03) 9875 4007 Peter.tracey@gea.com

Hypothetical case study

Description:	Capital cost	Energy Savings	Payback period	GHG savings	Key Assumptions
Milk homogenization at 40,000 Lph Base case P= 235 bar at 28.7 kW NanoVALVE P= 200 bar at 24.5 kW Saving 4.2 kW	$45,000 (valve set exchange only)	15,000 kWh/y 54 GJ/y	25 years (based only on energy savings)	17.5 Tonne (in Vic.)	Homogeniser running 12h/day

[10] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 10 Assessment snapshot of Forward Osmosis

Name:	Forward Osmosis (FO)
Technology Description	Forward osmosis uses the osmotic pressure of a saline draw solution to drive water across a membrane and thus concentrate product in the feed stream. The membrane is permeable to water but not salts and product. 
Application(s)	There is the potential to using salty waste streams (i.e. ion exchange brines, salty whey) to provide a driving force for the concentration of milk or other dilute dairy streams via forward osmosis membranes.
Potential Energy efficiency and/or carbon footprint improvement	Work done by CSIRO suggests that a 20% saving in gas and a 60% saving in electricity can be achieved with FO in comparison with a conventional evaporator.
Pros (Other benefits & advantages over common practice)	Low temperature operation of FO - avoids damage to heat sensitive components 50% solids can be achieved in the product stream and concentration without evaporation – saving energy by avoiding addition of latent heat of vaporisation Water can be recovered from the draw solution using RO while regenerating the draw stream concentration. Capital cost of FO is low in comparison with evaporators.
Cons (and technical risks)	Suitable draw streams with optimized osmotic pressure may not be available. The use of RO to regenerate the draw stream loses some of the inherent energy savings. Some cross contamination of each stream with the other is possible.
Apparent ease of implementation	Integration with current evaporation processes is required. A significant saline waste to use as the draw solution is favoured.
Potential Relevant government support schemes[11]	R&D tax concession may apply to trial applications.
Other Remarks	There was no relevant application to dairy processing found. This technology is in its early stages of commercialization. The use of ammonium bicarbonate has been suggested for the draw stream electrolyte as this may be recoverable. In Victoria, the net balance in GHG emissions is an increase of 2,858 t (CO_2-e)/yr. This will be a reduction in states with low GH intensity in electricity.
Vendor or agent details	Porifera (USA) Jennifer Klare - jennifer.klare@poriferanano.com Ederna (Spain) tel: +34 658 127 360 - www.ederna.com

Hypothetical case study

Description:	Capital cost	Energy Savings	Payback period	GHG savings	Key Assumptions
A feed of 50,000 kg/h of milk (13% solids) is concentrated to 50% solids -by evaporation uses 0.56 MJ/kg evaporated = 28 GJ/h. FO uses 0.208 MJ/kg = 10.4 GJ/h	$5,000,000	126,000 GJ/y (160,000 gas) (-34,000 elec)	7.9 years	8,192 T (gas) -11,050 T (elec) =-2,858 T	24 hour op 300 days/y Evap energy 80% gas 20% elec.

11 Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 11 Assessment snapshot of Membrane Distillation

Name:	Membrane Distillation (MD)	
Technology Description	Membranes are used to transport water vapour from a product or waste stream which is then condensed in a permeate stream affecting concentration of the feed stream. It requires low level waste heat to drive the vapour pressure and product concentration.	Memdist 
Application(s)	Concentration of water streams that have a low membrane fouling potential such as salty waste streams (whey waste water in cheese making). Lactose solution concentration is possible using MD.	

Potential Energy efficiency and/or carbon footprint improvement	The energy efficiency of hydrophobic membranes as measured by Memsys has varied between 1/3 and 1/10 of the theoretical energy required.
Pros (Other benefits & advantages over common practice)	MD has the potential to remove more water than RO. 30 to 45% solids can be achieved (Brix 30-45) Very energy efficient low grade using waste heat Permeate stream is clean water of less than 1% solids (Brix <1)
Cons (and technical risks)	Membranes will foul if fats and proteins are present in the feed stream The permeate will collect some product from the feed stream.
Apparent ease of implementation	This requires the availability of a waste heat source to heat the feed stream (50 to 80°C)
Potential Relevant government support schemes[12]	Circumstance dependent. Refer to Section 6 for options. R&D tax concession
Other Remarks	MD has not been established in the dairy processing space. The MemDist product is mainly targeted at small desalination systems and may therefore best suit salty waste streams.
Vendor or agent details	Memsys sell a "Memdist" system (Kui Zhao – kui.zhao@memsys.eu) **memsys water technogies GmbH** Walche 2 85567 Grafing bei München Germany Phone: +49 (0)160 - 9514 5356

Hypothetical case study

Description:	Capital cost	Energy Savings	Payback period	GHG savings	Key Assumptions
Memdist system compared to a triple effect evaporator using waste heat at 70C. and an efficiency factor of 6.5. Processing -(evaporating) 20,000 L/day of water.	$128,000	690 GJ/y ($23,000/y)	5.6 years	273 Tonne/y	Evap at 0.5 MJ/kg MD at 0.38J/kg

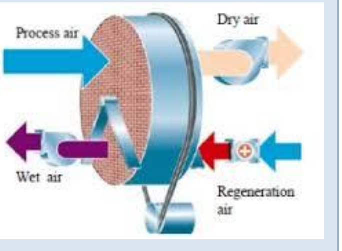
[12] Estimated ROI expressed as simple payback in years, excluding the impact of any possible government support.

Table 12 Assessment snapshot of High Pressure Processing (HPP)

Name:	**High Pressure Processing (HPP)**	
Technology Description	Liquid products in package are subjected to pressures of 4,000 to 6,000 bar. At this pressure range the micro-organisms and pathogens are destroyed at ambient temperatures.	 Avure AV-60
Application(s)	HPP can be used to stabilize milk and milk products in a similar manner to pasteurization. HPP has an effect on the texture of yogurt and cheese.	
Potential Energy efficiency and/or carbon footprint improvement	Heat energy is eliminated using HPP. The energy savings associated with HPP over steam pasteurization depend on holding times required for HPP.	
Pros (Other benefits & advantages over common practice)	Low temperature processing Texture improvement is possible Direct GHG emissions can be reduced (gas to electricity)	
Cons (and technical risks)		
Apparent ease of implementation	Major changes to processes and possibly utilities are required	
Potential Relevant government support schemes		
Other Remarks		
Vendor or agent details	Avure Technologies – Erlanger, KY 41018 USA info@avure-hpp-foods.com Hyperbaric S.A. – Burgos Spain info@hyperbaric.com	

Table 13 Assessment snapshot of Munters Desiccant dehumidification of Spray Dryer Intake Air

<table>
<tr><th colspan="3">Name: Munters Desiccant Dehumidification of Dryer Intake Air</th></tr>
<tr><td>Technology Description</td><td>Munters desiccant dehumidification systems remove moisture from the air by using a desiccant; a material which easily attracts and holds water vapor. Desiccant dehumidifiers are especially well-suited for removing moisture from air at a low temperature and low humidity level. See Animation weblink

The Munters system incorporates a rotating desiccant wheel. The desiccant is ‘regenerated’ continuously by a stream of heated ‘regeneration air’. The source of regen energy may be waste heat; however, waste heat is NOT typically required to achieve an overall net energy efficiency benefit.</td><td rowspan="2">
</td></tr>
<tr><td>Application(s)</td><td>Pre-conditioning of dairy spray dryer intake air such that humidity is both low, and constant, at all times of the day and the year.</td></tr>
<tr><td>Potential Energy efficiency and/or carbon footprint improvement</td><td colspan="2">Energy savings of 5% or more can be expected, and associated ghg benefits. Given that Spray driers use very large quantities of energy, even a modest % gain in energy efficiency will translate to very large cost and ghg saving.

Actual savings will be very case-dependent.

Maximum energy savings are achieved if the additional drying capacity created by the dehumidification of inlet air is utilised by increasing dryer concentrate feed rate.</td></tr>
<tr><td>Pros (Other benefits & advantages over common practice)</td><td colspan="2">Energy savings is typically the secondary benefit. The prime benefit is increased dryer production output and easier plant operation in high humidity environments or weather events. Reduced risk of ‘stickiness’ related operational problems and fouling. And possibly improved product consistency.</td></tr>
<tr><td>Cons (and technical risks)</td><td colspan="2">Due operational care must be taken to preserve the desiccant coating.

Large physical footprint.</td></tr>
<tr><td>Apparent ease of implementation</td><td colspan="2">Integration with current drying plant is required. Physical size may preclude retrofit in some circumstance.</td></tr>
<tr><td>Potential Relevant government support schemes</td><td colspan="2">Circumstance dependent. Refer to Section 6 for options.</td></tr>
<tr><td>Other Remarks</td><td colspan="2">Practicality and cost-effectiveness improved for a new dryer scenario.

Cost-effectiveness is improved if waste heat is harnessed for the task of regenerating the desiccant wheel.</td></tr>
<tr><td>Vendor or agent details</td><td colspan="2">Munters Pty Ltd
Clayton Victoria 3168 Australia www.munters.com/en/?country=au

Mr Ron Visser
Mobile: +61 418 331 451 E-mail: Ron.Visser@munters.com.au.</td></tr>
<tr><td colspan="3">Reference Experimental data

No example or case study was assessed for this study. Please refer to vendors.

Also, note useful reference at Humidity in Spray Drying</td></tr>
</table>

Table 14 Assessment snapshot of Removable Insulating Covers

Removable Insulation covers (hot surface blankets)		
Technology Description	A highly efficient thermal insulation that replaces old “box” technology with High Temperature Fabrics that can be easily removed and reinstalled.	
Application(s)	Any steam application that can be measured can be insulated. Most common applications are: Valves, flanges, heat exchangers, man-ways, boiler ends, traps, dryer tops, etc.	

Potential Energy efficiency and/or carbon footprint improvement	The thermal efficiency of these covers provides excellent potential for energy savings and reduced carbon emissions on steam and condensate applications.
Pros (Other benefits & advantages over common practice)	Insulating with these covers significantly reduces the risk of high temperature burns, as well as providing an acoustic value which reduces noise pollution. Steam Plant equipment has reduced wear and tear as thermal cycling is minimised. Maintenance staff can remove and replace these covers which equates to a low cost of ownership.
Cons (and technical risks)	The Covers can be damaged if not handled correctly and in the unlikely event of a high-pressure gasket failure, the cover will be compromised.
Apparent ease of implementation	Very straightforward. No special tools or skills required to install these covers. Vendor measures, supplies and installs.
Potential Relevant government support schemes	Circumstance dependent. Refer to Section 6 for options.
Other Remarks	Experience shows that fixed covers tend to degrade each time they are removed and replaced for maintenance of plant or valves. The removable feature guarantees sustained savings AND ease of maintenance. Each application is custom designed for ease of access and installation, as well as the best fit for Thermal efficiency.
Vendor or agent details	Core Industrial Solutions Mob 0498 444 008 or paul@coreindustrialsolutions.com.au

Example installation (actual)

Description:	Capital cost	Energy Savings	Payback period[13]	GHG savings	Key Assumptions
Victorian Dairy Processor 2016 Contact vendor for details.	$42K	$74K 9,400GJ p.a Or 225GJ per $1K of capex	7 months	480 tonnes pa	Historic weather patterns and 2016 gas price

[13] Estimated ROI expressed as simple payback in years, **excluding** the impact of any possible government support.

4. Low Carbon Technology Alternatives for Hot Water Generation

A substantial quantity of energy used by dairy processing plants is in the form of hot water. Consumption activities include heating, thermalising, sterilisation, wash down, CIP and pasteurization. Temperatures used typically range from 50°C to 95°C.

In most cases in the Australian dairy sector this hot water is generated via gas-fired steam, either directly or indirectly, and either at point of use or via a centralised supply system and reticulation network.

Good practice in energy management includes a strong focus on minimising hot water consumption. This Study Report compliments that effort by focusing on technologies for minimising the cost and carbon footprint of the generation of hot water.

The report does this by comparing the costs and benefits of a selection of technology options against generation from gas-fired steam.

To enable a meaningful assessment of the feasibility and benefits of utilising alternate technologies for the heating of water, it was necessary to define a hypothetical 'standard' hot water load and supply system. The following describes that hypothetical system, which was informed by interviews with dairy industry members.

4.1. Description/Specs of hypothetical base case hot water system and load

Overview

- A centralised hot water supply system that heats potable town water from 15°C.
- Two scenarios. One to supply 60°C hot water, and another 85°C.
- Incorporates a thermal storage tank/silo to buffer demand and reduce heater size (hence CAPEX).
- Load is 'use and dump'. No return line to hot water set.
- Multiple energy source scenarios have been modelled and costed including renewable biomass (wood chips and sawdust), flat plate solar array, and large scale heat pump.

Design load (duty)

- Supply temps = 60°C and 85°C
- Culinary standard
- All loads are use and dump
- Demand profile:
  - Daily volume consumed = 100KL
  - Daily energy demand therefore = 19GJ and 29GJ
  - Average thermal demand therefore = 218kWth and 340kWth
  - Peak volume demand of five times average, therefore = peak supply flow rate of 20,000 litres/hour.
  - Peak thermal demand therefore = 1.1MWth and 1.7MWth
  - 24/7 operation.
  - Feed water source = potable 15°C

General System Configuration and Features

- Stratified thermal store in all cases
- Supply temperature is regulated (boosted/trimmed as required) to ensure consistent supply temperature.
- Assumed that there is in place required point-of-use temp boosting and/or tempering occurring within the factory (i.e. not costed in the study's model).
- Storage tank and pipes are well insulated.

Solar System Configuration and Design Factors

- Latitude – Melbourne
- Collector type - Flat plate, ground mounted
- Glycol closed loop system with solar-side external HX
- Includes energy supplementation and supply temperature trim using steam from existing site boilers
- Solar fraction – 70%

Assumptions & Design Factors

- Cost of gas = $11/GJ delivered.
- Cost of electricity 12c/kWh delivered (overall average)
- Wood fuel characteristics and price
  - Two scenarios have been modelled and costed - woodchips and sawdust:
  - Wood type - Hardwood
  - Price (delivered)
  - Green hardwood chips $60/t
  - Green sawdust $45/t
  - Moisture content
    - Chips = 35% moisture (by dry weight)
    - Sawdust = 60% moisture (by dry weight)
  - On site fuel storage buffer capacity = 3 days
- For heat pump option, the source of waste heat is water loop at 35°C
- For steam based hot water (the base case)
  - Steam pressure - 10 bar
  - Boiler house fuel to energy in steam efficiency is 80%.
  - Steam to hot water (via HX) thermal efficiency (including steam distribution losses) is 90%

4.2. High Level Description of Solar System

Industrial solar hot water systems convert sunlight into useful thermal energy that can displace the use of heaters, boilers and furnaces. A system consists of solar thermal collectors, a storage tank (thermal store), pipes, pumps, insulation, heat exchangers and a control system. There are various types of solar thermal collectors that can produce temperatures from 30°C up to 300°C. Generally, the lower the temperature, the simpler and less expensive they are. Basic black plastic pool heaters, flat plate collectors, evacuated tube and evacuated flat plate collectors, concentrating collectors such a parabolic troughs and linear Fresnel mirrors are solar collector in order increased suitability for high temperatures.

For this Study EnergyAE has designed an Industrial solar hot water system to partially offset the gas used by a hypothetical existing steam based hot water system for a dairy processing plant to demonstrate the feasibility of solar hot water as a means to cost-effectively reduce energy costs and carbon footprint.

The efficiency of solar thermal collectors is depending in the temperature they operate at. Higher load temperatures result in a lower system efficiency.

EnergyAE simulated the system using the TRNSYS simulation software in a minute-by-minutes analysis over a year to get a detailed understanding of the energy saved. The results were used to calculate the energy saved and the financial savings.

4.3. Heating Method Comparative Analysis

The cost-effectiveness of each scenario is assessed in the context of purchasing equipment additional to an existing steam based hot water generation system. In ‘green-field’ situations (where a new dedicated hot water system was being selected) the cost-effectiveness in terms of total cost of ownership of all alternate options should be modelled and compared.

4.4. Comparative Summary

Table 15 and Figure 3 provide a snapshot comparison of the greenhouse savings, CAPEX, OPEX and simple payback of each technology. Note that in figure 3 the bubble size represents the quantity of annual carbon reduction.

Table 15 Costed Water Heating Options

Hot water heating Options	Budget **Turnkey** Total net CAPEX ($000's)	OPEX Savings ($000's p.a.)	Simple Payback (years)	Energy Savings (GJ p.a.)	GHG savings (CO2e tonnes p.a.)	Remarks
Dry Wood chip, 85oC	$ 455	$ 76,418	6.0	10,695	740	
Green Sawdust, 85oC	$ 455	$ 80,658	5.6	10,695	740	
Dry Wood chip, 60oC	$ 440	$ 39,126	11.2	6,862	480	
Green Sawdust, 60oC	$ 440	$ 41,852	10.5	6,862	480	
Flat Plate Solar, 60oC	$ 234	$ 43,884	5.3	4,444	230	70% fraction. STCs included. Disadvantaged by the model
Heatpump, COP 8, 60oC	$ 500	$ 75,800	6.6	8,100	175	at Victorian EF

Figure 3 Comparison of Water Heating Options

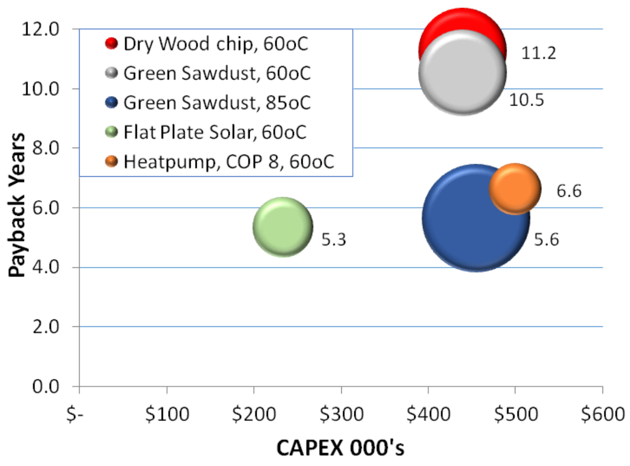


Table 16 Assessment snapshot of Heat Pump to Generate Hot water at 60°C

Name:	**Heat Pump for the production of hot water, 60ºC**
Technology Description	Heat pumps using waste heat can generate hot water through a reverse refrigeration cycle of a refrigerant gas, usually ammonia.
Application(s)	Extraction of waste heat for the generation of hot water at 60°C which can be used for a variety of purposes. Displace the use of gas used by heaters, boilers and furnaces as the prime mover of med-large scale industrial hot water systems.
Potential Energy efficiency and/or carbon footprint improvement	The Coefficient of Performance COP varies depending on the temperature of the waste heat stream and the temperature of the product stream at around 6 to 10. Resulting energy cost savings are strong (50% to 70%). Greenhouse intensity savings range from 17% to 50%. Note that carbon intensity increases if COP is below 5.[14]
Pros (Other benefits & advantages over common practice)	Less requirement for cooling systems such as cooling towers, condenser fans and evaporative systems. Less cooling water and steam is necessary adding to plant water savings. Plus, power use associated with these.
Cons (and technical risks)	Complex design. Needs adequate waste heat source, and timing of availability of waste must match demand unless a thermal store is used. Potential requirement for steam heat boosting. Will increase site electrical max demand
Apparent ease of implementation	Moderate. Modular heat pump units can be installed, but need to be integrated into existing heating systems. Also, cut-in requirements to plant ammonia or other waste heat sources.
Potential Relevant government support schemes	Various. See funding table.
Other Remarks	Heat from refrigeration condenser circuit is most often used as the heat source.
Vendor or agent details	GEA – Refrigeration Brad Chen (Engineer) brad.chen@gea.com Mayekawa (Mycom) – Plus+Heat – Peter O'Neill (Sales) peter.oneill@mayekawa.com.au Creative Water Technologies – Genesis heat pump evaporator – - Tony Jones tony.jones@creativewater.com.au

Hypothetical example hot water system with Heat pump

Description:	Capital cost	Energy Savings	Payback period[15]	GHG savings	Key Assumptions
Production of 100kL per day of 60°C hot water from 15°C feed stream (energy required = 18.8 GJ) using gas fired steam to hot water overall efficiency 72% takes 26.1 GJ. Heat pump with a COP of 8 takes 2.4 GJ of electricity (667 kWh) Waste heat source is water @ 35ºC	$500,000	Gas $105,000 – elec at $29,200 = $75,800 8,100 GJ/y	6.6 years	175 CO2e tonnes p.a. (net - less gas and more elec)	Gas $11/GJ Elec EF 1.2kg/kWh COP = 8 24/7

[14] Based on factors used by hypothetical case study
[15] Estimated ROI expressed as simple payback in years, **excluding** the impact of any possible government support.

Table 17 Assessment snapshot of Flat Plate Solar Collectors for Hot water, 60°C

Flat Plate Solar Collectors for hot water, 60ºC		
Technology Description	Flat Plate Solar Thermal Collectors to convert sunlight into hot water. Ground mounted. Coupled with heat exchangers, stratified hot water silo (thermal store), pumps, and control systems.	
Application(s)	Displace the use of gas used by heaters, boilers and furnaces as the prime mover of med-large scale industrial hot water systems.	
Potential Energy efficiency and/or carbon footprint improvement	Energy displacement up to 90%, depending on the load profile. Therefore carbon footprint of hot water load is reduced by up to 90%.	
Pros (Other benefits & advantages over common practice)	Sun energy is carbon and cost free. Well proven technology. Dairy seasonal hot water demand profile aligns well with solar resource profile.	
Cons (and technical risks)	Large space needed for collectors. The study's hypothetical (100 kl/day) requires 2,000m^2 of ground space. The system requires back up heating for low solar days.	
Apparent ease of implementation	Moderate	
Potential Relevant government support schemes	Primarily ARENA and STCs. Other possible funding includes NSW ESCs (only if no STCs), ERF, VIC Future Industries Fund, NSW Climate Change Fund, and VIC Future Industries Fund.	
Other Remarks	Hypothetical below assumes (i) suitable land is available, (ii) costed as retrofit to an existing baseline situation where hot water is made by steam from a typical gas-fired boiler house. The ROI (simple payback) will be much better if a new hot water plant scenario. ROI would also improve if the seasonal nature of the hot water load is taken into account in the modelling. ROI is slightly dependent on latitude.	
Vendor or agent details	For more information on collectors, or the hypothetical dairy case study contact Mr Jeremy Osborne of www.energyae.com mob 0400 063 327. Jeremy.osborne@energae.com	

Hypothetical dairy plant case study

Description:	Total System Cost[16]	Energy Savings	Payback period[17]	GHG savings	Key Assumptions
Arcon-Sunmark Flat Plate collector solar system to offset 60% of existing base-case load. Closed loop glycol solar-side with external HX. Solar field: 1,000m^2. 805kW heat. Storage: 28 m^3 of water. See body of report for more detail.	$235K net (after STCs) $600K gross	4,444 GJ/pa	5.3 years	230 tpa	Lat'd Melb. Gas $11/GJ. STCs $38

[16] Turnkey, including design, solar field, thermal store, gas booster heater, pumps, controls, 25% margin for site works.
[17] Estimated ROI expressed as simple payback in years, including STCs, but no other gov support.

Table 18 Assessment snapshot of Sawdust Hot Water System, 85°C

Dry wood chip fired Uniconfort EOS Hot Water Boiler, 85ºC	
Technology Description	Uniconfort EOS 30 Sawdust fired hot water boiler, coupled with fuel storage and handling, hot water silo (thermal store), supply pump, and control systems. Supplied in a containerised complete package. Fully automatic self-contained biomass heating plant and fuel storage system. 
Application(s)	Displace the use of gas used by heaters, boilers and furnaces as the prime mover of med-large scale industrial hot water systems. 
Potential Energy efficiency and/or carbon footprint improvement	Almost carbon neutral hot water source provided the fuel is from a renewable source.
Pros (Other benefits & advantages over common practice)	Low cost fuel supply. Much lower cost than gas. Well proven technology.
Cons (and technical risks)	Some carbon footprint associated with fuel transport. Fuel storage and handling must be managed.
Apparent ease of implementation	Moderate. Key success factor is securing a long-term fuel supply agreement that ensures sustained volume and consistent quality.
Potential Relevant government support schemes	Various. See Table.
Other Remarks	Recent examples of similar technology and scale have been recently commissioned in Yarragon, Victoria. See Waste Wood Warms Yarragon Tomatoes. The hypothetical below is costed as a retrofit to an existing baseline situation where hot water is made by steam from a typical gas-fired boiler house. The ROI will be much better if a new hot water plant scenario. ROI is very sensitive to the effective delivered cost of energy in lower heating value in $/GJ.
Vendor or agent details	For more information contact about EOS boilers or the hypothetical below, contact Mr Gary Ridout. Mob 0419 347 198 Email gr.act.group@gmail.com www.alternativecleantechnologiesgroup.com.au

Hypothetical dairy plant case study

Description:	Capital cost	Savings	Payback period[18]	GHG savings	Key Assumptions
Production of 100kL per day of 85°C hot water from 15°C feed stream using dry wood chips to displace hot water generated by gas fired steam. Single use and dump scenario. Existing sunk cost in working gas-fired steam based heating system.	$450K	Gas savings 15,000GJ OPEX savings $81K	5.6 years	700 tpa	Gas $11/GJ Sawdust $45/tonne delivered. Moisture 60% dry weight

[18] Estimated ROI expressed as simple payback in years, **excluding** the impact of any possible government support.

Table 19 Assessment snapshot of Woodchip Hot Water System, 85°C

Dry wood chip fired Uniconfort EOS Hot Water Boiler, 85ºC	
Technology Description	Uniconfort EOS 30 Woodchip fired hot water boiler, coupled with fuel storage and handling, hot water silo (thermal store), supply pump, and control systems. Supplied in a containerised complete package. Fully automatic self-contained biomass heating plant and fuel storage system. 
Application(s)	Displace the use of gas used by heaters, boilers and furnaces as the prime mover of med-large scale industrial hot water systems. 
Potential Energy efficiency and/or carbon footprint improvement	Almost carbon neutral hot water source provided the fuel is from a renewable source.
Pros (Other benefits & advantages over common practice)	Low cost fuel supply. Much lower cost than gas. Well proven technology.
Cons (and technical risks)	Some carbon footprint associated with fuel transport. Fuel storage and handling must be managed.
Apparent ease of implementation	Moderate. Key success factor is securing a long-term fuel supply agreement that ensures sustained volume and consistent quality.
Potential Relevant government support schemes	Various. See Table.
Other Remarks	Recent examples of similar technology and scale have been recently commissioned in Yarragon, Victoria. See Waste Wood Warms Yarragon Tomatoes. The hypothetical below is costed as a retrofit to an existing baseline situation where hot water is made by steam from a typical gas-fired boiler house. The ROI will be much better if a new hot water plant scenario. ROI is very sensitive to the effective delivered cost of energy in lower heating value in $/GJ.
Vendor or agent details	For more information contact about EOS boilers or the hypothetical below, contact Mr Gary Rid out. Mob 0419 347 198 Email gr.act.group@gmail.com www.alternativecleantechnologiesgroup.com.au

Hypothetical dairy plant case study

Description:	Capital cost	Savings	Payback period[19]	GHG savings	Key Assumptions
Production of 100kL per day of 85°C hot water from 15°C feed stream using dry wood chips to displace hot water generated by gas fired steam. Single use and dump scenario. Existing sunk cost in working gas-fired steam based heating system.	$455K	Gas savings 15,000GJ OPEX savings $76K	6 years	700 tpa	Gas $11/GJ Wood cost $60/tonne delivered. Moisture 35% dry weight

[19] Estimated ROI expressed as simple payback in years, **excluding** the impact of any possible government support.

5. Government Policy Developments related to Carbon Abatement

Below is provided a brief summary of current/upcoming national/international policy developments which may provide risk or opportunity towards achieving the industries GHG intensity targets.

The global community has recognized the threat to our climate generated by Greenhouse Gas (GHG) emissions. The intergovernmental policies written to address this threat have been driven by the United Nations:

Rio Summit 1972 - Framework Convention

Kyoto Convention 1997 – Kyoto Protocol (Australian goal a 12% increase in GHG emissions from 1990 to 2012)

Paris Conference 2015 – COP 21 agreements by individual countries (Australian goal a 5% decrease in GHG emissions from 2005 to 2020 and a further 26 to 28% reduction by 2030)

The IPCC has indicated that to achieve the stated goal of a maximum climate warming of 2°C by the end of this century a reduction to net zero emissions by 2050 is required, so an acceleration of decarbonisation efforts is necessary from 2030.

While the Australian government has no goal for GHG emissions beyond 2030, the states of South Australia, Victoria and New South Wales have pronounced targets of zero net GHG emissions by the 2050 year. Some states have also committed to extended renewable energy targets over the federal government's 2020 target.

Where does energy efficiency fit?

In developed nations, it is generally recognised that energy efficiency is a significant contributor to the achievement of Paris protocols to combat global warming. The main strategy adopted by the US[20] is a strategic alliance between governments, business and academics to develop policies that are non-partisan and work in the market place. Its strategies involve a mixture of sector goals, finance to assist in achieving them and education. The US has adopted a national goal of doubling energy productivity as measured by GDP from 2015 to 2030. There is a 5-year strategic plan that focuses on manufacturing, the built environment and transport. California has driven this agenda harder with a series of energy efficiency standards for equipment, appliances and cars. It also has a renewable energy target of 50% of the total electricity supply by 2030. These effectively have become national standards as an OEM manufacturers to meet the toughest standard and therefore meeting all of the others.

Europe has a similar approach to the US with a target of doubling energy productivity by 2030 and 100% renewable electricity generation by 2030. The UK has dropped targets and has focused on education of citizens which is run through the UK Energy Saving Trust.

Australia has followed the UK line to some extent, but does have a goal of a 40% improvement in energy productivity by 2030 (administered by the Department of Environment and Energy).

How does Australia plan to meet its GHG emission targets?

The Australian federal government has two main funding mechanisms to develop GHG emission reductions and two key initiatives to achieve reductions. These are influenced by the Department of Energy and Environment having major policy responsibility and the Department of Industry, Innovation and Science having a interest in industry policies.

In Australia, GHG emission reduction strategies are mainly centered around the Emissions Reduction Fund and the Renewable Energy Target, both of which will contribute to emissions reductions. The former via an open bidding system for carbon credits, and the latter via funding support for renewable energy installations (RECs21).

Where does energy efficiency fit?

A fair effort has been placed on exploring the potential for savings through energy efficiency. The Energy Efficiency Council published a report in 2016 that estimated a potential of 11.4 % energy savings in manufacturing industry from efficiency improvement measures in 2010-11 (Australian Energy Efficiency Policy Handbook).

Industry energy efficiency is seen by government as a low-cost route to emission reductions. It has set up the Energy Efficiency Exchange (EEX) as a body to support industry energy efficiency through a set of standards, management initiatives and strategies to support these measures for medium to large manufacturers.

EEX has a series of initiatives that center around information and training, although the support through mandating of planning, standards for equipment and evaluation of efficiency has not been continued. Climate Works has an Energy Efficiency Data project. Energy Audit standards have been updated for industrial and related activities (AS 3598.2 Energy Audits).

The Energy Efficiency Opportunities program was terminated by the federal government in 2014.

The states have industry assistance programs such as the Victorian Energy Efficient Technologies Fund and the Future Industries Program to promote the uptake of energy efficient technologies[22]. The states have energy

[20] This alliance has not been considered at this time by the new administration in the US.

[21] RECs Renewable Energy Certificates are issued for each MWh of electricity generated by renewable methods. Rebates are available for the generation of RECs up to 2030 (the deeming period).

[22] The VEET program funds projects based on energy savings with certificates traded on the basis of the

and GHG emission targets going out past 2020. EPAs have policies that require consideration of energy efficiency in industry development proposals within EIS reports and approval processes.

What does this mean for the dairy industry?

While dairy processors sit as contributing to GHG targets by improving energy efficiency, dairy farms are set with direct emissions from cattle and pasture. The farmers do have a level of flexibility in being able to offset these direct emissions with farm trees, animal husbandry, soil carbon or forestry.

Dairy processors participating in the Australian Dairy Industry Sustainability Framework have set a current target of 30% reduction in the industry's GHG emissions intensity by 2020 based on 2010-2011 levels. External analysts such as Climate Works Australia have suggested that the industry set aggressive targets in the region of a 40 to 80% increase in energy productivity in the next 15 years[23]. Current increases in energy prices, particularly that of natural gas (due to a complex interplay between domestic and international energy policy and market dynamics), are leaving Australian dairy processors with increasing incentives to reduce their reliance on non-renewable, grid-supplied energy and this will lead to further GHG emissions reduction.

The GHG reduction strategies that can be employed by the processors include:

- Energy Efficiency
- Waste heat reuse
- Use of green energy (renewable energy sources)
- Electrification of energy use (reduce the use of fossil fuels)[24]
- Reduction in direct GHG emissions (refrigerant switching to non GHG refrigerants, reduction of fermentation emissions, wastewater treatment emission reduction)

The National Energy Productivity Plan (DOE)[25] has energy productivity achieving 40% of the total emission reductions in Australia between 2020 and 2030 (approx. 150 Million Tonnes CO_2 Eq.).

quantum of energy savings. See the next section on funding assistance to gain details of state grants.

[23] AS presentation to the Dairy Australia Industry Forum May 4, 2016

[24] Assuming electricity source has lower carbon intensity that fuels for heat

[25] DOE Department of Energy and the Environment

6. Government Financial Support/Incentive Schemes

Following is a summary of current or upcoming state and national Gov Financial support/incentive schemes that are applicable to medium-large dairy processors and which have the potential to support activities and investments targeted at GHG intensity reduction (directly or indirectly) by Australian dairy processing sites.

6.1. Schemes Included in this report

- Dairy Australia Technology Assessment (DATA) Scheme
- Dairy Australia Grant Access Support (GAS) Scheme
- ARENA - Advancing Renewables Program
- Emissions Reduction Fund (ERF)
- Small-scale Renewable Energy Scheme (STC)
- Large-scale Generation Certificate Scheme (LGC)
- NSW Climate Change Fund
- NSW Energy Saver Scheme
- NSW Gas Efficiency Funding
- SA Energy Productivity Audit Grant Program
- SA Energy Productivity Implementation Grant Program
- SA Trade Waste Initiative - Food & Bev Assess Grants
- SA Trade Waste Initiative - Food & Bev Implement Grants
- Next Generation Manufacturing Investment Program
- TAS Jobs & Investment Fund
- VIC Regional Infrastructure Fund - Enabling Infrastructure
- VIC Future Industries Fund - Manufacturing Program
- VIC Future Industries Fund - New Energy Jobs/Tech Fund
- VIC Energy Saver Incentive (VEET)
- VIC Energy Saver Incentive (VEET), Project Based Activities

6.2. Non-Relevant Schemes

For context, listed below are schemes that are non-financial in nature, or not relevant to med-large dairy processors.

- NSW Energy Saver Program
- Local Council Environmental Upgrade Agreements
- NSW Sustainability Advantage scheme
- Clean Energy Innovation Fund
- SV Boosting Productivity Energy Efficiency Grants
- VIC Sustainability Fund

6.3. Snapshot of Schemes

To aid navigation of the complex government funding scheme landscape, the report provides a tabular overview which outlines key characteristics and provides weblinks. Please refer to Table 20- Snapshot of Gov Funding/Support Schemes.

Table 20 Snapshot and web links for Gov Funding/Support Schemes

Gov Financial Support/Incentive Schemes (applicable to med-large dairy processors)					Instrument			Caps		Project Component Funded			When is value realised?			Certif calc method		Application Evaluation Method		Target (explicit)						
Scheme Name	link	Status	State	Agency	Grant	Certificate	Finance	Value	Ratio	Pre-Project	Project	M&V	Up Front	Annual	Milestone	Deemed	PBA	Merit	Compete	Energy	Renewables	Carbon	Waste	Sustainability	Jobs	Business
Dairy Australia Technology Assessment (DATA) Scheme		Open	Nat'l	Dairy Australia	✓			$50k	100%	✓					✓			✓	✓	✓	✓	✓	✓	✓		
Dairy Australia Grant Access Support (GAS) Scheme		Open	Nat'l	Dairy Australia	✓			$10k	100%	✓					✓			✓	✓	✓	✓	✓	✓	✓		
ARENA - Advancing Renewables Program	Link	Open	Nat'l	ARENA	✓			$50M	50%	✓	✓				✓		✓	✓	✓		✓					
Emissions Reduction Fund (ERF)	Link	Open	Nat'l	CER		✓					✓			✓			✓		✓	✓		✓				
Small-scale Renewable Energy Scheme (STC)	Link	Open	Nat'l	CER		✓					✓		✓			✓		✓			✓					
Large-scale Generation Certificate Scheme (LGC)	Link	Open	Nat'l	CER		✓					✓			✓			✓	✓			✓					
NSW Climate Change Fund	Link	Pending	NSW	OEH																✓	✓					
NSW Energy Saver Scheme	Link	Open	NSW	IPART		✓					✓		✓	✓		✓	✓	✓		✓		✓				
NSW Gas Efficiency Funding	Link	Open	NSW	OEH	✓			$20K	50%		✓				✓			✓		✓						
SA Energy Productivity Audit Grant Program	Link	Open	SA	State Dev	✓			$15K	75%	✓			✓					✓	✓	✓						
SA Energy Productivity Implementation Grant Program	Link	Open	SA	State Dev	✓			$2.5M	50%		✓				✓			✓	✓	✓						
SA Trade Waste Initiative - Food & Bev Assess Grants	Link	Open	SA	Green Indust	✓			$10K	50%	✓			✓					✓		✓			✓			
SA Trade Waste Initiative - Food & Bev Implement Grants	Link	Open	SA	Green Indust	✓			$300K	50%		✓				✓			✓		✓			✓			
Next Generation Manufacturing Investment Program	Link	Hold	SA, VIC	DIIS	✓			$2.5M	33%		✓				✓			✓							✓	✓
TAS Jobs & Investment Fund	Link	Hold	TAS	DIIS	✓			$24M	33%	✓	✓				✓			✓							✓	✓
VIC Regional Infrastructure Fund - Enabling Infrastructure	Link	Open	VIC	RDV	✓			Flex	Flex						✓			✓						✓	✓	✓
VIC Future Industries Fund - Manufacturing Program	Link	Open	VIC	Business Vic	✓			$500K	25%						✓			✓							✓	✓
VIC Future Industries Fund - New Energy Jobs/Tech Fund	Link	Open	VIC	Business Vic	✓			$1.0M	Flex	✓	✓				✓			✓			✓	✓			✓	✓
VIC Energy saver Incentive (VEET)	Link	Open	VIC	ESC		✓					✓		✓			✓				✓		✓				
VIC Energy saver Incentive (VEET), Project Based	Link	Pending	VIC	ESC		✓					✓		✓				✓			✓		✓				

6.4. Scheme Summaries

- **Dairy Australia Technology Assessment (DATA) Scheme**
- Status: Open
- Delivered by: Dairy Australia
- Program Manager: 03 9694 3811
- The Dairy Australia Technology Assessment (DATA) Scheme is an initiative funded by Dairy Australia (DA) which provides financial assistance to Australian dairy processors to undertake a detailed commercial assessment of an innovative technology or practice which the project proponent can demonstrate has clear potential to significantly improve the Australian dairy industry's economic or environmental performance.
- What support or funding is available?
    - The maximum total project assistance that DA will provide to eligible projects under the DATA Scheme is $50,000.
    - No matching contribution is required. Project proponents must, however, communicate generic, non-commercially sensitive learnings from the project to the broader Australian dairy processing sector.
- Eligibility criteria include:
    - Applicant must be a an Australian-based dairy processor with a registered ABN/ACN
    - Applications from a consortium of more than one dairy processor will be highly regarded/encouraged.
    - The project must involve the development of a commercial assessment of an innovative technology which is not currently employed within the Australian dairy processing sector.
    - The commercial assessment can include a physical trials but must ultimately produce written reports which documents the findings of the cost-benefit study and outlines both the technical and economic considerations.
    - The project proponent must be able to demonstrate at the application stage the quantum of the potential benefit that the technology being assessed could provide to the dairy processor individually and the Australian dairy supply chain overall.
    - The project proponent must demonstrate that the project is one which could not be completed using the internal technical or funding capabilities of the applicant organization.
    - Priority will be given to projects which seek to assess technologies with the capacity to improve the sector's performance with respect to the manufacturing-based targets under the Australian Dairy Industry Council's Sustainability Framework – namely;
        - Reduction of greenhouse gas (GHG) emissions intensity
        - Reduction of consumptive water intensity
        - Reduction of waste to landfill
    - Contact Program Manager, Ian Olmstead, for further details iolmstead@dairyaustralia.com.au,
- **Dairy Australia Grant Access Support (GAS) Scheme**
- Status: Open
- Delivered by: Dairy Australia
- Program Manager: 03 9694 3811
- The Dairy Australia Grant Access Support (GAS) Scheme is an initiative funded by Dairy Australia (DA) which provides financial assistance to Australian dairy processors to engage specialist grant writers and technical consultants to assist with developing submissions for project funding support. By supporting Australian dairy manufacturers to access the many relevant funding opportunities available to them, the GAS Scheme is designed to encourage implementation of profitable infrastructure projects which sit outside the manufacturer's normal capital hurdles as well as facilitate increased adoption of innovative, best-practice technologies.
- What support or funding is available?
    - The maximum total project assistance that DA will provide to eligible projects under the GAS Scheme is $10,000.
    - No matching contribution is required. Project proponents must, however, communicate generic, non-commercially sensitive learnings from the project to the broader Australian dairy processing sector.
- Eligibility criteria include:
    - Applicant must be a an Australian-based dairy processor with a registered ABN/ACN
    - Applications from a consortium of more than one dairy processor will be highly regarded/encouraged.
    - The project must involve developing a grant application for funding assistance for a capital infrastructure project or a commercial demonstration project.

- The project proponent must be able to demonstrate at the application stage the quantum of the potential benefit that the project (if successfully co-funded) could provide to the dairy processor individually and the Australian dairy supply chain as a whole.
- The project proponent must demonstrate that the funding application is one which could not be completed using the internal technical capabilities of the applicant organization.
- Project proponents will be required to acknowledge Dairy Australia's support.
- Project proponents will be required to permit Dairy Australia to publish a brief description of the details of the project for which grant access support is being provided to on-line and/or print
- Priority will be given to projects which seek to assess technologies with the capacity to improve the sector's performance with respect to the manufacturing-based targets under the Australian Dairy Industry Council's Sustainability Framework – namely;
  - Reduction of greenhouse gas (GHG) emissions intensity
  - Reduction of consumptive water intensity
  - Reduction of waste to landfill
- Contact Program Manager, Ian Olmstead, for further details iolmstead@dairyaustralia.com.au,

SA Energy Productivity Audit Grant Program

- Status: Open
- Delivered by: SA Dep of State Development
- Business Victoria (13 22 15)
- The Energy Productivity Audit Grant Program offers funding of up to 75 per cent of the cost of a Level 2 energy audit, up to $15,000, to businesses to engage an external energy auditor to identify energy savings opportunities
- What support or funding is available?
  - Grants amounts: Applicants must contribute a minimum of 25 per cent in matching funds towards the cost of the energy audit exclusive of in-kind contributions
- Eligibility criteria include:
  - They consume energy at business premises at or above 160MWh per annum
  - Evidence that the proposed energy auditor has the skills required to undertake a Level 2 Energy Audit
  - Potential to significantly improve energy productivity and contribute broader market benefits (where broader market benefits includes improving the reliability, security, affordability and emissions intensity of South Australia's electricity supply)
  - They have a strategic commitment to achieving energy productivity improvements within two years.
- www.statedevelopment.sa.gov.au/resources/energy-efficiency/south-australian-energy-productivity-program

SA Energy Productivity Implementation Grant Program

- Status: Open
- Delivered by: SA Dep of State Development
- The Energy Productivity Implementation Grant Program offers grants to implement the recommendations of the Energy Productivity Audit Grant or the recommendations of a recently completed energy audit, with a preference for projects that provide broader market benefits to South Australia.
- A competitive grant program that is awarded based on the merit of applications. Grants will be available under two streams:
- Stream 1 - Grants up to $2.5 million based on a $1 from SA gov for every $2 contributed by the business
- Stream 2 - Grants up to $75K based on a 50:50 contribution basis.
- What support or funding is available?
  - This may include, but is not limited to:
    - Purchasing capital equipment
    - Purchasing of software
    - Engaging independent external expertise for reconfiguration of existing systems.
- www.statedevelopment.sa.gov.au/resources/energy-efficiency/south-australian-energy-productivity-program

SA Trade Waste Initiative - Food & Bev Implementation Grants

- Status: Open. Round one open until 19 May 2017
- Delivered by: SA Green Industries
- The Trade Waste Initiative will help businesses make improvements to the way trade waste is managed (focusing on quality and quantity), reduce operating costs and increase productivity

by improving the way materials, energy and water are used.

- The Initiative has two components:
  a. Resource productivity assessments, and
  b. Implementation grants.
- What support or funding is available?
  - Assessments – A subsidy of up to 50%, to a maximum of $10K
  - Implementation - A subsidy of up to 50%, to a maximum of $300K
- Permissible use of funds includes:
  - Cost of assessments
  - new plant/equipment
  - upgrades or additions to existing plant/equipment
  - shared infrastructure
  - Staff training and education
- Eligibility criteria include:
  - A customer of the SA Water trade waste (sewer) network
  - Certain trade waste volume and load-based thresholds.
  - Completion of an approved resource productivity assessment or on-site technology trials.
- www.greenindustries.sa.gov.au/food-beverage-implementation-grants

Next Generation Manufacturing Investment Program (SA, VIC)

- Status: Open (not accepting applications)
- Applications open: Yet to be determined
- Delivered by: Department Industry, Innovation & Science.
- The $90 million Next Generation Manufacturing Investment Programme helps businesses investing in capital projects, to establish or expand high value manufacturing operations in South Australia and Victoria.
- What support or funding is available?
  - Grants are available from $500,000 to a maximum of $2.5 million, for up to one third of eligible project costs.
  - Projects can take up to three years to complete. The project site must be in South Australia or Victoria.
  - What are eligible activities?
- Eligible activities include:
  - Buying, installing and commissioning new machinery and equipment
  - Changing or extending your existing premises to accommodate the new machinery and equipment acquired through the project
  - Training in the use and maintenance of new machinery and equipment acquired through the project.
  - Other activities may also be approved if they support programme outcomes.
- Eligibility criteria include:
  - If you receive this funding, you cannot receive any other Australian Government funding for the same project.
  - At least $1.5 million in total eligible project expenditure.
- https://www.business.gov.au/assistance/Next-Generation-Manufacturing-Investment-Programme

Regional Infrastructure Fund - Enabling Infrastructure (VIC)

- Status: Open
- Delivered by: Regional Development Victoria
- The Regional Infrastructure Fund (RIF) is the primary infrastructure program of the Regional Jobs and Infrastructure Fund (RJIF). Strategic infrastructure grants support innovative infrastructure solutions that demonstrate significant business and environmental sustainable outcomes. At the same time they lift industry standards and create or enhance the conditions for growth.
- What support or funding is available?
  - Grants amounts and conditions are flexible based on nature of project
- Activities that will be considered include:
  - projects that support innovation in an industry's management of its key infrastructure and offers a model that lifts industry standards (**e.g. conversion of waste to energy**)
  - access to utility services (i.e. water, energy, waste) that builds resilience and unlocks the growth potential of a business
  - water and energy demand management measures that address the security and reliability of supply, while improving the businesses' operational sustainability
  - internal energy integration and water recycling or use of other non-potable supplies in fit-for-purpose applications which build resilience, secure existing regional businesses' operations and provide certainty for future growth
  - projects that deliver improved supply chain efficiency.

- https://www.rdv.vic.gov.au/programs-and-grants/enabling-infrastructure

Future Industries Fund - Manufacturing Program (VIC)

- Status: Open
- Delivered by: Business Victoria (13 22 15)
- The Future Industries Manufacturing Program offers funding of up to $500,000 to companies to implement new manufacturing technologies and processes in their Victorian operations, providing a critical foundation for growth.
- What support or funding is available?
  - Grants amounts: Up to $500,000 to companies to implement new manufacturing technologies and processes in their Victorian operations.
  - All grants must be matched by a minimum cash co-contribution of $3 for every $1 granted.
  - The Manufacturing Program can support projects that involve the following activities:
    - Purchasing and implementing capital equipment items
    - Manufacturing product and process improvements
    - Prototyping, evaluation and testing of new manufacturing products and processes.
- http://www.business.vic.gov.au/support-for-your-business/future-industries/future-industries-manufacturing-program

Future Industries Fund - New Energy Jobs/Technology Fund (VIC)

- Status: Open – 2nd round of applications close 1st of March 2017
- Delivered by: Business Victoria (13 22 15)
- The New Energy Jobs Fund will support Victorian-based, commercially ready projects that:
  - Create long-term sustainable jobs
  - Drive economic development
  - Increase community participation
  - Increase the uptake of renewable energy generation
  - Reduce greenhouse gas emissions
  - Drive innovation in new energy technologies
  - Build new energy technology capability and capacity in the state.
- What support or funding is available?
  - Grants funding for individual projects will range from $50,000 to $1 million.
  - Eligible projects may include physical projects, innovative business and finance models, and projects that address skills gaps in the sector.
- http://www.business.vic.gov.au/support-for-your-business/future-industries/new-energy-technologies

Tasmania Jobs and Investment Fund (TAS)

- Status: Open (not accepting applications)
- Applications open: Yet to be determined
- Delivered by: Department Industry, Innovation & Science
- The $24 million Tasmania Jobs and Investment Fund provides grants for businesses that want to grow and create jobs in Tasmania.
- The fund will be competitive and merit based. It will be open to all industry sectors, including advanced manufacturing, tourism, agriculture and aquaculture.
- The Fund will support new projects that create sustainable business investment and job opportunities that will contribute to the strengthening of Tasmania's economy. The Fund will encourage applications from projects that generate new, sustainable business growth and jobs.
- What support or funding is available?
  - The minimum grant amount is $50,000.
  - There is no maximum grant amount but grants must be within the limit of $24 million total available funds.
  - You can apply for a grant up to a maximum of one third of the project costs.
  - Eligible activities include:
    - purchase of equipment and machinery
    - construction and/or fit-out of new infrastructure.
- https://www.business.gov.au/assistance/tasmanian-jobs-and-investment-fund

Aus. Renewable Energy Agency (ARENA) – Advancing Renewables Program (National)

- Status: Open
- Delivered by: Australian Renewable Energy Agency (ARENA)
- Purpose: To support activities that reduce the cost or increase the value delivered of renewable energy, advance renewable energy technologies towards commercial readiness, reduce or remove

barriers to uptake, or increase relevant skills, capacity and knowledge.

- What support or funding is available?
    - ARENA Grants awarded to Activities under the Program are expected to be between $100,000 and $50 million, with Applicants typically expected to at least match the funding being sought from ARENA.
    - Priority areas include:
        - Large-scale solar photovoltaics
        - Integrating renewables and grids
        - Renewables for industrial processes
- https://arena.gov.au/programs/advancing-renewables-program/

Emissions Reduction Fund (ALL STATES)

- Status: Open
- Delivered by: Clean Energy Regulator
- The objective of the Emissions Reduction Fund (ERF) is to help achieve Australia's 2020 emissions reduction target of five per cent below 2000 levels by 2020. The Government has provided $2.55 billion to establish the Emissions Reduction Fund, with further funding to be considered in future budgets.
- Voluntary scheme to encourage implementation of projects to reduce greenhouse gas (GHG) emissions. Eligible projects can be registered with ERF prior to making final financial decision to proceed with project. Once implemented, Australian Carbon Credit Units (ACCUs) can be earned according to the volume of GHG emissions avoided. These can be sold by agreement to the Clean Energy Regulator through a series of auctions, sold to another party with an obligation under the "safeguard mechanism" of the scheme or to any other eligible party.
- Minimum contract size is 2,000 tonne CO2e abatement (project life total).
- Additionality requirements:
    1. "Newness" - Project must not have commenced, nor final investment decision be made prior to registration with CER
    2. Regulatory Additionality - Must not be required to be carried out under other existing legislation
    3. Program Additionality - Must not be likely to be carried out under another existing program other than ERF eg RET
- Safeguarding emissions reductions
    - A safeguard mechanism will ensure that emissions reductions paid for through the Emissions Reduction Fund are not offset by significant increases in emissions elsewhere in the economy.
- *Note: Previous auctions have yielded approx. $13-14/t ($CO_2^{-e}$) with a minimum project volume of approx. 2,000 t (CO_2^{-e})*
- *Next auction likely to be in April*
- *$440 million left*
- https://www.environment.gov.au/climate-change/emissions-reduction-fund/about

NSW Climate Change Fund (NSW)

- Status: *Open for public consultation*
- Delivered by: NSW Office of Environment and Heritage.
- The Climate Change Fund (the Fund) was established in 2007 to address the impacts of climate change, encourage energy and water saving activities and increase public awareness and acceptance of climate change.
- The NSW Government has released the Draft Climate Change Fund Strategic Plan for public consultation. This draft plan sets out priority investment areas and potential actions for up to $500 million of new funding between 2017–18 and 2021–22.
- The *draft strategic plan* proposes three priority investment areas that will form the basis of future action plans for:
    - Accelerating advanced energy
        - Up to $200 million from the Climate Change Fund will be invested in accelerating advanced energy. This investment area focuses on supporting our transition to a net-zero emissions future.
    - National leadership in energy efficiency
        - Up to $200 million from the Climate Change Fund will be invested in energy efficiency. This investment area focuses on boosting energy productivity and putting downward pressure on energy prices for households, businesses and industry.
        - The potential actions will support the delivery of our ambitious

energy savings target to achieve 16,000 gigawatt hours of annual energy savings by 2020.

    - Preparing for a changing climate
        - Up to $100 million from the Climate Change Fund will be invested in preparing for a changing climate. This investment area focuses on:
            - reducing costs to public and private assets arising from climate change
            - reducing the impacts of climate change on health and wellbeing, particularly in vulnerable communities
            - managing the impacts of climate change on natural resources, natural ecosystems and communities.
- https://engage.environment.nsw.gov.au/Environmental-Future-Consultation-CCF-Strategic-Plan

Small-scale Renewable Energy Scheme (STC) (ALL STATES)

- Status: Open
- Delivered by: Clean Energy Regulator
- STCs are created under Small-scale Renewable Energy Scheme (SRES)
- Eligible small-scale renewable energy systems are entitled to a number of small-scale technology certificates (STCs).
- The number of STCs that can be created per system is based on its geographical location, installation date, and the amount of electricity in megawatt hours (MWh) that is:
    - generated by the small-scale solar panel, wind or hydro system over the course of its lifetime of up to 14 years, or
    - displaced by the solar water heater or heat pump over the course of its lifetime of up to 10 years.
- As a guide, one STC is equal to one megawatt hour of eligible renewable electricity either generated or displaced by the system.
- Once created and validated, STCs act as a form of currency and can be sold to recoup a portion of the cost of purchasing and installing the system, or transferred to other individuals and businesses at a negotiated price.
- Eligibility includes
    - Solar PV up to 100kW; 250MWh/yr
    - Wind up to 10 kW; 25MWh/yr
    - Hydro up to 6.4kW; 25MWh/yr
    - eligible solar water heaters and air-source heat pumps.
- Implementation must be no more than 12 months prior to creation of certificates.
- Note: Approx. STC spot price in 2016 was $38 to $40
- http://www.cleanenergyregulator.gov.au/RET/Scheme-participants-and-industry/Agents-and-installers/Small-scale-technology-certificates

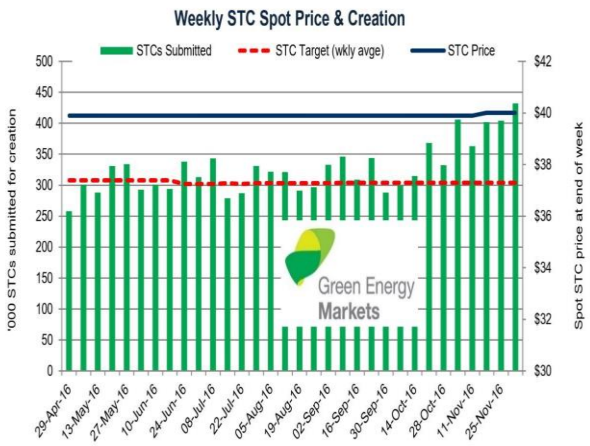


Image Source: http://greenmarkets.com.au/resources/stc-market-prices

Large scale generation certificates (LGC) (ALL STATES)

- Status: Open
- Delivered by: Clean Energy Regulator
- LGCs are created under the Large-Scale Renewable Energy Target (LRET)
- Accredited renewable energy power stations are entitled to create large-scale generation certificates (LGCs) based on the amount of eligible renewable electricity they produce above their baseline. As a guide, one LGC is equal to one megawatt hour of eligible renewable electricity.
- Renewable energy must be from an approved source. Full list available under Section 17 of the Renewable Energy (Electricity) Act 2000.
- Once created and validated, LGCs act as a form of currency and can be sold and transferred to other individuals and businesses at a negotiated price. Large-scale generation certificates are usually sold to liable entities (electricity retailers), who are required to surrender a set number of certificates to the Clean Energy Regulator each year.

- LGCs, equivalent to 1MWh of eligible generation are sold on an open market and LGC futures contracts are listed on ASX.
- 2016 LGC spot prices have been around $80 to $90
- www.cleanenergyregulator.gov.au/RET/Scheme-participants-and-industry/Power-stations/Large-scale-generation-certificates

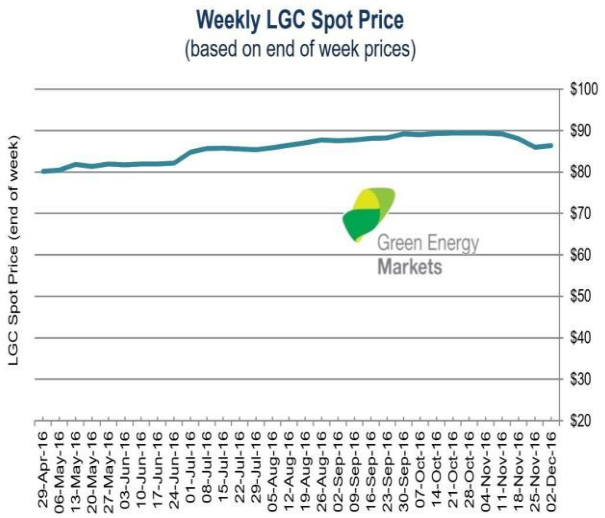


Image Source: http://greenmarkets.com.au/resources/lgc-market-prices

Sustainability Advantage scheme (NSW)

- Status: Open
- Delivered by: NSW Office of Environment and Heritage
- The Sustainability Advantage program is assisting organisations across NSW to achieve increased competitiveness and improved bottom lines through better environmental practices.
- Sustainability Advantage is open to organisations from the not-for-profit, government and medium-to-large business sectors, and attracts participants from many industries, including manufacturing, commercial property, registered clubs, health, aged care, transport and education.
- While results depend on a company's own efforts, this membership-based program provides expertise, training and business tools such as:
- Practical workshops.
- A comprehensive range of guides, case studies and templates.
- One-on-one specialist support.
- Facilitated networking and targeted seminars.
- An extended network of like-minded organisations.
- The Office of Environment and Heritage promotes the environmental achievements of participating organisations through its Sustainability Advantage recognition scheme.
- http://www.environment.nsw.gov.au/sustainabilityadvantage/index.htm

Energy Saver Program (NSW)

- Status: Open
- Delivered by: NSW Office of Environment and Heritage
    - NSW Energy Saver Program helps to target, prioritise and implement the best energy efficiency opportunities for your business
    - Assistance provided
        - Connecting businesses with an energy specialists.
        - Assist access to project funding, including the Energy Savings **Scheme**.
        - Training courses.
    - http://www.environment.nsw.gov.au/business/energy-saver.htm

Energy Saver Scheme (NSW)

- Status: Open
- Delivered by: NSW Office of Environment and Heritage
- The Energy Savings Scheme (ESS) is an energy efficiency "white certificate" scheme allowing creation and sales of Energy Savings Certificates (ESCs) based on demonstrated improvements in energy efficiency. Demand for certificates is created through obligation on energy retailers to purchase and surrender certificates. Originally applicable to electricity savings only, now extended to also cover gas savings. Under the Energy Savings Scheme, Energy Saving Certificates (ESCs) can be created for a range of industrial energy efficiency projects that save electricity or gas in NSW.
- Eligible projects can have certificates generated by accredited certificate providers (ACPs), based on the number of tonnes of carbon dioxide equivalent abated. An energy savings certificate represents one notional Megawatt hour (MWh) of energy. They are currently trading about $20 before aggregation fees.
- Certificates can be forward-created with annual top-up over a 10-year period depending on calculation method applied.
- The easiest way for businesses to access funds for their project under the Energy Savings Scheme is to contact an ACP.

- Some types of projects must be assessed against government prescribed M&V methodology, by Certified M&V Professionals.
- It is to choose the right method for your industrial energy efficiency project (Metered Baseline, PIAM&V, High Efficiency Appliances for Business, etc.) in order to maximise the number of certificates available and minimise administrative complexity.
- Eligibility includes:
    - Energy savings must be achieved by a Recognised Energy savings Activity (RESA)
    - An Accredited Certificate Provider, with accreditation in the relevant RESA, must be nominated as the Energy Saver for a project prior to commencement.
- www.environment.nsw.gov.au/business/energy-savings-scheme.htm
- www.ess.nsw.gov.au/Home

Funding for Gas Efficiency (NSW)

- Status: Open
- Delivered by: NSW Office of Environment and Heritage
- The scheme aims to save gas and promote regular maintenance of steam and hot-water distribution systems.
- You can apply for:
    - up to $10,000 of matched funding per site to replace and repair steam traps
    - up to $10,000 of matched funding per site to install lagging on steam and hot-water pipes, valves and tanks.
- www.environment.nsw.gov.au/business/gas-efficiency-funding.htm

Energy Saver Incentive (Victorian Energy Efficiency Target (VEET))

- Status: Open
- Delivered by: Essential Services Commission
- The Victorian Energy Efficiency Target (VEET) scheme is a Victorian Government initiative promoted as the Energy Saver Incentive.
- It is an energy efficiency "white certificate" scheme allowing creation and sale of Victorian energy efficiency certificates (VEECs) based on implementation of approved products or prescribed activities. Certificates equivalent to 1 tonne CO_2e emissions deemed to have been avoided by the implementation. Demand is created by an obligation on electricity retailers to purchase and surrender certificates.
- Victorian industrial facilities not listed on the EREP register are eligible to participate.
- Victorian facilities that **are** currently listed on the EREP register will likely be brought into the scheme in the near future, once proposed changes take effect.
- are currently trading at about $16 before aggregation fees.
- The quantity of VEECs are calculated over the life of an energy efficiency project and typically paid in a lump at the start.
- The Vic government is expected to introduce Project Based Assessments (PBA). This would enable Victorian industrial energy efficiency projects to generate VEECs from gas and electricity savings.
- www.veet.vic.gov.au/Public/Public.aspx?id=Overview

Appendices

Table 21 Unevaluated technologies or practices of potential merit

Technology description	
AD to produce biogas from waste and subsequent firing of generation or CHP	Microwave-Vacuum drying
Advanced control system for evap/dryer	Model based process optimisation eg NIZO Premia Simulation Platform, and Premic control system
Air shutters for busy cool room doorways	Multistage pumps with VSDs
An intersection of water treatment and waste heat/energy transfer technologies, e.g. reverse osmosis, membrane filtration in conjunction with heat pumps???	Nanotechnology
Artificial intelligence software to optimise sub-processes	Ohmic heating
Back pressure steam turbine/generator as steam pressure reduction in parallel with steam pressure reduction valve.	Open Modular Architecture Control
Best Practice Energy Management and all that that entails	Other natural refrigerants
Chilled CO2 loop instead of chilled water loop. Smaller pipe work diameter means lower capex and lower pumping costs	Phase Change Materials - PCM - cool storage panels to store cooling energy
CIP efficiency	Pinch analysis to aid optimisation of heat capture and reuse
Cogeneration	Pulsed electric fields
Cold plasma	RF heating
Cold store floor insulation	Wood Fuelled Steam Production
Condensing flue gas fired water heaters,	Potential for SPX Cavitator on dryer feed concentrates to reduce viscosity for improved drying performance
Conversion of direct steam jackets to indirect	High efficiency steam injectors
Direct contact gas fired water heaters for hot water production	Smart KPIs and targets based on multi-variable regression analysis
Electronically Commutated (EC) electric motors	Solar absorption chillers
Energy recovery from drying air streams	Minimising filtration loop bypass with anti-Telescoping Devices
Flash drying	Solar hot water – high temp
Flash steam Recovery. Application to be decided but possibly to heat water.	Solar steam
Fluid Bed drying (secondary stages)	Solar wall
Forced circulation systems	Spent steam energy recovery via recompression using screw compressors. Similar concept to MVR.
Frozen glycol off peak cold energy storage system	Substitution of steam network with high pressure hot water network for certain applications eg pasteurisation or UHT plants. In some case convert whole site from steam to hot water eg MG Kiewa.
High intensity pulsed light	Thermal storage tanks, and/or hot and cold water wells, to augment waste heat capture and re-use, plus allow for heating or cooling plant to operate at optimum efficiency
High pressure processing	Trigeneration
High speed magnetic bearing compressors	Ultrasonics
Hybrid solar (electricity and hot water)	Ultrasound
Ice/2-phase slurries	VSD control of dryer fan speeds (instead of air flow damper control)
Irradiation systems	Microwave heating
Large scale Condensing Steam boilers (>5MW). i.e. increased thermal efficiency by extracting heat from flue gas to produce low grade hot water. Methods include spray condensing.	
SPX Cavitator for scale-free heating of high fouling products	





Dairy Australia
Your Levy at Work

Dairy Australia Limited ABN 60 105 227 987
Level 5, IBM Centre
60 City Road, Southbank VIC 3006 Australia
T + 61 3 9694 3777 F + 61 3 9694 3701
E enquiries@dairyaustralia.com.au
dairyaustralia.com.au