

Dairy farm cuts hot water bill by 30%

An innovation that cuts dairy farmers' hot water energy requirements by up to 30% is proving itself in the Waikato, thanks to an EECA grant promoting new technology uptake. This case study backgrounds the issues and shows how Dairy Innovations' advanced heat recovery unit could contribute to energy savings all round.



Brent begins his daily plant wash.

Hot water in large quantities is an integral part of dairy farming. It's used mainly to wash down the cups and milking plant at intervals from daily to weekly.

Once that water falls below the temperature that keeps milk fats and proteins in suspension, it is disposed of.

The temperature at disposal is still quite high, around 60°C. At the same time, cold water of anything from 10-20°C is entering the hot water cylinder to be heated for the next wash.

The difference in the temperatures creates the potential for some sort of heat exchange system. If farmers could somehow extract the heat still remaining

in the waste water and use it to pre-warm the incoming water, less energy would be needed to heat the new batch to the 85°C required for the next wash.

An advanced heat recovery unit called The Retriever, developed by Dairy Innovations, has managed to fulfil this requirement.

Spotting the potential in the device, Morrinsville farmer Brent O'Regan applied for and received a grant from the Energy Efficiency and Conservation Authority (EECA) to help fund the introduction of this energy innovation into his dairy shed.

The results have been exciting – a 30% reduction in the energy used by his hot water cylinder, one of the biggest costs of running the shed.

Innovation at Awarua Farm

Awarua Farm is a 242 hectare spread at Tahuna, 26km north of Morrinsville. Around 200 hectares is in use for dairying, providing a platform for 630 cows – twice New Zealand's average herd size. It's a fully self-contained dairy unit and runs young stock as well as milking cows. Sharemilked for the last five

years by Brent and Delwyn O'Regan, in a good season it produces a more-than-respectable 215,000kg of milk solids.

Brent's the sort of farmer who hates waste and likes to keep everything as efficient as possible – along with doing his bit for the environment. Concerned about a cowshed power bill he thought was "hideously dear", he'd already spotted the potential for recovering the energy in the hot water that went down his cowshed drain after each milking.

"I'd thought of trying to make some sort of heat exchanger in the past," he recalls.

Brent saw a demonstration of Dairy Innovations' unit (The Retriever) at the 2005 Mystery Creek Fieldays and was impressed. "I got home and sat down and worked out roughly how much I thought this would take to pay for itself, and I found it looked quite promising."

His timing was perfect. Co-inventors of The Retriever, Dairy Innovations' Bruce MacKinnon and Charlie Morrison had sold several units, but were encountering scepticism from elements in the industry who didn't believe their reported savings were actually achievable.

Bruce and Charlie were keen for independent monitoring, but the cost involved was beyond their budget. They found out that EECA grants required and would help fund monitoring and suggested Brent apply for EECA assistance to help fund the introduction of this energy innovation into his dairy shed.

"The EECA grant created a win-win-win situation," comments Murray Bell, EECA's Business Manager.

"Brent got support to trial a relatively new technology, Dairy Innovations now has independently verified results it can use to encourage dairy farmers to adopt the technology, and the industry as a whole can have confidence in a development that could make a worthwhile energy saving for farmers and for New Zealand."



Energy Efficiency and
Conservation Authority
Te Tari Tiaki Pūngao

Making the connections that made The Retriever

Like many worthwhile innovations, The Retriever was born from some fortuitous connections.

Originally Charlie Morrison presented his idea to the Auckland Inventors' Evaluation Committee. On the panel was Bruce MacKinnon who realised he had a way to take the project even further.

Bruce had recently read about an innovation called the Spirex that was being used to help super-heat water for a chemical-free weed-killing system.

Bruce suggested replacing Charlie's original 15m copper tube heat exchange with a Spirex unit and this is probably now the most important innovation in The Retriever.

Spirex units are a New Zealand invention, developed and patented by Vaportech in Napier.

"Basically they take a 6m long, 19mm diameter titanium tube, deform it and make it into a spiral like a concertina or bolt thread," explains Bruce MacKinnon. "In the process it shrinks to 4 metres and becomes flexible so it can be rolled into a coil of 100mm diameter. So you end up with 6m of tube in a canister of only 100mm diameter and 450mm long.

"The shape creates internal currents that mean fluid inside it not only spirals – which would itself increase its exposure – it tumbles. So there's this double action of spiral and tumble that maximises heat transfer. It's far more efficient than water simply passing over a flat surface or a tube where you get just a 'skin' effect, where only the outside gets heated."



Even in the confined area of Awarua's engine room, there's still space for co-inventor Bruce MacKinnon (left) and sharemilker Brent O'Regan to check the unit in operation.



Dumped hot wash water enters The Retriever at approximately 60°C.

How The Retriever works: overview

Before the hot wash water is disposed of, it is transferred into The Retriever's tank. There, it is circulated around advanced heat exchange units.

Flowing through these exchangers is the cold mains or bore water bound for the hot water cylinder. The warm water cools, the cold water gets warmer – and enters the cylinder already well on the way to the target temperature of 85°C.

Key components of the system

The heart of the system is the plastic tank which can be sized to suit the quantity of hot water required – generally 200 or 400 litres.

Mounted vertically in the tank are one or two titanium Spirex heat exchange units. These are piped to receive the incoming water headed for the shed's hot water cylinder.

The water that is now too cold for washing down the shed is diverted into the tank and circulated by an externally-mounted pump. The flow of water and the operation of the pump are managed to maximise heat recovery. A timer controls the pump to ensure it operates for only as long as the time it takes to refill the hot water cylinder.

The system in operation

At the end of the wash, water is deposited into the tank at approximately 60°C. The circulating pump is turned on for its timed period and the valve controlling fresh, incoming water is opened. The cold water that would normally go directly into the hot water cylinder is pre-heated in The Retriever, reducing the electricity required to heat the water in the cylinder to the required temperature set point. The average temperature increase can be anything from 20°C to 30°C.

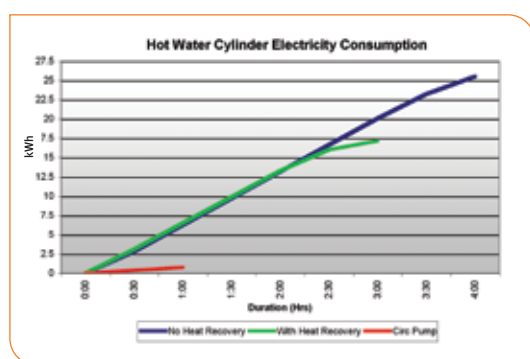
Independently tested

Power Solutions Ltd carried out the analysis.

Brent milks around 600 cows a day in a 48-aside dairy shed, and uses approximately 400 litres of washdown water once a day. The Retriever unit installed was designed for 400 litres and has two heat exchangers.

Using Testo temperature loggers and an Ideal Power Analyser, Power Solutions monitored electricity use for two consecutive weeks, one with The Retriever in use, and one without. Water temperatures and volumes were also monitored to provide more information on how The Retriever works.

Results: a 30% energy saving



The graph shows the energy savings. Without The Retriever, it took 25.5kWh to heat his 400 litres to the set point: using The Retriever reduced demand to 17.2kWh.

The saving was offset a little by the extra energy required to run the circulating pump. After some experimenting, it was found the optimum time to run the pump to ensure maximum heat extraction was 45 minutes, which required 0.56kWh.

Overall, the monitoring validated a net saving of 7.74kWh or 30%.

On a reasonably typical farm where cows are lactating for 290 days a year and the plant is hot washed once daily using 400 litres of hot water, the saving would add up to 2,245kWh/year.

That equates to a saving in CO₂ emissions of approximately 1 tonne a year.

If the plant were washed twice a day, the savings would of course double.

Payback and factors affecting performance

All sorts of factors affect the payback – particularly the farm's electricity rate and of course the size of the unit and installation costs.

Awarua Farm enjoys a relatively unusual electricity contract: it is paying only 12.42c/kWh, which is particularly competitive. In Brent's situation the 2,245kWh/year equates to a saving of \$279 a year, for an installed cost of around \$2,200.

For other farmers paying more per unit, the 30% electricity saving will be considerably more in dollar terms.

Various other factors would affect the figures.

For instance, during calving at Awarua, the hot wash water is used to wash calf rearing equipment 2-3 days a week and so wouldn't be available for The Retriever. Frequency is another issue: many farms wash more or less often. The temperature of the incoming water will also affect the results. During the test, water from Brent's bore averaged 19°C. The results will be better in seasons, or on farms, where the incoming water is colder.

To extract the maximum return from The Retriever and minimise the payback period, the vat wash water should also be captured and re-used.

Awarua Farm uses another 400 litres of hot water daily to wash the vat. Brent is currently figuring out a way to pipe this water to The Retriever which will double his savings and halve the payback time.

If dairy farms in New Zealand used The Retriever to process plant and vat wash, carbon emissions would be reduced by around 26,400 tonnes annually.

Factors to consider

Installing The Retriever is relatively simple: on Awarua Farm, it took Brent around half a day although he points out that, facing an uncertain tenure (like all sharemilkers) his installation was less permanent than some owner-farmers might prefer.

In his particular engine room, part of an old cowshed that has been expanded over time, finding room for the unit was “a bit of a squeeze”. In more modern sheds space shouldn’t be any problem.

Brent says using The Retriever fits in well with his normal routine, so long as he remembers to empty the now-tepid water after extracting the heat. Waiting to empty a tankful he overlooked the night before can add 4-5 minutes to his routine.

Bruce MacKinnon points out there are other benefits to The Retriever.

“If every farm had one, the lines companies’ peak load duration could be reduced by up to 30% because they’d all be switching off their water heaters that much sooner. At Awarua Farm for instance, they’re switching off an hour and a quarter sooner.

“There’s also potential for a sizeable energy saving nationally. If each of the 13,200 or so dairy farms in New Zealand had The Retriever and used it to process both the plant wash and the vat wash, it would save enough electricity to power 7,270 homes a year and reduce carbon emissions by around 26,400 tonnes annually.”

The Retriever cost savings

Saving 30%, using 400 litres/day	At Awarua Farm’s 12.42c/kWh	At a more typical 21.04c/kWh*
Consumption saving kWh/yr	2,245	2,245
Dollar saving p.a.	\$279	\$472
CO ₂ emissions saved p.a.	1 tonne	1 tonne

* Genesis Energy Anytime Rate, April 2007.

Subsequent experience has suggested savings on some farms could be greater than the 30% used for this table – a second monitored farm in Waverly has averaged close to 35% savings with some days at 40%.

Figures assume a minimum of 80% of the daily hot water must be recovered for use, and that The Retriever is set up and used according to manufacturer’s instructions.

EECA grants

Grants for demonstration projects are available to businesses in energy intensive sectors. Grants of up to 40% of the capital cost of the project are available, with a maximum of \$100,000 for each grant. EECA is looking to support energy efficient technologies that are commercially available but are not yet commonplace in New Zealand.

EECA grants are available for businesses from the following sectors: heavy transport fleets, wood processing, basic metals, glasshouse crops, irrigated dairying, irrigated arable crops, food and beverage processing, fishing fleet operation, and non-metallic products.

Other businesses where energy is greater than 5% of their total business costs are also eligible.

Full details on the grants are available at www.eecabusiness.govt.nz/eib



The two canisters encase the 6m, 20mm titanium Spirex heat exchangers – the heart of The Retriever.

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CONTACT EECA

For more information on EECA’s technology grants and services, call 0800 358 676 or visit www.eecabusiness.govt.nz/eib