Dairy Australia
Your Levy at Work

Opportunities for Reducing Cost and Intensity of Waste Production in the Australian Dairy Processing Sector

Prepared for:

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Acknowledgments

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- Jenny Downey
- Allan Box
- Sean Trebley
- Neil Rosier

Disclaimer

Contents

Abbreviations

AS	Activated Sludge
BOD	Biochemical Oxygen Demand
CAPEX	Capital Expenditure
CIP	Clean in place
COD	Chemical Oxygen Demand
DAF	Dissolved Air Flotation
DS	Dry solids
EC	Electro coagulation
FOG	Fat, Oil, Grease
IAF	Induced Air Floatation
MABR	Membrane Aerated Bioreactor
MBR	Membrane bioreactor
MBBR	Moving bed bioreactor
OPEX	Operational Expenditure
TSS	Total Suspended Solids
UASB	Upflow anaerobic sludge blanket reactor

Executive Summary

Australian dairy processors are striving towards improved sustainability and corporate responsibility though reduced waste organic and solid/ packaging-related material. As part of this, they have voluntarily committed to reduction targets with respect to a number of environmental indicators through their participation in the Australian Dairy Industry's Sustainability Framework. This study is intended to assist dairy processors in the task of achieving these targets by providing information about emerging technologies that have potential to assist dairy processors in their pursuit of reducing the economic and environmental cost of disposing organic and solid/packaging-related material.

A large quantity of technologies and techniques were considered for their potential to reduce waste production as well as reduce waste through treatment. These were then filtered to produce a list of seventy-five potentially promising technologies. Fifteen technologies were then short-listed based on a set of selection criteria and examined further through discussions with Dairy Australia to identify and prioritise seven key technologies of interest. These are detailed within this report.

The technologies are split into three main categories: upstream waste reduction (organic and packaging waste); wastewater treatment and sludge reduction. The technologies investigated are commercially available, though many are based outside of Australia.

Each technology of the seven prioritised has been profiled in detail in the report and evaluated in terms of cost effectiveness versus waste reduction potential. The remaining shortlisted technologies are profiled in the Appendices.

Upstream waste reduction

Upstream waste reduction is mainly driven by the desire to reduce the amount of product that is lost as this has the biggest financial impact in terms of both upfront costs and backend wastewater treatment/disposal cost. This can be achieved either though better operated CIP processes or more intense monitoring of the production process. This is typically achieved through ongoing process optimisation activities but it can be supported through new CIP techniques (e.g. Suez Ice Pigging) and monitoring equipment (e.g. Alvim and Arenal PCS sensors).

In terms of packaging waste, dairy processors have the ongoing challenge of working with the supply chain to source more recyclable and sustainable options. Resource recovery of unrecyclable material, however, offers the potential to divert waste from landfill.

Wastewater treatment

Wastewater treatment is a complex space with a huge range of options for a huge variety of scenarios, with a wide range of water qualities achieved. The largest savings of trade waste charges can be made through technologies which reduce flow and BOD. Suspended solids however, can also make up a significant proportion of disposal cost. It is therefore logical that the treatment option selected should reflect the area of greatest cost saving based on its treatment ability (e.g. Creative Water Technology for BOD and SS removal as well as flow reduction).

Interestingly, while it may not always be suitable to replace existing processes, there are emerging opportunities to retrofit technologies which make the overall system more efficient. An example is the Enviplan Aquatector system which can be installed into existing DAF systems. Such an approach may be suitable for sites with a small footprint or as a cost-effective upgrade to improve final effluent quality.

Many more advanced wastewater treatment processes can provide a water quality that would only need minimal polishing to provide high quality water for re-use. Re-use would also be a way to reduce trade waste charges associated with water volume, and water could be re-used in several areas on sites such as wash down of equipment or floors, or even toilet flushing.

Sludge treatment

Sludge overall did not seem to be a major issue for members who could store the sludge, send to composting or dispose of as animal feed. The requirement though for more advanced wastewater treatments, either for water re-use or minimising trade effluent costs, will potentially lead to greater amounts of sludge being produced. This may also be coupled with the need to ensure organic wastes are diverted from landfill, therefore driving a move towards reduction of volumes and alternative disposal.

In the short term though, those companies who are not already doing so can change chemicals used upstream to food grade or use chemical free treatment processes to provide greater options for disposal (e.g. as animal feed).

There are also many opportunities to reduce the moisture content in the sludges to reduce trucking cost via dewatering (e.g. AMCON Volute) and destruction/drying technologies (e.g. Pyreg).

Alternative waste disposal options

Packaging waste without a clear recycling route appears to be a particular challenge for dairy processors. In the course of this study, packaging washing technologies were raised as a good option for dairy processors to increase waste diversion rates to recycling facilities, especially where landfill levies are high. There is also the option to get involved in the CSIRO ASPIRE (Advisory System for Processing,

Innovation & Resource Exchange) program - an online marketplace which intelligently matches businesses with potential remanufacturer, purchasers or recyclers of waste resources.

Future technologies

Several technologies were evaluated as part of this project but were deemed at too early stage of development. For instance, MABR (Membrane aerated bioreactors) shows future potential for wastewater treatment as it is robust, has a good treatment ability and has low energy consumption. There are also some interesting technologies being developed at CSIRO such as Forward Osmosis for extracting/thickening products and using resins to extract useful components from waste.

Background

The Australian dairy processing sector produces significant amounts of organic waste and solid/ packaging-related material at its processing sites as by-products of ongoing operations. Both types of wastes take on many forms and vary from site to site based on the scale of production and mix of dairy products produced. An indication of typical waste streams generated from a large dairy processing site might, however, include:

- Organic waste streams:
  - Off-spec raw milk/intermediates/final product
  - Process first flush/product changeover
  - Out of date final product (packaged/unpackaged)
  - Process by-products (i.e. whey, mother liquor, lactose concentrate)
- Wastewater:
  - Wastewater treatment by-products
  - Dissolved/induced air flotation sludge
  - Aerobic treatment sludge
  - Anaerobic digestion sludge
- Solid/Packaging-related waste streams:
  - Plastic/paper powder bags
  - Film wraps
  - Cardboard
  - Metal
  - Timber/pallets
  - Residual packaging from off-spec product

The disposal routes for these waste streams is varied and often costly. For organic wastes, processors pay volume/load-based charges for disposal to trade waste/sewer, landfill, or compost. Costs can also be incurred for re-use of some of the organics as stock feed – either due to de-packaging, transport and/or off-take agreement costs. Costs are also incurred for disposal and/or irrigation to land – both in terms of transport/pumping infrastructure and environmental monitoring/testing. For solid/ packaging-related wastes, in many instances these can be diverted from landfill and recycled/re-purposed. However, there are still significant packaging waste streams that end up in landfill and, as such, processors incur waste management and landfill-related costs to their business.

The true cost of waste production for dairy processors, however, does not just include the final cost of disposal but also costs associated with wasted production inputs (i.e. milk, ingredients, water, energy, labour, capital utilisation etc) and waste management costs (i.e. storage and handling, treatment/stabilisation, compliance testing etc). The sum of these costs is often poorly understood. What is clear is trade waste costs and landfill costs have risen considerably in recent years while at the same time regulators such as EPA Victoria are placing greater scrutiny on organic waste management and disposal practices – thereby potentially increasing the costs of regulatory compliance.

Apart from the obvious commercial drivers for reducing the cost of waste, many the largest Australian processors have also recognised that demonstrating the principles of sustainability and corporate social responsibility are key to maintaining a social licence to operate and is increasingly influencing consumer behaviour. As such, these companies have also voluntarily committed to reduction targets with respect to a number of environmental indicators through their participation in the Australian Dairy Industry Sustainability Framework. Specifically, these reduction targets include;

- **Target 9:** Reduce the consumptive water intensity of dairy manufacturers by 20%
  - Based on a 2010/11 baseline of 1.75 litres of water per litre of milk processed
- **Target 10:** Reduce greenhouse gas emissions intensity by 30%
  - Based on a 2010/11 baseline of 178.7 tonnes of CO2-e per ML milk processed
  - Includes Scope 1 and 2 emissions
- **Target 11:** Reduce waste to landfill by 40%
  - Based on a 2010/11 baseline of 2.69 tonnes of waste per ML of milk processed

The dairy processors who have made commitments to these targets report on progress each year and substantial in-roads have been made towards achievement of the goals 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 supporting processor's progress 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 eight core dairy processors. These members include: Devondale Murray Goulburn, Lion Dairy and Drinks, Parmalat Australia, Warrnambool Cheese & Butter, Bega Cheese, 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.

In order to support the DMSC and the Australian dairy processing sector in achieving its 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 that might hinder or support progress. These reports will look to cover three main areas of influence on these targets; emerging technology, policy developments, and funding availability.

The objective of this study and report is to provide a brief overview of the current state of the Australian dairy processing industry, provide a short list of potential technologies that can provide a reduction in the cost and intensity of waste production. Also, it provides funding avenues and a summary of current/upcoming national and international policy developments which provide opportunities for reducing intensity of waste production in the Australian dairy processing sector.

Technology selection

Technology Selection Criteria

The study conducted a global scan to identify emerging technologies with potential to reduce cost and intensity of waste production 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
- Commercially available
- Demonstrated as applicable to Australian dairy milk processors
- Will result in materially-significant savings to waste production intensity of management costs
- Practical to implement

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
- Isle Utilities' technology database
- Industry analysts
- Technology suppliers to the industry
- Research institutions
- Overseas technology suppliers
- Technical literature and
- Publicly available literature.

Over 75 technologies and techniques with potential to reduce waste production intensity within a dairy processing facility were identified and considered for a more detailed analysis. These technologies were split into three main categories:

- Upstream waste reduction (organic and packaging waste)
- Wastewater treatment
- Sludge treatment

A breakdown of how these technologies are spread across the three areas is shown in Figure 1 below.

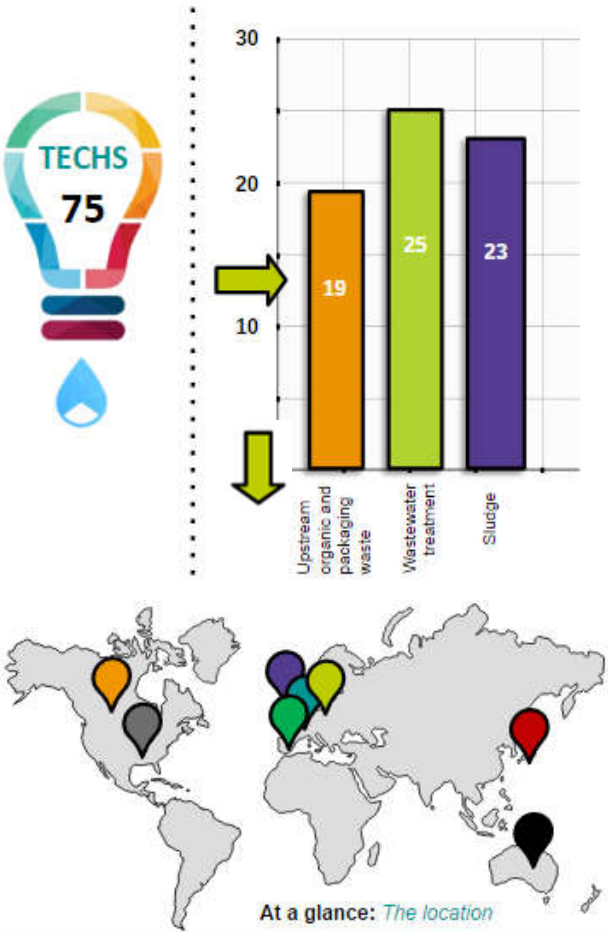

Figure 1 Technology selection at a glance

These technologies were then narrowed down to approximately 5 technologies per category and the selection criteria used is shown in Table 1 below.

Table 1 Criteria for technology selection

Selection criteria	Description
Applicability	Technologies that are applicable to the food and beverage industry with a focus on dairy processing
Technology development	Technologies that are well developed and available to the market for waste reduction and treatment (though they may not be already used in dairy processing)
Uniqueness	Technologies that are not widely used in the dairy industry but provide a potential improvement in waste management
Relevance and Case Studies	Technologies that have case studies in the food and beverage industry that are relevant to dairy processing

DMSC Members waste survey

In October 2016 Dairy Australia consulted the DMSC to understand problematic organic wastes and to assess the value of co-funding a Meat and Livestock

Australia project aimed at exploring opportunities for adding or recovering value from organic food processing waste streams. A survey conducted at the time provided a high-level overview of the main concerns faced by the DMSC members and a snapshot is summarised in the Figure 2 below.

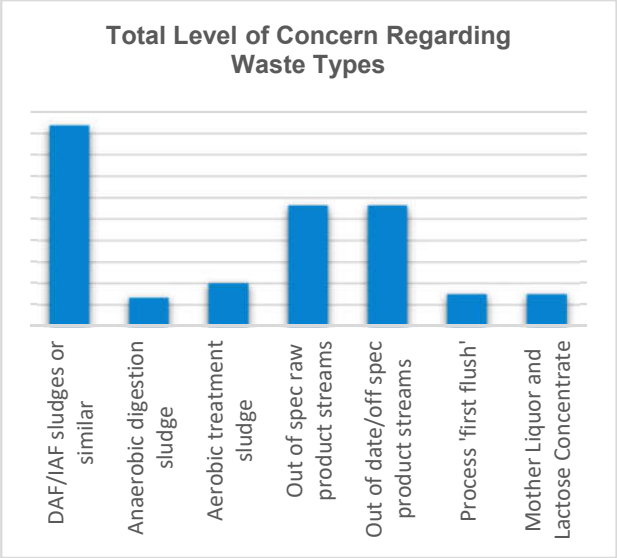

Figure 2 Results of DMSC waste survey

DMSC members expressed a clear concern at the time with respect to DAF/IAF sludges from wastewater treatment, but also organic streams associated with product loss. These results helped to inform the current study and the technologies shortlisted. Technologies considered were therefore broken up into three categories; a) those which can minimise the chance of off spec products, b) those which produce less or different type of sludge from a different process, or c) those which treat the sludge.

DMSC Members discussions

A number of DMSC kindly gave up their time to provide information on their waste sources, waste treatment processes and disposal routes. These members were:

- Parmalat
- Bulla
- Norco
- Lion
- Bega Cheese
- Fonterra

A summary of the members' experiences is included under each technology category section.

Upstream Waste Reduction

DMSC members experiences

The discussions with DMSC members covered:

- Upstream waste sources such as CIP, tainted product disposal and general washing of equipment;
- CIP systems operation, chemicals used and optimisation techniques;
- Production losses and methods employed to reduce and recover these waste streams where possible;
- Packaging waste from raw products as well as from the final product packaging process.

In particular, many members expressed a desire to improve their CIP systems in an effort to minimise product loss and also employ chemical recovery, though this was very much part of ongoing optimisation and improvements being undertaken by each company.

Packaging waste was mostly being recycled where possible, though there were issues with unrecyclable waste and therefore a desire exists to widen the packaging options available. Also recycling abilities tended to be location specific due different waste handlers in different areas taking different types of waste and different levels of contamination.

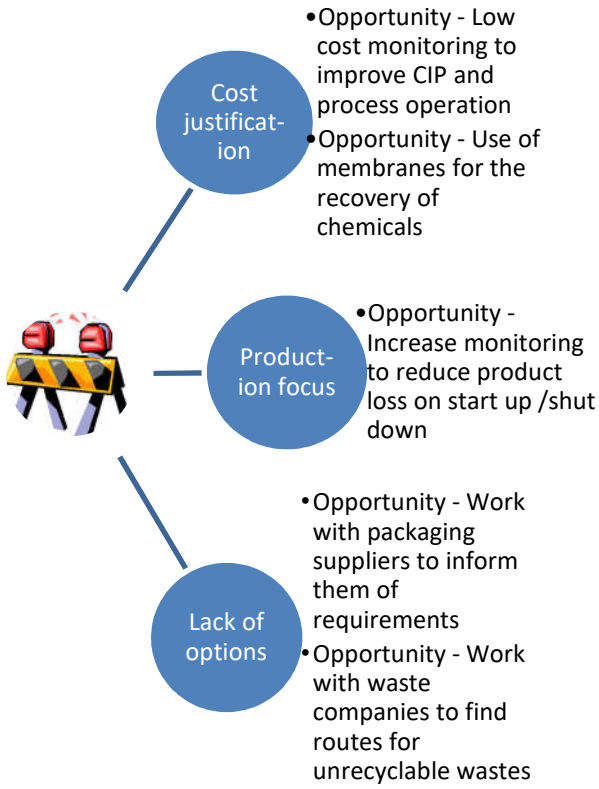

Figure 3 Perceived barriers to innovation in upstream waste reduction

Figure 3 is an overview of the perceived barriers to innovation and potential opportunities

Upstream waste sources

Based on the discussions with Dairy Australia and the DMSC, three clear areas within upstream waste reduction surfaced:

- CIP
- Product loses
- Packaging

Potential technologies in these areas were investigated and were shortlisted to 5 using the criteria described in the table above “Criteria for technology selection”

Figure 4 below shows the areas that waste reduction could be achieved and an overlay of the technologies shortlisted.

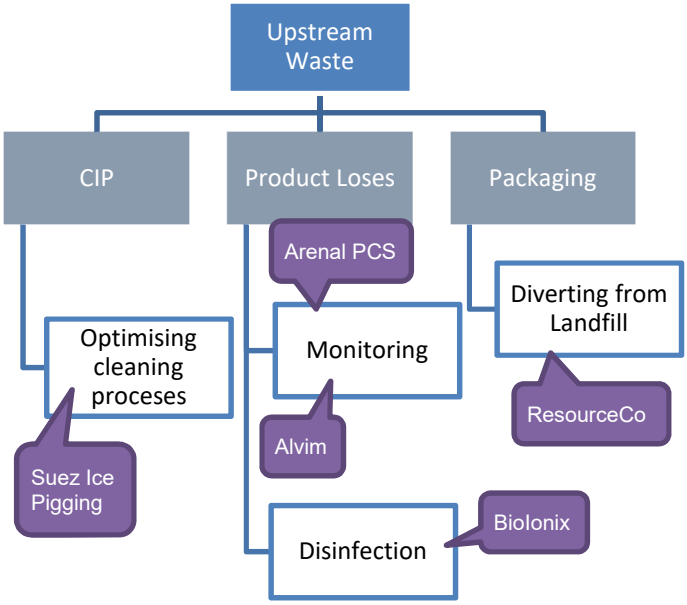

Figure 4 Waste sources and technology opportunities for waste minimisation

The technologies selected are described in more detail in Table 2 below

Table 2 Shortlist of upstream waste reduction technologies

Company name	Description
Suez Ice pigging	A simple technique for cleaning pipes by pumping a thick ice slurry through piping to act as an "ice pig" - providing enhanced cleaning shear on the pipe walls, and which easily adapts to the local topology of the pipe (i.e. expansions, reductions, branches, valves and fittings)
Alvim	The ALVIM real-time, on line biofilm monitoring system is able to detect bacterial colonisation of surfaces from the initial phase (down to 1% of surface coverage)
Arenal PCS	Arenal PCS produce an analyser for the online monitoring of COD and TSS in industrial wastewater (both organic and inorganic contaminants). The analyser incorporates sensors based on two techniques: ultrasonic sonochemistry and conductivity measurement.
Biolonix	Biolonix has developed an electrochemical process that is primarily used in food processing applications to disinfect process liquids and in many cases also products. The Biolonix process treats contaminants by applying an electrochemical field in the liquid as it passes through a reactor.
ResourceCo	ResourceCo manufacture process engineered fuel (PEF) from commercial and industrial, and construction and demolition materials. These typically include but are not limited to timber, metals, plastics, cardboard, paper and bedding, plus some concrete, bricks and rubble.

Cost and waste reduction technology mapping

The technologies were mapped in Figure 5 Figure 5 to provide an indication of cost effectiveness and is based only an indicative cost information because in many cases cost is site dependent.

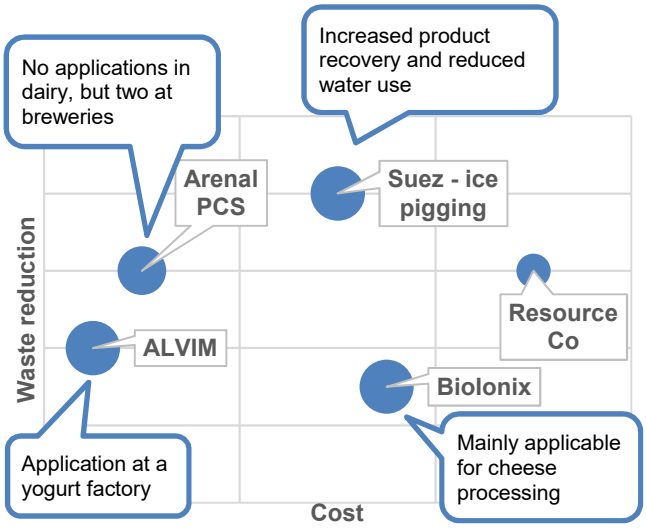

Figure 5 Mapping of upstream technologies

A summary of the cost effectiveness of the technologies:

- ALVIM - low cost, widely applicable across many areas of dairy manufacturing
- Arenal PCS - moderate cost, evaluate per site to understand extent of biofilm problem and potential savings
- Biolonix - high cost, niche market, evaluate per site to understand process suitability and potential savings
- Suez Ice Pigging - medium cost, evaluate per site to understand potential savings based on number of CIP runs
- Resource Co - cost neutral (worst case), applicable in South Australia and soon in NSW

Technologies prioritised

Following detailed discussions with Dairy Australia, the most applicable technologies, with the greatest potential cost benefit were prioritised and these were:

- Suez Ice Pigging
- ALVIM
- Arenal

On the next pages are summary descriptions of each of the prioritised technologies including information on:

- Applicability
- Effectiveness of the technology
- Case Studies
- Indicative costs
- Contact details of the supplier

ResourceCo were also highlighted as a potential technology of interest because of the diversion of non-recyclable waste from landfill, though it will only be applicable for members who are located close to Adelaide. ResourceCo though have plans to build a second plant in NSW in the near future therefore it may become a more widely available option. Information on this technology and the others that were not prioritised can be found in Appendix A.

Alternative options for packaging waste

Packaging Washing to increase recycling

In certain locations, plastics that are contaminated with organics are unable to be recycled and therefore are sent to landfill. An alternative solution is to invest in packaging washing to ensure a greater amount of plastic is diverted to recycling. An example of where this has been successful is at an Ingham Enterprises plant in Queensland which introduced plastic washing and

shredding, diverting an additional 20 tonnes per month from landfill.

Database of potential waste disposal options

CSIRO ASPIRE (Advisory System for Processing, Innovation & Resource Exchange)

- An online marketplace which intelligently matches businesses with potential remanufacturer, purchasers or recyclers of waste resources.
- This project is currently active but not in all areas of the country. Click here for more details.

Conclusions

Upstream waste reduction is mainly driven by the desire to reduce the amount of product that is lost as this has the biggest financial impact in terms of both upfront costs and a backend wastewater treatment/disposal cost. This can be achieved either though better operated CIP processes or more intense monitoring of the production process. It will mainly will be part of an ongoing optimisation task that will need to be undertaken by most dairy producers but it can be supported through new CIP techniques and monitoring equipment.

CIP Process

There are improvements to the operation of CIP that can be made, such as recovering cleaning chemicals (e.g. caustic) that are becoming more common. Technologies such as Suez Ice Pigging though have a high potential to reduce water, are ready to go and could be validated through demonstration followed by implementation

Product waste

Specific monitoring, such as for COD, conductivity or biofilm would be most effective at identifying either unplanned product wastage or contamination which may lead to product loss.

Packaging

Dairy processors have the ongoing challenge of working with the supply chain to source more recyclable and sustainable packaging. Resource recovery though of unrecyclable material will be a potentially interesting area in the future.

Suez Ice Pigging
A simple technique for cleaning pipes and ducts by pumping through a thick ice slurry

Technology highlights:

- 70-99% product recovery
- Shorter cleaning cycles and minimal process downtime
- Reduced effluent volume and cleaning costs

Description: The ice slurry forms an "ice pig" which provides enhanced cleaning shear on the pipe walls, and easily adapts to the local topology of the pipe. It differs from conventional solid pigging in that the Ice Pig is capable of navigating complex pipework which may incorporate changes in pipe diameter, bends, valve systems, heat exchangers and other obstructions with no risk of becoming stuck. The Ice Pig is composed of fine ice crystals and a carrier fluid containing an additive used to maintain the correct fluid characteristics. In most cases the additive can be an ingredient already used in the product.

Applicability:

- Ice pigging was originally developed by Bristol University (UK) as a solution for pipe cleaning in the potable water industry
- The technology applies itself well to the first cleaning step of CIP and can easily retrofitted into place
- Applicable to pipe diameters ranging from 5mm to 300mm
- The technology has been proven in the Food and Beverage industry in Europe, though there have been no applications in this area in Australia

Effectiveness of the Technology

- Product recovery can range between 70-99%, depending on the product, compared to 20-30% in traditional CIP processes
- Typically, 180L of water is used per clean with the ice pig

Case Studies

- Yeo Valley (UK) - Ice Pigging was used to remove a custard product from production machinery. Compared to the usual flushing process, the process could recover an additional 50 litres of product per run, which was 75% of the product in the line.
- Food manufacturing client - Ice Pigging was used for the removal and recovery of a thick and creamy cake topping from production lines while also significantly reducing their water consumption and the amount of effluent produced. Per week the process saves 124,000 litres of water, 121,000 litres of effluent and an additional 16,000 litres in product recovered.

Indicative costs

- AQL500 system costs approximately $380,000 depending on the hygiene specification. This does not include the cost of installing valves and pipework in the factory to distribute the ice
- Suez can provide a detailed business case of the potential cost benefits of the technology if they have details of the frequency of the CIP, pipe lengths/diameters, product value etc
- An example of the cost benefits of the process using a theoretical situation is shown in Appendix D

Contact details of supplier:

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ALVIM – Biofilm monitoring system
Real-time, on line biofilm monitoring system that is able to detect bacterial colonisation of surfaces from the initial phase

Technology highlights:

- Low cost
- Biofilm more representative of biology in pipework
- Discriminates between biofilm and other kinds of deposit

Description: Biofilm is a major problem in many fields, increasing the corrosion rate of metals and the resistance of bacteria to sanitation treatments. The ALVIM real-time, on line biofilm monitoring system is able to detect bacterial colonisation of surfaces from the initial phase (down to 1% of surface coverage). These measurements can be utilised to automatically adjust, optimise and/or monitor the efficacy of disinfection/sanitation processes. It is based on sophisticated electrochemical measurement of oxygen reduction kinetics on a metal surface, coupling advanced analogue signal conditioning with a digital, microprocessor-driven stage.

Applicability:
Specific applications of ALVIM's system include:

- Analysis of biofouling growth (frequency and intensity) in various locations through the process including cooling water systems and heat exchangers;
- Comparative evaluation of different biocides

A project was undertaken with a UK university to provide information on the representativeness of the ALVIM system. The project compared the bacteria growth on the sensor with growth on stainless steel in the same tank and the results showed very similar bacteria colonised both locations.

Effectiveness of the Technology

- Biofilm growth is detected when it grows directly on the surface of the sensor, therefore positioning in the process is crucial
- Increase in signal once 1% of the surface is covered by biofilm
- Typically takes a minimum of 8 hours to detect growth but this is dependent on flow, temperature and cleaning products applied

Case Studies

- Milk processing plant – The ALVIM probe was utilised to show that the CIP process was effective and that no biofilm grew while the pipe was out of service (but full of clean water). This application was able to identify when CIP runs were not carried out and when lines were left empty
- Food production plant – When a flavour was changed at the plant the pipeline was washed with water in a closed loop that was filtered and treated with UV. Every 3 weeks the loop was cleaned with chemicals and the filters were sterilised with steam. Over time bacterial concentrations rose and the ALVIM was used to identify that the cleaning strategy was not robust enough to removal all the biofilm in the system

Indicative costs

- The ALVIM system for hygienic use costs approximately $5000 (no spare parts required), this does not include the cost for fitting the monitor. It is likely that multiple systems would need to be employed depending on the process. A control for the ALVIM system would cost $550.
- Multiple, spatially distributed probes and other devices can be simultaneously connected to the site control PC or PLC for centralised monitoring

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Arenal PCS
Continuous monitoring of organic or inorganic contaminations

Technology highlights:

- Unique combination of ultrasonic sonochemistry conductivity measurement and chemometry
- Contamination (e.g. biofilm) does not affect sensor performance
- Wide range of concentrations can be measured

Description: Arenal PCS produces an analyser for the online monitoring of COD and TSS in industrial wastewater (both organic and inorganic contaminants). The analyser incorporates sensors based on two techniques: ultrasonic sonochemistry (measuring the propagation of ultrasonic waves as they encounter changes in the environment, a unique and new method developed by Arenal) and conductivity measurement. COD concentration is determined using advanced chemometric methods (the science of extracting information from chemical systems by data-driven means), TSS using acoustic attenuation. A third sensor, e.g. for pH measurement, can be added if the specific application necessitates it. Ultrasonic sonochemistry offers performance and cost advantages over chemical and optical measurement techniques.

Applicability

- The system can be used for 24/7 monitoring of CIP and other process discharges
- Measurement COD and TSS loading also can be used to control contact time in contact tanks and optimise aeration processes in waste treatment.
- In combination with additional sensors connected upstream, the device can be used for detection and prevention of liquid leakage (milk, cream etc) and hence reduce costs as well as waste

Effectiveness of the Technology

- A change of the physical property of the water, like with an increased concentration of organic contaminations, the acoustical physical properties will change as well
- All concentrations above 1 mg/l are monitored 1000 times per second

Case Studies

- The distributor Arenal monitor for the food and beverage industry have installed 12 systems so far (6 in Breweries and 6 in soft drink manufacture). The key reason for installation was to detect peak levels of sugar (as COD). The sensor was coupled with a conductivity sensor to ensure the readings were corrected especially during the CIP process.

Indicative costs

- A single point Arenal COD+TSS analyser costs $26,000. ROI is less than 2 years when compared to current TOC or wet-chemical COD analysers (such devices incur annual O&M costs of approximately $15,000).

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DMSC members experiences

The discussions with the DMSC covered:

- Typical wastewater treatment processes
- Wastewater treatment challenges
- Trade waste disposal of effluent and associated costs
- Spray irrigation using effluent

In particular, many members expressed a desire to improve their treatment process but did not have the financial driver or clear benefits associated with doing so.

There was also a common concern raised with regards to handling the variable flows that are due to CIP processes and the impact of the cleaning chemicals used in CIP, on the treatment process. Therefore, many members had issues with managing flow balancing, pH correction and sodium levels in the wastewater effluent.

Figure 6 is an overview of the perceived barriers to innovation and potential opportunities.

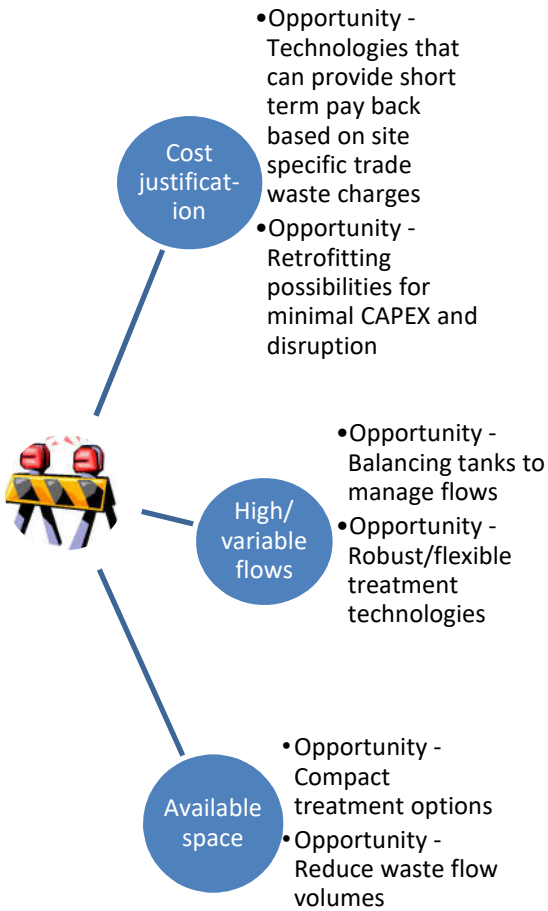

Figure 6 Perceived barriers to innovation in improving wastewater treatment

Cost of trade waste discharges

The primary cost incurred by dairy processors regarding their wastewater appeared to be in relation to the discharge of the waste as trade effluent (at sites where this is relevant). Therefore, this seemed to be a key driver in the type of treatment process that was employed. Figure 7 is an overview of three different, but typical, ratios of charges incurred by dairy processors from trade waste discharges. This indicates that, due to different processors experiencing a combination of different wastewater composition profiles and trade waste charge structures (based on the type of sewer network it is discharging into, as well as the capacity and treatment abilities of the downstream municipal works), trade waste charge ratios will vary between sites. However, in terms of cost reduction, dairy processors should be primarily targeting BOD and suspended solids removal, but volume reduction would also be a cost reduction benefit if it could be achieved economically.

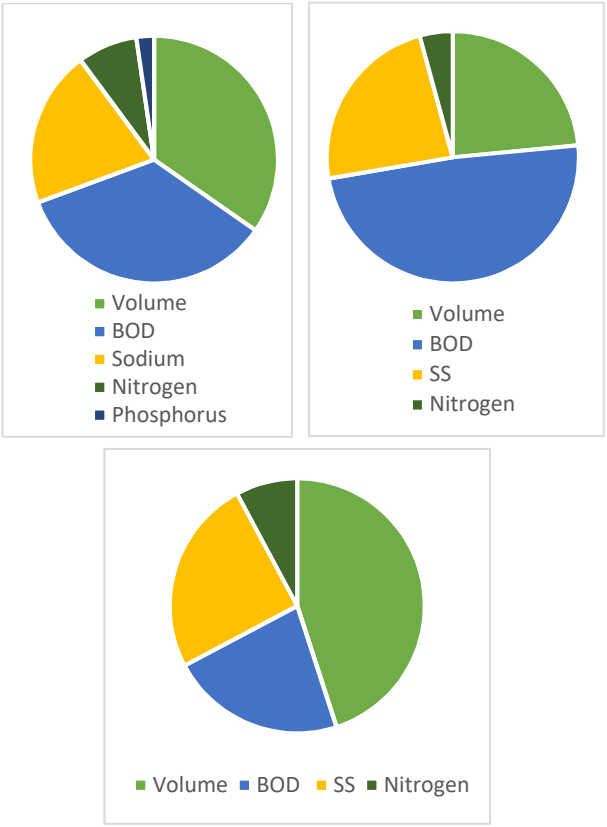

Figure 7 Three examples of trade waste cost ratios

Wastewater Technology mapping

To understand which types of technologies are available and most suitable to minimise levels of BOD and suspended solids in a wastewater stream, they can be mapped for comparison. In Figure 8 below, various

technologies have been mapped in terms of their technical complexity against the water quality that they produce.

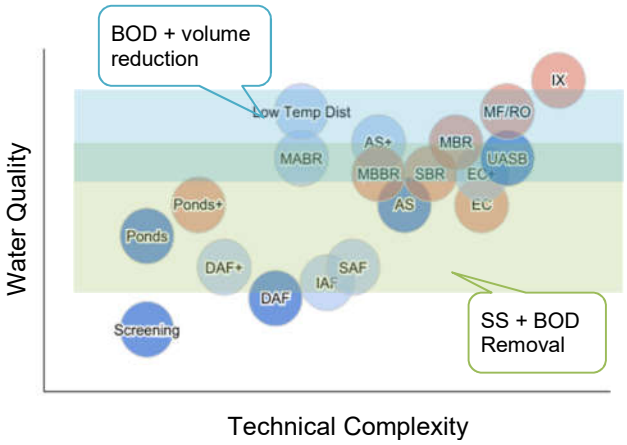

Figure 8 Typical treatment technologies mapped by complexity against treatment ability

As can be seen from Figure 8 above, typically technologies employed by the dairy industry for processing wastewater tend to have a lower level of complexity and are targeted towards SS and BOD removal primarily and a medium water quality. This suggests that technologies such as MBBR, USAB, EC and MBR might be the areas to investigate. Ideally a technology would have a lower level of complexity (and likely a lower cost) but achieve the treatment requirement, though these types of technologies are in the earlier stages of development.

Wastewater treatment

Based on the discussions with Dairy Australia, the DMSC and the analyses above, three clear wastewater treatment objectives surfaced:

- Solids reduction
- BOD reduction
- Volume reduction

Technologies with the potential to achieve these objectives were investigated and six were shortlisted using the criteria described in the table above “Criteria for technology selection”

Figure 9 below shows key technologies types where waste reduction could be achieved through wastewater treatment and an overlay of the technologies shortlisted in these areas.

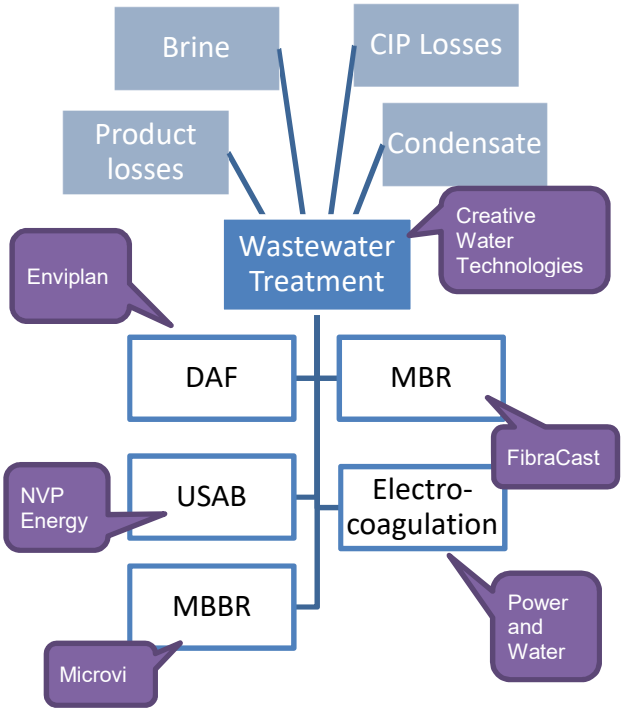

Figure 9 Waste sources and technology opportunities for wastewater treatment

The technologies selected and their target treatment abilities are described in more detail in Table 3 below.

Table 3 Shortlist of wastewater treatment technologies

Company name	Description
Enviplan	**FOG, solids, low BOD.** Enviplan’s Aquatector Microfloat (eMF) is a micro-flotation process for water and wastewater treatment, utilising micro bubbles of 20-50 µm (>90% of the micro bubbles are in this range) for separation of suspended solids and colloidal material.
NVP Energy	**High BOD.** NVP Energy has developed a Low-temperature Anaerobic Digestion (Lt-AD) process which can be used for secondary treatment of low strength wastewater (COD <3,500 mg/L) at temperatures as low as 4°C.
FibraCast MBR	**Med BOD.** FibraCast designs and manufactures a unique, high efficiency hybrid immersed UF membrane called FibrePlate. FibrePlate is used in membrane bioreactors (MBR) to treat wastewater to reuse or high-quality discharge standards.
Microvi	**Broad spectrum treatment or nitrogen specific.** Microvi has developed an efficient, versatile waste water treatment system based on advanced biological carriers (Biocatalysts). Biocatalysts are small, extremely permeable polymer spheres with complex internal structures, providing a protective environment for high concentrations of microbes, specifically selected for target pollutants.

Power and Water	**Broad spectrum treatment.** Sonoelectrochemistry is the next advance in electro-based water treatment. Combining power ultrasound with electrolysis. The treatment process offers the advantage of physical, chemical and oxidative (advanced oxidation process, AOP) treatments with all the benefits of physical treatment.
Creative Water Technology	**Volume reduction and mineral removal**. Creative Water Technology (CWT) is a Melbourne based Australian company that has developed world-class techniques in zero liquid discharge (ZLD) and fractional crystallization of minerals to apply to a wide range of water treatment and recycling applications.

Cost and waste reduction technology mapping

The technologies were mapped to provide an indication of cost effectiveness and is based only an indicative cost information because in many cases cost is site dependent. In addition to the shortlisted technologies, membrane aerated bio-reactors (MABR) have be mapped on the diagram. This technology is currently at a relatively early stage of development but has potential for high rate, low energy treatment. This technology is described in more detail below.

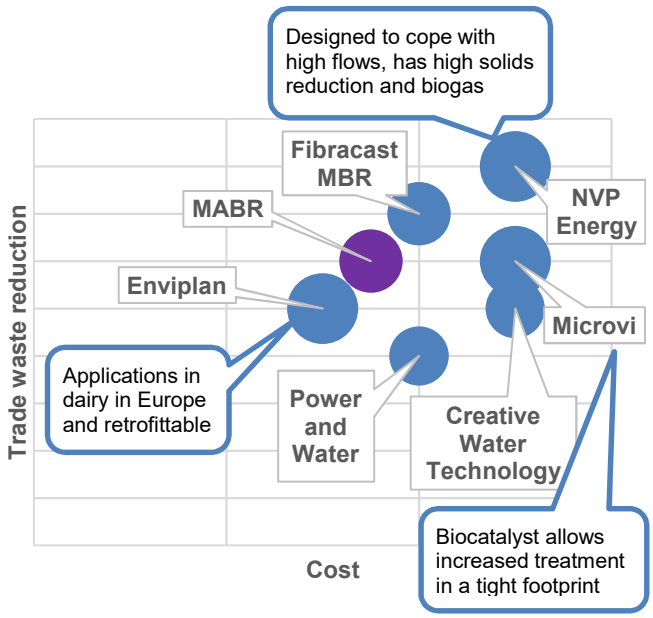

Figure 10 Mapping of wastewater treatment technologies

The technology mapping in Figure 10 provides an indication of installation cost relative to trade waste charge reduction. As previously mentioned due to complexity of these technologies, all plants will need site-specific business cases due to variability in waste characterisation

Technologies prioritised

Following detailed discussions with Dairy Australia, the most applicable technologies, with the greatest potential cost benefit were prioritised, these were:

- Enviplan
- Creative Water Technology

Power and Water were also considered as a potential technology of interest because electro-coagulation could be a suitable alternative to chemical coagulant dosing before a physical separation process such as a DAF and it is particularly effective at removing soluble or colloidal constituents.

Information on this technology and the others that were not prioritised can be found in Appendix B.

On the next pages are summary descriptions of each of the prioritised technologies including information on:

- Applicability
- Effectiveness of the technology
- Case Studies
- Indicative costs
- Contact details of the supplier

Future opportunities

MABR (Membrane aerated bioreactors)

A unique attached growth process which allows aeration from the carrier side. Due to the environment, the attached biofilm is very robust and can handle hydraulic shocks. There is also a much lower sludge yield than typical aeration processes. There is also a low energy consumption due to the low pressures required and 95% of the oxygen can be transferred to the bacteria. Typically, it can be retrofitted into an existing tank. Currently the technology is the early stages of commercial use

CSIRO Agriculture and Food

The projects below are at an early development stage but they have potential for reducing waste in the future and should be closely watched

- Forward Osmosis for extracting/thickening products
- Use of resins to extract useful components from waste

Conclusions

Wastewater treatment is a complex space with a huge range of options for a huge variety of scenarios, with a wide range of water qualities achieved.

Trade Waste

The largest savings can be made through reduction on SS and BOD, though waste volume can make up a significant proportion of cost. Therefore, it is logical that the treatment option should reflect the area of greatest cost saving, based on its treatment ability.

Retrofitting

It may not always be suitable to replace existing processes but there are opportunities to retrofit with more efficient technologies. This may also be a suitable solution to sites with a small footprint or as a cost-effective upgrade to improve final effluent quality.

Water re-use

Many advanced wastewater treatment processes can provide a water quality that would only need minimal polishing to provide high quality water for re-use. Water re-use would be a way to reduce trade waste charges associated with flow and water does not have to be re-used in the process, it could be for wash down of equipment or floors, or even toilet flushing on site.

Enviplan - Aquatector Microfloat
A micro-floatation process that produces a high bubble density for superior separation

Technology highlights:

- Advanced control and optimisation
- Uses no or less chemicals than conventional IAF/DAF systems
- Self-cleaning valves
- Simple to retrofit

Description: Enviplan's AQUATECTOR Microfloat (eMF) is a micro-flotation process for water and wastewater treatment, utilising micro bubbles of 20-50 µm (>90% of the micro bubbles are in this range) for separation of suspended solids and colloidal material. The high bubble density and turbulence free distribution in the micro-flotation tank provides over 99.9% separation. Particles <10 µm can be separated. Most existing eMF plants operate without chemicals or flocculating agents. eMF systems offer high hydraulic and solids loading rates in a small footprint, low energy consumption and maintenance free operation thanks to the iFloat self-cleaning injector nozzles.

Applicability

- The Aquatector can be installed as a new process step or retrofit into existing tanks
- The iFloat injector nozzles and expansion valves flush when the controller detects a rise in pressure making them especially applicable for wastes with high levels of FOG
- The process has already been proven at a number of dairy processors but mainly in Europe

Effectiveness of the Technology

- The removal efficiencies will vary depending the wastewater type but typically the Aquatector can achieve a COD removal of 45-70%, TSS removal of 90-99%, FOG removal 90% (depending on if it is particulate), if dissolved FOG then much lower removal.

Case Studies

- Ehrmann AG – Enviplan installed micro-floatation plant at a site processing raw milk and producing yogurt, following a demonstration to prove the effectiveness of the technology. The process feed rate is 45m^3/h and achieves 52% reduction in COD and 100% of settleable solids. The pressure in the system is 2.5bar and the energy requirement is 30Wh/m^3.
- Molkerei Gropper GmbH & Co. KG – Due to production increases at the site, Enviplan upgraded their own plant in 2017 which was originally installed in 2009 to treat wastewater from processing raw milk and producing various dairy products. The process feed rate is 100m^3/h and achieves 58% COD removal, 90% settleable solids removal and 91.5% removal of oily substances.

Indicative costs

- As an indication of cost, the CAPEX for an 800m^3/d plant is approximately $250,000. The operation costs will be mainly based on the energy required to pressurise the air in the water
- There is an opportunity to rent small microfloat system (1-12m^3/h) for testing the performance of the system. The service cost for this is typically $11,000 (not including transport of the system in a container) and then there is an ongoing weekly rental fee of $2200

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Creative Water Technology
Low temperature thermal distillation

Technology highlights:

- Handles high levels of contaminants
- Reuses waste thermal energy from the process (e.g. boilers, spray dryers, cooling towers)
- Recover chemicals and minerals for reuse or resale
- Recovers high quality water for reuse in the production process

Description: The GENESIS series uses a low temperature, thermal distillation process known as adiabatic recovery to desalinate, dewater and/or recycle highly saline and highly contaminated wastewater. The technology has been specifically designed to handle the high levels of contaminant that alternative technologies struggle to process, with proven results for water samples with TDS levels over 300,000 ppm that were reduced to less than 20 ppm. The unit has a low power cost of 15 kWh per tonne of water evaporated and can use existing thermal energy sources, such as spray dryers, boiler and cooling towers, as a primary power source (site application dependent). The GENESIS series has a simple self-cleaning cycle using its own recycled water and no problematic filters or membranes. Soluble and insoluble contaminants are separately extracted for reuse or, with optional accessories, dried and/or bagged for sale. The compact nature of the process allows it to be located on a clean site or as a retrofit to existing water processing plants to treat waste or brine discharge.

Applicability

- The system is custom designed specifically for each application making the process very versatile
- The process has applications in dairy industry primarily due to the potential heat that may be available from existing processes
- As a rule of thumb it is suitable for any waste that is liquid enough to be pumped

Effectiveness of the Technology

- GENESIS WRX reclaims up to 97% free water where required and up to 100% of the contaminants contained in the feed water.
- Recover up to 25% of water for re-use where minimising waste volume is a priority.
- The principle of this technology is to achieve industrial quantities of evaporation at normal atmospheric pressures with temperatures as low as 30°C. This is used to desalinate, dewater and/or recycle highly saline and highly contaminated wastewater.
- If containment level below 5% TS then Creative Water Technology suggest a filtration system upfront

Case Studies

- Organic Pharmaceutical Wastewater – The wastewater (retentate after ultra-filtration) was organic in nature and had a high nutritional value, containing high BOD, COD, TSS and TDS. The flow originally was 40,000 litres a week but the capacity of the system was double. After treatment, results showed the total dissolved solids had been reduced by 99.8% and volume was reduced by 87.5%. The remaining liquid was sold as a fertilizer and the clean water was used for various uses on site such as truck washing. The total solution was less than $500,000 and payback was less than 12 months compared to the original trade waste charges.

Indicative costs

- The system is custom designed specifically for each situation, heat available and treatment objectives.
- Demonstrations of 1kL - 4 kL process are available at Creative Water Technology's site.
- The GENESIS series system may also be rented for a trial and the cost of this is $2,500 / day onsite including operator plus all expenses at cost. Expenses include delivery, insurance, and operator expenses.

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DMSC members experiences

The discussions with the DMSC covered:

- Sources of sludge from dairy processing
- Any dewatering or thickening techniques utilised
- Disposal routes such as site storage, composting, fertiliser, animal feed, composting or landfill and the associated costs with each method.

There was a general consensus that there needed to be a move away from any sludge going to landfill and therefore all options would be considered.

In particular, many members expressed a concern regarding their IAF/DAF sludge in terms of handling and disposal, with some who felt that use as animal feed was the best solution and others who wished to find alternative and more profitable uses.

Figure 11 below provides an overview of the perceived barriers to innovation and potential opportunities.

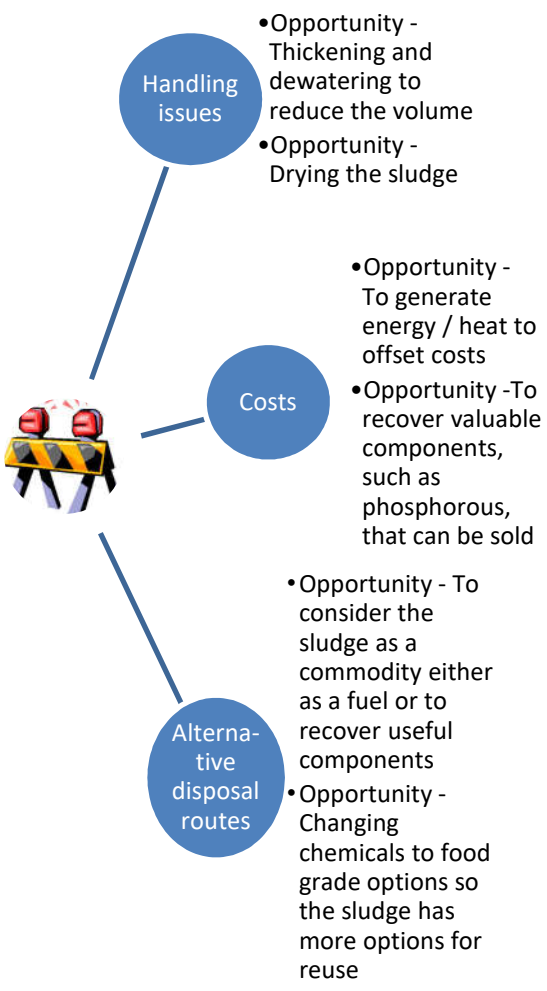


Figure 11 Perceived barriers to innovation in sludge handling

Sludge sources

Based on the discussions with Dairy Australia and the DMSC, there are three clear types of sludge that are typically produced from the treatment of the dairy processing wastewater:

- Grease trap sludge
- IAF/DAF sludge
- Secondary treatment sludge

Technologies with the potential to achieve these objectives were investigated and four were shortlisted using the criteria described in the table above “Criteria for technology selection”

Figure 12 below shows the areas that waste reduction could be achieved and an overlay of the technologies shortlisted.

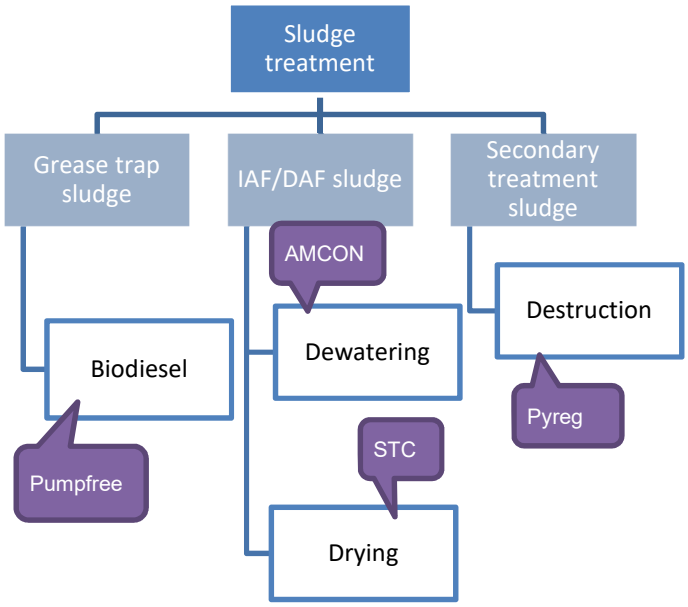


Figure 12 Waste sources and technology opportunities for sludge reduction

The technologies selected are described in more detail in Table 4 below.

Table 4 Shortlist of sludge reduction technologies

Company name	Description
PumpFree	The PumpFree approach involves retrofitting existing grease traps with an organic filter and an adsorbent media layer. This set up means that the tankers only pump out and carry valuable FOG and organic matter

AMCON	The Volute is a dewatering screw press made up of fixed rings and moving rings with a uniquely designed tapered shaft and flights. It has a modular design, operates on a continuous process and the shaft motor is controlled by a frequency drive and rotates at 2 rpm.
Pyreg	PYREG 500 is a carbonisation technology that can treat a wide range of biomasses to produce a range of products including a mix of fixed carbon, biochar, and mineralised ash and heat.
STC	STC manufactures drying equipment that uses hot air convection processes. The STC thermal dryer takes dewatered sludge, with a dry solids content as low as 20%, and produces sludge pellets with greater than 90% DS.

Cost and waste reduction technology mapping

The technologies were mapped to provide an indication of cost effectiveness. Cost information is indicative only as, in many cases, cost is site dependent.

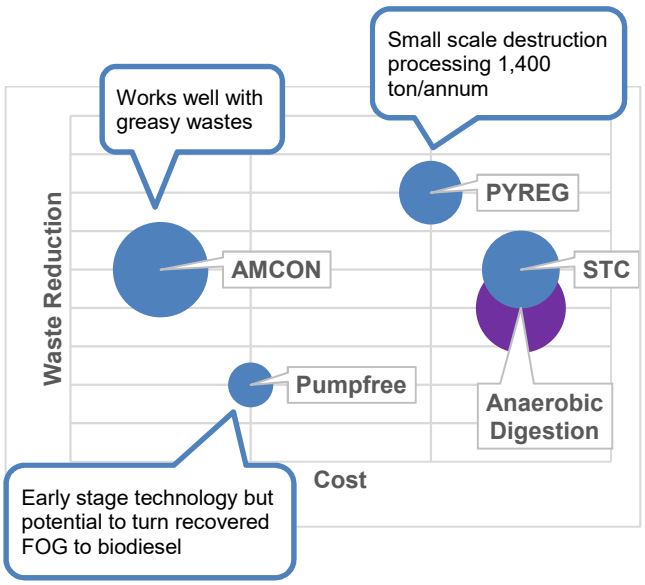


Figure 13 Mapping of sludge reduction technologies

The technology map in Figure 13 above is an indication of the cost effectiveness in relation to the transport and disposal costs of the sludge. The CAPEX cost though tends to be variable due to the wide range of sludge types and volume. All plants will need site-specific business cases

Based on scale, the suggested technologies have a high potential.

Technologies prioritised

Following detailed discussions with Dairy Australia, the most applicable technologies, with the greatest potential cost benefit were prioritised and these were:

- PYREG
- AMCON

Pumpfree were also selected at a potential technology of interest because of the potential opportunity to selectively remove FOG at a high quality for reprocessing as bio-diesel. This technology also can potentially be applied in grease traps and DAF units but at the moment the scale is only applicable for retail food outlets.

Information on this technology and the others that were not prioritised can be found in Appendix C.

On the next pages are summary descriptions of each of the prioritised technologies including information on:

- Applicability
- Effectiveness of the technology
- Case Studies
- Indicative costs
- Contact details of the supplier

Conclusions

Despite the results of the October 2016 DMSC member survey, sludge did not seem to be a major issue for some members who could store the sludge, send to composting or dispose of as animal feed. The requirement for more advanced wastewater treatments though, either for water re-use or minimising trade effluent costs, will potentially lead to greater amounts of sludge being produced. This may also be coupled with the need to ensure organic wastes are diverted from landfill, therefore driving a move towards reduction of volumes and alternative disposal.

Diversion from landfill/composting

DAF sludges are suitable to be used as an animal feedstock if the chemical used in the upstream processes are altered to food grade options or processes used are chemical free.

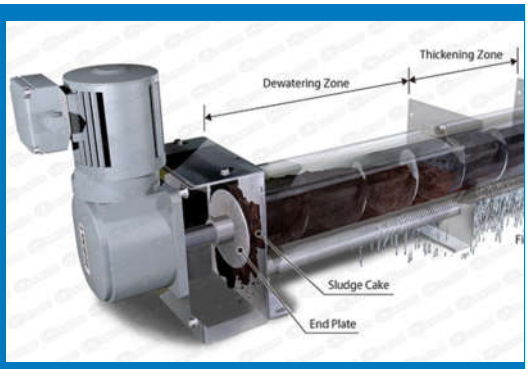
Transport costs

There are many opportunities to reduce the moisture content in the sludges to reduce trucking cost, with technologies for dewatering and drying.

AMCON - Volute
Compact screw press for thickening and dewatering

Technology highlights:

- Capable of dealing with oily/greasy sludges
- Low energy requirements
- Reduced or no chemicals required
- Low wash water requirements



Description: The Volute is a screw press made up of fixed rings and moving rings with a uniquely designed tapered shaft and flights. It has a modular design, operates on a continuous process and the shaft motor is controlled by a frequency drive and rotates at 2 rpm. The Volute when direct dewatering from an activated sludge plant can achieve substantial commercial savings on the requirement for polymers, thickeners and sludge storage tank construction. The system can be quickly installed without significant amount of civil infrastructure work. The system can be installed for new infrastructure or retrofitted into existing treatment plants. Volute can be installed in places where placement would not be possible with other technologies for reasons such as low building ceilings or limited area. Therefore, the construction cost of a large building for installation is not required.

Applicability

- The volute has been employed on many oily sludges in the food and beverage industry (e.g. meat processing, frozen food production, juice processing etc) that are difficult to thicken and dewater with standard equipment
- It can easily be retrofitted into place and it has a small footprint
- Improving the solids content of the sludge will reduce the costs associated with transportation regardless of the disposal route

Effectiveness of the Technology

- DAF sludge that is 1.5% to 3% dry solids can be dewatered up to 30% dry solids
- Compared to a standard screw press the footprint can be reduced by 70%
- The Volute can also achieve up to 85% energy saving compared to centrifuge technology due to the simple press operation of the system and low rotation speed

Case Studies

- Dairy processor – The volute replaced an existing belt press to dewater a mixture of DAF and secondary sludge. The wastewater was dewatered from 2.4% total solids to 18% solids with a throughput of 18.7Kg DS/h

Indicative costs

- The capital cost for the system is between $4,500-$80,000 for equipment that can process sludge at 5% TDS from 4Kg DS/hr to 800Kg DS/hr. Operational costs will depend on labour cost, disposal cost, power price, etc. Multiple case studies of this technology indicate that the overall operating costs is lower than belt process by 20 to 35% and centrifuges by 10 to 30%
- The maintenance costs for moving rings starts from $1,800 to $55,000 (largest unit with 843 rings) per unit. Time required for overhaul service is between 8 - 96 hours per year.
- Energy consumed of the units is between 4.06 - 26.14 kWh/d
- Volute can be installed in places where placement would not be possible with other technologies for reasons such as low building ceilings or limited area. Therefore, the construction cost of a large building for installation is not required.

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PYREG
Advanced thermal conversion

Technology highlights:

- Suitable for small, compact decentralised deployment
- Produces excess heat that can be used to dry the sludge and also potentially could be used in the dairy processing
- The biochar can be used for fertiliser, especially if it contains high levels of phosphorus

Description: Pyreg (owned by ELIQUO STULZ) has developed an advanced thermal conversion (ATC) technology referred to as slow pyrolysis. Pyreg 500 is a carbonisation technology that can treat a wide range of biomasses to produce a range of products including a mix of fixed carbon, biochar, and mineralised ash and heat. The process requires temperatures up to 800°C and a retention time of 15-30 minutes, after which biomass feed stocks are reduced to one third in volume of biochar and two thirds to syngas. The system can process approximately 1,250 t/a of sludge at approximately 80% DS and will mean an output of approximately 500 t/a ash with up to 20% P and up to 200kW$_{th}$ excess energy. The feedstock should be characterised by dry solids greater than 50% and particle sizes lower than 30mm. The footprint of the system is only 8.8m × 3.5m × 2.7m (L/W/H). Typically, the Pyreg technology is coupled with the EloDry low-temperature belt dryer from ELIQUO STULZ upfront, this is to ensure the correct dry solids range is reached.

Applicability

- Applicable for all types of sludge feedstocks
- Carbohydrate based substrate will lead to a bigger biochar yield and the low levels of heavily metals will make it very suitable as fertiliser
- Protein based substrate will have a smaller yield on biochar as more material will be transferred into gas phase
- For dairy sludge, it is expected that there would be a smaller throughput than the typical 120KgDS/hr due to the higher gas yield

Effectiveness of the Technology

- The combustible gas generated in the PYREG reactors is completely burned by the FLOX method (flame-less oxidation) at a temperature of 1.250°C inside a separate combustion chamber, therefore thermal NOX is significantly avoided
- The process is self-sustaining once it has started, therefore no further external energy is required

Case Studies

- Linz-Unkel WWTP (Germany) –Municipal sewage sludge is dewatered to 31%DS and then further dried with the EloDry to above 85% DS using the spare heat from the Pyreg unit. Two dual screws then transport the sludge through the Pyreg reactor, which is at approx. 650 °C. The input is designed for 700t/a and produces 400t/a of phosphorus rich ash. The project contract value was $2 million, but the sludge transportation has been reduced by 90%.

Indicative costs

- The CAPEX for a PYREG 500 is approximately $674,000 ex-works, with an additional allowance to establish feed systems, product delivery and storage, site delivery, installation and commissioning in the region of $250,000. If required the wet scrubbing system (dependant on emission regulations) including the activated carbon filter for a PYREG P500 is approximately $220,000 to 300,000. OPEX is approximately $150,000 per annum.
- The biochar produced is likely to have 35 to 45 % of carbon and therefore it is likely that it could be sold for multiple applications such as a soil enhancer.

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Government Policy Developments for Waste Reduction

The following section is a brief summary of the current/upcoming national and international policy developments which may provide risk or opportunity towards achieving the industry's waste-to-landfill intensity reduction targets.

International conventions and agreements

Australia is party to a number of these international conventions and agreements relevant to waste that have been reflected in national legislation. Below is a summary of the most relevant.

Paris Agreement 2015

The Paris Agreement sets in place a durable and dynamic framework for all countries to take climate action from 2020, building on existing international efforts in the period up to 2020.

Though the agreement is not strictly about waste, it is clear that the targets to reduce greenhouse gas emissions will especially impact on organic waste going to landfill. Australia in particular has set an ambitious target to reduce emissions by 26-28 per cent below 2005 levels by 2030

This may result in policy changing with:

- A move away from waste incineration to reduce emissions
- An increase in levies at landfills
- A move towards composting to increase carbon capture

Kyoto Protocol 2012

The Kyoto Protocol (Kyoto Protocol to the United Nations Framework Convention on Climate Change), which entered into force in 2005, obligates certain developed countries (including Australia which ratified the Protocol in 2007) to reduce their emissions of six main greenhouse gases. The Kyoto Protocol was amended in 2012 to incorporate a second commitment period from 2013-2020. Similarly, to the Paris agreement this will influence industry targets relating to organic waste going to landfill.

Australian legislation

As mentioned, the International agreements have been reflected in national legislation and below is a summary of ones that are relevant to waste.

National Environment Protection Council Act 1994.

Under this the National Environment Protection Measures (NEPMs) are a special set of objects and the key one relating to the dairy industry is the Used Packaging Materials NEPM. This objective is to reduce environmental degradation arising from the disposal of used packaging and conserve virgin materials through the encouragement of reuse and recycling.

Product Stewardship Act 2011

This provides the framework to effectively manage the environmental, health and safety impacts of products, and in particular those impacts associated with the disposal of products

Industrial Waste Resource Regulation Review

The Regulations are an important part of Victoria's regulatory framework for environmental protection, and expire in mid-2019. The Regulations categorise industrial wastes by risk profile to ensure that each is appropriately handled, stored, treated, transported and disposed of. The Victorian Government's response to the Independent Inquiry into EPA signals an intention for major reform of the Environment Protection Act 1970. The reform is likely to require changes supporting regulations such as the Industrial Waste Resource Regulations. The review of the Regulations will focus on the hazard categorisation of waste so that it appropriately reflects the risks arising from the management of waste. EPA is reviewing scientific understanding of the contaminants and components of waste, from its creation to disposal. This research will inform the new Regulations to ensure human health and environmental impacts of waste are minimised.

Direct waste reduction policies

The first comprehensive domestic approach to waste management was agreed under the 1992 National Strategy for Ecologically Sustainable Development, which committed Australia to improving the efficiency with which resources are used, reducing the impact on the environment of waste disposal; and improving the management of hazardous wastes, avoiding their generation and addressing clean-up issues. These aims were eventually put into a dedicated waste policy in 2009.

Australian National Waste Policy 2009

The National Waste Policy is an efficient and environmentally responsible approach to waste management in Australia. The policy sets Australia's waste management and resource recovery direction to 2020. The aims of the policy are:

- To avoid waste generation and reduce waste disposal;
- Manage waste as a resource;
- Ensure that waste treatment, disposal, recovery and re-use is undertaken in a safe, scientific and environmentally sound manner; and
- Contribute to the reduction in greenhouse gas emissions, energy conservation and production, water efficiency and the productivity of the land.

What does this all mean for the dairy industry

Within the National Waste Policy there are 16 waste strategies and a number of these will impact directly on the dairy industry around the following areas:

- There is an ongoing covenant for industry to reduce the environmental impacts of consumer packaging by creating/using more recyclable materials;
- Reduced biodegradable (organic) material to landfill through increased landfill levies and increasing composting options;
- Schemes to avoid commercial and industrial waste and resource recovery to increase recycling;
- Regional and remote waste and resource recovery to increase the options for industry located far from regional hubs.

Government Financial Support / Incentive Schemes

The following section is a brief summary of current/upcoming national funding programs available which have the potential to reduce the cost and intensity of waste production (directly or indirectly) for Australian dairy processors.

Potential appropriate financial support /incentive schemes (Table 50

- Dairy Australia Technology Assessment Scheme (DATA) Scheme
- Dairy Australia Grant Access Support (GAS) Scheme
- The Enterprise Solution Centre
- Innovation Connections
- Organics Infrastructure Large and Small
- Bin Trim Rebates Program
- AgriGrowth Loan Scheme
- Resource Recovery Infrastructure Fund
- Advanced Food Manufacturing Grants Program
- Recycling Infrastructure Grants Program
- Food and Beverage Implementation Grants

Schemes not directly relevant (Table 6)

The following schemes are not financial in nature but could provide dairy processors with relevant support in reducing waste generation and disposal

- Certain Input to Manufacture
- Supplier Improvement Plan
- Business Evaluation
- ACTSmart Business Recycling Program
- Better Business Partnership
- ecoBiz Queensland
- Resource Productivity Assessments

R&D Tax Incentive

The R&D Tax incentive is a self-assessment program. It provides a tax offset for some of a company's cost of doing eligible research and development (R&D) activities by reducing a company's income tax liability. Tax offsets of 43.5% or 38.5% are available for costs incurred on eligible activities depending on a company's annual aggregated turnover. The 43.5% benefit is a refundable offset.

To be eligible for the R&D Tax Incentive the dairy processer must conduct at least one activity that meets the legislated definition of a core R&D activity. A core R&D activity involve at least one hypothesis guided experiment that is undertaken to generate new knowledge. Other non-experimental activities that directly support a core R&D activity may be eligible as supporting R&D activities. Core and supporting R&D activities are defined under sections 355-25 and 355-30 of the Income Tax Assessment Act 1997.

More details can be found here

Table 5 Details of potential Government Financial Support / Incentive Schemes

Name	Link	State	Agency	Status	Description	Funding available	Ratio	Contact details
Dairy Australia Technology Assessment Scheme (DAT) Scheme		National	Dairy Australia	Open	An initiative providing 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	$50K	100%	Ian Olmstead Program Manager T: 03 9694 3811
Dairy Australia Grant Access Support (GAS) Scheme		National	Dairy Australia	Open	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.	$10K	100%	Ian Olmstead Program Manager T: 03 9694 3811
The Enterprise Solution Centre	Link	National	FIAL	Open	The programme aims to boost competitiveness and capability in the Australian Food and Agribusiness Sector by providing matched funding to industry partners to deliver innovation that addresses a technical challenge that is limiting a company's ability to maximize their market potential.	$50K	50%	T: 03 9731 3422 info@fial.com.au
Innovation Connections	Link	National	AusIndustry	Open	Provides small and medium sized businesses with access to expert technology advice to address technology and knowledge gaps, and collaborate with the research sector in developing new ideas with commercial potential.	$50K	50%	T: 13 28 46
Organics Infrastructure Large and Small	Link	NSW	NSW EPA	Round 4 Closed	The Waste Less, Recycle More Organics Infrastructure (Large and Small) Program provides $43 million over four years to fund infrastructure and equipment to reduce food and garden organics waste going to landfill.			T: 1300 361 967 organics.recycling@epa.nsw.gov.au
Bin Trim Rebates Program	Link	NSW	NSW EPA	Open	Bin Trim Rebates Program, part of Waste Less, Recycle More initiative, aims to increase workplace recycling by providing rebates to small and medium-sized businesses for recycling equipment.	$50K	50%	T: 1300 361 967 Bintrim.rebates@epa.nsw.gov.au
AgriGrowth Loan Scheme	Link	TAS	Business Tasmania	Open	Scheme to provide low interest loans to Tasmanian farm businesses and agri-food businesses with the aim to increase the value of the agriculture and agri-food sectors in Tasmania.	$1.5M		T: 1800 440 026 businessfinance@stategrowth.tas.gov.au
Resource Recovery Infrastructure Fund	Link	VIC	Sustainability Victoria	Round 1 closed	Program to support the development of infrastructure which improves the collection and processing of recycled materials. The program seeks innovative projects that will increase jobs in the resource recovery industry while also increasing the recovery of priority materials.	$500K	50%	T: 1300 363 744 grants.enquiries@sustainability.vic.gov.au
Advanced Food Manufacturing Grants Program	Link	SA	SA Food Innovation Centre	Round 3 closed	The AFM grants program is designed to encourage collaboration between food manufacturers and research and development providers, creating partnerships that will lead to future opportunities. Grants are available to support South Australian food businesses to partner with public or private research providers to develop innovative or novel products or processes.			T: 08 8226 0109 PIRSA.foodinnovationcentre@sa.gov.au

Name	Link	State	Agency	Status	Description	Funding available	Ratio	Contact details
Recycling Infrastructure Grants Program	Link	SA	Green Industries SA	Open	Aims to help companies and organisations install equipment and/or provide innovative ways to reuse, recycle or repurpose resources and decrease the amount of landfill waste	$300K	50%	Justin Lang Program Manager M: 0419 948 931
Food and Beverage Implementation Grants	Link	SA	Green Industries SA	Open	Food and Beverage Implementation Grants offer eligible businesses the opportunity to install, upgrade, or add to trade waste management infrastructure at a reduced cost.	$300K	50%	Oliver Lovat Project Officer, M: 0437 641 138

Table 6 Details of indirect schemes to provide support to reduce waste

Name	Link	State	Agency	Status	Description	Contact details
Certain Input to Manufacture	Link	National	AusIndustry	Open	The Certain Inputs to Manufacture (CIM) programme aims to improve the competitiveness of Australian industry. CIM does this by providing import duty concessions on certain imported raw materials and intermediate goods such as good used in food packaging	T: 13 28 46
Supplier Improvement Plan	Link	National	AusIndustry	Open	Supply Chain Facilitation services are tailored to assist and enable eligible Australian small and medium businesses to participate in domestic and global supply chains, generate sustainable business growth and find opportunities to connect and network with their customers	T: 13 28 46
Business Evaluation	Link	National	AusIndustry	Open	Provides businesses with access to experienced, independent Business Advisers to review the business and provide a Business Evaluation Action Plan with recommended strategies for business improvement or growth. The Evaluation includes up to 12 months of mentoring to help implement the strategies.	T: 13 28 46
ACTSmart Business Recycling Program	Link	ACT	ACT Government	Open	ACTSmart Business Recycling is a free, 10-step program that helps businesses with efficient recycling and waste management.	T: 13 22 81. actsmartbusiness@act.gov.au
Better Business Partnership	Link	NSW	Better Business Partnership	Open	Better Business Partnership aims to help reduce energy and water bills of businesses in Sydney's North Shore region. Businesses will gain recognition for joining the scheme and reducing their energy, water and waste. Participation in the Better Business Partnership is free for small to medium sized businesses located in Ku-ring-gai, North Sydney and Willoughby City Council areas.	Nathan John Manager T: 9777 7516
ecoBiz Queensland	Link	QLD	CCIQ	Open	The program provides Queensland businesses and organisations access to complimentary tools and events including one-to-one coaching, site survey, online benchmarking, workshops and webinars to reduce energy, water and waste	T: 1300 731 988 ecobiz@cciq.com.au
Resource Productivity Assessments	Link	SA	Green Industries SA	Open	Aims to identify opportunities for improving business operations by making it more efficient, saving resources (materials, water, energy), preventing waste and increasing productivity, all of which can help reduce operating costs and improve business performance and profitability.	Oliver Lovat Project Officer, M: 0437 641 138

Appendix A

Upstream Waste Source – Technology profiles

Biolonix
Advanced disinfection treatment for difficult liquids

Technology highlights:

- Directly treats process liquid
- Utilises strong but short-lived oxidants
- High capacity
- Designed for CIP systems
- Reduces chloride discharges

Description: Biolonix has developed an electrochemical process that is primarily used in food processing applications to disinfect process liquids and in many cases also products. The Biolonix process treats contaminants by applying an electrochemical field in the liquid as it passes through a reactor. This generates a range of complementary oxidants (including hydroxyl radicals and various superoxides) that provides both virtually instantaneous disinfection, and a safe, low-level, long-term residual disinfection effect. Biolonix utilises advanced catalytic ceramic plate materials that optimise specific performance parameters and extend running times. In addition, the Biolonix automated control system minimises (or eliminates) operator intervention and provides an online estimate of disinfection efficacy.

Applicability:

- Biolonix is primarily used to treat liquid streams containing at least trace quantities of sodium chloride (salt)
- A common application is the disinfection of process brines for reuse.
- Currently there are systems in meat; cheese; poultry; RTE slicing; and seawater.

Effectiveness of the Technology

- Provides a low level of residual oxidation in the processing fluid, so it continues disinfecting any surface it encounters.
- Unlike chemical alternatives, Biolonix disinfects without the use of expensive consumables and produces no harmful by-products or toxic gases
- Biolonix have successfully treated liquid streams containing 2500ppm NaCl

Case Studies

- There are currently 15 full-scale systems operating worldwide
- Kraft/Polly-O - This plant manufactures mozzarella and string cheese and with the Biolonix system there is no need for CIP. Helps provide a longer shelf life of the product and extended the life of the brine.

Indicative costs

- Systems range from $100,000 – $525,000+ depending on requirements. Typically, the ROI is from 3 months to 1 year and this achieved through the cessation of chemical dosing, enhancement of existing treatment system performance, reduction of cleaning down time, increased production rates, increased product shelf life and reduction of chloride discharge.

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ResourceCo
Processed engineering fuel production

Technology highlights:

- Diverts un-recyclable waste from landfill
- Alternative fuel source

Description: ResourceCo manufacture process engineered fuel (PEF) from commercial and industrial waste. This material is typically comprised of mixed light loads which usually contain a mix of timber, metals, plastics, cardboard and paper. This material is sorted and the ferrous and non-ferrous metals, inert fractions (bricks, concrete etc.) and non-recyclables are removed from the combustible portion of this material stream. The combustible material is then processed for manufacturing of PEF. PEF has a high calorific value and can be used as a fuel substitute for coal and gas in high combustion facilities. Their facility in South Australia was built in 2007 and has the capability to convert up to 350,000 tonnes of raw material per annum into 100,000 to 150,000 tonnes of PEF. All raw materials are separated during processing and over 90% of the material is recycled.

Applicability:

- ResourceCo can turn non-recyclable commercial and industrial waste, that is currently going to landfill, into PEF for use as an alternative fuel
- ResourceCo have plans to build a second plant in NSW in the near future

Effectiveness of the Technology

- Over 90% of the material bought into the plant is recycled

Case Studies

ResourceCo have a facility in Wingfield, SA which has the capacity to convert up to 350,000 tonnes of raw material per annum to 100,000 to 150,000 tonnes of PEF. The finished alternative fuel is transport to the Adelaide Brighton Cement Birkenhead plant for use as a fossil fuel substitute in the cement making process.

Indicative costs

- The gate fee for ResourceCo will depend upon the waste composition and the quantity, but will be within the range of local landfill costs.

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Appendix B

Wastewater treatment – Technology profiles

NVP Energy
Low temperature anaerobic digestion

Technology highlights:

- Low sludge production
- Low temperature
- Suitable for retrofit and new installations

Description: NVP Energy has developed a Low temperature Anaerobic Digestion (Lt-AD) process which can be used for secondary treatment of low strength wastewater (COD <3,500 mg/L) at temperatures as low as 4°C. The technology attenuates high levels of COD (~80%) and TSS (~50%), producing biogas as a by-product. Low-strength wastewater enters the reactor at the base and travels up through the tank at a rate of 3m^3/hr, mixing with suspended granular seed sludge to initiate anaerobic digestion. The wastewater then passes through a filter to remove solids, after which it is either re-circulated or removed from the top of the reactor vessel. Biogas is collected at the top of the reactor. Sludge production is almost negligible.

Applicability:

- NVP Energy reactors treat the mixed liquors from primary settlement, augmenting or replacing conventional secondary biological treatment technologies (activated sludge, trickling filters, etc.).
- NVP energy currently has a reference site at Arrabawn Dairies in Ireland.

Effectiveness of the Technology

- NVP energy reactors are carbon neutral and energy positive, operating <20^{0}C (a low temperature for a high-rate AD reactor). Effluent is high quality and in many cases, can meet discharge requirement for COD without the need for post-treatment.
- Where most AD systems only remove COD, the Lt-AD technology removes both COD and TSS.

Case Studies

- A pilot scheme with dairy wastewater has been trialled at Arrabawn Dairies Co-op, Carbery Foods and Kerry Group, Ireland.
- Arrabawn Co-op – After installation the influent COD 2,466 mg/L was treated to 657 mg/L (73% removal). Equally the Influent BOD was 1,675 mg/L and treated to 157 mg/L (91% removal)
- Kerry Group - After installation the influent COD 2,197 mg/L was treated to 193 mg/L (91% removal)

Indicative costs

- Modular system so CAPEX and OPEX are dependent on the characteristics and volume of the wastewater requiring treatment. Although CAPEX may be more than activated sludge treatment the OPEX is much lower, so there are significant whole-life cost benefits over conventional technologies.
- No energy intensive aeration is required. Thanks to its biogas production capabilities the system can be energy positive.
- Typical 2 MLD of dairy wastewater (4 NVP Energy reactors) has a CAPEX of $7 million and OPEX of $110,000 per year

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FibraCast MBR
Hybrid UF membrane

Technology highlights:

- Combining benefits of hollow fibre and flat sheet membranes
- Low footprint
- High flux capacity

Description: Fibracast designs and manufactures a unique, high efficiency hybrid immersed UF membrane called FibrePlate. FibrePlate is used in membrane bioreactors (MBR) to treat wastewater to reuse or high-quality discharge standards. FibrePlate combines the strengths (omitting the weaknesses) of conventional hollow fibre and flat sheet membranes configurations into a new, smaller, smarter and stronger hybrid platform with superior backwash capability and excellent hydraulics. The result is a reinforced sheet with hundreds of hydraulically efficient channels that act as fibres for permeation and back pulsing.

Applicability:

- FibrePlate is used in MBRs for industrial, commercial and municipal wastewater treatment.
- The technology can be installed in greenfield developments or retrofit into existing MBRs/conventional wastewater treatment plants to increase capacity and/or discharge quality.

Effectiveness of the Technology

- Compared to conventional immersed membranes, the unique FibrePlate configuration provides ≥50% smaller footprint, ≥40% energy saving (for air scour) and ≥30% higher peak flux.
- Additionally, FibrePlate systems have the ability to auto-desludge (in-situ) for recovery from plant upsets.
- More resistant to FOG than other membranes

Case Studies

- Fibracast has 25 sites operational or in construction in North America, Europe and Asia
- Fibracast have retrofit into both flat sheet and hollow fibre MBRs
- Applications in municipal water and wastewater treatment, as well as industrial MBRs

Indicative costs

- FibrePlate systems have a lower CAPEX requirement thanks to smaller footprints, fewer connections and higher peak flux capabilities. OPEX is reduced through energy and chemical savings in the membrane air scour process.

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Power and Water - Soneco
Next generation electro-based water treatment

Technology highlights:

- No chemical (flocculants / coagulants) addition
- Small footprint
- Automated

Description: Sonoelectrochemistry is the next advance in electro-based water treatment. Combining power ultrasound with electrolysis. The treatment process offers the advantage of physical, chemical and oxidative (advanced oxidation process, AOP) treatments with all the benefits of physical treatment. Adaptive software ensures optimum treatment performance and energy efficiency. Chemical-free, with no moving parts, the design is simple, safe, and effective, with lower CAPEX and OPEX compared to comparable water treatment technologies.

Applicability:

- Applications focus on secondary wastewater treatment.
- It can be used for Electro-coagulation, Electro-flocculation, Electro -flotation, Electro - disinfection and AOP.
- Process would require a solid/liquid separation tank downstream, therefore could be coupled with existing DAF systems.

Effectiveness of the Technology

- The technology is patented, robust, and simple with no moving parts.
- Adaptive software control ensures optimum treatment performance and energy efficiency even under changing influent flow and water quality.
- The treatment units are modular and can be delivered as factory built solutions.
- Expected COD reductions are 30-70% depending upon the soluble nature and composition of carbohydrate, fats, proteins etc in the waste stream

Case Studies

- Mining water remediation (UK) - Sono-electrochemical treatment (combined electrolysis and power ultrasound) was used to produce magnesium hydroxide to raise pH of the water, precipitate iron as insoluble iron hydroxide ($Fe(OH)_2$) and preferentially precipitate other metals in their stable hydroxide forms. Iron was reduced from 800mg/L to below 0.02mg/L and copper from 40mg/L to <0.1mg/L.

Indicative costs

- Based on the case study above and a flow of 12L/s the CAPEX is $1.4million for the Soneco reactor and power supply excluding the solid-liquid separation tank. The OPEX is $380,000 per annum for the Sono-electrochemical plant excluding replacement anodes.
- The operation costs will vary from application to application depending on what the treatment requirements are.

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Microvi
Biocatalytic wastewater treatment

Technology highlights:

- Specific microbes for targeted pollutants
- Reduced sludge production
- No additional chemicals

Description: Microvi has developed an efficient, versatile waste water treatment system based on advanced biological carriers (Biocatalysts). Biocatalysts are small, extremely permeable polymer spheres with complex internal structures, providing a protective environment for high concentrations of microbes, specifically selected for target pollutants. The Biocatalysts are suspended in an MBBR-like reactor. Polluted water enters the permeable biocatalysts and is biologically degraded into harmless end-products (e.g. N2, CO2, H2O). Biocatalysts are retained in the system through hydraulic design. Microbes never leave the biocatalysts and remain functional for years with no loss of performance. The high concentration of purpose-built pollutant removers accelerates biodegradation processes, offering significantly faster treatment compared to conventional biological processes

Applicability:

- The Microvi system is suitable for primary, secondary and tertiary treatment of various municipal and industrial wastewaters.
- It is designed to remove all pollutants of concern including BOD, COD, nitrate, ammonia, phosphorus and pharmaceuticals.
- Microvi have had multiple municipal and industrial installations in North America, Asia and Australia.

Effectiveness of the Technology

- In contrast to conventional biological wastewater treatment processes Microvi utilises specific microbes to target pollutants, rather than making do with the thousands of undifferentiated microbes provided by nature, most of which are not useful in the treatment process.

Case Studies

- BOD removal case study, Sydney - Influent into the process has a BOD range of 4,000-6,000 mg/L, after treatment the effluent has <100 mg/L COD. Hydraulic retention time is 8 hours
- Municipal WWTP application - Influent into the process has a BOD of 120 mg/L after treatment it is <10 mg/L. Similarly, influent COD is 250 mg/L and after treatment effluent has <40 mg/L COD. Hydraulic retention time is 2 hours

Indicative costs

- Much smaller footprint and significant lower CAPEX compared to conventional treatment, with savings of 50% for new plants being common. Higher savings are achievable when retro-fitting to existing infrastructure.
- OPEX savings of around 30% are realised through lower air and pumping requirements, as well as reduced sludge generation.
- Example Project: 10 MLD Municipal WWTP – Retrofitting the Microvi reactor, secondary clarifier, solids disposal and blower system. Estimated CAPEX - £5,000,000. Estimated OPEX - £173,000 per year.
- Significant savings over activated sludge and MBR alternatives

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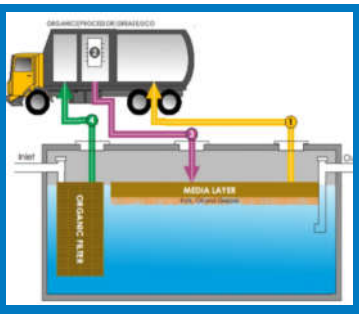
Appendix C

Sludge treatment – Technology profiles

Pumpfree
Onsite grease trap cleaning and

Technology highlights:

- Onsite grease trap cleaning
- FOG, BOD and SS reduction
- Oil recovery for use as a biodiesel



Description: Onsite Grease trap cleaning technology which removes the need to haul ~90% of water with Fats, Oils & Greases (FOG) from grease trap. The Pumpfree technology consists of an organic filter and proprietary media installed into a grease trap. Organics and food waste are trapped by the filter and FOGs are absorbed by the media. To extract the FOGs, the media is vacuumed out of the grease trap and processed to desorb the FOG, the clean media is then returned to the grease trap. The organics and food waste in the filter are also vacuumed out of the grease trap for disposal. These FOGs can then be used a biodiesel feed stock. The water left in the grease trap is has reduced FOG, BOD and SS.

Applicability:

- Pumpfree have focused on cleaning commercial grease traps (restaurants) with the reduction of trade waste costs.
- Pumpfree believe that the technology could easily be used in industrial grease traps but the technology has not yet been used in larger scale operations / applications.
- Retrofitting the system into a DAF may be possible but not if polymers are being used as these degrade the oil

Effectiveness of the Technology

- Increase in grease trap water quality with a reduction in BOD of 54%, a reduction in FOG of 75% and a reduction in SS of 65%

Case Studies

- Trials have been completed in conjuncture with Sydney Water, focusing on restaurant grease traps and decreasing trade waste costs. Removal rates in these trials have been between 40-60% of BOD and 60-80% of FOG
- A large restaurant saved up to $6,000 per year through the reduction of trade waste costs.

Indicative costs

- Capital and operational costs will depend on the volume of FOG and whether it is more economical for the dairy processor to purchase the equipment to regenerate and extract the oils from the media on site or whether an outside contractor performs this task.
- In the trials with Sydney Water trade waste customers it was estimated that they each will make a saving between $2,000-6,000 per annum.

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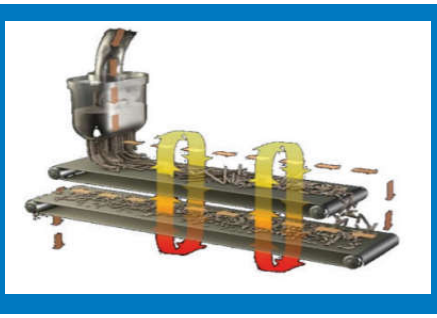
STC
Low Temperature drying

Technology highlights:

- Decrease waste volumes
- Use waste heat sources
- Fully automated



Description: STC is a Spanish company that specialises in the design, manufacture, installation and maintenance of drying equipment through hot air convection processes. The STC thermal dryer takes dewatered sludge, with a dry solids content as low as 20%, and produces sludge pellets with greater than 90% DS. The first stage of the process consists of an extruder which produces strings of the dewatered sludge and evenly spreads them across the drying belt. As the sludge travels along two consecutive belts, hot dry air circulates perpendicular to them and the resulting hot moist air is drawn into heat exchangers where the water is condensed. The energy needed to heat up the sludge and evaporate the water is recovered from the saturated air at the same time as condensation takes place, maximising the use of residual heat. The dryer operates using water at temperatures of between 85 and 90°C and is perfectly suited for coupling with low grade or waste heat sources such as CHP engines, gasifiers or pyrolysers. The final product then passes through a crushing mill to produce a homogenous pellet.

Applicability:

- The STC system has been installed in municipal WWTPs in Spain, France and the UK. The largest installation has a capacity 70,000 tonnes of sludge per year.
- There are limited commercial or industrial installations of the system as of yet.

Effectiveness of the Technology

- Re uses waste heat from other processes to dry the sludge, therefore waste heat needs to be available
- Can produce 90% DS pellets from sludge at 20% DS

Case Studies

- Industrial case study – Cement plant in Spain: 60,000 tonnes per year capacity equipped with two drier units with a capacity of 3,000 litres per hour of evaporated water per unit. Heat used for the process is waste heat recovered from the plant
- Shanganagh Municipal Wastewater treatment (Ireland) – The system has 2 lanes each with 1260 kg H_2O/h and uses residual heat from CHP generators combined with a biogas boiler
- Yorkshire Water (UK) - 1.000 Kg/h of urban digested sludge is dried from 25% to 90% dry matter in one unit with an evaporation capacity of 700 L/h and the heat is from the cogeneration engine on site.

Indicative costs

- Higher CAPEX compared to competitors, but less OPEX due to utilisation of spare heat from the site
- Approx. 0.3 kWe consume per kg H_2O evaporated

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Appendix D

Suez Ice Pigging cost example

Below is an example scenario provided by Suez for the installation of Ice Pigging including assumptions and payback

Key Inputs and Assumptions		
Number of lines	**8 Lines**	
Ice Pigging operations	120	Per week
Average current recovery	45	%
Estimated recovery with Ice Pigging	85	%
Average product temperature	4	°C
Average CIP 1st rinse volume	640	Litres
Key Outputs		
Ice required per week	4,288	Litres
AQL500 Utilisation	50	%
	Per Week	**Per Year (50 weeks)**
Additional product recovered (litres)	1,736	86,809
Water saved (litres)	68,168	3,408,399
Effluent saved (litres)	67,397	3,369,839
Potential savings	**$4,135**	**$206,726**
Payback Period (Years)		
	Cost	**Quantity**
AQL500 cost	$380,000	1
Installation cost per line	$8,500	8
Payback Time	**2.2**	**Years**

Additional assumptions:

- Electricity price of 0.13kWhr
- A product value of between 1-2$/L
- Freezing point depressant used is Sugar at $0.64/Kg
- Cost of water $3.39/1000L
- Cost of effluent $23.70/1000L
- Cost of NaOH $0.25/L

N.B This calculation does not factor in a monetary value for time savings.

Dairy Australia
Your Levy at Work

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