TECHNICAL GUIDE 7.0

Improving Energy Efficiency
A guide for New Zealand Dairy Farms

To succeed, New Zealand businesses need to be as competitive as possible. This means taking a serious look at ways to improve productivity and streamline processes. Energy management is a key way dairy farmers and sharemilkers can reduce their ongoing costs and improve the bottom line.

This guide focuses on assisting farmers to improve energy efficiency on dairy farms. It presents a range of options, from simple checks to cutting edge technology; all designed with energy efficiency in mind.

It should be read as a starting point for further discussion, research and tailoring of energy saving activities that will work the best for you.

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PUTTING ENERGY TO WORK

How to use this guide

This guide has been written so you can easily find the energy area you are most interested in. It focuses in turn on key components which are broken into six parts where appropriate:

- The energy challenge
- Available solution / technology
- Description and benefits
- Considerations
- Cost
- Contacts / further information

Costs

The costs indicated for each technology/service are categorised according to the following criteria. *Note these costs are given as a guide only.*

- LOW $0 – $500
- MEDIUM $500 – $1,500
- HIGH $1,500 and above

Disclaimer

Inclusion in this guide is not to be taken as any form of recommendation or endorsement by EECA of the stated skills or experience, or of any product offered by companies or organisations listed.

Readers of this guide are encouraged to undertake their own research to ensure that they employ the right method, product, company, contractors or energy saving technique for their farm and specific requirements.

Costs are indicative only and accurate at time of printing. Users are urged to seek quotes from a range of suppliers before making any decision or capital outlay.

Contents

Introduction

Dairy products are New Zealand's largest export earner. In the December 2008 year dairy exports accounted for 21.6% of NZ's total merchandise exports at a value of $9.3 billion (Statistics NZ, 2009).

While it has long been accepted that to go dairying means incurring higher energy costs than other primary sectors, electricity today is one of the fastest rising costs in dairy farm operation. Dairy NZ reported in 2009, that fuel and electricity prices have increased by 130% and 90% respectively since 2000.

Dairy farmers today are often managing multi-million dollar assets. As such, they often find themselves juggling the various roles involved in every aspect of farm management; business and financial planning, animal and environmental welfare, plant, equipment and land maintenance, business improvement, human resource management and community involvement.

There is good information and technologies available to a dairy farmer if they want to investigate improving their overall energy efficiency. This includes internet sites like www.dairysavings.co.nz and the Energy Efficiency and Conservation Authority's www.eecabusiness.govt.nz. Handbooks are available like the Ministry for the Environment's Energy Efficient Ways and Dairy NZ's Dairy Exporter Great Farming Guide – Saving Energy. Specific information on a particular technology can be gathered from the various companies that supply each technology.

This guide focuses on assisting farmers to improve energy efficiency on dairy farms. It presents a range of options, from simple checks to cutting edge technology; all designed with energy efficiency in mind.

It should be read as a starting point for further discussion, research and tailoring of energy saving activities that will work the best for you.

Why energy efficiency matters

To succeed, New Zealand businesses need to be as competitive as possible. This means taking a serious look at ways to improve productivity and streamline processes. Energy management is a key way dairy farmers and sharemilkers can reduce their ongoing costs and improve the bottom line.

Improving the energy efficiency of your farm will:

- reduce operating costs
- reduce greenhouse gas emissions
- build a more sustainable business long term
- improve returns for investors
- improve productivity and free cash to re-invest in the business
- create added value for the end consumer
- be better for the environment.

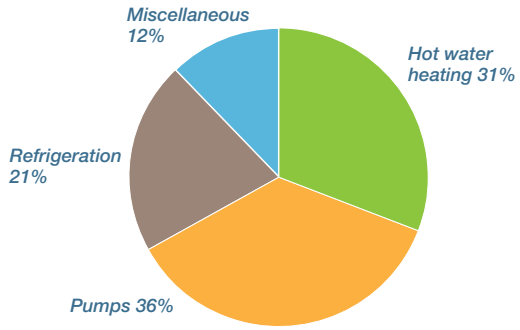
Taking a proactive approach to improving efficiency puts more control in the hands of the farm owner who can make cost savings and better overall decisions about energy use.

Energy use on New Zealand's dairy farms

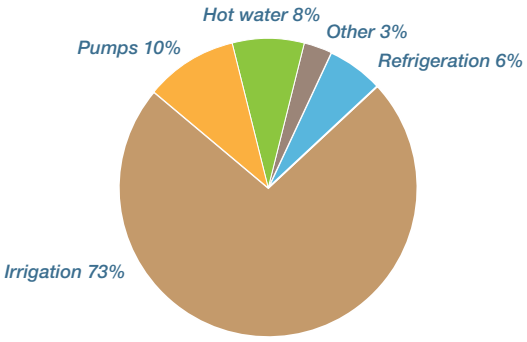
The main electrical loads on dairy farms are:

- hot water heaters
- rotary milking platforms
- lighting
- pumps (vacuum, water, pre-cooling, wash-down, milk, effluent).

Typical dairy shed energy use



Electricity use on an irrigated dairy farm



Typical dairy farm energy use[1]

Waikato – non-irrigated	6.3% of total farm working expenses (3.4% – electricity; 2.9% – fuel)
Canterbury – irrigated	9.0% of total farm working expenses (7.1% – electricity; 1.9% – fuel)

[1] MAF Pastoral Monitoring Report 2008
http://www.maf.govt.nz/mafnet/rural-nz/statistics-and-forecasts/farm-monitoring/2008/pastoral/index.htm

Simple savers – energy efficiency measures

Before you consider specific components of farm energy efficiency, there are some simple energy savers that often get overlooked.

1. Turn off all machines, monitors, equipment, lighting when not in use. Preset switch timers can assist.
2. Use energy efficient light bulbs, fluorescent instead of incandescent lights.
3. Use natural light where possible (e.g. clear Perspex corrugated sheets).
4. Ensure cow comfort in and around the milking shed to reduce effluent discharge and consequential removal cost.
5. Bury or insulate coldwater pipes from pump to refrigeration unit. Don't lash a cold and hot water pipe together.
6. Check that every ICP number on electricity invoices match with a real meter on the farm.
7. Take your own meter readings from time to time and match them to the invoiced reading.
8. Know what tariffs you are on and where possible feed energy loads into off-peak tariff times. Timer switches can assist.

Refrigeration is a major energy user on the dairy farm.

Where to begin

The first step in reducing on-farm energy use is to understand where the energy is being used. As the previous graph showed, nearly 90% of dairy sheds' energy use goes on refrigeration, pumps and water heating. Irrigation systems, when used, typically account for more than 70% of electricity usage.

Having a clear picture of what energy is being used and where, and how much it costs, enables two key things:

1. Being able to monitor, measure and demonstrate savings.
2. Being able to target energy saving efforts in a prioritised and structured way.

Dairy shed energy audit

The energy challenge

Trying to improve energy efficiency without understanding the current situation is like trying to reach a destination without knowing where you're starting from.

An audit is a snapshot of your energy expenditure at a fixed point in time and is the first step to planning improvements. Without an audit, whatever good strategies you put in place, it will be hard to measure their success.

Description

At its most basic, energy use in the dairy shed is measured and analysed over a fixed period of time. A detailed report is provided detailing where the energy is being used, what savings can be made, the unit cost of these measures and the payback period.

Additional services could include analysing billing, matching of invoiced readings to actual meters, re-design concepts or a whole farm audit.

Benefits

- An audit draws a picture of energy use and costs that allows you to plan changes with a strategic approach.
- Documentation makes measuring savings and ongoing monitoring easier and more accurate than relying on invoices alone.
- External consultants can offer specialist knowledge (including payback periods, challenges and supplier information) and have a wide knowledge of available and emerging technologies.
- Local advisors or contractors appreciate the constraints and complexities of your farm and region and are often farm managers themselves.

Considerations

- Whether to invest in a whole farm audit or solely the milking shed.
- Whether to undertake the audit yourself or employ a contractor / energy consultant.

Available solution / technology

- A consultant will usually provide a list of recommendations with associated costs for you to consider.
- Smart meters may be employed to monitor individual component energy consumption.

Cost

MEDIUM TO HIGH. Very site and scope dependent, check with supplier.

Contacts / further information

Manufacturer / Service Company	Phone Number	Website	Location
Natural Systems Ltd	03 376 5547	www.naturalsystems.co.nz	National

> Without an audit, whatever good strategies you put in place, it will be hard to measure their success.

Component energy saving guidelines

The following section details energy-saving options for specific farm components.

Power switch controls

The energy challenge

Appliance or light switches being left on accidentally 24/7.

Description

Power switch controls generally offer a countdown mode, and cycle mode or a start up timer – all designed to ensure the appliance or switch is on only when needed.

Available solution / technology

Switch controller or standard electricity timer plug.

Cost:

LOW.

Contacts / further information

Manufacturer / Service Company	Phone Number	Website	Location
Local electricians			
eSource Products Ltd	09 527 6655	www.intelliswitch.co.nz	Auckland

Pumps
Vacuum, milk, water and effluent

The energy challenge

Dairy farm pumps account for the majority of milking shed energy costs. While much focus is directed towards purchase cost, the total cost of ownership of pumps can demonstrate large inefficiencies in use, particularly when they run at full RPM.

Description

There are many practices and technologies that can improve pump efficiency.
See Available solution / technology section.

Benefits

- Over 50% of the pump lifecycle costs are energy and maintenance expenses.
- System optimisation can save up to 20% of energy expenditure.

Considerations

- The age and condition of your existing pump.
- The cost-benefit ratio of installing a new one or retro-fitting.

Available solution / technology

As with any technology, following best practice helps to get the most out of your pumps.

- Choose the most efficient pump type and size for your operation at installation. Consult your pump supplier and consider the flow and head requirements, inlet pressure or net positive suction head available, and the type of liquid to be pumped.
- Consider the cost effectiveness of two smaller pumps rather than one large one. The two pumps can be operated in parallel during peak demand periods, but one pump only operates during lower demand periods. Alternatively, install one variable-speed pump and one constant-speed pump.

- Design the system head and capacity based on reasonable requirements and add capacity later if requirements increase. (Installing a larger pump may consume up to 20% more energy than a smaller pump operating at a more efficient point on the pump curve).
- Reduce velocity in heat exchangers and eliminate open bypass lines.
- Reduce total head requirements by minimising height differences when pumping liquids between tanks, lowering friction losses through use of larger pipes and low-loss fittings.

Maintaining the water system and fixing leaks

- Essential for maintaining an energy efficient farm.
- Check pipes and fittings.

Cost:

LOW.

Regularly maintain pumps

- Maintenance of bearings and shaft seals.
- Check smoothness of impeller and casing waterways.
- Dairy plant supplier should tune the vacuum system twice a season.

Cost:

LOW.

Flow meters

- Can be fitted into individual branch waterlines and fixed to fence posts to track water use and indicate leaks.

Cost:

LOW TO MEDIUM.

Gravity feed and water ram pump

- Generally more suited to sheep and beef farms due to terrain and lower flow requirements.

Cost:

MEDIUM TO HIGH.

Variable speed drives

The energy challenge

Water and vacuum pumps running at full RPM waste energy and wear out the pump.

Description

A variable speed drive controls the speed of a motor by varying the motor's supplied voltage and frequency of power. Their use is most applicable where the pump is required to operate over a wide range of flows, be that water or air. A variable speed drive such as the Varivac adjusts to actual airflow requirements, enabling the pump to run at the required capacity rather than at the maximum speed the whole time.

Consider the cost effectiveness of two smaller pumps rather than one large one.

Benefits

- Savings of 40 – 80% of electricity use by the vacuum pumps.
- Variable speed drive technology can be applied to any pump mechanism.
- Soft start reduces pump wear, shock loading and power consumption.
- Less noise and vibration results in happier cows, less cup kicking, faster milking, less effluent to remove (reduced pumping and water usage) and reduced somatic cell counts (therefore reduced penicillin usage).
- Improved milk cooling efficiency and reduced milk frothing.
- Some providers claim more vacuum than air regulators, thus significantly reducing vacuum overshoot and no air regulator to clean.
- Possible to reduce motor sizes and lower the payback period.

Considerations

- System must allow for the adjustment of vacuum pressure during the season and during milking e.g. higher for herd testing, lower for heifers in spring, higher for washing.
- If you are throttling your pump (e.g. a partially closed gate valve) you are wasting money.

Available solution / technology

- Variable speed drives.
- Some drives can be retrofitted.

Cost:

15 kW unit: $8,000 – $10,000.
Soft start controller $2,000 – $3,000.

Contacts / further information

Manufacturer / Service Company	Suppliers of	Phone Number	Website / Contact	Location
Corkill Systems Ltd – (Varivac)	Variable Speed Drives	0800 10 7006	www.corkillsystems.co.nz	National
Danfoss – (Varivac)	Variable Speed Drives	09 259 2510 03 365 6123	www.danfoss.co.nz	National
Waikato Milking Systems – (Smart Air VSD)	Variable Speed Drives	0508 645 5464	www.waikatomilking.co.nz	National
Tom Harrison & Sons Ltd	Water ram pumps	09 407 9915	harrisons@actrix.co.nz	National
Water Supply Products Ltd	Pumps, meters, control valves	09 916 0094 03 348 1293	www.effluentseparation.co.nz	National
De Laval	Dairy shed equipment	07 849 6020	www.delaval.co.nz	National

Further information: www.pumpsystemsmatter.org
Hydraulic Institute www.pumps.org

Hot water
Heating, insulation, recovery and transfer

The energy challenge

Hot water generation and storage accounts for around 30% of the entire milking shed energy use. Cleaning represents the largest part of this use.

Description

While hot water is essential in the milking shed, significant energy savings are possible by analysing every component for possible efficiencies. This section covers the key areas, beginning with the least expensive.

Benefits

- Lower electricity bills.

Considerations

- Hot water needs to be available at correct temperature the time cleaning is required, this may vary from shed to shed.
- Storing hot water all day should be avoided. Heat water just before it is required.

Available solution / technology

Minimise hot-water use

While hygiene is paramount for consumer safety, there may be some hot water use that can be decreased without compromising quality, health and safety. (Special care is needed if there are cows on antibiotics.)

- If considering reducing hot water use in sanitisation, an increase in one of the four washing components is required: concentration of detergent, temperature of fluid, turbulence of fluid through the system or length of washing time.
- Deosan Supernova detergent enables less hot water to be used as part of the plant wash programme. Trials show a 25% reduction in hot water is possible. A 24-cluster plant could save $320/yr.
  (As part of the Deosan AgriQuality approval, clients are required to take part in a Quality Management System specifically designed to ensure milk quality is maintained at a high level. Refer to www.deosan.co.nz for more details.)

Leaks

- Check the pipes and fittings regularly for leaks. Two leaky drips per second costs $50/year and multiple leaks could save up to 500 kWh/year.

Cost:

LOW.

Thermostat temperature

- Check thermostat is set to 85°C (Fonterra required temperature) and is working correctly.
- A plant with 24 clusters and a 9,100 litre vat would save around 221 kWh per degree (around $40 per season).

Cost:

LOW.

Insulation

- Insulating hot water cylinders could save 400 – 1,200 kWh/year.
- Insulation can be retrofitted to older cylinders.
- Pipes can also be insulated.

Cost:

LOW. A cylinder wrap costs $90 – $120, with savings of up to $240 per year.

Cylinder size and location

- Consider cylinder location when designing the shed. Site away from prevailing winds and on the sunny side of the shed.
- If the hot water system is being upgraded consider what capacity is needed. Over-sized cylinders result in heating water that will not be used.

Cost:

LOW.

Heat recovery

A heat recovery system can enable enormous energy savings in the milking shed and consistently shows some of the biggest opportunity for reducing electricity costs. Heat recovery works by collecting the waste heat from the milk or the refrigeration unit's condenser and converting the incoming cold water into stored hot water.

- Some systems (e.g. Mahana Blue) can reduce hot water costs by 50 – 60% and can be retrofitted.
- DTS heat recovery system can save 50% of hot water heating costs and can be retrofitted.
- A 10°C increase in inlet water temperature could save 2,210 kWh (24 cluster 9,100 litre vat).

Cost:

HIGH. A heat exchanger for a 250 litre system ranges from $1,500 – $8,000 depending on complexity and size.

Solar energy

New Zealand has high levels of solar radiation. This can be harnessed with solar panels to heat water used in the dairy shed. Hot water energy savings may be as high as 75%. A recent EECA project investigated the use of a 'portable' solar energy system that share milkers could take from farm to farm to reap the rewards of lower power bills (www.eecabusiness.govt.nz).

Cost:

HIGH. Varies widely. A new system for a 400 cow farm costs between $15,000 – $33,000.

Contacts / further information

Manufacturer / Service Company	Suppliers of	Phone Number	Website / Contact	Location
Dairy Technology Services (DTS)	Insulation, heat recovery	0800 500 387	www.dts.co.nz	National
The Warehouse (EcoWrap), most hardware stores, Placemakers, Mitre 10, etc	Insulation	–	www.thewarehouse.co.nz www.placemakers.co.nz	National
Julian's Electrical and Energy Conservation	Insulation	06 756 7248	www.julians.co.nz	Taranaki
Danfoss – (Mahana Blue)	Heat recovery	09 259 2510 03 365 6123	www.danfoss.co.nz	National
Good Energy	Solar hot water	07 866 0455	www.goodenergy.co.nz	Upper North Island
Solar Commercial Ltd	Solar hot water	07 847 3122	jstack@xtra.co.nz	Hamilton
Solar Industries Association	Solar hot water	04 385 3359	www.solarindustries.org.nz	National
Infinergy	Solar hot water	0800 373 376	www.solarhotwater.co.nz	National
Sunz	Solar hot water	0800 786 469	www.sunz.co.nz	National
Deosan	Reduced hot water washing system	0800 336 726	www.deosan.co.nz	National
Thermocell	Solar hot water	0800 955 000 03 982 5000	www.thermocell.co.nz	National
Azzuro Solar	Solar hot water	0800 299 876	www.azzurosolar.co.nz	National
Ecogise	Solar hot water	03 548 0093	www.ecogise.co.nz	Upper South Island
Ecosolar	Solar hot water	0800 326 7652	www.ecosolar.co.nz	National
Climatemaster	Heat pump water heater	04 384 2813	www.eeca.govt.nz/node/5517	Lower North Island

Refrigeration

The energy challenge

Refrigeration is generally the third highest energy user on a dairy farm.

Description

While chilling the milk prior to pickup is essential for food safety and quality, the energy saving measures listed below show where savings can be achieved. Refrigeration is often a significant aspect of many industrial processes so measures developed in other industries can often be adapted to the dairy farm.

Benefits

- Less likelihood of grades due to plant machinery failure.
- Significant energy savings are available.

Considerations

Optimising refrigeration plant performance is a specialised skill. While service companies may need to perform certain tasks, you can:

- schedule regular system checks
- perform regular maintenance (e.g. cleaning condensers and evaporators)
- challenge the service provider on issues like vat and pipe insulation, plant room ventilation and refrigerant charge.

Available solution / technology

Maintenance

- Check regularly for leaks.
- Clean and repair fans for efficient operation (dirty ventilation fans and air ducts can increase running costs by up to 60%).

Cost:

LOW.

Ventilation

South side and shady location of refrigeration unit reduces cooling costs. In addition, good ventilation:

- lowers refrigeration costs
- minimises warming of milk in vat.

Cost:

LOW.

Insulation

- Insulating vat and pipes could save 300 – 700 kWh/year.
- Energy savings from insulating vats in three case studies was 20 – 30%.
- DTS's Thermo Wrap is glued and strapped on, so can't be re-used. DTS's Polar Wrap is strapped on so can be re-used, and also has a PVC cover so it lasts longer.
- Energy savings are likely to be greater for vats standing outside than those inside.

Cost:

MEDIUM TO HIGH. Polar wrap $2,017 (7,800 litre vat).
Thermo Wrap $569 for the kit or $1,044 fitted.

Insulating pipes will prevent energy loss.

Spherical vats

This has been developed by Tenix Robt Stone in Hawera (www.robtstone.co.nz/wwdo_prod_sphericool_tanks.html). The spherical design gives a highly effective storage, hygiene and cooling process.

- Cooling costs are reduced due to a smaller vat area being exposed to the sun.
- The quicker chilling method uses less overall energy.

Plate coolers

Plate coolers pre-cool the milk before it enters the vat.

- Coolers must be kept clean to prevent milk contamination and to provide efficient cooling.
- 2.5:1 ratio should cool milk to within 2°C of water source temperature.
- Design of water/milk flow ratio is critical for efficient use.

Contacts / further information

Manufacturer / Service Company	Suppliers of	Phone Number	Website	Location
Dairy Technology Services (DTS)	Insulation	0800 500 387	www.dts.co.nz	National
Julian's Electrical and Energy Conservation	Insulation	06 756 7248	www.julians.co.nz	Taranaki
Robert Stone Stainless	Spherical milk vats	06 278 5186	www.robtstone.co.nz	National
Thermocell	Ice banks	0800 955 000 03 982 5000	www.thermocell.co.nz	National
Alfa Laval Ltd	Dairy shed equipment, plate coolers	07 849 6025	www.alfalaval.co.nz	National
Waikato Milking Systems	Dairy shed equipment, plate coolers	07 849 8755	www.waikatomilking.co.nz	National
Milfos International	Dairy shed equipment	07 843 1780 (See website for local numbers)	www.milfos.com	National
Dairycool Ltd	Dairy refrigeration	03 307 8903	–	Canterbury

Irrigation

This section of the guide is split into two aspects of irrigation:

- design and equipment
- operation and maintenance.

Irrigation – design and equipment

The energy challenge

Building in energy efficiency considerations in the design stage of projects is one of the most cost-effective ways to reduce your energy use. Careful research and time is needed to ensure your design delivers the most cost-effective irrigation solution for your property.

Description

On an irrigated dairy farm irrigation will be the single largest energy user. Establishing and operating the system at its optimum level is critical to managing energy costs and water use.

Benefits

- Focusing on the whole of life costs, rather than minimising the initial capital cost, will ensure significantly lower running costs.

Considerations

- Optimum irrigation requires the system design to match the maximum evaporative demand of the grass or crop and allows variation in the depth of water applied.
- An irrigation distribution evaluation will quantitatively describe how well your system is performing and where improvements can be made.
- Improving irrigation uniformity from 70 to 90% can reduce water applications by 30%, which consequently cuts energy use by 30%, or can allow you to increase the irrigated area thereby boosting production and profits.

Building in energy efficiency considerations in the design stage of projects is one of the most cost-effective ways to reduce your energy use.

Available solution / technology

Pumps, pipes and system design

- Use energy efficient pumps and motors.
- Highest pump efficiency occurs when operating at the maximum efficiency flow and selecting the pump brand and model matching your irrigation requirements.
- Over 50% of the pump lifecycle costs are energy and maintenance expenses. System optimisation can save up to 20% of energy expenditure.

System design

- Over-sized pumps result in excessive pressure within the irrigation system which requires throttling back. This means high electricity usage for the volume of water pumped.
- Tight bends and sharp corners restrict flow resulting in higher-pressure losses.
- Minimise head loss in rising columns and mainlines through appropriate sizing.
- Correct pipe diameter sizing and headworks reduces friction loss resulting in lower running costs.
- Replacing rising columns will be necessary if they are damaged, corroded or pressure loss is excessive.

Improve irrigation uniformity

By applying the irrigation water as evenly as possible there is the opportunity to significantly reduce water and energy use or alternatively irrigate more land with the same volume of water.

- Choose the most appropriate irrigation system at the design phase, as changing systems once installed is considerably more expensive.
- Auditing systems can show inefficiencies in the design and/or operation of the system. Operators can audit their own system or contract the services of company specialists.
- Improving distribution uniformity from 70% to 90% will reduce water and energy use by 30%, or alternatively allow 30% more area to be irrigated.
- Soils vary across paddocks so a compromise is usually required. It may be possible to irrigate different soil types separately but often this is impractical.

Cost:

LOW.

System maintenance

- Pre-season maintenance reduces the risk of having non-operational periods during critical irrigation application times, which could lead to low soil moisture levels and reduced grass growth.
- Pre-season maintenance allows the system to run more efficiently during the season including:
  - replacing worn sprinklers and nozzles
  - removing blockages in pipes and emitters.
- During the season monitoring pumps, cleaning blocked emitters and detecting leaks improves efficiency.
- Check well performance by measuring static water level and specific capacity (pumping rate / drawdown) and compare the results with previous measurements such as drilling.

Cost:

LOW - MEDIUM.

Variable speed drives (VSD)

- VSDs reduces the wear and tear on pumps and motors by evening out the load.
- VSDs are particularly useful where changes in elevation affect hydrant pressure. They avoid the need to use energy dissipating devices like pressure reducing valves, or worse partially closed gate valves. It may be possible to reduce the motor size and lower the capital payback period.

Cost:

HIGH 5kW unit $8,000 – $10,000.
Soft start controller $2,000 – $3,000.

Irrigator types

Use efficient irrigators

Generally centre-pivot, linear move and fixed-boom linear type irrigators are the most efficient, followed by rotorainers and solid set irrigators; then travelling guns, followed by side-rolls and K-lines.

Centre pivot

- High initial cost.
- Energy requirement can be high.
- Uniformity of application is better than most other systems.
- They have a short irrigation return interval (1 – 3 days).
- Can operate at 90% efficiency if less than 500m long.
- Used with accurate soil moisture measuring systems they can achieve very efficient irrigation applications. Accurate soil moisture measuring can give confidence to turn irrigators off without sacrificing grass growth rates.

Rotorainer, linear and rotary booms

- Lower capital cost than centre-pivot.
- The irrigation return interval can be 7 – 15 days. Application rates can be low thereby avoiding ponding.
- Can operate at 75% efficiency.
- Strong wind causes rotation and travel speed to slow therefore application rates increase. In calm conditions uniformity is generally good if the boom is operated at the correct pressure and correct sized nozzles are used.
- Linear booms suit rectangular shaped paddocks.

Self propelled gun sprinkler, hard and soft hose

- Subject to interference by wind. Operating at closer lane spacings, using low angle guns and operating at the correct gun pressure can reduce the impact of wind interference.
- Often these irrigators are the only viable option, particularly when an irrigator needs to be moved around the district.

Side rolls and hand sift pipes

- Are moved manually down the paddock.
- Application rates are low. Providing the same nozzles are used and they are not worn, they can achieve uniform distribution.
- Low capital investment.
- Laterals need to be shifted at the recommended spacing.

K-line

- Very difficult to achieve uniform application.
- Application rates are very low seldom leading to surface ponding. Systems are often designed to operate 24 hours a day and tend to have long rotation times.
- Efficiency often as low as 40%.
- Low capital investment.
- Requires manual moving down the paddock.

Contacts / further information

Manufacturer / Service Company	Suppliers of	Phone Number	Website	Location
Irrigation New Zealand	Irrigation manuals	03 379 3820	www.irrigationnz.co.nz	National
PGG Wrightson	Irrigation systems	0800 102 276	www.pgg.co.nz	National
Water Dynamics	Irrigation systems	09 378 0383	www.waterdynamics.co.nz	National
AgriLINK New Zealand	Irrigation evaluations	09 412 5520	www.agrilink.co.nz	Auckland
Page Bloomer Associates	Irrigation evaluations	06 876 6630	www.pagebloomer.co.nz	National
Danfoss – (Varivac)	Variable speed drives	09 259 2510 03 365 6123	www.danfoss.co.nz	National
Rainer Irrigation	Irrigation systems	03 307 9049	www.rainer.co.nz	Canterbury
Plains Irrigators	Irrigation systems	03 307 2027	www.plainsirrigators.co.nz	Canterbury
Bosch Irrigation	Irrigation systems	0800 500 424	www.boschirrigation.co.nz	National

Irrigation – operations and management

The energy challenge

Irrigation management is often a relatively new aspect for many dairy farm owners and managers. For most irrigated farms it will be the single largest energy cost. Improving knowledge on how to optimise the system and monitor performance is likely to take up a significant amount of time.

Description

Irrigation management is largely about answering two questions:

- how much to apply
- how often to apply it.

Correctly answering those two questions can be difficult, especially if you are new to irrigation practice. Monitoring is essential. Monitoring should include the quantity applied, rainfall, evapotranspiration and the soil moisture.

Benefits

- Applying the correct amount as evenly as possible will ensure optimum performance. Savings of more than 30% (energy and water) have been seen following improvements in irrigation performance.

Considerations

- Check your Regional Council requirements before starting to design and operate your irrigation system. (Be aware there can be daily restrictions, which override permits and consents.)
- Monitoring is essential including:
  - rainfall
  - quantity of water applied
  - soil moisture level.
- Gain knowledge from others experienced in your region.

Available solution / technology

Irrigation manual

The irrigation manual is essential information for anyone irrigating. The guide covers everything from pre-season planning, maintenance, soil moisture monitoring, and setting performance indicators to irrigation system design and regulations.

Cost:

LOW $125.

Irrigation evaluations

You cannot manage what you don't measure. Irrigation evaluations show in quantifiable terms exactly how an irrigation system is performing. A full evaluation is conducted by service providers following a code of practice. A simplified do-it-yourself system has also been developed for annual checking and calibration. Visit www.pagebloomer.co.nz/irrig8/ for more information.

Cost:

MEDIUM.

Irrigation when required on a little and often basis

Light soil types require low application depths. This may mean running the irrigator at higher speeds and two shifts per day.

- Consideration of time component, labour availability is necessary. Running two irrigators covering half the area and applying half the water volume each may be appropriate.
- Consider changing nozzle sizes.
- Short cycle systems need to be incorporated into the system design.

Avoid irrigating in windy conditions

- Irrigation should be avoided in windy conditions as it requires greater application rates. However, this is not always possible if the system does not have capacity over and above the minimum requirements. Not irrigating in windy conditions may lead to reduced grass growth. Also windy periods can last for days.
- In windy conditions lane spacing is reduced and application rates can be decreased to improve distribution. Evaporation rates will be higher. Systems discharging water close to the ground are less affected by wind e.g. centre-pivots or booms with drop tubes, long laterals, k-lines or micro-sprinklers.
- Operating at lower pressure can increase droplet size and reduce losses, but application rates should be monitored to avoid run-off.
- Using drop tubes on centre-pivots and travelling irrigators places the water closer to plants and reduces application pattern distortion and water losses.

- Growing shelterbelts can reduce wind influence but they must be designed to filter the wind rather than blocking it, which produces turbulence and damage. Shelterbelts have to be sited so as not to interfere with the irrigator's path of application. They can harbour insects and reduce the productive pasture area. They also provide shelter and shade to cows.

Irrigation at night

- Irrigating at night when possible, reduces evaporation losses.
- Possibly lower night-rate electricity tariffs.
- Most systems cannot supply sufficient water to operate only at night.
- May be possible in wet periods and either side of irrigation seasons.

Reduce peak load

Turning the irrigator off during milking to reduce peak load tariff charges can reduce line charges. To do this a time of use meter is needed.

- Additional labour may be required.
- This may waste some water as the pressure in the line falls and builds up again.
- Starting the pump and motors puts load on them even with soft starts and VSDs, which adds extra wear and tear.
- The majority of irrigation systems are designed to operate for 20 – 22 hours per day. Stopping for milking will upset the irrigation application pattern and may reduce grass growth.
- Careful analysis of tariff savings versus negative effects on the irrigation is needed to find the ideal balance.

Monitoring – rain gauge

Install rain gauges under the irrigator and outside the irrigation area to monitor irrigation and rainfall.

- Ensure rain gauges under the irrigator are representative of what is being applied.
- The gauges should have a cone shaped lid to prevent evaporation loss.

Cost:

LOW $40 – $200.

Monitoring – water meters

Meters are an essential component of managing an irrigation system, by ensuring you accurately know and can track how much water has been applied. It should be noted that these often require Regional Council consent.

- Most meters will have an accuracy of better than ± 5%.
- Meters need to be installed in a straight length of pipe. The guideline is 10 times the pipe diameter of straight pipe, before the meter, and 5 times the pipe diameter of straight pipe after the meter.

Cost:

LOW TO MEDIUM $200+.

Monitoring – soil moisture

No strategy can be implemented without soil moisture monitoring. Measuring soil moisture provides information on when to irrigate and how much water to apply.

- Maintain soil moisture between stress point and field capacity to ensure growth is not limited.
- Continuous readings (data logging system) give the greatest level of accuracy. This should be combined with observing the effect of various irrigation / rainfall events on plant performance.
- Data logger systems can be linked to telemetry or automatic control systems.

Weekly soil moisture monitoring service

Some companies provide soil moisture monitoring services during the irrigation season.

- Monitoring and analysing soil moisture levels to schedule the irrigator can provide significant savings.

Cost:

LOW. $35 per week per site.

Tensiometers

Tensiometers measure soil water tension through vacuum pressure on the tip. As the soil around the tip dries, water moves out of the tip until the equilibrium is re-established between the tip and the soil. Thus a vacuum is created equivalent to the soil water potential. The soil water potential relates directly to the amount of energy the root uses to remove water from the soil, hence is a measure of plant stress rather than soil water content.

- They are not affected by osmotic potential of the soil solution (i.e. salt concentration) however plant roots can be affected.
- The tube requires refilling after a dry period.
- Avoid repeatedly standing close to the tensiometer to prevent soil compaction.
- It can take 24 hours for an irrigation application to reach to the depth of the ceramic tip. As a general rule a 1mm application will decrease the tensiometer reading by 1 centibar.
- If the tip is in an area of limited root activity or loses contact with the soil you can get unrepresentative readings of the soil moisture status.
- They only measure the soil moisture in the immediate vicinity of the tensiometer tip.
- They tend to be installed in permanent positions.
- Install midway between the irrigator and the limit of its throw, avoiding wet or dry spots. A shallow and deep tensiometer should be installed. The shallow tensiometer indicates when to start irrigating and the deep when to stop to avoid deep percolation losses.
- It is advisable to install a number of tensiometers across the farm to account for topography, soil type and climatic differences.
- If the irrigation cycle takes more than three days it is recommended that tensiometers are installed at both early and late cycle periods as application rates may need adjustment.

Cost:

LOW TO MEDIUM $260 – $1,350.

Time domain transmission

Measures the dielectric constant of soil to find its volumetric water content. The sensors measure the signal oscillation frequency, which is related to the soil dielectric constant. The signal gives a good indication of the soil moisture status. Temperature is also measured. It can be linked to a datalogger (with or without telemetry options) or spot read using a laptop or palmtop.

- Some sensors (e.g Aquaflex), measure soil moisture over a 3m length and cylindrical 6-litre volume of soil. As soil moisture is not uniform this method gives spatial averaging to readings increasing the accuracy.
- Installation in pasture recommends a sensor sloping through the profile from about 50mm below the surface down to 400mm. A second sensor at 500mm can be used to check if water is draining out below the active root zone.
- Like all monitoring systems installation is critical and soil is re-laid over cable as close to the original configuration as possible.

Cost:

MEDIUM TO HIGH $1,350+.

Capacitance sensor

These sensors use electrical capacitance to measure soil moisture. Originally they were connected to a data logger for continuous monitoring but now are also available in a portable version.

- It is imperative that any soil moisture monitoring equipment is placed in a representative part of the paddock and that the installation does not disturb the surrounding soil as that will change the water holding characteristics of the soil being monitored.
- EnviroSCAN and Diviner are two products available.

Cost:

HIGH $4,500+.

Contacts / further information

Manufacturer / Service Company	Suppliers of	Phone Number	Website	Location
Hydro-Services	Soil moisture monitoring	03 341 0970	www.hydroservices.co.nz	National
Netafim NZ	Monitoring equipment	09 256 2551	www.netafim.com	National
Deeco Services	Monitoring equipment	0800 433 326	www.deeco.co.nz	National
Prosol	Monitoring equipment	09 414 1028	www.prosol.co.nz	National
Scott Technical Instruments	Monitoring equipment	03 374 2101 07 847 0646	www.scottech.net	National
Streat Instruments	Monitoring equipment	03 384 8900	www.streatsahead.com	National
PGG Wrightson	Monitoring equipment	0800 102 276	www.pgg.co.nz	National
Water Dynamics	Monitoring equipment	0508 477 44283	www.waterdynamics.co.nz	National
Fruitfed Supplies	Monitoring equipment	09 448 0510 (See website for local numbers)	www.fruitfed.co.nz	National
Irrigation New Zealand	Irrigation manuals	03 379 3820	www.irrigationnz.co.nz	National
Fruition Horticulture	Soil moisture monitoring	03 547 3959 (See website for local numbers)	www.fruition.net.nz	National

Conclusion

Dairy farming in the 21st century presents ongoing complexities that New Zealand's pioneer farmers could not have imagined. Fluctuating product prices, global competition, compliance and regulatory requirements, investor and consumer expectations all challenge modern farmers on a daily basis.

While energy efficiency can be viewed as a single component of farm management, it can also be seen as a mindset that can positively underpin all farm activities.

We thank all the farmers and industry representatives who have contributed their knowledge and experience to this guide.

We hope it provides a starting point for looking at your farm energy use critically and in the long run, helps you run the most efficient farm you can.

As always, we welcome your ideas, suggestions and feedback.

EECA Business team

We thank all the farmers and industry representatives who have contributed their knowledge and experience to this guide.

Further information

Many government, private sector bodies and industry groups have produced guides and helpful information specifically aimed at dairy farms and energy efficiency. As well as conducting your own research formally and informally, here are some helpful references.

Relevant EECA resources and case studies about the dairy industry
www.eecabusiness.govt.nz/case-studies

Dairy New Zealand
www.dairynz.co.nz/publicationorder.aspx

Environment Southland
www.cowshed.org.nz

Ministry for the Environment
Energy Efficient Ways – to improve the economic bottom line of your dairy farm
www.energyfed.org.nz/Dairy_Farm.pdf

For more information contact The Energy Efficiency and Conservation Authority:

EECA HEAD OFFICE:
PO Box 388, Wellington, (04) 470 2200

EECA AUCKLAND:
PO Box 37444, Parnell, Auckland, (09) 377 5328

EECA CHRISTCHURCH:
PO Box 13983, Christchurch, (03) 353 9280

www.eecabusiness.govt.nz

MARCH 2010/EEC1369