Saving energy on dairy farms

Disclaimer

Whilst all reasonable efforts have been taken to ensure the accuracy of *Saving energy on dairy farms,* use of the information contained herein is at one's own risk. To the fullest extent permitted by Australian law, Dairy Australia disclaims all liability for any losses, costs, damages and the like sustained or incurred as a result of the use of or reliance upon the information contained herein, including, without limitation, liability stemming from reliance upon any part which may contain inadvertent errors, whether typographical or otherwise, or omissions of any kind.

ISBN 978-1-925347-35-7 *(Digital)* ISBN 978-1-925347-41-8 *(Print)*

Contents


Dairy Australia

Foreword

Electricity is a major but unavoidable cost for dairy farms. Dairy farmers are under pressure from the rising cost of electricity and concerns over energy security. Real opportunities exist for dairy farmers to better control their energy costs and prepare for potential impacts on power supply, while simultaneously reducing greenhouse gas emissions from energy use.

Energy assessments of dairy farms

Since 2012 over 1,400 dairy shed energy audits (21% of dairy farms) have been conducted in all dairy regions across Australia as part of the national *Smarter Energy Use on Australian Dairy Farms* project, funded by the Australian Government and Dairy Australia.

The project provided funds for trained assessors to evaluate energy use in Australian dairies and identify opportunities to reduce consumption in order to lower energy costs and improve efficiency. After a detailed evaluation of annual energy, the farm owner or manager was given a report that identified where energy was currently being used, whether the dairy system was working as efficiently as it should, and what improvements could be made to reduce energy consumption. It was then up to the farmer to decide which recommendations to implement on their farm.

How to use this booklet

Many of the farmers across Australia who had an energy audit conducted at the dairy as part of the project are already reaping the benefits of having identified areas for improvement, and are investing in changes.

The audits found that while no two dairies are the same, milk cooling, milk harvesting and hot water production are the areas of highest energy use at 80% of a dairy's energy use on average. More than half of the assessments identified savings of up to $2,000 per year. About 40% of properties had potential to save between $2,000 and $10,000. Substantial savings of up to $29,000 were identified for 5% of the assessments.

Focusing on ways to reduce energy consumption for milk cooling, milk harvesting and hot water production will provide the greatest gain for improving energy efficiency.

2018 update

Since producing this publication in 2014, there have been many advances in energy efficiency knowledge and technologies. This refreshed *Saving energy on dairy farms* booklet aims to present tips, technologies and ideas for reducing energy use in the dairy.

It focuses on improvements that are relatively low cost, have short payback periods and can be implemented in most dairies across Australia.

It also provides examples of farmers who have implemented some energy saving ideas to reduce dairy running costs.

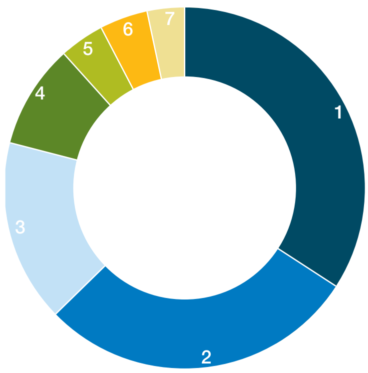
1 Introduction to energy use

Energy use on dairy farms

The national average energy use on dairy farms is 48 kWhr/kL of milk. The three main contributors to energy use are hot water, milk cooling and milk harvesting. Together they account for about 80% of energy costs, with the remaining coming from cleaning and effluent, stock and dairy water, feed and sheds and lighting.

Energy use per kL milk is highly variable and there is a herd size impact on energy use. Dairies with larger herd sizes have lower energy use per kL milk.

The type of dairy does not necessarily affect energy use except for automatic, small rotaries (<150) and large walk throughs (>300), which all have higher energy use compared to others with a similar herd size.



Energy use in dairy farms

1 Milk cooling **42%**

2 Milk harvesting **21%**

3 Hot water **17%**

4 Cleaning & effluent **9%**

5 Stockwater **9%**

6 Shed & lights **4%**

7 Feed **3%**

Source RMCG National report 2015

Saving energy is a team effort

Getting everyone in the dairy to think about energy efficiency is important. Have you discussed energy efficiency with your staff? They may have good ideas on how to reduce your energy bills.

It is important to make sure staff have been instructed properly on the operation and maintenance of electrical equipment including guidelines on timing and volumes for your dairy.

Smarter energy use

Follow these steps to reduce energy use and lower energy costs and greenhouse gas emissions.

FIND the leaks

Step one is to understand your energy use and identify any leaks.

An energy assessment or audit can help, but just as important is measuring and monitoring energy use.

Use the Energy Assessment Checklist on page 8 to identify options for further action.

PAY LESS for your energy

Understand the breakdown of costs of your energy bill and consider opportunities for shifting energy use to off-peak (via load shift or battery storage) and/or comparing energy plans to get the best deal.

See pages 11 to 12 for more on understanding your bill.

REDUCE demand and IMPROVE energy efficiency

There are two opportunities for reducing energy use in the dairy:

1. Better design of the dairy system to reduce the overall energy use profile (reducing demand).

Examples include:

- Purchasing of energy efficiency equipment
- Insulation (against heat gain or loss)
- Utilising natural attributes (for example, re-installing the first stage heat exchanger has the potential to save ~5,000 kWh and $1,060 per year)
- Sizing systems to suit
- Reducing/avoid wasting (for example, turning off lights when not needed) and/or
- Utilising renewable energy sources.

2. Maximising the operational efficiencies within the existing dairy system (improving energy efficiency).

Examples include:

- Maximising time-of-use and design of the system
- Correct operation, cleaning and maintenance of equipment
- Measuring and monitoring changes to energy use will also help in improving energy efficiency over time.

Page 16 of this booklet provides for more information on opportunities for reducing energy on farm.

OFFSET remaining energy needs

Where cost-effective, consider opportunities for use of renewables (solar, wind, hydro, biogas) on your property.

Learn more about possible renewable opportunities on page 30 of this booklet.

2

Find the leaks

Understanding energy use in your dairy

To reduce your power use in the dairy shed, the first step is knowing how much you use and what equipment uses the most. There are several ways to calculate your dairy energy usage and identify where improvements and savings can be made.

Dairy shed energy assessment

The energy saving checklist provides a preliminary energy assessment of your dairy shed and identifies potential opportunities for energy savings.

See page 11 for the dairy shed energy saving checklist.

The checklist should be a starting point for identifying opportunities for energy savings that can be further investigated within this booklet.

The next level of understanding energy use in your dairy would be to commission an independent energy audit of your farm business.

An energy assessment needs to consider:

- **hot water:** water used for cleaning milking plant and vats
- **milk cooling:** vat compressors, ice banks, glycol chillers, plate cooler equipment and cooling towers
- **milk harvesting:** vacuum pumps, milk pumps and rotary platform drives
- **cleaning/effluent:** wash pumps, effluent pumps and dairy water pumps
- **feed:** mills, mixers, transfer augers, delivery augers and feed pumps
- **stockwater:** pumps on waterways, dams, bores and tanks to fill troughs
- **shed and miscellaneous:** electric fences, air compressors, computers, fridges and fans
- **lights:** lights and floodlights.

Independent energy audit

When undertaken by a trained assessor, an energy audit expands on an energy assessment by considering the energy use, cost and load profile for your dairy to better prioritise energy efficiency actions.

An energy audit is a vital step when embarking on a major capital upgrade or installation to reduce the power bills of your dairy.

Commonly, an energy audit will include an analysis of energy consumption patterns, as well as a site visit to record fundamentals of energy usage, equipment data, operational behaviour and other factors that affect energy consumption. Modelling of energy consumption will be undertaken using meter data (if available) or analysing the following data:

- Milking times and operation hours
- Peak and off peak energy consumption based on energy bills
- Experience of dairy energy consumption patterns.

Tariff modelling is often also undertaken to identify the appropriate tariff structure for the dairy, in relation to local network charges and also different retailer charges. A good energy audit will also consider the energy charges by comparing the current energy prices being paid to your retailer under the current contract with what you would pay under a wholesale energy contract.

After a detailed evaluation of annual energy, the farm owner or manager is given a report that identifies where energy is currently being used, whether the dairy system is working as efficiently as it should, and what improvements can be made to reduce energy consumption. This provides a list of opportunities which the farmer can use to help make informed decisions about where best to invest capital.

Benefits of an energy audit

- Provides a thorough breakdown of energy use, including consumption patterns, operational behaviour, and equipment data (where available) that affect energy consumption.
- Quantifies cost-effective ways to reduce your power bill, for example shifting of electrical peak demands or identifying more cost-effective tariff structures.
- Compares and recommending the best value energy contract for the site/business.
- Details the costs, savings and payback periods for each energy saving opportunity.
- Prioritises energy saving opportunities and consequently helps inform future investment.

Cost of an audit

The cost of an audit will differ, depending on the assessor and the size of your business. Funding is available for completion of audits in some locations.
Additional information available at the Dairying For Tomorrow Website here: dairyingfortomorrow.com.au

Tips on how to find an energy assessor

- Ask someone you know to recommend an assessor within your area.
- Seek a referral from your local council or regional body.
- Choose from a list of assessors — Energy Efficiency Council or Sustainability Victoria provide some examples.

A good assessor should:

- Demonstrate their ability to conduct audits on dairy farms. Seek recent references, testimonials and case studies
- Have experience delivering energy assessments to best practice standards (Australian Standard AS/NZS AS3598:2014). Seek their experience with delivering audits to the standard
- Provide an Energy Audit report (see below) following the audit.

Preparing for an energy audit

Prior to meeting the assessor, compile:

1. Copies of energy bill/s for at least one quarter that best represents the average energy consumption and expenses on-farm
2. Information about energy use (including diesel if appropriate), costs and existing contracts
3. Information, including NMI, for energy meter/s.

Energy audit report

Some requirements of an energy audit report are:

- Background to the site/business with description of the key activities contributing to energy use
- Objectives of the assessment
- Site layout and location plan
- Scope of the assessment and assessment methodology
- Energy use profile for the baseline period, including:
  - Data sources, and
  - An assessment of the level of accuracy of the data
- An executive summary table giving a clear breakdown of each energy saving opportunity.

Case study:
Identifying energy saving measures through an energy audit

Nangkita Hills Dairy — Mt Compass

For South Australian dairy farmer Michael Connor, conducting an energy audit on his Mt Compass farm, Nangkita Hills Dairy, provided clear and simple opportunities for savings.

Facing year-on-year increases to power bills on his 550 cow farm, Michael and his team decided an energy audit was an important step forward.

'Costs are continuing to go up and the entire dairy industry is being affected,' Michael said. 'Through an energy audit, we were able to maximise efficiency and really understand what we can do to minimise energy costs.'

The energy audit analysed all of the meters and power use in the dairy shed and across the farm. The energy audit identified a number of energy saving measures, demand management measures and energy storage/generation measures. Calculated savings amounted to $50,658 per year, resulting in a simple payback period of three years (assuming an implementation cost of approximately $164,640).

Energy savings amounted to 104.2MWh per year, with 55 tonnes of carbon dioxide (tCO_2e) emissions reduction.

At the conclusion of the audit, an extensive report was provided which outlined ongoing energy costs and areas where simple changes could be made to produce significant savings.

The energy audit gave Michael a better understanding of the multi-layered on and off peak energy system in South Australia, meaning Michael was able to save money by adjusting his milking and irrigation routine.

'We were still using the same amount of power but by understanding the best times to operate the dairy and irrigate, we were able to be strategic and save money while not necessarily reducing energy consumption,' Michael said.

Since the audit, Michael has planned his power use and adjusted timers to minimise maximum load.

'We would not hesitate to recommend that other farmers conduct even a basic audit of their energy use,' Michael said. 'An independent consultant is able to come to your farm and make meaningful recommendations, giving you a good return on your investment.'

Monitoring energy use and meters

Permanent energy monitoring is a great way to drill down into the energy use at a site and to quantify savings from energy efficiency measures.

Energy monitoring allows you to drill down into the energy use at a site, but it's not the only way. Unless it has been installed for over a year, it only provides a snap shot without reference to seasonal and operational variations over time.

What is energy monitoring?

Energy monitoring involves attaching current transformer (CT) clamps to electrical circuits to measure the electricity going through the circuit

It is the only way to measure how much energy individual circuits in the shed are using. For example, the energy used by the hot water circuit or the energy used by the vat circuit.

Types of energy monitoring equipment

Energy monitoring gear is now commercially available, but there are differences in costs and practicality of different set ups.

Dairy farmers need robust gear that logs over time and can be viewed with easy-to-use software. Permanent monitoring is preferred over temporary.

Some electrical contractors now offer energy monitoring services where gear can be hired and installed in sheds for a fixed period at fixed cost. It is worth investigating whether your energy retailers may also install a interval meter an minimum or no cost.

If solar PV is to be installed an import export meter would be required that has interval metering capabilities.

Benefit of energy monitoring

Energy monitoring data can be used by trained assessors to:

› Provide a benchmark of efficiency
› Identify problem areas
› Highlight options for saving money
› As a decision support guide for prioritising energy efficiency actions.

If there are anomalies or inconsistencies in the power bill energy monitoring can help trouble shoot these issues. For example, if the power bill is unusually high energy monitoring can help track the problem.

Energy monitoring can also help independently quantify savings from energy efficiency or renewable energy upgrades.

However, there are limitations to energy monitoring. Unless it has been installed for over a year it only provides a snapshot without reference to seasonal and operational variations over time.

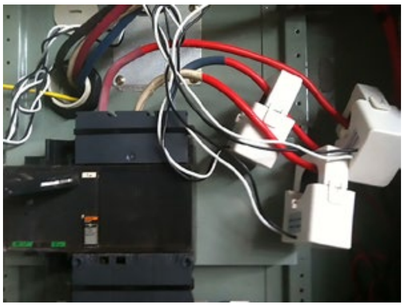


Figure 1 CT clamps on dairy shed circuit

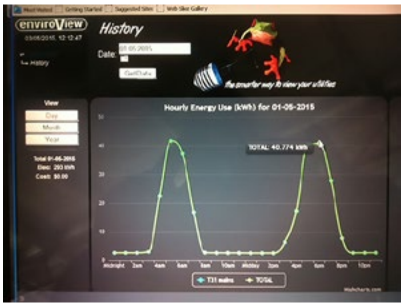


Figure 2 Unit to log and record energy use

Figure 3 Software with simple graphics to view energy use on each circuit

Source (Figure 1-3) 0277-6-CS SEU energy monitoring fact sheet

Dairy shed energy saving checklist

Reducing your electricity bill	Yes	No
Tariffs		
Are you making the most of off peak tariffs or controlled load tariffs?		
Have you compared your current tariffs with others on offer?		
Have you checked for better offers from electricity retailers?		
Measuring and monitoring		
Are you using an interval meter to quantify and/or monitor energy use?		
Are meter readings taken regularly and do they seem to be reflective of billing cycle and seasonal energy use?		
Have you updated to digital meters (from analogue)?		

Reducing demand and improving energy efficiency	Yes	No
Hot water systems		
Have you reviewed your hot water use volume and temperatures with your chemical supplier?		
Have you checked actual hot water temperatures delivered, compared to thermostat reading?		
Have you considered option of pre-heating the water that goes into your hot water service (solar hot water systems, heat pumps, and/or heat extraction from refrigeration units)?		
Do you check the sacrificial anodes regularly?		
Do you flush the unit regularly?		
Do you have sufficient hot water storage capacity to use the lowest off peak tariffs?		
Are your timers or off peak clocks set correctly?		
Are metal pipe connections well insulated?		
Have you checked your hot water is not boiling at night?		
Does the Clean in Place (CIP) storage fill quickly and is it used immediately?		
Milk cooling		
Precooling		
Are you using the coldest water available?		
Do you know the milk temperature entering the vat?		
Is it less than 2–3°C warmer than the water temperature entering the plate cooler?		
If not:		
Has the plate cooler been correctly sized for the job?		
Do the milk and water flow in opposite directions through the plate cooler?		
Do you have an even flow of milk through the plate cooler?		
Does the water flow rate exceed the maximum milk flow rate by a ratio of at least 3:1 for ‘m’ type plate exchangers, or 2:1 for industrial types?		
Milk harvesting		
Have you considered options for reducing milking times, in order to reduce the time that equipment is running?		
Are annual tests carried out by a technician to check vacuum regulation, airflow, leaks, drive belts, etc.?		
Has your milk plant technician checked you do not have excess reserve in your plant?		
Is the vacuum pump motor clean and well ventilated?		
Have you considered installing a variable speed drive (VSD) to match the speed of vacuum pumps with air flow?		

Maintenance and cleaning	Yes	No
Refrigeration plant		
Is the refrigeration unit protected from rain and direct sunlight?		
Has your refrigeration technician checked for leaking refrigerant?		
Does a qualified refrigeration mechanic undertake annual maintenance?		
Condenser units		
Are they located to take advantage of prevailing winds and to allow unrestricted airflow?		
Are the fins clean and undamaged?		
Have you checked that oil from the vacuum pump has not blown/is not blowing on the condenser fins?		
Water pumping		
Can water pumping be done in off peak times?		
Can the existing pump(s) be changed to a more efficient type?		
Do you regularly check for leaks in the system?		
Dairy shed		
Are you using energy efficient lights?		
Do you clean your light globes and fittings annually?		
Are lights switched off after milking?		
Have you investigated sky lights as an option?		
Is your dairy shed well ventilated?		
Are the walls and structures positioned to maximise airflow and reduce the need for fans?		
Are you considering the future energy saving potential for all new equipment purchases?		

Renewables and offsets	Yes	No
Before seeking quotes for any renewable project (solar, wind, hydro, biogas or storage):		
Have you established the current electricity use (or demand) profile for the dairy and whole farm?		
› If so, will the energy demand match the supply from the renewable source (e.g. maximum daytime use for solar energy)?		
› If not, do you have access to real-time energy use data for all sites?		
Do you know your peak and/or demand charges? Be sure to ask for advice on whether there is potential for renewables/storage technology to reduce or avoid the peak and demand charge, as this will outweigh the up-front and operational costs of installation.		
Have you considered whether you want to build, own and operate or lease the renewables? And/or have you sought advice on the best financing option for your renewables project?		
Have you considered the type of system (grid-connected, to allow for Feed-in-Tariffs, or stand alone) best suited to your site and situation?		
› If grid-connected, have you checked/sought advice on whether this is feasible with your existing grid supply and if there are any restrictions to the generation capacity of the system?		
› If stand-alone, have you considered all storage options (thermal, pressurised or electrical energy storage)?		
Do you have irrigation pumps running during daytime hours in summer? If so, offsetting this peak demand with renewables may be an option.		
If not already, have you considered installing monitoring equipment to track your use of energy over time (and the performance of energy efficiency/renewable measures implemented)?		
Further advice on selecting a supplier and the key questions to ask to ensure the design of a renewable system matches your needs, is available in the renewables section (pg 30).		


VACUUM PUMPS
STOP
START
ROTARY PLATFORM
STOP
START
BACKING GATE ENERGISER
ENERGISER ON
REVERSE
BACKING GATE
FORWARD
YARD LIGHT
WEST LIGHTS
EAST LIGHTS
BARREL FAN
DAIRY FEEDING SYSTEM
STOP
START
MISS
EXTRA
FEED SYSTEM DROP TIMER

What can I do?

- Get quotes from a number of suppliers.
- From your bills, calculate your peak, shoulder and off peak use and controlled load use.
- Take meter readings of the times you actually run the equipment at the dairy, if peak and off peak are not displayed on your bills.
- Look at changing to TOU, controlled load tariffs.
- Take into account the extra service fees charged for some tariffs.
- Bear in mind the cost of breaking contracts.
- Read all the fine print and conditions.

55%
Retail and other charges

Includes the wholesale cost of generation, retailer hedging through futures markets, retailer charges and retailer margin.

35%
Network charges

Include fees charged for the cost of transporting electricity across long-distance high voltage transmission networks and medium to low voltage distribution networks to businesses and households.

10%
Environmental charges

Include costs charged to consumers for government efficiency schemes.

Source ACCC 2018

Understanding your electricity bill

To help clarify how your electricity is being charged, it is important to understand the separate components that make up your bill. Essentially, there are three separate categories of charges on your bill – retail, network and environmental. Figure 1 provides a breakdown of each of these components.

Retail charges are the major component to electricity costs at 55%, as retailers purchase wholesale electricity and on-sell at fixed retail prices. Other costs – notably network charges, and to some extent environmental charges – are simply passed through to customers.

There are different options available for network and energy charges, so understanding the breakdown of your charges is an important first step.

Why is the cost of electricity increasing?

The National Electricity Market (NEM) comprises five interconnected states that also act as price regions: New South Wales (including the Australian Capital Territory), Queensland, South Australia, Tasmania and Victoria.

All electricity in the NEM is traded through a spot market, where supply and demand are matched in real time through a centrally coordinated dispatch process.

Higher wholesale prices were the overwhelming driver of the electricity bill increases experienced by businesses during 2016 and 2017. Over this period there were cumulative increases in wholesale electricity prices of between 77% and 176% across the four major NEM states.

Three key trends are in the process of NEM transformation – the generation mix is changing (from fossil fuels to renewables), the grid is decentralising (with multiple sources of generation, storage and demand management) and the demand profile is shifting (with businesses increasingly controlling not just where their energy comes from and how much they use, but when they use it). New renewable generation is entering the wholesale market, increasing supply, and therefore competition, and even more renewables are being built. Even so, few experts expect wholesale prices to return to the lows of 2015.

Determining electricity demand and energy use

There are some common terms used to identify electricity demand and energy use on your bill:

kVA Kilovolt-amps: units of electrical power demand.

kWh Kilowatt-hours: units of electrical energy use. Your average daily energy use is measured in kWh and megajoules (MJ) for gas.

MWh Megawatt-hours: units of electrical energy consumption.

Off peak Any power used between 10pm and 7am weekdays and all weekend will be billed at off peak rates.

> You can check the wattage on motors and multiply the kilowatts (kW) by the run time to calculate the kilowatt hours (kWh) of energy usage.

Electricity use and tariffs

Electricity retailers have a range of tariffs for different customers and for electricity supplied at different times of the day. Cheaper rates at lower or off peak times encourage consumers to run water heaters and other appliances or motors during off peak periods and help the energy provider spread the load.

There are four common tariffs offered by electricity retailers:

Single or flat rate tariff

All electricity use is charged at the same rate. This tariff can be the best option where milking in the morning continues into the peak tariff period and if used in conjunction with a 'controlled load' (see below).

Time of use tariff (TOU)

Provide a range of charges depending on the actual time power is being consumed. Polyphase meters with TOU capability record both the time and kilowatt hours during each of these periods: peak, shoulder and off peak on a daily basis.

Note: Some retailers have even more time periods than peak, shoulder and off peak—for example, a flexible pricing tariff. Flexible pricing tariffs are not available in all areas yet. You will only be able to search for flexible pricing tariff offers on Energy Made Easy *if they are available in your area. Normally, these tariffs attract higher service fees, so it is worth checking the savings achievable.*

Controlled loads

Controlled load tariffs are available for specific equipment such as water heaters, stockwater pumps, ice banks and chiller units. There are various names for these tariffs, but essentially there are two types:

- Overnight: this is normally the cheapest tariff, with power available to the equipment wired to the meter only during the night, normally 10.00pm–7.00am. This tariff is typically used for water heaters where there is sufficient hot water storage available for the day's requirements.
- Overnight and limited availability during the day: this is normally more expensive than the overnight tariff, but less than the general tariff. Power is available to the equipment wired to the meter during the night and limited periods during the day. This is typically used for pumps and ice banks, chillers or hot water systems with insufficient storage for the whole day.

Not all distribution areas have 'controlled loads' available (except in South Australia, where they simply have TOU rates).

Demand tariffs

A demand tariff is comprised of standard electricity supply and usage charges, as well as an additional fee called a 'demand' or 'capacity' charge. Demand (measured in kilowatts) is a measure of how intensely you use electricity at a point in time, instead of your usage over time.

Demand tariffs have traditionally been used in large business, but as of 2017, retailers can now offer them to residential and small business customers.

Demand charges vary across different electricity distributors and retailers. Demand charges are also different in 'summer' (December-March) and 'winter' (April-November). Typical rates are anywhere from 30c per kW/day to 40c per kW/day in summer, and from 8c per kW/day to 20c per kW/day in winter.

Demand tariffs encourage enterprises to spread their electricity usage over time, rather than all at once. So long as your electricity usage is stable to avoid exorbitant demand charges, this makes it possible for a demand tariff to save you money.

It is important to understand how a network demand tariff works. In particular:

- how the demand charge is calculated (any-time or time-of-use)
- your demand charge threshold (below which you are not charged)
- the peak and off peak periods, if applicable, and the different rates
- if the charge is applied to your maximum demand or your average demand.

Options for reducing your energy costs

1. Negotiating a price and supplier

Contact your energy supplier to negotiate a better deal for your electricity. You could also contact other suppliers to find out their best rates, even if it only gives you a better price to negotiate with your current supplier.

'Obsolete' tariffs are no longer available for new connections, but sometimes have better conditions or rates than current tariffs.

Check that your obsolete tariff is not more expensive now than alternatives. Many tariff charges have changed in recent times, in particular service fees.

The Australian Government comparison website could be used to assess options in your area: energymadeeasy.gov.au

There are a number of online brokers who can give you a good list of suppliers to contact. Bear in mind each site may not access all suppliers available, so review a few brokers:

electricitywizard.com.au

iselect.com.au/energy

goswitch.com.au/compare-electricity

energyaction.com.au

2. Reduce peak power use

Savings will depend on timing of the morning milking and any other tasks that use power performed during the off peak period.

Potential savings can be calculated by:

- Reading the existing ordinary meters at specific times during the day.
- If polyphase meters are in place, an analysis of power bills will determine whether a change to TOU tariff can save money.

3. Reduce 'demand charge'

Demand tariffs could deliver real savings to your business, especially if you can reduce your network demand during peak times.

Seek advice from an independent energy advisor to assess which tariff is right for your business.

4. Consider power factor correction equipment

If you consume more than 160 MWhr/year on one meter, you are 'contestible' and may be required to move to a larger business plan or non-standard contract. These contracts contain different terms and conditions to a 'standard' contract and may include variations in price, fees, charges, contract length, payment options and early termination and exit fees.

- These contracts also charge you for 'losses' of kVa in your system.
- The cost of kVa can be 30–50 per cent of your bill and is dependent on your 'power factor'.
- Power factor is often shown on your bill. 0.95 is achievable. If yours is 0.70, there is potentially a 25 per cent saving in your kVa costs by installing power factor correction equipment.

5. Generate power onsite

As demand for electricity continues to rise, utilities and grid operators continue to look for ways to increase the electric grid's capacity. Where once the only option was to fire up costly backup plants, power providers can now look to energy users to relieve the grid of excess demand at critical times.

Consider your options for on-site renewable energy generation.

Further information on this is available in the Renewables chapter page 30.

What can I do?

- **Check your tariffs and service charges.**
- **Check your supplier is offering the best deal.**
- **Check offers, rates and service charges from other suppliers. Make sure you understand the offer, including complete costs and charges.**

In addition to seeking to change your tariffs or service charges, you should also review the energy efficiency of equipment in the dairy by:

- **Getting an energy assessment on your dairy to establish the breakdown of costs and the range of options to reduce your usage**
- **Reviewing the times you use electricity in the dairy and considering how much 'off peak' power you use**
- **Measuring and reviewing water and milk temperatures in the dairy**
- **Carrying out the low-cost actions to reduce your bills**
- **Researching available rebates and government funding.**

Things to consider when reviewing your tariff options:

Check your tariff — the dairy should be on a business tariff, not linked to your home with its residential tariff.

It is worth checking that the tariff you are on is the most suitable for your use pattern. Some farmers have found that their tariff has increased in cost compared to other tariffs available from the same supplier.

TOU tariffs have higher service fees than general tariffs and controlled load tariffs, but can offer substantial savings for dairy farms where milking is completed before the peak tariff comes on in the morning or equipment is installed with timers to take advantage of the lower off peak tariff times.

If approximately 40–50 per cent of the activities at the dairy are done during off peak times, TOU metering can result in significant savings.

TOU tariffs require polyphase meters. Normally these meters are provided free by the energy supplier, but the cost of installation is borne by the customer. A Class 2 electrician is required to change meters.

Case studies:

Tariff change to maximise opportunities for demand savings

Brad and Karin Fischer, Lake Albert in Meningie West, South Australia

Brad and Karin Fischer's dairy underwent a significant upgrade in 2014, with a focus on extensive automation. Various new technological systems were implemented, such as the installation of variable speed drives with smart phone controls for the irrigation pumps, to optimise pumping pressures and minimise energy consumption. The Fischers' herd was increased to 600 cows, with milking scheduled for three times a day. The property has 240ha of centre pivot irrigation, which draws water from Lake Albert at the bottom end of the Murray River system, supplying water for crops such as maize and lucerne.

Increased cost of their energy and the operational costs of the pumps were putting a strain on the business. They are also subject to costly and constantly changing network charges that target demand, measured in kVA in South Australia. Consequently, an energy audit in 2018 was undertaken to help them save money and increase their energy security.

The electrical supply for the irrigation pumps was identified as a large savings opportunity in terms of network charges. The tariff structure at the time was Agreed Demand, where the demand limit was set for the year and the site was billed uniformly each month – even when the pumps were not in use. This resulted in high network charges even through winter, when the pumps were off. Moving the site to an Actual Demand tariff structure changed the way the demand charges were billed to incorporate an actual meter reading. This eliminated the unnecessary winter network charges and allowed the site to load shift to ensure that further savings were realised throughout the rest of the year.

The cost of operating the irrigation pump (without regard for the demand charges of the previous year) was $64,687. By avoiding use of the pump in the peak demand period (from 4pm to 9pm, November to March, Monday to Friday), approximately $6,000 will be saved. A further $6,000 could be saved if the pumps are switched off between 12pm and 4pm all year round. If operation of the irrigation pumps was avoided during both the peak demand period and the shoulder demand period (from 12pm to 4pm, all year round), the savings would increase to approximately $12,000.

These measures were implemented and the savings were realised immediately – at no additional cost as the VSD controls were already in place.

Load shifting is a common zero cost measure that can be implemented at a dairy or with an irrigation system to offset peak energy rates or demand charges.

Energy—watts it worth?

Jack Laidlaw and Tim Clarke, West Gippsland, VIC

Jack Laidlaw knows a bit about saving energy in the dairy. He's farm manager at DPI Ellinbank, where they've cut plant cleaning consumable costs (power and chemical) by a whopping 60per cent, saving more than $4,500 a year.

'Our researchers estimated we could save up to 75 per cent of our energy use. It sounded good but my first priority was to ensure milk quality was protected,' said Jack.

The savings came from two simple changes: altering the cleaning system and maintenance.

Most of the energy saved was achieved by altering the cleaning system to reduce the amount of hot water used. Some of the hot waste wash phases were replaced with 'cold chemical' phases, using chemicals specially designed and registered for this purpose.

The hot water services were reviewed to make sure they were sized appropriately and functioning correctly.

4

Reduce energy needs

Better design and improving energy efficiency in the dairy

Once you understand the greatest areas of energy use in your dairy, the next step is to consider opportunities for improving the design and consequently energy demand of your system.

There are two opportunities for reducing energy use in the dairy:

1. Better design of the dairy system to reduce the overall energy use profile (reducing demand)
2. Maximising the operational efficiencies within the existing dairy system (improving energy efficiency).

Reducing demand

Reducing demand can be realised through implementation of some or all of the following actions which relate to the design of your system:

- Insulation (against heat gain or loss)
- Utilising natural attributes (for example, re-installing the first stage heat exchanger has the potential to save ~5,000 kWh and $1,060 per year)
- Sizing systems to suit
- Reducing or avoiding waste (for example, turning off lights when not needed)
- Utilising renewable energy sources.

Case study:
Design and maintenance to reduce energy demand

The Van Diemens Land Company, Tasmania

The Van Diemens Land Company (VDL) is the oldest continually operating company in Australia and as of 2015, when the energy audit was undertaken owns and operates 23 large dairy farms in northwest Tasmania, 11 of which are on the historic Woolnorth property. The majority of the farms are 50 unit rotaries or larger, and the smallest are 32 unit herringbones. The smallest herd size is 350 and the largest is 1800, the average being 850. Most of the dairies were built in the 1990s.

VDL's Paul Niven said the company was concerned about rising energy costs. 'We recognised that our energy costs were rising sharply so saw undertaking energy assessments as a way to take a close look at what was happening and what we could do to make positive change to the way we used energy in our dairies,' he said.

The energy assessments showed that 74% of the dairy plate coolers were not performing at their optimum level, and were consequently leaving more energy intensive work to be done by the refrigeration units. The majority of the VDL farms have access to a valuable cool 15 degree bore water resource, which should ideally be able to take care of up to 60% of the total cooling duty with a properly sized and functioning plate cooler system.

As a result of the assessments, VDL re-evaluated the design size of the plate coolers and the current water flows through them, and also developed a comprehensive service and maintenance program. It is clear that on the older dairies the milk volumes have increased over time but the plate cooler sizes have remained the same, or if they have been upgraded then the water pumps supplying them may not have been.

The assessment results estimated that ensuring all plate coolers are running optimally across VDL farms could save around 120,000 kWhrs per year, which would equate to a saving of a massive $24,500 per year for the company (based on 2015 prices).

Building a new dairy

Plan to reduce energy use from the start by considering location, construction and design of the dairy.

Location

Have you selected the best location for your dairy?

Consider:

- Distance to electrical grid connection and road infrastructure.
- Natural fall away from the site to allow effluent flow to ponds without pumping.
- Take advantage of natural aspects for shade in hotter areas and sun in cooler areas.

Construction

Have you optimised dairy shed design to take advantage of the surrounding environment?

Consider:

- The ability to open up the shed structure for natural ventilation in summer and close up for winter heat retention.
- The use of skylights or skylight wall tops to provide natural light.
- Insulation – especially under the roof.
- Heat reflective cladding in warmer climates.

Design

Reducing energy consumption for milk cooling, milk harvesting and hot water production provide the greatest energy savings.

Consider:

- Milk cooling: adequately sized plate coolers, double bank plate coolers, cooling towers, glycol cooling.
- Milk harvesting: variable-speed drives for vacuum and water pumps, aiming for short milking times if practical.
- Hot water: optimise water use and temperatures, off peak heating, insulating pipes and cylinders, heat recovery or solar water heating systems.

Improving efficiency

There are three parts to energy efficiency at the dairy:

1. Energy efficient equipment
2. Maximising time of use and design of the system
3. Correct operation and maintenance of equipment.

To improve energy efficiency, consider the following:

- **Hot water:** ensure that amount being heated matches the needs of the cleaning cycle, checking and replacing anodes, Clean In Place (CIP) processes, noticing changes (for example a boiling hot water system), temperatures on gauges and excessive use of hot water.
- **Milk cooling:** noticing if the compressors run for longer than normal, monitoring milk temperature going into the vat, flushing out/cleaning the plate cooler properly, periodically checking water flow rates.
- **Milk harvesting:** knowing the expected milking time for your dairy; longer milking times equal equipment running for longer.
- **Cleaning:** appropriate volume and temperature of water used for washdown.
- **Maintenance:** check systems for leaks and damage and repair and replace, ensure systems are operating at their maximum capacity, and regularly clean filters.
- **Lights:** upgrading to LED lighting will have energy, demand and maintenance savings.
- **Tariffs:** Off peak electricity utilised when practical.

Implementation of new technologies, for example variable speed drives (VSDs), and better design of dairy sheds can also improve efficiencies. Also factor in future energy savings potential when selecting new equipment.

Measuring and monitoring changes to energy use will also help in improving energy efficiency over time.

The greatest return on investment can be from implementing simple energy saving changes, which may have immediate benefits.

Further advice for reducing demand and improving energy efficiency for specific component of the dairy system are on the following pages.

5 Water heating

Water heating accounts for a quarter of on farm energy costs. Preheating hot water and installation of thermal heat recovery systems in the dairy can be great options financially and environmentally.

What can I do?

- Minimise the volume of water used to wash the plant and vat.
- Wash at the lowest temperature possible without compromising hygiene.
- Use a thermometer to monitor hot water inputs and outputs.
- Install a water heater with capacity for all daily wash requirements so that all heating can occur the off peak tariff.
- If a TOU tariff is in place, install a timer to ensure water is only heated during the overnight off peak period.
- Install a hot water preheating device such as a heat recovery unit or solar hot water heater so that most of the heating can occur without using extra electricity.
- Insulate pipes to reduce heat loss.
- Keep storage tanks out of breezeways and drafts.
- Use the best quality water available—high levels of minerals or organic matter reduces heating performance.

Solar hot water systems

Factors to consider when installing solar hot water system at the dairy

- For many dairies, the solar system will not produce hot water at a high enough temperature for plant wash when required, and the preheated water will need to be boosted to the required temperature. If this boosting uses peak power, it can be costly. The system must be carefully designed to take advantage of the solar preheating, but not increase the use of peak electricity.
- Correct installation and mounting is critical to success. The roof needs to be strong enough to hold the system. The collector should be mounted to face north or the amount of energy that can be captured is reduced.
- The tilt angle should be the same as the latitude of the installation site.
- The higher the quality of collectors in the system the hotter the water produced.
- If your gas/electric hot water system has plenty of life in it, consider retro-fitting the collectors, pump and controller to an existing storage tank. The retrofit option can save large amounts on installation and eliminates the need to replace an existing hot water cylinder.

Preheating water to 60–65°C using solar and then boosting* it to the required temperature with the dairy heater can save more than 40 per cent of electricity costs of heating water.

There are two types of solar hot water systems: flat plate collectors and evacuated tube solar collectors.

Flat plate solar collectors have copper pipes running through a glass covered collector, often connected to a water storage tank on the roof. The water thermo-siphons in and out of the tank, heating the water.

Evacuated tubes use a glass tube with a vacuum inside and copper pipes running through the centre. The copper pipes are attached to a common manifold connected to a slow flow circulation pump. This pumps water to a storage tank below, heating the hot water during the day. The hot water can be used at night or the next day due to the insulation of the tank.

For more information and references visit:

Dairying For Tomorrow:
bit.ly/2FHwTzL

Agriculture Victoria:
https://bit.ly/2CrAFKk

Image: Example of evacuated tube hot water system on a dairy farm.

This table is a comparison of flat plate and evacuated tube hot water solar systems.

Flat Plate	Evacuated Tube
May be less expensive.	Can be more expensive.
Operates most efficiently in the middle of the day.	Can heat water to a higher temperature as they have a greater surface area exposed to the sun at any one time (approximately 40 per cent more efficient).
More sensitive to frost causing damage to the collectors.	Can be used in sub-zero and overcast conditions (can extract heat out of the air on a humid day).
Heavier	Risk of overheating. As the water reaches its maximum temperature in the tank the pressure and temperature valve automatically activate and release some hot water to allow for cold water to come back in, reducing the temperature build-up. To minimise the risk, the number of tubes must match the quantity of water to be heated.
	Lighter—some lightweight designs can be mounted on walls and even poles.
	Uses smaller roof area.
	Less corrosive than flat plate systems.
	Are durable and broken tubes can be easily and cheaply replaced.

Thermal heat recovery systems

A large amount of waste heat generated during milking can be harvested and used. Sources include plate coolers, refrigeration systems and some vacuum pumps.

Heat recovery systems are available that capture the heat from the milk refrigeration system and use it to heat water to 65°C.

- The system sits between the compressor on the milk vat and the air cooler condenser to extract the heat during milk cooling.
- The hot refrigerant gases from the compressor are transported to the heat recovery system where the heat is released into the cycling water in the system.
- Most of the commercial units available have 450 litre capacity. This water can be fed into the hot water system.
- Using water to remove heat from the refrigeration system is more efficient than using air so improves the efficiency and life of the compressor.

Cost

A project from Agriculture Victoria developed a case study dairy farm in south Gippsland to demonstrate the cost and savings of a heat recovery system to heat 700 litres of water to 65°C.

- The preheated water entered the electric hot water service to heat to 90°C overnight.
- The energy saved under the system was 41kWh which equated to $2,905 saved in the first year.
- The capital investment of the system was $7,375 plus $3,000 for installation.

The savings generated by the system meant that the initial cash outlay was recouped by the fifth year, after which the system would be a cheaper alternative to electric hot water. At the end of the tenth year the system was $16,800 better off than business-as-usual and had an internal rate of return (IRR) of 27 per cent.

Factors to consider when installing thermal heat recovery systems:

- Correct installation on the existing milk cooling system to achieve target water temperatures.
- The volume of the water tank and volume used during and between milkings.
- The amount of milk to be cooled will determine how much heat can be captured.
- The type of refrigerant gases and the configuration of the installation.
- Combining an evacuated tube solar hot water system with the thermal heat recovery system. This can be an option that will reduce dependency on electricity but the complexity of combining the different systems will need to be considered.

Advantages	Disadvantages
Free energy from the refrigeration system	Capital expense ($7,000 – $11,000)
Can reduce milk refrigeration costs if properly designed	Poorly designed systems can result in water that is too hot and reduce the overall efficiency of the refrigeration
Can prolong the life of the compressor	Difficult to recover heat from the large volume of warm water generated from the plate cooler (without insulated storage)
In some cases can heat water to greater than 75°C	

For more information and references visit:

Agriculture Victoria: bit.ly/2ymNVNq

Heat pumps

Facts about heat pumps

- Most have a volume of 340 litres, however 400 and 1,000 litre tanks are also available. Two or more tanks can be installed in manifold to supply large volumes of hot water.
- Tanks are made of stainless steel, copper or ceramic lined steel.
- Compressor motors are usually small drawing 0.7kW to 4.2kW depending on the model and size of the unit.
- Smaller units run off single phase and large models require three phase power.
- Of the energy required to heat the water, two thirds come from the heat in the air, and the remaining one third from the power used to drive the compressor.

A heat pump can reduce power consumption and costs by preheating large volumes of water to 60°C. An air-conditioned (solar) heat pump works like a refrigerator in reverse. The compressor on the heat pump transfers heat from the surrounding air to water held in an insulated tank. The water from the heat pump is then transferred to the hot water heater so it can be heated to the temperature required to wash the milking machine. They are not a substitute for the hot water system.

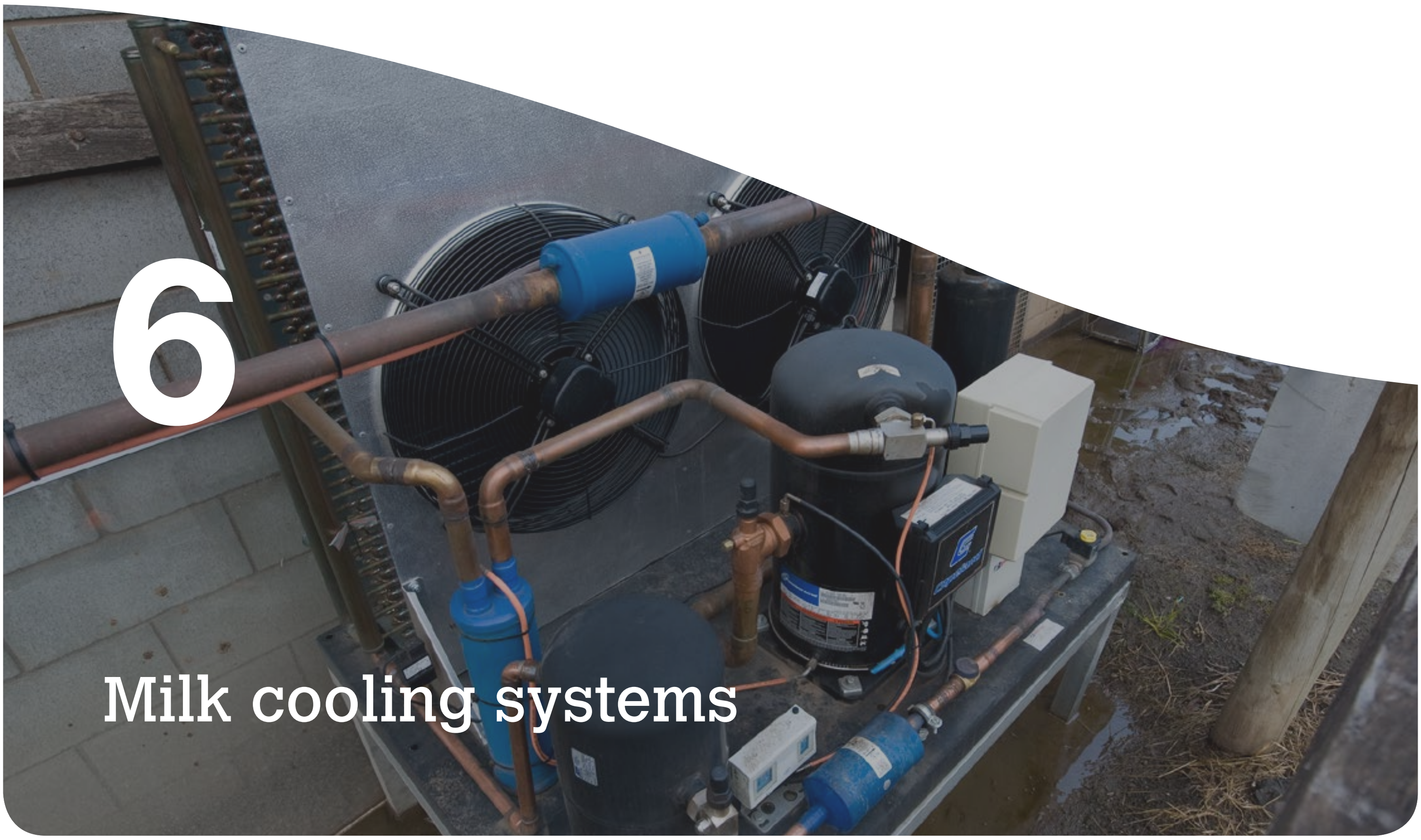
Savings of approximately 40 per cent can be made with heat pumps. To heat 800 litres of water to 85°C, savings ranged from $700 for off peak hot water systems to $2,500 when there was no off peak hot water at the dairy (EWEN Project). Careful installation is essential to prevent short circuiting in the water delivery pipeline, otherwise no savings will be achieved.

Heat pumps are also highly technical equipment and require fully qualified technicians to repair; when they go wrong they can be an expensive fix.

Manufacturers recommend that heat pumps are operated during the warmer part of the day, as they will work most efficiently when the ambient temperature is highest. They can operate at night, however, as they do not require direct sunlight to work. Some heat pumps have been designed to work in ambient temperatures ranging from -10°C to 40°C.

Costs and savings

Before 2010, heat pumps were a very attractive option with high government rebates available. However, these rebates have been significantly reduced and costs and savings must be carefully considered before installing them.



6

Milk cooling systems

Cooling milk from 35°C to 4°C accounts for the biggest proportion of total dairy energy costs, at between 30 and 60 per cent. Operating an efficient milk cooling system can reduce energy demand and costs. In many cases the cooling system needs to be evaluated to ensure it is working efficiently and not costing you money.

What can I do?

- Ensure the plate cooler is the correct size for the volume, pressure and milk flow rate. This will ensure effective cooling of milk so vat compressors are not running for extended lengths of time.
- Use a plate cooler with a single pass of cool water that is not recirculated unless it is re-cooled, for example with a cooling tower.
- Have your plate cooler regularly serviced by a technician.
- Consider double bank plate coolers where the coldest source of water flows through the first plate cooler. The second plate cooler can use glycol or chilled water to cool the milk even further. It is beneficial if the chiller can be run during off peak power.
- Consider adding thermal storage (glycol or ice) to benefit from off peak energy rates and avoid high demand charges. Especially for the sites in the southern states with a high duirnal range.

Plate coolers

Plate coolers are an extremely cost effective way to cool milk, but in many cases are poorly utilised. There are several factors that impact on the effectiveness of plate coolers.

Flow rates

The system needs to be designed according to the peak flow rate of milk expected from the milk pump. Providing an even flow of milk from the milk pump by installing a variable speed drive will help make the plate cooler system easier to size and make use of the cooling water more efficient. Using a transfer (rather than pressure) pump is a preferable way to supply the cooling fluid.

Surface area

The latest plate coolers are designed to have a greater surface area to give them greater heat exchange capacity and improve their cooling efficiency. Different types of plate coolers require different flow rates for the cooling medium. The standard ‘M’ and ‘P’ series plate coolers operate on a ratio of 2.5–3 litres of water per litre of milk passing through the cooler. Newer industrial models work on 1.5–2 litres of water per litre of milk.

Plate compression

Plates that are too tight restrict flow so aim for three millimetres for each plate and gasket.

Plate cleanliness

Contaminants of either the water or milk that adhere to the plates will affect the heat exchange capacity, flow rate and efficiency of the plate cooler.

Source water

The temperature of the source water is the greatest limitation to plate coolers. In winter, when water temperatures are low, plate coolers operate very efficiently. In summer, when water temperatures increase, there can be very little margin between the water temperature and milk temperature. This means the vat will do the majority of the chilling, which uses a lot of electricity, usually at peak tariff rates.

Consider the option of introducing secondary precooling with glycol solution to further reduce the temperature to about 4°C before entering the vat. Secondary cooling reduces energy consumption of vat compressor by 90%.

Plumbing

To maximise heat transfer the water should flow through the plate cooler in the opposite direction to the milk.

Case Study:
Maximising plate cooler performance

Brendan Martin, Bamaum, Murray

Brendan Martin of Allanby Pastoral runs a 720 cow dairy operation at Bamawm. He uses approximately 200,000kWh of energy annually. Brendan was seeing his electricity costs rising, so in 2015 undertook an energy audit to investigate any strategies that could be implemented to reduce his usage.

An energy audit in 2015 identified that milk cooling was a large component of his energy use (45%). The assessment reviewed the performance of the plate cooler and found it to be very poor with a 7.7 degree difference between water entering and milk leaving the plate cooler. To maximise energy efficiency, ideally this difference should be a 2 degree difference or less.

The most common causes of poor performance in plate coolers is cleanliness and relative flow rates between water and milk. It was found that Brendan’s flower rate was mostly likely to be the cause behind poor plate cooler performance. As a general rule a flow rate of 2:1 of water to milk is required to achieve the best performance. To address this issue, the pipes need to be checked and cleaned, and Brendan found he needed a new plate cooler pump installed, at an estimated cost of $900.

Addressing the plate cooler performance and having the milk entering the vat at 20°C would save approximately $4,300 a year, with a payback of less than 3 months (based on 2015 electricity prices and energy audit analysis). This also would lead to a saving of 27.6 tCO_2-e in GHG emissions.

Brendan is more than happy with the results and recommendations of the assessment. 'It was all very thorough and we are always looking at ways to reduce costs and make our business more profitable,' he said. 'Power usage in the dairy is down by 9 per cent. With prices continuing to rise it is more important than ever to be energy efficient. Every little bit you do helps and even though our bills continue to rise through no fault of our own, we are definitely in front from a milk cooling perspective.'

How hot is it?

There are two quick and easy ways to test the temperature of either milk or water running in and out of the plate cooler.

- **Thermometer test strips**
  Temperature difference is easy to measure by applying strip thermometers to the water inlet pipe and to the milk outlet pipe. Contact your RDP or milk company for purchase.
- **Digital non-contact infrared thermometer gun**
  Can measure surface temperature of hot, hazardous or hard to reach objects. Simply point the red light at the pipe or object to be measured and pull the trigger to get a quick temperature reading. They are a great tool for around the farm. You can find them at hardware or electronics shops.

In warmer climates where the available water is warm, plate coolers have limited impact. In addition, high humidity can mean cooling towers are not a viable option. Off peak chillers may be an option, but the high costs mean you will need to carefully consider the savings achievable.

Bring in the expert

Testing the efficiency of your plate cooler is an important first step that you can do yourself. If you have determined there is a problem it may be a good idea to call on the services of a skilled technician. They will be able to clean the plates (a harder job than it looks) and ensure the plate cooler is reassembled properly. They will also be able to advise on resizing, extra pumping capacity, additional cooled water storage or a complete dismantle and service.

The additional capital and cost of the servicing should be compared to the cost of an inefficient plate cooler. The cost of an inefficient plate cooler can run into the thousands of dollars a year depending on milk production and the difference in temperature of the water and milk entering and exiting the plate cooler.

New technology in refrigeration

Electronic control valves have been used to improve energy efficiency of refrigeration units, with claims of 15–25 per cent savings. These valves are an add-on component that can help to improve the performance of milk vat refrigeration. The valves change the liquid dynamics of the refrigerant gas, allowing more of it to come into contact with the copper and cooling plates. This reduces temperatures faster and more efficiently. It also enables temperatures to be held more consistently. It can be installed without altering any of the other system components. The starting cost is $2,400, and estimates for return on investment anywhere between nine to 36 months.

Is your plate cooler doing the job?

The best way to check if your plate cooler is up to the task is to compare the temperature of the milk leaving the plate cooler with the incoming temperature of the cooling water. A plate cooler working properly should cool milk to within 2–3°C of the incoming cooling fluid. If water coming into the plate cooler is 18°C then the temperature of the milk should be about 20–21°C.

Step 1
Identify water inlet and milk outlet pipes.

Step 2
Apply strip thermometers to water inlet and milk outlet pipes and measure the temperature of the water and milk during peak milk flow as it exits the plate cooler.

Step 3
If you get more than 3°C difference there is room to improve the performance of your plate cooler.

Step 4
Measure the flow rate of water leaving the plate cooler. This is done by timing how long it takes to fill a 20 litre bucket when the pump is operating at normal speed and flow rate. If the water is being recycled or recirculated into a tank put the bucket under the discharge pipe. For example, if it takes 13 seconds to fill a 20 litre bucket the flow rate is 20 ÷ 13 = 1.5 L/sec).

Step 5
Measure the time taken to fill the bucket with milk at the vat entry point while the milk pump is working at capacity (all cups on). If it takes 40 seconds to fill a 20 L bucket the flow rate is 20 ÷ 40 = 0.5 L/sec. If it is not possible to measure during milking, simulate using water at a later point.

Step 6
Divide the cooling fluid flow rate by the milk flow rate to determine the ratio. Using the numbers mentioned in steps 4 and 5 the flow rate would be 1.5 ÷ 0.5 = 3. The water flow rate is three times the milk flow rate or 3:1.

Cooling towers

If you discover that the water entering your plate cooler is too warm, a cooling tower could be an option.

A cooling tower is a heat rejection device — relying on evaporation to remove heat from the water. The tower allows a small portion of the water being cooled to evaporate into a moving air stream to provide significant cooling to the rest of that water stream. The heat from the water stream transferred to the air stream raises the air temperature and its relative humidity, and this air is discharged to the atmosphere. Water can be cooled to within 5°C of the wet-bulb temperature* in a tower that is properly designed.

Key considerations for cooling towers:

- Cooling towers are a relatively cheap technology.
- They do not work well on days of high relative humidity and high wet bulb temperatures.
- They can reduce the temperature of the water entering the plate cooler, improving its efficiency and reducing the cost of milk cooling. Check the temperature of the water entering the plate cooler to see if a cooling tower could be an option.
- Bore and well water will have a relatively stable temperature all year round but the temperature may rise considerably in hot weather depending on how this water is stored.
- Positioning, burying, screening or planting shade around tanks are options to help insulate.
- Mechanical-draft cooling towers rely on power-driven fans to draw or force the air through the tower and are more effective than natural-draft cooling towers.
- They allow for water from the plate cooler to be cooled so it can recirculate without jeopardising milk cooling.
- Cooling towers can be very effective at cooling water in areas of low humidity.

** Wet-bulb temperature is measured using a standard mercury- in-glass thermometer, with the thermometer bulb wrapped in muslin, which is kept wet. The evaporation of water from the thermometer has a cooling effect, so the temperature indicated by the wet-bulb thermometer is less than the temperature indicated by a dry-bulb (normal, unmodified) thermometer against the warming effects of direct sunlight.*

Case study:

Energy savings on a robotic dairy (milk cooling)

Matthew and Allison Cahill, Rathdowney

Matthew and Allison Cahill from Hillview near Rathdowney in Queensland, milk an average of 270 cows through 5 robotic machines on their property. The cows are fed a total mixed ration diet on a large feed pad which is flood washed 4 times a day.

The Cahills were interested to understand how they could improve their energy efficiency and signed up for an assessment with Dairy Australia*.

Unlike conventional systems where farmers are at the dairy shed at a set period of time for milking, the nature of continuous milking in robotic dairies means that milking times are undefined and it is more difficult to get accurate time frames of milk vacuum pump run times and compressor run times. The data is available in the software that monitors the robot, but can be difficult to extract. For the energy assessment, estimates based on discussions with the farmers and the technicians that installed the equipment were used.

For the Cahills, the assessment highlighted some key potential areas for saving on energy use. Milk cooling was an area that could be improved by the installation of a plate cooler as a milk pre-cooling system which could result in savings of approximately $2,100 per year*. The installation of a heat recovery unit to pre-heat water could estimate $3,100 per year*. The effluent pump in the sump was also identified as in need of an upgrade. Mr Cahill recently replaced the 5Kw sump pump with a 2.7Kw chopper pump and saw some great changes.

'The new pump cost less than the previous one did and is almost half the size,' said the Cahills. 'Yet the old pump would work for over 3 hours a day and this chopper pump only needs to work for less than an hour'.

**Energy audit and estimated savings based on 2015 prices.*

7 Milk harvesting and variable speed drives

The decision of what size variable speed drive to install comes down to the effective lifetime of the unit, payback period for the investment and ongoing running costs. Every farm is different and it is important to seek advice from a pump technician or other appropriate service provider.

In many dairies vacuum and milk pumps operate at a constant speed, which is required to create a desired vacuum or flow rate. Power savings of 40–65 per cent can be made when a variable-speed drive (VSD) is fitted to the vacuum pump. Further savings can be made when VSDs are fitted to the milk pump as they can improve the efficiency of heat exchange through the plate cooler.

A VSD uses a sensor in the vacuum line to detect changes in pressure and then adjusts the speed of the pump motor to match the demand for vacuum or flow rate. This lowers energy consumption. There is less wear and tear on the motor and noise levels are lower during milking. One VSD can control up to two motors at one time and can work with both three-phase and single-phase power supplies.

VSDs can be fitted to new or existing pumps. Vane and blower vacuum pumps are the two most commonly used vacuum pumps. Blower vacuum pumps are more efficient than vane pumps but are more expensive.

VSDs are better suited to blower vacuum pumps as they can operate at lower revolutions than vane pumps and still maintain sufficient vacuum. They are usually quieter and have a longer life.

Some vane pumps are not suited to VSDs if the revolutions can not be lowered without wearing out the pump. They will also require additional lubricating oil, which will be an added cost.

What can I do?

- **Investigate variable speed drives for vacuum pumps (best suited to blower-type vacuum pumps) where there is sufficient excess vacuum being produced for the motor to be able to reduce power output.**
- **Reduce milking times where practical.**
- **Consider variable-speed drives for large water pumps.**

Factors to consider before installing VSD on milk and/or vacuum pumps:

- Existing pump—blower vacuum pumps are generally more efficient than a vane pump. The working condition of the pump can influence potential savings, particularly on older pumps.
- The size of the dairy relative to the number of cows being milked. The greatest gains are made on longer running times.
- The size of the pump is relative to the size of the shed. A small pump in a large shed provides opportunity to save money by upgrading the pump and installing a VSD.

A VSD needs to be correctly installed by a qualified technician. The full energy savings are often not achieved if the VSD is installed without filter protections and if it is not tested to ensure it is operating efficiently.

Different vacuum pumps with the same motor size can have different air consumption due to the layout of the system. Leakage of air in the systems as a result of incorrect installation can also reduce efficiency.

Greater energy savings are possible where the pump can operate at lower RPM. A 1400 RPM motor that can be geared down to 700 RPM will benefit from adding a VSD. If the pump can only be lowered to 1100–1200 RPM there is relatively little benefit from installing a VSD. Motor speeds should not be lowered below the minimum operating requirement of the motor as the motor will wear out prematurely.

VSD on vacuum pumps

Advantages

- Only uses energy needed to meet the load on the milking system.
- The longer the milking time the better the savings.
- Reduces noise in the dairy.
- Reduces wear on the motor and pump, prolonging their lives.

Disadvantages

- Capital expense.
- Not everyone can repair them. Requires yearly servicing.
- Typical payback times range from 4 to 7 years depending on how many hours per day they are used.

VSD on milk pumps

Advantages

- Can give better milk cooling due to more constant rate of milk flow.
- Enables better matching of pre-cooled water to daily milk volume, which can save water.
- Reduces the need for a ‘choke’ on the milk line, which may have an impact on milk quality.

Disadvantages

- Capital expense.
- Typical payback times for VSDs range from 2.5 to 5 years depending on daily milk volume and the expected improvement in milk cooling efficiency.
- Not everyone can repair them. Requires yearly servicing.

Cost

Cost will vary depending on the make, country of manufacture and whether the VSD is pre-programmed for the model and type of vacuum. The EWEN project quotes prices (ex GST) for VSD that range from $2,300 for a 4kW motor/pump to $10,500 for a 22kW motor/pump.

Agriculture Victoria developed a case study dairy farm in south Gippsland to estimate the cost and energy savings of installing a VSD on new and existing pumps. The most profitable option was installing a VSD kit on an existing blower vacuum pump. New blower vacuum pumps were profitable investments but new oil vane pumps would not recoup the initial costs by the end of year 10.

For more information and references visit:

Agriculture Victoria
https://bit.ly/2AianIP

	Existing pump		New pump	
	VSD on vane	VSD on blower	VSD on new vane	VSD on new blower
Net present value (7 per cent discount, 3 per cent inflation on cash flow)	$10,336	$18,789	-$833	$2,102
Internal rate of return (real)	34 per cent	51 per cent	6 per cent	9 per cent
Years to breakeven (before interest and tax)	4 years	3 years	>10 years	10 years

8

Renewable energy generation on dairy farms

Solar, wind or hydro resources can provide a positive alternative to offset costs on dairy farms and reduce energy consumption. Environmental outcomes should be considered alongside affordability and reliability.

Are renewables right for your farm?

When considering if renewable energy is right for your farm think about:

- Current energy efficiency — consider renewable energy when the dairy is running energy efficiently.
- Hot water production can be a good option as it directly turns solar energy into hot water which can be more economical than other renewable options. Examples include heat recovery systems, solar hot water units and heatpumps.
- Match solar power and the size of renewable systems to the energy used in power production time.
- Wind and hydro may be an option if your location is suited.
- Consider all requirements of the shed rather than just energy efficiency, e.g. walking distance, road infrastructure, future expansion, cow and human comfort and accessibility.

Understand the business case for renewables on your farm

The first step in designing a renewable energy generation system is to establish the current electricity use (or demand) profile for the dairy and whole farm. If the demand matches supply from the renewable source, and if a high proportion of this demand is normally filled by using peak rate electricity, the investment has a good chance of being worthwhile. The demand profile will also help determine the most appropriate size or capacity of the renewable source you are considering.

Determining your demand profile

Peak demand in most dairies occurs early in the morning and later in the afternoon during and immediately after milking times. However a significant proportion of the farm's total power demand can be overnight; for example where off peak chillers, ice banks or hot water systems are in use.

Any power used during off peak times (usually between 10.00pm and 7.00am weekdays and all weekends) will be billed at off peak rates. Savings will depend on timing of the morning milking and any other tasks that use power performed during the off peak period.

On many farms, irrigation pumps are run overnight in the off peak period, with the additional benefit of reduced evaporation losses during application. During the summer months, however, irrigation may be required during daytime hours to apply sufficient water, and offsetting this peak demand with renewables may improve the cost effectiveness of the investment.

For solar or wind systems that supply more than the demand on the farm at any time, surplus power may need to be either fed into the grid or stored in batteries.

Shop around for Tariffss (FiT)

Feed-in Tariffs (FiT) are the payment you receive for exporting any extra renewable energy (not utilised by your business or home) to the grid.

As of 1 July 2018 the Essential Services Commission (who set the price for minimum FiT) has set both a single-rate and a time-varying tariff.

The minimum price under the single-rate tariff is 9.9 cents per kilowatt hour. Rates for the time-varying tariff are between 7.1 cents and 29 cents per kilowatt hour, depending on the time of day power is exported (off peak, shoulder and peak).

These rates are subject to change, so for more details visit:

Essential Services Commission
bit.ly/2RgzQIV

It would not be economic to invest in renewable schemes based on feed-in tariffs alone. The best way to make an investment worthwhile is to utilise as much renewable power generated as possible to replace alternative peak power. Where the power generated replaces off peak power used, this lower tariff must be used in calculating the benefit or return from the renewable energy generation project.

It is important to shop around and read the condition of FiT offers very carefully. There are sites available that can compare the FiT offered by the electricity retailer in your area – such as solarquotes.com.au/energy/

Consider adding storage to your system

Renewable energy's main challenge is that its use is restricted to when the renewable resource is available (e.g. when the sun shines or the wind blows). Storage allows more of that renewable energy to be retained so it can be used on-site at a later time (reducing higher peak charges) and further reduce electricity consumption from the mains power grid. In this context, storage can also provide a portion of a dairy's peak demand – thereby lowering its demand from the electricity network and reducing its demand charge .

There is of course the separate environmental benefit that storage can allow more renewable energy to be utilised on-site, furthering lowering a dairy business' carbon footprint.

The key questions to ask regarding the economic benefits of energy storage are:

- Does the value of the avoided peak and demand charges outweigh the up-front and operational costs of installing storage in the first place?
- Can I get a reasonable return on investment from a storage project?

A key consideration is the type of storage option to use.

See the 'Storage' section later in this chapter for more detail on energy storage options.

Do you want to build, own and operate or lease the renewables?

Some companies offer power purchase agreements, though they may require year round purchase of energy. Check with your financial advisor for the best option for you.

Further advice is also provided on financing options, later in this chapter.

Things to consider in order to determine the business case for renewables:

- Savings can be made on power bills by taking advantage of as much off peak and/or 'controlled load' power as possible where available. This is ideal for water heaters, ice banks, chillers and stock water pumping.
- Savings associated with solar are highest when solar is used on the farm during peak energy times, as it offsets the bill at the highest rate. The second best savings are from off peak times (e.g. weekends).
- Seek independent advice to quantify your demand profile.
- For solar or wind systems that supply more than the demand on the farm at any time, surplus power may need to be either fed into the grid or stored. These need to be factored into the business case as well.
- Storage options, including batteries, super capacitors, flywheels and pumped hydro, could be an option for some dairies.

Specific information on each renewable energy option is provided in the following pages.

Solar photovoltaic (PV)

The installation of a solar system will bring many opportunities for cheap onsite generation of electricity and financial savings. Sunlight is an abundant and free source of power, and the prices of solar systems have fallen dramatically during the past few years.

Typical solar systems do not have any moving components, require minimum maintenance and can last for more than 25 years. However, the viability of a solar system is highly dependent on the consumption on farm of PV-generated power. For many dairy farms, the demand does not match the energy generated by the solar system.

The main challenge in using solar power as an energy source for dairy farms is the hours of use. Typical dairy farms will have maximum energy demand during morning and evening milking, whereas solar energy generation has its peak around the middle of the day. This means that most of the PV energy generated will not be consumed and, if possible, this can be sold back to the grid. However, current feed-in tariffs are low and annually regulated.

Things to consider before purchasing solar PV

If you are thinking of buying a PV system, first you may need to have some equipment (motors, pumps and vats) running consistently during the day. To improve the cost effectiveness of the system, rescheduling dairy energy consumption may be investigated. For example, moving the operational times of water heaters or stock water.

The key elements when considering solar are:

- **Type of system** (grid connected, to allow for feed-in to the grid, or stand alone)
  - Storing some of the excess solar during the day in a battery for use when the sun sets
  - Changing to a retailer that provides payments for excess solar fed back into the grid (commonly known as feed-in tariffs).
  - High efficiency panels can be used to increase the capacity on a limited roof space, or allow for extra capacity in the future when battery storage is considered to be cost effective and to therefore justify a larger system.
  - Panel optimisers to allow each panel to operate individually, thereby increasing efficiency, managing shading and increasing monitoring capabilities to help identify problems.
- **Site specifications** (shading, orientation, tilt, will all effect the performance of a solar PV system)
  - Installing some of the panels facing east and some west to increase the solar generation closer to milking times
  - Location (peak sun hours vary across Australia). Solar panels convert solar radiation into electrical energy. The amount of electricity that can be generated by a solar PV system depends on how much sunlight it receives – expressed as 'peak sun hours'. This can vary across Australia and seasons.
- **Set up and connectivity**
  - Setting up a monitoring system and installing a consumption meter, which will provide solar generation and power consumption visibility.
  - System sizing allowing maximum eligibility for Small-scale Technology Certificate point-of-sale discounts, or income from the Large-scale Generation Certificates for systems greater than 100 kWp.
  - Installing solar energy diverters for electric hot water control.

Cost

The cost of a solar PV system can vary greatly, depending on its size and type, location, site characteristics and installation requirements. Incentives are also available via the Small-scale Renewable Energy Scheme (SRES) for those renewable systems with 100kW or less of generation capacity and produce less than 250 MWh/year. Systems up to 100 kW will receive small technology certificates (STCs) as a point of sale discount. The number of certificates reduce each year until 2030. The value of the certificates also varies due to market forces.

To calculate Small-scale Technology Certificate visit:

Clean Energy Regulator site
bit.ly/2TP9xLi

However, solar doesn't produce electricity when the sun doesn't shine – and when many businesses may have demand for energy. Battery storage can help to extend the use of solar power into other parts of the day.

Consider using the free solar feasibility calculator available here:

Renew website
renew.org.au/resources/sunulator/

Potential difficulties and pitfalls

- Shading from trees or silos during certain periods of the day is a significant obstacle. Systems should be designed with consideration of roof space, orientation, etc. to reduce this hazard, while existing systems can be reconfigured with optimisers to increase efficiency.
- On top of the installation costs of a system, extra costs may be incurred in obtaining a connection agreement. These will vary depending on the size and location of the system.
- Some connection agreements and import/export meter replacements can be costly and difficult to arrange, especially in remote areas.
- Systems above 100 kWp do not receive the STC point-of-sale discount.

- Main switchboard may need to be brought up to current standards before connections can be undertaken.
- Interstate or inexperienced companies installing solar with limited local knowledge of the network's connection agreement requirements.
- Voltage spikes on the line can trip out the inverters, resulting in a loss of production.
- Voltage rises and/or drops can occur due to undersize cables that may have been appropriate when they were installed but are not fit for purpose once a site's energy demand has grown over time.
- Roofs that are not structurally adequate for the installing of solar panels.
- Noise associated with the impact drivers used for fixing the railing will frighten the cows during milking, affecting the installation times.

For more advice on feasibility of solar on your dairy read:

Solar energy for dairy farms
bit.ly/2PLRgwh

Installation and maintenance

As most solar systems have no moving parts, there is little ongoing maintenance. However, the solar panels must be kept clean to maximise efficiency. Panels that are installed with a minimum tilt of 10° will clean themselves when it rains.

They should also be wiped over periodically with a damp cloth, especially during dry periods, after bushfires and if smoke from a fuel stove or heater, fumes from machinery or dust from dirt roads or a hammer mill regularly blow in their direction.

Whilst maintenance is low for solar PV, monitoring systems are essential to ensure faults re quickly identified and rectified. Most faults are likely to occur with isolators and inverters.

Checklist for comparing solar PV options

✓ Do the panels have Clean Energy Council approval?

✓ What are the brand and type of solar panels and where are they made?

✓ Are the solar panels and inverter made by the brand name company or are they made by a different manufacturer and relabelled?

✓ How many panels are required for a selected kW system and what size is each panel (in watts)?

✓ What is the average daily and yearly KWh production for this system?

✓ Does the inverter have a larger capacity than the panels or are they size matched?

✓ How long is the inverter likely to last?

✓ What is the warranty on? For example, panels, inverter, mounting frame or workmanship?

✓ What is the total purchase price for the selected kW system?

✓ What are the additional costs on top of the system purchase price, e.g. grid connection costs?

✓ Does someone inspect the property first to check the site is appropriate and whether extra installation costs might apply?

✓ For how long have the solar panel and inverter brand name companies been selling these products?

✓ What is the after sales service for enquiries and trouble shooting and warranty issues?

✓ How long has the installer been installing solar voltaic batteries?

✓ Who is responsible for organising metering and switchboard modification, including the inspection and paperwork?

The information above is adapted from the Alternative Technology Association booklet, Solar Electricity: Plan your own solar electricity system, November 2017.

Considering solar PV for your dairy

Follow these steps in preparation for talking with a potential supplier:

Before purchasing solar

Understand your energy usage and consider future energy demand needs – Use earlier chapters in this booklet to help review your electricity bills to understand energy use across your farm. Factor in any energy efficiency opportunities, as this will also help determine the size of the system needed.

Maximise your day-time energy use – Consider options for rescheduling dairy energy use to peak times in order to maximise the use of energy generated on farm. For example, move operational times of water heaters.

Maximise efficient use of energy as much as possible – There is no point installing a system that will become too big for energy use in the future. Also consider installing monitoring equipment to track the use of energy over time.

Be clear on the type of system best suited to your dairy

Determine the type of system (grid-connected, to allow for FiT to the grid, or stand alone) before seeking quotes – This will help with comparing quotes and ensure any grid connection or changes to network charges are incorporated into the business case. For example, systems larger than 5kW will require a grid connection.

Do your research on feasibility of solar on your property – do you have a suitable shade-free site available for solar? Is council approval required?

Selecting a supplier

Does your chosen solar retailer and installer have Clean Energy Council Approved Solar Retail Accreditation? Australian Government rebates will only be paid if the systems are installed by accredited individuals. The Clean Energy Council has compiled lists of approved products and accredited installers — cleanenergycouncil.org.au

If installing batteries, does your installer have grid-connect installation accreditation with battery endorsement or grid connection installation accreditation plus standalone accreditation? See: solaraccreditation.com.au/consumers/findaninstaller

Ensure that the supplier provides a detailed report that includes everything required for your system, including utilisation of existing infrastructure. See the checklist of questions to ask a supplier on follow page. Be sure to get more than one quote to test the market and seek out the best product for your business.

Confirm the manufacturer's warranty and specifications. What is the manufacturer guaranteeing compared with the installer? Who has what responsibility for each warranty case? What is the responsibility of the customer? What is the process of invoking a warranty if the manufacturer is from overseas? Will the supplier own the process?

Do your due diligence – How long has the business been around? Do they have a good reputation and a track record in your local area?

Installation and maintenance

Ensure you are on site for installation of the system. Confirm how long the installation of the system will take and when will it be operational. Ask the supplier to install during a time that will minimise noise or disturbance to cows.

Ensure your contract with the approved supplier includes the roles and responsibilities for ongoing maintenance of the system. What is the maintenance regime and operational checks? Will the supplier guarantee ongoing performance? If the solar system fails, is there a bypass mode that can enable activity to resume using electricity only? Who will fix it and within what time frame? Read the contract carefully to know what you are liable for over the life of the system.

Case study:
Phased installation of solar in South Australia

This case study of Tauwitchere Dairy demonstrates how changes in electricity rates over time can impact on the feasibility of on-site solar generation. Using external energy expertise has helped them negotiate the best system for their site over time.

Tauwitchere Dairy is located near the Coorong in Narrung, southeast South Australia, and is one of the largest organic dairy farms in the state. The farm has a milking area of 150ha, with a herd size of 200-300 (depending on seasonal conditions), producing 1.7 million litres of milk.

In 2014 the Harveys brought in an external energy expert to provide advice on the feasibility of on-site solar power generation to reduce energy costs. At the time, installing solar would have pushed the site onto a demand tariff resulting in a significant increase to the power bill. The analysis identified however, that a 7kW solar PV system could be installed to offset the running costs of the workshop and some minor pumping loads, as the workshop was identified as a site where demand charges were not applicable.

Two years later, in 2016, external experts were again asked to look at solar opportunities at the dairy given the tariff structures for the network charges had changed. A feasibility study was undertaken identifying that a 60 kW system would be most appropriate. It also identified that moving some of the loads, such as hot water and refrigeration (with glycol storage), into the solar window would help improve the yearly savings associated with the installation of solar PV.

The Harveys agreed to go ahead with the system and opted for a no cash upfront finance option over five years. During the initial stages of planning the system and obtaining approvals, it was discovered that the energy provider was offering an incentive for the excess solar power, as a Feed-in Tariff (FiT), that was double the charge for off peak power. With this knowledge, it was that the load shifting strategies designed to maximise the solar self-consumption were no longer appropriate and instead the Harveys decided to allow the excess solar to be exported to earn credits on the bill. The system was installed and completed in October 2016.

Specifications and projections

The solar PV design included north-facing panels on the north side of the dairy and east and west-facing panels on the south side. A Solar Edge optimised inverter system was installed along with 209 JA 285 watt panels with embedded Solar Edge optimisers. The system was also installed with a Modbus consumption meter and mobile internet connection to allow the monitoring of the site load, solar generation and individual panel performance.

Details of the solar PV system

Solar PV: 60kWp (JA Solar – 285W x 209 panels)

Inverter: SolarEdge 2 x 27.6 kW

Consumption (before solar): 189,618kWh/year

Solar generation: 83,970kWh/year

Self-consumption: 21% (year to date as of 8/6/2018)

Demand reduction: 15-35 kVA/month

Energy savings: 17,634kW/year

Emission reduction: 66.3TCO_2e/year

Savings: $20,000/year

Simple payback: 4.8 years

2018 energy savings analysis

In early 2018 the Harveys again sought external advice to explain why their December 2017 bill was not showing any cost savings from the solar installation. The reappraisal of the solar system and energy monitoring data revealed that significant savings had in fact been realised, but that energy rates being charged by the retailer had increased. Increasing energy retailer rates often have the effect of obscuring the savings that have been achieved by the installation of solar. In this way, the Tauwitchere dairy's December 2017 bill reflected that energy rates continued to increase after the installation of solar, thus masking the savings that had been achieved.

The self-consumption of solar on Tauwitchere offset the purchase of energy from the retailer, saving $1,275 (assuming 36.5c/kWh peak and 20.5c/kWh off peak). Without solar the bill would have been $5,916, excluding the kVA savings that would also have been achieved but are difficult to calculate. Therefore the actual cost of the bill would have been over $6,000. This shows that while the bill was still high (partly a result of the considerably inflated network charges of the retailer), the solar is effectively minimising the impact of the increased retailer rates.

Future implications for solar

As energy charges vary constantly, there is a need to make continual adjustments and improvements in approach to on-farm energy generation. In the case of the Tauwitchere dairy, this will involve revisiting the hot water heating scenario and devising methods to improve the self-consumption ratio. Future amendments to the application of FiTs may also make shifting the loads into the daytime cost effective.

Wind

Key considerations for on-site wind generation:

- Wind is a free resource, however is not suitable at all locations.
- A site specific survey must be done to confirm the reliability of wind for your location.
- Demand management and on-site storage may need to be factored into wind systems to make them viable for dairy load profiles.

Wind turbines convert wind energy into electricity. The main problems facing wind power as an energy source for dairy farms are the initial cost, the amount of power produced relative to the requirement and the time of day that power is produced, as wind is the most highly variable of all the renewable resources.

The viability of wind turbines is highly dependent on the location.

The output from a wind turbine depends on the wind speed, wind shear and wind turbulence.

Site requirements

There must be enough wind to allow the turbine to work almost constantly during the day; good sites should have consistent wind speeds of 5 to 7 m/sec. If you are considering installing a wind turbine, a specific survey must be done.

For more advice read:

Wind power in dairy farms
bit.ly/2q63Paw

Cost

The cost of a wind turbine system can vary greatly depending on the components and site characteristics. The size of the system, height of the tower and type of turbine, generator and inverter can all affect the price.

Installation costs can also vary. For example, engineering requirements for the base that supports the tower will depend on the soil type and its structural properties.

Depending on the site, wind can be extremely variable; one day your wind turbine can be operational during the whole day and the next day it can shut down because there is not enough wind.

Current feed-in tariffs are much lower than the price of electricity, so it is most effective to have a wind turbine which displaces the use of grid electricity rather than to create surplus energy that is sold to the grid and must be bought back at much higher prices.

Maintenance costs must also be factored into the business case for wind. Regular maintenance and inspection should be done twice per year to make sure all components are still working properly.

For many dairy farms, the demand does not match the energy generated by the wind turbine. To improve the cost effectiveness of the system, rescheduling dairy energy consumption should be investigated.

Wind power

Advantages	Disadvantages
Wind is a free resource	Wind speeds in some dairy districts may not be adequate to drive a turbine
Many farms have suitable sites	Energy output varies with changes in wind speed
Minimal running costs after installation	Peak power generation may not match peak load
Systems can be expanded by adding more turbines	High initial cost
Low land use	Lengthy payback time

Hydro

Key considerations for on-site hydro generation:

- Hydro power can be a very reliable source of energy, however is not suitable at all locations. It is most suited to sites that have a permanent creek or river located close to the site of the dairy.
- Although hydro power systems can run with very small heads and flow rates, the amount of power produced is also very small.

For dairy farms with a permanent creek or river flowing through suitable terrain, hydro power may be the most cost-effective form of renewable power to meet at least some of the dairy's energy needs. An advantage of hydro power over other renewable sources is the continuity of supply. Power is produced 24 hours a day, seven days a week. Surplus energy can be stored either in the settling pond by switching off the turbine or in batteries.

Unlike commercial hydroelectric stations, small-scale hydro power systems do not require large volumes of water to be held in dams. They are usually 'run of the river' systems that allow river or creek flow to continue, reducing the environmental impact of the plant.

The small-scale systems are often divided into three categories, depending on the output of electricity:

- Micro-hydro – produces less than 100kW
- Mini-hydro – produces from 100kW to less than 1MW
- Small-hydro – produces from 1MW to less than 10MW.

For more detail read the following fact sheet:

Hydro systems fact sheet
bit.ly/2OI7v0T

Although hydro power systems can run with very small heads and flow rates, the amount of power produced is also very small. A head of 10m and a flow rate of 70L/s are required to produce 5kW of electricity. Doubling the head to 20m or the flow rate to 140L/s will double the power output. These figures allow for a turbine-generator efficiency of 75%. Both turbines and generators vary in their efficiency from about 50% to 80%, depending on the type and set up.

A micro-hydro plant producing 10kW would need a head of 10m and a flow rate of 136L/s. This is equivalent to the small waterfalls that are not uncommon in the high-rainfall hinterland areas of the east coast of Australia and in many parts of Tasmania.

Site requirements

If you are thinking of installing a hydro power system, you need to have answers to the following questions:

- Does the farm have a permanent creek or river?
- Is there sufficient head and flow to meet some or all of the farm's energy requirements?
- Does the terrain allow a settling pond and penstock to be constructed?
- Does the terrain allow access to the site for construction and maintenance?
- How far is the site from the dairy?
- How common and severe are droughts in your area?

Also consider the water source; it may have sufficient head and flow rate, but be remote and difficult to reach. Theoretically, electricity can be transmitted across any distance but there is a loss of voltage and power as the length of the wires increases. The greater the distance from the site to the dairy, the higher the power production needed to compensate for this loss.

Costs

Hydro power is a cheap source of renewable energy per kW installed, but it is also the most site-dependent source. A heavy and stable flow of water is needed before a hydro power system will become viable; even then, the system can be severely disrupted in times of flooding or droughts

The average hydro power turbine and generator costs about one-tenth of a solar PV unit of equivalent output.

A 5kW hydro power unit may cost around $1,500 before rebates. Other costs may need to be taken into account. These include construction costs for the settling pond and penstock, the cost of pipe or channel for the penstock and poles and wires or underground cabling to transmit the power to the dairy.

For more advice visit the **Energy Matters website:** bit.ly/2J8Z88z

Hydro power

Advantages	Disadvantages
Continuous supply of electricity	Many dairy farms do not have suitable water sources and terrain
Low flows and head can still generate electricity	Requires structural changes which may be costly
No reservoir required — low environmental impact	Greatly affected by rainfall or snow
System purchase costs much lower than for other renewable sources	Power production limited by the capactiy of the available water resource
Low maintenance requirements	Expansion may not be possible as power demand increases
	Floods can damage the turbine and generator

Anaerobic digesters

Key considerations for onsite anaerobic digesters technology:

- Biogas is produced by anaerobic digestion (AD) of organic materials.
- Biogas technology (digesters or anaerobic ponds) does not have to be complex or difficult to operate, but it does need to be tailored to the specific needs of the farm.

Despite dairy farm waste being a good resource for **biogas** production, there are currently few working examples of biogas technology (**Anaerobic Digesters**) in Australia's dairy sector.

Anaerobic digesters (AD) supply renewable energy, but can also provide the following co-benefits for dairy farms:

- Simplified waste management
- Reduced odour and Greenhouse Gas (GHG) emissions
- Improved fertiliser value of manure and other by-products.

Biogas technology does not have to be complex or difficult to operate, but it does need to be tailored to the specific needs of the farm in terms of farm management, waste characteristics and biogas use.

Biogas formation

Biogas is produced by anaerobic digestion of organic materials and consists of 50–70% methane (CH_4) and 30–50% carbon dioxide (CO_2) as well as minor gas components, such as water vapour, nitrogen and hydrogen sulphide. AD is a multi-step process that involves a range of micro-organisms that all have specific requirements (e.g. pH, temperature, nutrients). However, given sufficient time, a productive and stable micro-organism community can be established for a wide range of organic materials and operating conditions.

Milking shed effluent and the more concentrated manure scrapings or slurries from dairy cow housing systems or feed pads are the main organic materials available for anaerobic digestion on dairy farms.

Biogas use

Appropriately treated biogas could theoretically be used for all the applications that natural gas is currently used for, but three options are most relevant for dairy farms:

1. Flaring – for AD schemes that primarily focus on reducing odour and methane GHG emissions.
2. Hot water provision using gas boilers – particularly for small AD schemes.
3. Biogas as generator fuel – for the provision of electricity (and hot water).

Hot water

Biogas can be combusted in slightly modified standard gas hot water boilers without the need for substantial biogas quality improvements.
The equipment costs for this hot water use are AU$4–8k and little operation and maintenance is required.
A hypothetical 400 cow all pasture fed dairy farm may be able to produce ~1400 L of hot water (90˚C) per day with the biogas recovered from the cow shed effluent.

Electricity generator fuel

The use of biogas as electricity generator fuel is the most common use of biogas worldwide, but does require a moderate level of biogas quality improvement. A biogas fuelled generator not only substitutes grid electricity but will also provide a backup source of electricity for the farm during power outages. The capital cost of an electricity generator large enough to power a milking shed (~50 kW) ranges from AU$30k for entry level equipment to AU$80–120k for more advanced equipment. A hypothetical 600 and 1,000 cow dairy farm could generate 220 and 1000m^3 of methane per day, respectively. Additionally, several thousand litres of hot water (90˚C) per day could be recovered from the biogas generator engine coolant and exhaust gases.

Key considerations prior to investing in AD technology

For large biogas schemes incorporating co-digestion of off-farm materials, export of generated electricity to the grid could be a substantial source of revenue. However, the value of exported electricity is often much lower than the value of imported electricity and the size of the scheme may be limited by a lack of spare capacity in rural electricity networks. Moreover, some states (e.g. WA) require very sophisticated safety equipment and procedures for grid connected electricity generation schemes, making their establishment cumbersome and costly. Large biogas electricity generation export schemes, therefore, require thorough and long-term planning.

The most common technologies for on-farm AD are either engineered, heated and completely stirred tank digesters (CSTD), or ambient temperature, unmixed Covered Anaerobic Ponds (CAP) (see table on the next page). On an annual basis the quantity and quality of biogas produced by both technologies is similar.

Which AD technology is most appropriate will depend on site-specific factors at each farm. In general CAP systems can be applied at smaller scale, require less operation and maintenance, and can be constructed much more cost-effectively than CSTDs.

The opportunities for CSTD systems are with larger systems that are often developed as standalone businesses and address regional organic waste problems, generate electricity for export and recover nutrients from off-farm waste for agricultural use.

The amount and quality of dairy farm waste available for anaerobic digestion is difficult to estimate, since small management differences can lead to up to ± 50% variation in the amount of waste available between otherwise identical farms. Differences can include the time taken to milk the herd (small shed compared to large shed, running the herd as several mobs, etc.) whether milking is once or twice daily, the feed type and quality (i.e. age/condition of pasture), average animal live weight as well as several other factors.

The below table provides a comparison of the most common technologies for on farm AD: either engineered, heated and completely stirred tank digesters (CSTD), or ambient temperature, unmixed Covered Anaerobic Ponds (CAP).

	CSTD	CAP
Construction	Concrete or steel tank with insulation, heating, mixing and plastic membrane roof.	Earthen pond with plastic cover (and plastic liner where required).
Substrate dry matter [DM] concentration	>4%	<5%
Operating temperature	Heated: 35–39˚C or 55˚C	Varies with ambient temperature (5–25˚C).
Advantages	Applicable to a wide range of materials, shorter treatment time, small size, standard designs, applicable for use in all climates.	Lower cost construction using local resources, lower operation and maintenance requirement, no heat demand, tolerant of shock loads, cover also provides biogas storage.
Disadvantages	Higher construction and operation costs including heat demand, requires skilled operation.	Large size, suitable only for liquid organic materials and tenoerate to warm climates.

How to determine if AD is feasible for your business?

The decision support compass is intended as a first scoping tool to help farmers assess if and why one of the two most common biogas technologies may be appropriate for their farm, by giving a relative weighting to key drivers for the technology.

The decision support compass includes drivers that are often more important than financial considerations.

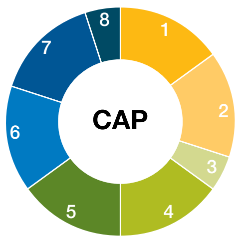
Anaerobic digestion schemes could be established on Australian dairy farms for any of the benefits that they provide. However, when considered individually, these benefits may not be sufficient to justify installation of AD technology on a farm. But, when multiple benefits are accounted for, the rationale for installing AD technology often becomes much clearer.

Which AD technology is most appropriate will depend on the individual situation of each farm.

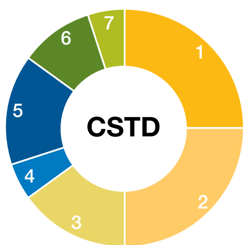
Biogas electricity generation will be of most benefit when substituting imported grid electricity and would be particularly beneficial for total energy self-sufficiency or off-grid farms and cow sheds which are currently supplied by diesel generators.

For more information see:
Feasibility of biogas report
bit.ly/2DVMPfS

Biogas decision support compass



1 Energy cost reduction **15%**
2 Energy independence **10%**
3 Business add-on **5%**
4 GHG reduction **15%**
5 Odour reduction **15%**
6 Easy water recycling **15%**
7 Easy irrigation **15%**
8 Low-tech **5%**



1 Energy exports **25%**
2 Off-farm waste management **25%**
3 New stand alone business **15%**
4 Joint projects **5%**
5 Sophisticated technology **15%**
6 Additional nutrients **10%**
7 GHG reduction **5%**

Monetary drivers
Farm Management drivers
Environmental drivers

Energy storage options

Key considerations for on-farm storage:

- If you are planning for on-site energy generation, such as solar, consider options for adding storage capacity as this might help size the energy system required.
- Consider storage options if you have unreliable supply of energy to your property and/or are concerned about energy security. Storage may be able to supplement the energy needs of critical infrastructure, such as pumps or hot water systems.
- Before engaging independent advice, understand you potential energy storage needs. For example, are you using storage for back-up energy needs or to integrate with a new renewable energy system and day-time use patterns.
- Do not consider storage options in isolation of other energy efficiency measures or farm business operations. Understand your existing electricity tariffs and consumption patterns, as any change to these will influence the business case for different energy storage options.

In dairies, energy can be stored in different forms to be utilised later than on demand consumption from grid which may not be cost effective. Energy storage options include thermal energy (in the form of hot water storage or producing coolant which is used for cooling milk or refrigeration), potential energy stored in the overhead water tank, and electrical energy stored in batteries.

The most appropriate energy storage strategy for your dairy will be driven by multiple considerations such as energy tariff (Time of Use, Flat rate, demand based, etc.), renewable generation, equipment on farm, refrigeration and more importantly investments required.

Based on the factors to the left, one or more storage strategies can be considered. A list of energy storage options and their pros/cons have been listed in the table on the next page.

While energy storage is beneficial for dairies where lower cost energy (e.g. solar energy, peak and off peak/ controlled load rates) is available, the strategies in the following table can also be considered for dairies with demand (kW or kVA) based tariffs to further increase the savings potential. The storage options also include demand cost reduction strategies by using conventional battery storage during demand period and/or load shifting methods of utilising energy outside of demand period to reduce demand charges.

Storage strategy	Storage option summary	Advantages	Disadvantages
Thermal energy storage			
Hot water storage Hot water storage is a form of energy storage as the thermal energy required to heat water uses electrical energy consumed by the heating element.	**Waste energy storage** Pre-heating the water using thermal energy from heat exchangers on compressors or return water from the outlet of the plate cooler and storing it before heating will improve efficiency and reduce energy required in heating water.	› Optimised usage of energy › Pre-heated can be used for washing if the water reaches required temperature without need for additional heating.	› Will need additional strategies for heating › Temperature may not be enough for use in dairy, and additional heating (boosting) may be required.
	Off peak energy Heating water during off peak (lower) energy rate period and storing in well insulated tank for later use will reduce cost of energy. This option would be possible where additional tank storage is available and it is recommended that devices, such as timers, are used to take advantage of off peak rates.	› Taking advantage of off peak rates › Can be used with other strategies.	› Not feasible if differential tariff is not offered by retailer.
	Solar Energy Diverters Solar Energy Diverters are devices which help in utilising excess solar energy to heating water. This is useful for installations where Feed-in-Tariff (FiT)s are lower than the off peak energy rate.	› Maximising use of solar energy via self-consumption › Can be used with other strategies.	› Not viable if Feed in Tariff is higher than the lowest tariff currently being charged.
	Secondary HWS The main HWS can be filled from the secondary storage after the first milking, if the secondary storage water temperature is sufficiently heated. This will avoid or minimise the use of energy at peak rate to boost the temperature of the hot water. The preheated water stored in this tank can be heated using renewable energy or at off peak times.	› Minimising risk of using energy from grid during high tariff periods.	› Available roof space, orientation and shading constraints.
Milk cooling and Refrigeration Some dairies use pre-cooled water or coolant such as Glycol to cool the milk before storing the milk in vat for refrigeration. Typically, ice banks and cooling towers are used for cooling the water and chiller unit are used for glycol cooling.	**Off peak energy demand management** Producing and storing pre-coolants during off peak (lower) energy rate period will reduce cost of energy. Recommend doing this in conjunction with load shifting, i.e. operating the compressor during off peak and/or outside the peak demand period. This could be done manually or using a device to automate this process. Alternatively you can consider increasing the storage capacity, for example, to allow for enough coolant to be stored for two milking periods.	› Taking advantage of off peak rates › Can be used with other strategies › Load shifting for Demand cost reduction	› High capital investment if pre-coolant system is not existing in the dairy
	Renewable energy storage Producing and storing pre-coolants during periods when excess renewable energy is available will help in reducing the energy consumption from the grid.	› Maximising use of solar energy › Can be used with other strategies.	› Not viable if Feed in Tariff is higher than the lowest energy tariff rate › Available roof space, orientation and shading constraints.

Storage strategy	Storage option summary	Advantages	Disadvantages
Pressurised energy storage			
Pumping Energy is stored as potential energy (pressure) in the tanks or just pumped to location for use by stock, etc. Since pumps use electrical energy for pumping water, consideration to use the lowest cost energy available will result in saving costs.	**Off peak energy demand management** Pumping and storing water during off peak (lower) energy rate period will reduce cost of energy.	› Taking advantage of off peak rates › Can be used with other strategies › Load shifting for demand cost reduction.	› Not feasible if differential tariff is not offered by retailer.
	Renewable energy storage Pumping water during periods when excess renewable energy is available will help in reducing the energy consumption from the grid. The following list of application can be considered: › Pumping water to fill overhead tanks › Pumping water for stock feed › Irrigation pumps › Delaying yard wash until excess renewable energy is available	› Maximising use of Solar energy › Can be used with other strategies	› Not viable if Feed in Tariff is higher than the lowest energy tariff rate › Available roof space, orientation and shading constraints.
Electrical Energy storage			
Various types of batteries such as conventional cell technology, lead acid, lithium-ion and emerging technologies such as flow batteries, flywheel, etc. are available to store electrical energy. Selecting the right technology and capacity will need evaluation of cost, safety, feasibility and application.	**Batteries** Batteries can be used to: › Store excess solar through the day and used during the evening milk. › Store cheap off peak power by charging during the night and discharge during the morning milk, when peak rates occur. › Provide back-up power during grid failure.	› Proven technology that can support energy cost saving strategies. › Provide reliable energy security and back-up › Can be designed for assured demand reduction › High storage capacity batteries available › High efficiency batteries provide >90% DoD.	› High investment cost › Fire and safety risks analysis consideration is required › May require on-site generation for business case › Not all batteries will operate during a power outage.
	Emerging technologies Exciting new energy storage technologies are being developed and are beginning to be commercially available in different storage capacity. Few of the products to look forward for are Flow batteries, Super Capacitors and Flywheel storage.	› Some of the new technologies are safer (e.g. greater fire safety rating) › More sustainable materials and recycle capacity.	› Not proven in the field › Technology not mature.

Micro-grid and off-grid options

There are emerging options for on farm energy generation that may change the distribution of energy across the grid.

Before you commit to purchasing or upgrading energy generation system on your property it is important to understand all costs associated with system installation, system costs, metering costs and if applicable, any network upgrade requirements.

A connection alteration is an alteration to an existing connection, including an addition, upgrade, extension, expansion, augmentation or any other kind of alteration (including micro embedded generation).

Make sure you tick off the following steps before you consider any alteration to your energy system:

- Engage an installer. Ensure they visit your premises, recommend a suitably sized system and provide an estimate inclusive of all costs.
- Contact your network distributor. Follow up any required approval and connection requirements they may have.
- Contact your retailer regarding metering arrangements and any changes that will occur to your existing energy rates
- Document all costs, charges and changes associated with your system change.

Where can I find a designer/ installer of renewable energy systems?

To find an accredited supplier visit:

Clean Energy Council website
bit.ly/2dH2oHB

The Council maintains a list of accredited installers who can assist you.

Case study: 2018 Latrobe Valley Microgrid Study

A new feasibility study involving up to 200 dairy farms in the Gippsland region will examine how emerging 'virtual microgrid' technology could help the industry meet its energy cost and reliability challenges.

The study aims to assess how the technology can provide additional value to owners of solar energy systems, reduce brownouts and put downward pressure on retail energy pricing.

A virtual microgrid works by providing a peer to peer energy trading platform whereby farmers with energy generation capacity can sell any excess into their local community. The farmer would benefit by achieving a higher value than current feed-in tariffs while purchasers would have access to power at lower than current retail rates.

Participants in the project will have the opportunity to have a free assessment of their farm’s ability to either have solar power installed or to get more value for the excess energy it produces. They will also be briefed on finance options to fully fund the implementation of energy infrastructure at their farm.

The project is co-funded by Australian Renewable Energy Agency (ARENA) and is being led by technology provider, LO3 Energy. Dairy Australia is supporting the project by helping to recruit dairy farmers to be part of the project while also ensuring the study maintains a focus on delivering positive outcomes for the farming community.

9

Finance and incentives for energy efficiency measures

As the price and availability of electricity and renewable technology evolves, so too do on-farm finance opportunities. A number of options for cost savings and financing renewables on-farm are available. It is important to consider these alongside your business and future energy needs.

Environmental Upgrade Agreements (EUAs), chattel mortgage or lease

Environmental Upgrade Agreements (EUAs) are where solar projects can be 100% financed at discounted rates and cash flow positive from day one.

Purchasing a solar system via a chattel mortgage or lease from a lender who has access to the Clean Energy Finance Corporation (CEFC) incentives is a good option for some farms. Key considerations of this approach:

- It will not require any up front capital and will generally be cash flow positive from the first month after commissioning.
- Solar PV is very low maintenance and if installed properly using quality products, should provided many years of virtually maintenance free savings.
- Interest rates are typically in the 5-6% range for systems up to $175k with a low doc approval process.
- Most of the big four banks have access to the CEFC money as well as many other smaller lenders.
- Ownership is clear from the outset and the savings are retained with the farmer.
- Most farmers would be familiar with equipment finance for machinery purchases. This is exactly the same.

Another option is to use a lease arrangement. This would be used if the farmer wants an off balance sheet solution. However, careful consideration of the fine print of a lease, in particular with the end of lease residual payout to obtain transfer of ownership, should be undertaken before signing. This can sometimes be vague and not to the farmers best interest.

Power purchase agreements (PPAs)

A PPA is a contract between two parties, one which generates electricity (the seller) and one which is looking to purchase electricity (the buyer). The PPA defines all of the commercial terms for the sale of electricity between the two parties, including when the project will begin commercial operation, a schedule for delivery of electricity, penalties for under delivery, payment terms, and termination. The agreement can take several forms and can provide both parties with greater certainty about price over a long period.

PPAs can also be used to finance on-site solar PV systems. An on-site PPA is where the renewable energy generation assets are owned and operated by a third-party for a period of time and farmers simply buy discounted power for a set term. Depending on the terms of the PPA, the assets then transfer to the farmer.

In addition to zero up-front outlay in some cases, benefits include:

- Removal of the costs of ownership and maintenance of a system
- Electricity continues to be included as an operational expense
- Savings on electricity costs
- Hedges electricity price rise risk.

Whilst PPAs are a method of hedging against increased price rises, the main beneficiary is the third party who owns the solar system.

All PPAs are subject the supervision of the Australian Energy Regulator (AER).

Things to consider before entering into a PPA:

- Understanding you electricity needs and match the system to suit
- Ensure the PPA sets out the roles and responsibilities of each party, including site access and safety for maintenance
- Carefully review the terms of the agreement before signing.
- Undertake technical due diligence for the project and commercial due diligence on the supplier(s).
- Understand that whilst PPAs are a method of hedging against increased price rises, the main beneficiary is the third party who owns the solar system. Ensure you understand the details of the PPA before committing to the arrangement.

For a guide to PPAs, click here: bit.ly/2zrGcyf

Incentives and grants

Energy assessment and energy efficiency grants are available in Victoria, NSW, Tasmania and Queensland. Energy efficiency subsidies are also available through the federal Clean Energy Finance Corporation.

For more information:

Vic Govt grants

agriculture.vic.gov.au/agriculture/farm-management/agriculture-energy-investment-plan/grants

NSW grants

energysaver.nsw.gov.au/business

ess.nsw.gov.au/Home

Tasmanian Energy Efficiency Loan Scheme

auroraenergy.com.au/teels

Queensland Agribusiness Energy Efficiency

business.qld.gov.au/industries/farms-fishing-forestry/agriculture/agribusiness/energy-efficiency

Clean Energy Finance Corporation

cefc.com.au/where-we-invest/agribusiness

Need more information?

Energy comparison sites

Energy made easy
energymadeeasy.gov.au

Electricity wizard
electricitywizard.com.au

iSelect comparison site
iselect.com.au/energy

Go Switch comparison site
goswitch.com.au/compareelectricity

Energy action
energyaction.com.au

Victorian Energy Compare Victorian
bit.ly/2r4cOcE

Renewables advice

Clean Energy Council
cleanenergycouncil.org.au

Clean Energy Regulator – Small-scale Technology Certificates
bit.ly/2TP9xLi

Essential Services Commission – Minimal Feed-in-Tariff
bit.ly/2RgzQlV

Feed-in-tariff comparison via Solar Quotes
solarquotes.com.au/energy

Renew Sunulator tool
renew.org.au/resources/sunulator

Community Solar Portal – support and resources for community owned solar projects (currently Vic focused)
communitysolar.org.au

YourHome – Federal Govt site with comprehensive guides to components of renewable energy
yourhome.gov.au/energy

Energy Matters
bit.ly/2J8Z88z

Renew – renewables advice
renew.org.au/resources/advice

Power Purchase Agreements
bit.ly/2P4rfXU

Agriculture Victoria: Energy on dairy farms

Agriculture Victoria have a range of useful resources to improve energy efficiency in the dairy shed, including information about heat recovery systems, the cost effectiveness solar voltaic systems and variable speed drives.

bit.ly/2CrAFKk

Dairying Australian energy resources

Solar fact sheet
bit.ly/2PLRgwh

Wind fact sheet
bit.ly/2q63Paw

Hydro fact sheet
bit.ly/2OI7v0T

Biogas/Anaerobic digestors technical report
bit.ly/2DVMPfS

Battery storage/stand-alone systems
bit.ly/2RbCUpw

Dairy Climate Toolkit
dairyclimatetoolkit.com.au





Dairy Australia

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

1437 | Dec 2018