Assessing energy supply options for dairy manufacturing sites

CASE STUDY SUMMARY[1]

1 Project overview

Energy remains a significant input cost for Australian milk processing facilities. These energy needs are typically derived from electricity and natural gas supplied by national grids. It is well-known, however, that Australian grid-supplied energy costs have increased dramatically in recent years – particularly natural gas prices. At the same time the costs for renewable energy have reduced and energy procurement models have evolved. Optimising energy delivery costs at a dairy processing site is therefore a complex and dynamic task.

The aim of this Dairy Australia Technology Assessment (DATA) project was to make sense of the energy delivery options available to Union Dairy Company's (UDC) milk powder production site at Penola, South Australia, and to examine whether a change from the conventional approach to energy supply might result in business benefits – in terms of reduced cost, reduced carbon emissions and longer-term price security.

Specifically, the project examined options for energy supply from a variety of electrical and thermal sources. These options included onsite, 'behind the meter' heat and power co-generation via solar, biomass and natural gas sources as well as off-site power purchase agreements (PPAs) via third-party solar and wind projects.

The project assessed the benefits of each option in terms of cost and carbon emission reductions while also considering combinations of options (i.e. onsite natural gas cogeneration plus an offsite renewable PPA). While specifically focused on a modern four tonnes per hour processing plant, the broad outcomes of the study are applicable across the wider dairy manufacturing sector.

2 Industry needs the project addressed

This project addressed the industry need to reduce energy costs and improve longer-term price security while also reducing the carbon footprint of Australian dairy products.

The Australian dairy manufacturing sector uses approximately 13.5 petajoules (PJ) of energy per year at an aggregate cost of approximately $175 million per annum[2] . The top ten manufacturers process roughly 85 per cent of Australia's milk and, in general, operate in a low margin environment. With Australian gas and electricity prices rising sharply over recent years this has resulted in substantial cost pressures for these businesses. This limits both our international competitiveness and the price that processors can afford to pay farmers for milk.

In a carbon constrained future, it is also important that dairy processors continue to reduce their greenhouse gas footprint by seeking out lower or no emission energy options.

[1] This case study summarises the outcomes of a more detailed study completed by Headberry Partners P/L on behalf of Union Dairy Company. This study was supported through funding from the Dairy Australia Technology Assessment Scheme.

[2] The average Australian dairy processing site uses roughly 1.5 terajoules of energy per megalitre (TJ/ML) of milk processed. Assuming national milk production at approximately 9 billion litres this equates to roughly 13,500 TJ per year. Approximately 20% of this 13.5 petajoules is used for electrical energy requirements and 80% for the thermal needs of the manufacturing sites. (From Prasad, P., Eco-efficiency for the Dairy Processing Industry, 2019 Edition. Dairy Australia, 2019 pp. 56-57). To arrive at this approximate annual energy cost, conservative gas and electricity prices of $8 per gigajoule and $0.12 per kWh (delivered) were assumed.

3 Project relevance to the Australian dairy industry's sustainability goals

The Australian Dairy Industry Sustainability Framework outlines the industry's commitment to creating a vibrant industry that produces nutritious, safe, quality food while providing best care for our animals and being good stewards of the environment[3].

The Framework sets out eleven sustainability goals for 2030 and this project seeks to specifically address two of these:

Goal 1: Increase the competitiveness and profitability of the Australian dairy industry

- Through seeking lower costs of energy for the processing of milk products

Goal 10: Reduce greenhouse gas emissions intensity

- Through identifying cost-effective approaches to energy supply that result in lower carbon emissions from the processing of milk products

[3] Australian Dairy Industry Sustainability Report 2018, p.1

4 Key outcomes

By developing a simple model for comparing energy supply options (outlined below), this DATA scheme project was able provide Dairy Australia with guidance as to the potential benefits from each of the options explored and to test the sensitivity of changing various inputs. The key findings were:

Gas price matters

- For most Australian dairy manufacturers, 80 per cent of their energy needs is for thermal processes (i.e. heating and drying milk, hot water for cleaning). Ensuring the best possible natural gas price can therefore make a big difference.
- Lower priced gas also makes onsite gas-fired co-generation of heat and power a more attractive option.

Behind the meter energy projects have benefits

- By producing energy onsite and 'behind the meter' dairy companies can benefit from reduced network supply and peak demand charges as well as reduce their grid-supplied energy usage. Going completely 'off-grid' is not currently feasible from an energy security perspective.
- The benefit of behind the meter energy projects therefore needs to carefully consider network connection costs and peak demand management for supplying the balance of a site's energy needs in order to maximise the value of the onsite resource.
- The project assessed options for behind the meter cogeneration of heat and power via solar, biomass and natural gas. The highest ranked options were from solar cogeneration (if the low-quality heat can be used) and biomass (if there is close proximity to low cost biomass sources). Both have potential to deliver lower cost energy and less carbon emissions.

Accessing offsite renewable energy generation via PPAs should be considered

- While complex in nature, and still incurring network supply charges, corporate PPAs offer an opportunity to access renewable energy at a competitive rate and provide longer-term price security. Maximising the value of PPAs requires a retailer well versed in optimising the renewables mix while maintaining back up supply from conventional sources.
- For this project, it was identified that a mix of solar and wind provided the best outcome.

Diversifying your energy supply matrix may be best:

- Due to the nature of energy demands at dairy manufacturing sites and the dynamic nature of energy markets, it is prudent to consider a diverse mix of energy supply options which balance cost reduction and flexibility with longer-term price assurance.
- The project identified that improved cost and risk reduction by combining certain energy supply options was optimal. The project identified that the cost of gas has a massive impact. If lower gas prices could be achieved by close proximity to new gas resources the best outcome appears to be from negotiating lower priced gas combined with a mix of onsite solar/thermal energy generation and a PPA for wind and solar power.

5 Next steps

The project has provided a framework for prioritising energy supply options which can be then investigated in detail. The assessment model and final report will also be made available for the broader dairy industry to make use of the enable them to further assess and prioritise their own energy supply options.

For further information please contact Ian Olmstead, Program Manager - Manufacturing Innovation & Sustainability **ian.olmstead@dairyaustralia.com.au**

6 Using the Energy Options Assessment Model

First the user provides their company-specific data and assumptions relating to energy usage, costs, term of investment, etc. into the 'assumed values' column as inputs into the model. See example below.

Table 1 Input table

Input	Assumed value[4]	Units
Annual electricity usage	17	GWh
Peak electricity usage	2500	kVA
Annual gas usage	280	TJ
MDQ gas	1000	GJ
Annual production	25,000	tpa milk powder
Market price electricity	75	$/MWh
Market price gas	11	$/GJ
Price reduction for local gas	2	$/GJ
Price LGC[5]	40	$
RPP[6]	20	%
Price STC[7]	40	$
STP[8]	10	%
Emissions from grid	0.49	T/MWh
Emissions from gas	51.53	/TJ
Cost of capital	8	%
Term for recovery of self invested capital	15	years

4 Hypothetical inputs for energy use within a 4 tonne per hour dairy powder manufacturer
5 Large-scale generation certificates (LGCs)
6 The renewable power percentage (RPP) (**cleanenergyregulator gov.au/RET/Scheme-participants-and-industry/the-renewable-power-percentage**)
7 Small-scale technology certificates (STCs)
8 Small-scale technology percentage (STP) (**cleanenergyregulator.gov.au/RET/Scheme-participants-and-industry/the-small-scale-technology-percentage**)

The model then generates a series of approximate outputs in terms of cost and emissions savings based on the options considered by the study. The results of these model outputs can then help a business rank those energy supply options which it would like to pursue in more detail.

Note: The original basis for developing the model was a four tonnes per hour milk powder facility.

Table 2 Output table

Option	Description	Cost per year ($)	Emissions t (CO_2-e) per year	Indicative saving $/t (milk powder)	Indicative emission saving t (CO_2-e) per year
	Base case	6,106,100	22,758	0	
1	Reduced cost local gas	4,827,697	22,758	$51.14	0
2a	On site solar	5,983,389	21,010	$4.91	1,748
2b	On site solar + thermal	5,834,468	19,331	$10.87	3,427
3a	Biomass steam + elec	4,420,000	0	$67.44	22,758
3b	Biomass steam + elec + exhaust	3,020,000	0	$123.44[9]	22,758
4a	Offsite wind	5,802,842	18,038	$12.13	4,720
4b	Offsite solar		20,398		2,360
4c	Offsite solar and wind	5,823,241	17,448	$11.31	5,310
5a	Gas Turbine (elec + steam)	6,152,539	17,582	-$1.86	5,176
5b	Gas Turbine (elec + steam + exhaust)	5,683,026	16,654	$16.92	6,104
6a	Gas Turbine (steam + elec) + local gas	5,189,639	17,582	$36.66	5,176
6b	Gas Turbine (steam, elec +exhaust) + local gas	4,863,490	17,582	$49.70	5,176
6c	On site solar + offsite solar+wind	5,700,530	15,700	$16.22	7,058
6d	Onsite solar/ thermal + offsite solar + wind	5,551,609	14,611	$22.18	8,147
6e	Local gas + onsite solar + off site solar and wind	4,273,206	14,611	$73.32	8,147

9 This saving is questioned as while the boiler might be smaller, having less steam raised would increase the price of steam.

Dairy Australia Limited ABN 60 105 227 987
E enquiries@dairyaustralia.com.au
T +61 3 9694 3777
F +61 3 9694 3701
dairyaustralia.com.au

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