Some Observations on Saving Electricity on the Farm

Jim Miller (Millbridge Consulting Ltd), February 2013

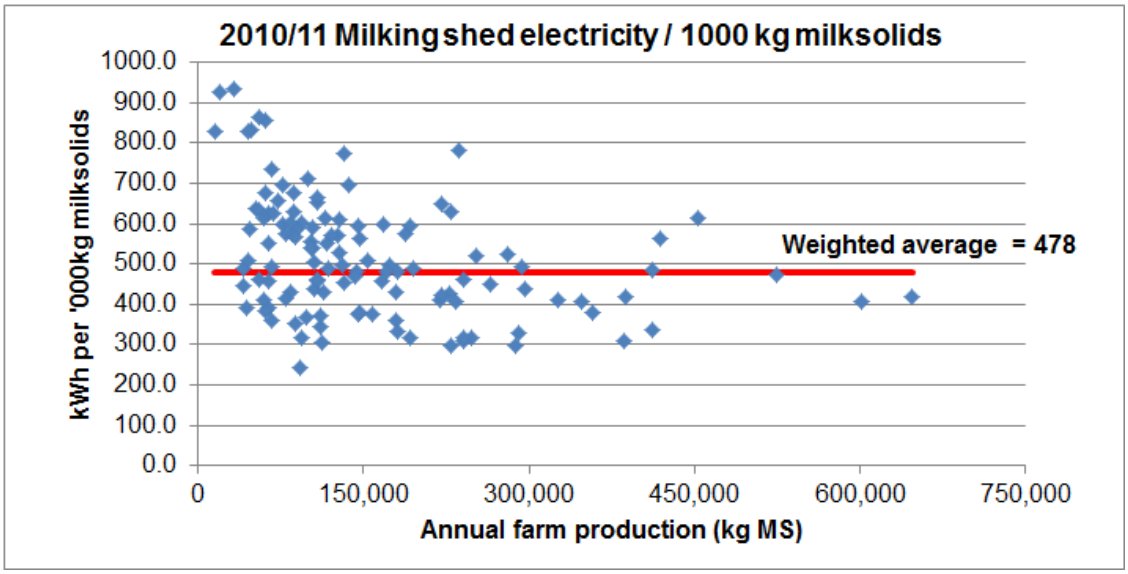
Electricity Use on Farm

The 2011/12 MPI Farm Monitoring Report shows that average electricity costs on farm are $0.13 per kg milksolids, or 3.3% of farm expenses. This is not a big fraction of farm costs but still likely to be around $17,500 - $20,000 a year spent on the average-sized farm. Generally we see 10-15% savings being achievable on most farms so that is still worth going after.

A joint MAF/EECA/Fonterra funded project undertaken during 2009/10 and 2010/11 gathered electricity use data from 150 randomly selected farms. It was found that the average dairy farm used 75,000 kWh per year, excluding pasture irrigation, and that all up New Zealand's dairy farms use around 2.5% of all electricity generated. For those interested in emission impacts, that average farm electricity use gives rise to 12.5 tonnes of CO_2 emissions per year based on New Zealand's average electricity generation mix.

Benchmarking Electricity Use

The following figure shows the distribution of electricity use per 1000 kg of milksolids on the 150 sample farms. Again this excludes pasture irrigation, but includes all other milking and herd related electricity use, including farm and shed water supply, implement sheds, and effluent irrigation.



There are many reasons why a particular farm will be above or below the line and this is not always related to efficiency but it is a useful exercise to calculate your own index and see how it compares. If you are significantly above the average it is a good indication that you should dig a bit deeper and perhaps have an energy audit done. This audit may cost $1000 to $1500 but it is worth paying this sort of money for good, independent advice.

To work out the electricity/milksolids index for yourself, get 12 months electricity usage and milksolids production data. This **must cover 12 months to give a valid result** but that 12

months can start and stop anytime over the season. Get the electricity data from invoices (not always easy to follow), from the electricity retailer's website where most now have on-line account access, or directly from the retailer. Get data from actual to actual reads and you may need to scale this to get to 365 days as shown in this example.

kWh	Reading	Date	Days
1996	Estimate	12/10/2010	29
2990	Actual	13/09/2010	31
1228	Estimate	13/08/2010	29
90	Actual	15/07/2010	29
80	Estimate	16/06/2010	33
-894	Actual	14/05/2010	30
1965	Estimate	14/04/2010	28
2194	Actual	17/03/2010	30
2156	Estimate	15/02/2010	32
2555	Actual	14/01/2010	35
2206	Estimate	10/12/2009	30
1965	Actual	10/11/2009	32
2302	Estimate	9/10/2009	30
1048	Actual	9/09/2009	28
1365	Estimate	12/08/2009	29
-848	Actual	14/07/2009	29
996	Estimate	15/06/2009	32
-320	Actual	14/05/2009	27
2156	Estimate	17/04/2009	32

kWh used 18,837
Days 369

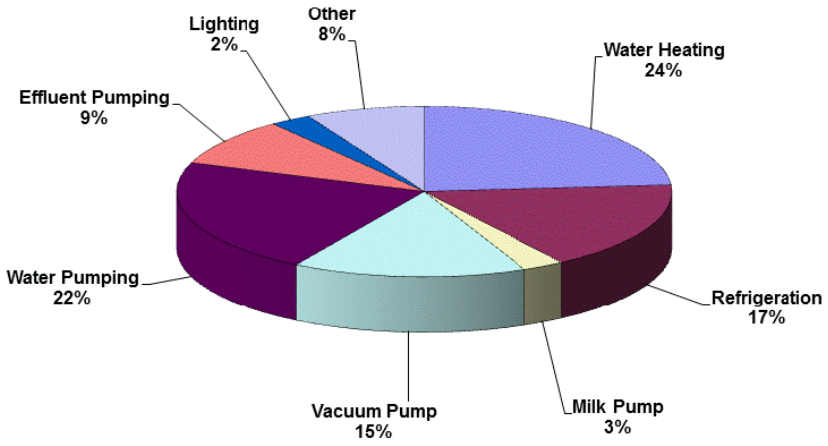
Scaled to 365 days
= 18,837 x 365 / 369
= 18,633

Milksolids total over
Sep 09 to Aug 10
36,050

Specific Electricity use
= 18,633 / 36,050
= 0.52 kWh/kg MS
= 520 kWh / tonne MS

Where Electricity is Used

The breakdown of where electricity is used varies a lot from farm to farm but the next figure shows the average breakdown.



Water Heating Opportunities

Before looking at options to heat water more efficiently, look to minimise the amount of hot water you need by:

- once daily hotwash if and when you can without compromising milk quality,
- fixing any leaks,
- setting the thermostat no higher than necessary,
- keeping cylinder insulation and cladding in good nick, and
- fitting a jacket to older cylinders where the insulation is likely to be less effective.

Almost all farms will have an option, with a 3-5 year payback, to recover heat from the refrigeration plant to preheat water. There are several options ranging from recovering heat from refrigerant de-superheaters through to the more sophisticated heat pump heat recovery systems. The best fit in each case depends on tariffs, how much hot water you use, and how much capital you are prepared to spend. Look at all your options.

Solar hot water panels, ground- or air-source heat pumps, and bottled LPG are also options which might be considered for water heating.

Refrigeration

Keep condensers clean and allow free air movement around them otherwise they have to operate at a higher temperature to get rid of the heat, which in turn means the refrigeration compressor runs at a higher pressure and consumes more electricity. Optimise the precooler performance as that provides you with free cooling. Do this by using the coldest water you can, insuring the water side of the heat exchanger is kept clean, and flows are adequate. The precooler will work better also if the flow of milk is kept steady so VSD control on the milk pump is better than an on-off pump.

Chilled water and ice-bank systems have their place but generally use a little more electricity than direct refrigeration systems due to needing a second cold vessel and an extra circulation pump. However there can be significant cost savings if night rate electricity can be used.

Vat insulation should be considered for outside vats where wind and rain really accelerate the heat losses. Generally these will give paybacks of 2-3 years.

Vacuum Pump

The vacuum pump is the main load in the milking plant itself, ranging from 1 kW to 30 kW. Often vacuum is controlled by running the pump at a fixed speed and bleeding air in to maintain the vacuum at the required level. The more efficient approach is to control the vacuum with a variable speed drive (VSD). VSD controllers are not cheap to retrofit and as a general rule are only justified with larger vacuum pump and longer milking times.

Effluent and Water pumping

Pumping is becoming an increasingly large component of the milking electricity with some quite large pumps appearing on effluent systems. Generally if you reduce water use you will reduce electricity used in pumping water to and effluent away from the shed. General recommendations to that end are:

- keep clean storm water out of the effluent system,
- design water reticulation to minimise the number of pumps and avoid double pumping,
- match pump size to the actual requirement,
- avoid throttling valves,
- opt for higher efficiency motors for pumps (it is worth noting here that a 4kW pump/3ph motor set will cost around $1,800 but will use $12,000 worth of electricity over 10 years), and
- consider variable speed only if the pumping duty varies a lot.

Evaluating the best options

A lot of efficiency opportunities are either/or situations. For example if you install a desuperheater to recover heat from the refrigeration plant you lessen the case for solar water heating and vice versa. This means it is wise to not jump at the first suggestion that sounds good and instead take the time to work out the best option for you to get the best bang for your buck. In a similar vein, don't just accept a salesperson's generalised claims of payback time as that will be different for each farm. Work out the payback for your particular situation. Here again, an energy audit can be money well spent to get independent advice if the capital spend is significant.

Tariff Management

There are a couple of cost savings opportunities here to consider.

- Minimise your electricity connections if you can. Often milking operations will have 3 or 4 separate ICPs (connection points) and despite being all one account each ICP will cost you $1 - $5/day.
- Exploit day/night tariffs where offered. Night-time (11pm to 7am) rates may be about 70% of daytime rates so if you are on a day/night tariff think about how to push more use into the night tariff, e.g. put hot water heating on a timer, start the morning milking a little earlier, irrigate effluent at night.

Further Information

Much of the information presented here is from the Dairy Electricity Advisory Programme (DEAP), a project jointly funded by MPI (was MAF), EECA and Fonterra over the 2009/10 and 2010/11 seasons. This involved taking a random sample of 150 dairy farms and analysing their electricity use over two seasons, doing an energy audit on each farm, and evaluating various energy efficient technologies. The full report is available on the EECA site at:
http://www.eecabusiness.govt.nz/sites/all/files/reducing-electricity-use-on-nz-dairy-farms-dec-2011.pdf

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