

Green CleaningTM Systems

low temperature ♦ re-use ♦ energy efficient

Green CleaningTM Systems – Commercial trials confirm savings

by Gabriel Hakim¹
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KEY POINTS

- ✓ Electricity down by 62%
- ✓ Water use down by 57%
- ✓ Chemical savings of 26%
- ✓ Reduced greenhouse gas emissions
- ✓ More savings are possible
- ✓ Good insulation is essential to minimise wasting energy
- ✓ Always evaluate the total cost of ownership when considering options

Green CleaningTM systems are milking machine wash systems that operate at low temperatures, re-use the cleaning solutions, and are energy efficient.

The various makes and models now available comprise an automated cleaning unit that is capable of capturing, storing, and re-using the wash solutions.

They use chemicals that are specifically designed for re-use, and to work at lower temperatures (less than 50°C).

In some models the wash solutions are heated using energy from renewable sources such as solar or heat recovery. The storage tanks are well insulated to minimise any heat losses.

It's been over a year since the first commercial Green CleaningTM systems appeared on several farms across Victoria. The dairy farmers who installed the systems were doing so for a range of reasons; energy and cost savings being integral factors. These early systems functioned as "trial systems" for the companies making them. It was an opportunity to monitor, adjust, and enhance the systems before they were offered more widely.

So, one year on, how have they performed? Have there been savings? And if so, where have they been?

Three different companies – Ecolab, GEA Farm Technologies and Milka-Ware – have Green CleaningTM systems installed on dairy farms in Victoria. Each system is different but they all aim to achieve the essential elements of Green Cleaning, that is: operate at low temperatures, re-use the cleaning solutions, and be energy efficient.

Over the year, all farms have experimented with different re-use chemicals, different cleaning programs, and different operating temperatures. Fine tuning is continuing (as of May 2012) to further reduce energy consumption. One of the farms where the principles of Green Cleaning have been fully deployed the savings have been substantial and serves as a good example of what can be achieved.

About the farm

The farm is typical of many; a herd size of around 400 cows, milking twice a day through a 50 unit rotary. There is an automatic wash system to clean the milking machine.

The original wash program was similar to that used on other dairy farms; cold rinse, hot wash (alternating between alkali & acid) and a warm rinse as the final cycle. All solutions were discarded after use. Water used for cleaning the milking machine was heated to 90°C using a 1,800-litre conventional dairy hot water service.

The Green CleaningTM system was installed on this farm in February/March 2011. It comprised three 750 litre, well insulated tanks to store the cleaning solutions, a heat recovery unit (on the refrigeration system) to pre-heat water, and the control system.

Water heated in the heat recovery unit is used for the pre-rinse (1st cycle), and to top up the hot water service (HWS). The hot water from the HWS is used to top up the alkali tank (~120 l/day) and as a means to heat the alkali to the required temperature (initially 60°C but now 50°C). The thermostat in the hot water service was turned down to 70°C to reduce standing heat losses in the HWS.

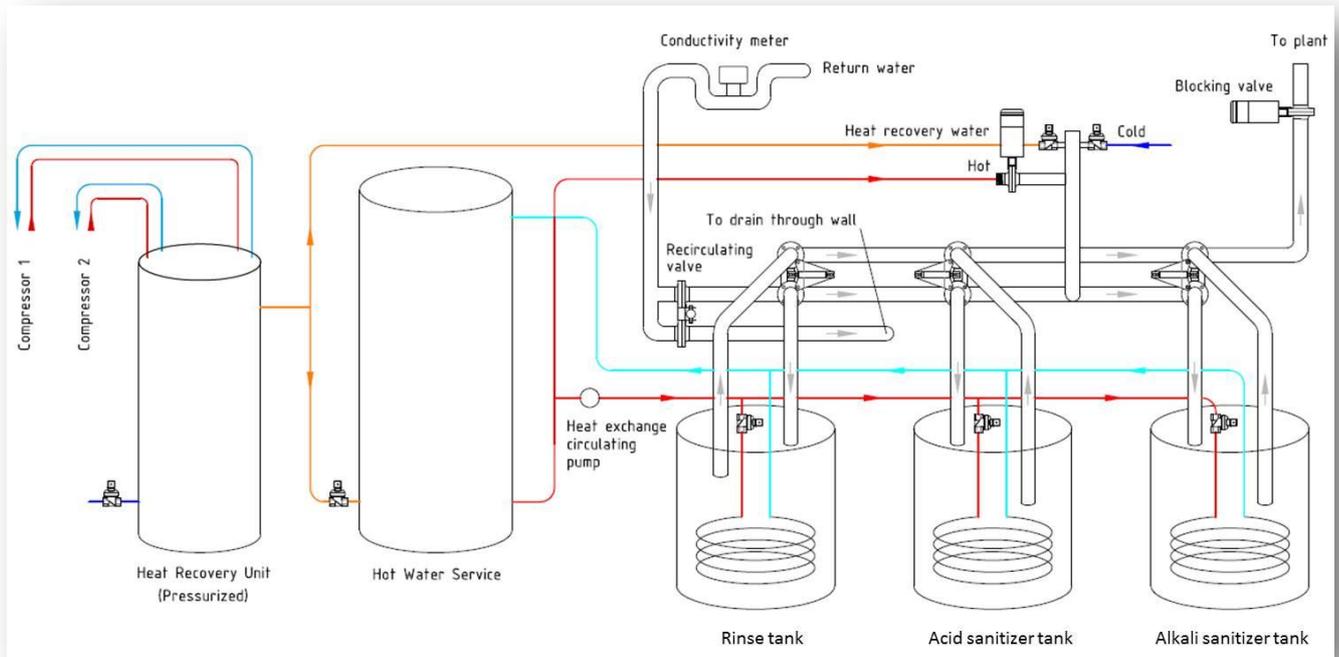


Figure 1: Layout of the Green Cleaning System. This uses heat recovered from the refrigeration system to pre-heat water used by the cleaning system. Any additional heating requirement is undertaken by the HWS. The wash solution is heated by water passing from the HWS through the coils mounted inside the tank. The cleaning system consumed ~46 kWh/day of which 25 kWh was associated with standing heat losses from the HWS. Without these losses consumption would be ~18 kWh/day, 85% less than the original auto cleaning system.

The savings

The table below compares the two cleaning systems. The Green Cleaning™ System has

resulted in reductions in electricity use, chemicals, water, and greenhouse gas emissions. For this farm the overall milking machine cleaning costs have been reduced by 38.5% - a good outcome.

	BEFORE Original Wash System (single use)		AFTER Green Cleaning™ System (re-use)		Impact
	AM	PM	AM	PM	
1st cycle	Warm pre-rinse	Warm pre-rinse	Warm pre-rinse	Warm pre-rinse	
2nd cycle	Hot alkali wash	Hot acid wash	Combined warm alkali wash & sanitizer	Combined cold acid wash & sanitizer	
3rd cycle	Warm rinse	Warm rinse			
Cycle volume (L)	400	400	400 (rinse) 550-575 (Alkali sanitizer)	400 (rinse) 550-575 (Acid sanitizer)	
Total hot water used (L)	600	600	120	0	90%
Total water used – i.e. discarded (L)	1,200 (400/cycle)	1,200 (400/cycle)	520 (400 for 1 st cycle & 120 to top up alkali)	520 (400 for 1 st cycle & 120 to top up acid)	57%
Electricity use (kWh/day)	114		43		62%*
Daily Greenhouse gas emissions	140.7 kgCO _{2-e}		52.9 kgCO _{2-e}		62%
Daily electricity cost**	\$8.09		\$3.04		62%
Total daily chemical use (L)	2.3		1.7		26%
Daily chemical costs	\$9.57		\$7.83		18%
Total daily costs	\$17.67		\$10.87		38%

* Standing heat losses in the HWS were estimated to be 25 kWh/day. Minimising heat loss would see electricity use decrease by 85%.

** Average electricity off-peak tariff rate was 7.07 cents/kWh – lower than the 10-14 cents/kWh found on many dairy farm electricity bills.

Electricity

As was demonstrated in the original Green Cleaning trial (conducted in Gippsland in 2009-10) when the temperature required for effective cleaning and sanitizing is lowered, energy use can be dramatically reduced. The Gippsland trial reported a 75% reduction in the electricity used for heating water to clean the milking machine. On the farm reported here the savings also have been impressive – 62% with further savings still possible.

Using the HWS – at a lower temperature – for heat storage and as a heat source seems a logical and cost effective option (see Figure 1). However, a review of energy use of the Green Cleaning™ System identified that this may not be the best option. This is because of the standing heat losses in the HWS. Of the 43 kWh used in the Green Cleaning System 25 kWh was attributed to HWS heat losses, which means 58% of the energy consumed was actually lost through poor insulation! Removing this HWS heat loss by using an alternative way of heating the alkali solution (such as having a heating element inside the tank itself, or by improved insulation of the HWS) would see electricity use drop to around 18 kWh per day – representing an 85% reduction in electricity consumption.

This highlights the importance of good thermal insulation of tanks, pipes and fittings.

Water

The new cleaning system uses 400 litres of warm (38°C) water as the first rinse. This is then discarded. The alkali and acid tanks each hold 550-575 litres of solution. Approximately 100-120 litres of fresh water is added to each tank every day. This covers the solution that can't be recovered from the plant after cleaning as well as the 80 litres or so that is diverted to drain at the start of the cycle. This diversion is undertaken to prevent the risk of any residues from the previous rinse cycle entering the tanks.

This cleaning routine has reduced water consumption by 1,360 litres/day or 0.5 ML/year. Given that town water is used for cleaning the milking machine, the saving is appreciated.

Chemicals

This farm uses a low-temperature alkali-sanitizer as part of the cleaning routine. This is a newly registered chemical suited for low temperature re-use cleaning.

Although it costs significantly more, and requires a slightly higher dose rate than the alkali detergent previously used on the farm, analysis has shown that total alkali usage decreased by 34.5%. Alkali detergent costs fell by only 3.0%.

Reducing heat losses will make heating more efficient and will ultimately lead to an 85% reduction in the electricity used for water heating.

Total daily cleaning costs would fall to \$9.10 – an overall reduction of 48%.

The acid cycle was replaced with an acid sanitizer cycle. Typically using an acid sanitizer is more expensive than using an acid detergent and hot 85°C water for the sanitizing role. However, in a re-use system this is not necessarily the case.

In this case the acid sanitizer was cheaper than the acid detergent but

required a higher dose rate. It was used at ambient temperature. Because of the re-use system, total usage dropped by 14.4% and costs fell by 30.3%.

Total dairy chemical use fell by 26.1%. Costs fell by 18.2%.

Total dairy chemical volumes reduced by 26.1% and cost reduced by 18.2%. This is a positive outcome for the environment and the hip pocket.

Milk quality

Good plant hygiene and milk quality have been maintained by the Green Cleaning™ System. On the odd occasion where there has been a “high” thermoduric or Bactoscan count, it has been quickly addressed. The Green Cleaning™ System has not necessarily been the cause for these higher counts.

To achieve these types of savings requires the purchase and installation of a Green Cleaning™ system.

A range of makes and models are now available through existing dairy equipment and chemical suppliers, starting from about \$25,000 installed. Top of the line models, incorporating a heat recovery system are on the market for around \$40,000. In comparison, the costs of a conventional automated milking machine wash system, including a large hot water service(s) is around \$20,000 installed.

Total Cost of Ownership (TCO)

A good way to compare the financial merits between a conventional cleaning system and a Green Cleaning™ system is to work out the total cost of ownership for each option. The total cost of ownership is a financial tool that can help determine

the total cost of a piece of equipment over its lifetime. It includes the initial capital cost as well as the operating costs during its practical service life.

Taking the findings from this case into consideration – but using better insulating properties and more representative electricity tariff rates – a TCO comparison between the Green Cleaning™ system and the pre-existing system can be made. This is shown in Figure 2.

Like most energy efficient equipment, the initial capital cost of the Green Cleaning™ system is likely to be greater than conventional auto-wash systems, but the on-going operating costs are lower. In this case, there is an existing system so no capital outlay is required. A Green Cleaning™ system costing \$40,000 is used for the comparison.

For the first 6 ½ years the total cost of ownership for the Green Cleaning™ system is greater than the conventional auto-wash system.

After this time the total cost of ownership will be less for the Green Cleaning™ system. After 10 years, the existing system has cost \$26,884 more to own and operate.

If the same conditions were applied to a new dairy where the options were \$20,000 for a conventional auto wash (with large HWS) or a high-end Green Cleaning™ system costing \$40,000 then the total cost of ownership becomes less for the Green Cleaning™ system after 3.25 years, saving \$46,884 (in today's dollars) over a 10 year lifespan.

Whilst only one of the farms trialling the Green Cleaning™ systems has been reported here, the outcomes for the others have been similar.

The savings for farms considering Green Cleaning will vary according to the type of cleaning system being replaced and the way the new system will operate.

As the companies continue to refine their systems the savings are likely to improve further and the case for installing a Green Cleaning™ system will become increasingly compelling.

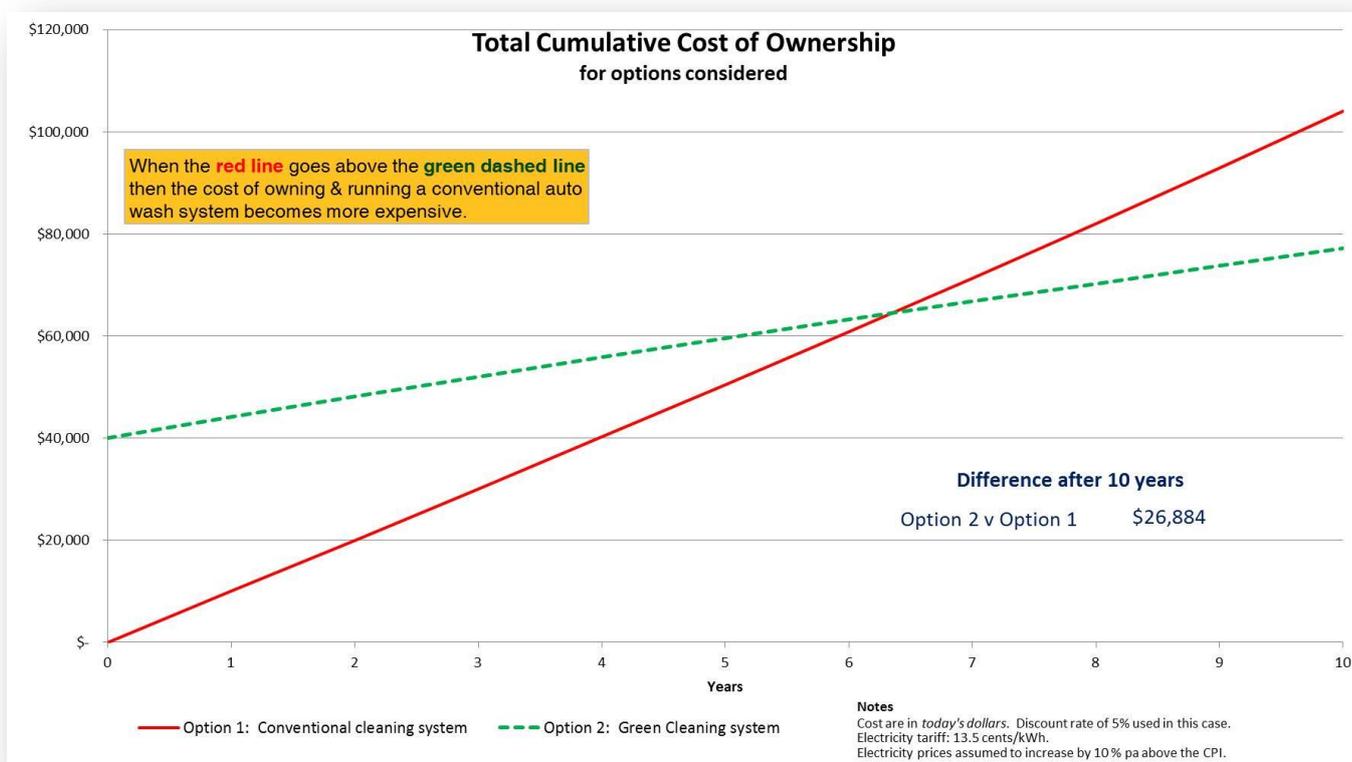


Figure 2: Total cost of ownership. This shows that after 6.5 years the cost of each option has been the same. After 10 years the Green Cleaning™ system will have cost \$26,884 (in today's dollars) less to own and operate.

For more information on Green Cleaning™ systems contact your local milking machine or dairy detergent supplier. A website has been established specifically for information about Green Cleaning™ systems

www.agvetprojects.com.au/greencleaning. It also contains an economics calculator so specific options can be compared and analysed.

ⁱ Gabriel Hakim is a Director of AgVet Projects and the Technical Manager of the Green Cleaning Project. The Green Cleaning project was delivered by AgVet Projects on behalf of GippsDairy, and was funded through the Victorian Government's Sustainability Fund and the Gardiner Foundation.