CASE STUDY
Heat, light and waste are the key areas of energy savings for a small poultry facility

With LPG around 20 to 30 percent more expensive than natural gas and the cost of LPG expected to increase over the next few years, gas-dependent poultry farmers are looking for alternatives to LPG so as to remain competitive in a growing sector.

Along with exploring alternatives to costly LPG, the owners of Stratheden Glen poultry farm are implementing or considering initiatives including a lighting upgrade that will result in significant energy savings, voltage optimisation to improve the power delivered to site, and solar power for the main pump that supplies drinking water to the chickens and water for the evaporative coolers.

Pilot site: 'Stratheden Glen' – Stratheden , NSW 2470
Date of visit: 21 August 2014
Authors: Gerry Flores, Leigh Rostron & Phil Shorten

Will Crawford is a relative newcomer to the poultry industry, but he has embraced the challenges of the business and the need to drive innovation in order to respond to a growing market. Like many in the industry, Will has plans to increase his production, which means more sheds, greater energy costs and, potentially, increased business risk. To help manage brownouts and blackouts, which can be a risk to the wellbeing of his birds, he is investigating energy-efficiency opportunities as well as sources of alternative energy.

Energy needs and planning for the future

The NSW Farmers' Energy Innovation Team collated Will's data to develop an energy baseline that highlights the areas that warrant investigation. LPG makes up 70% of the total energy consumed at Stratheden Glen and 50% of the farm's total energy costs.

Stratheden Glen's energy profile

Table 1: Energy breakdown

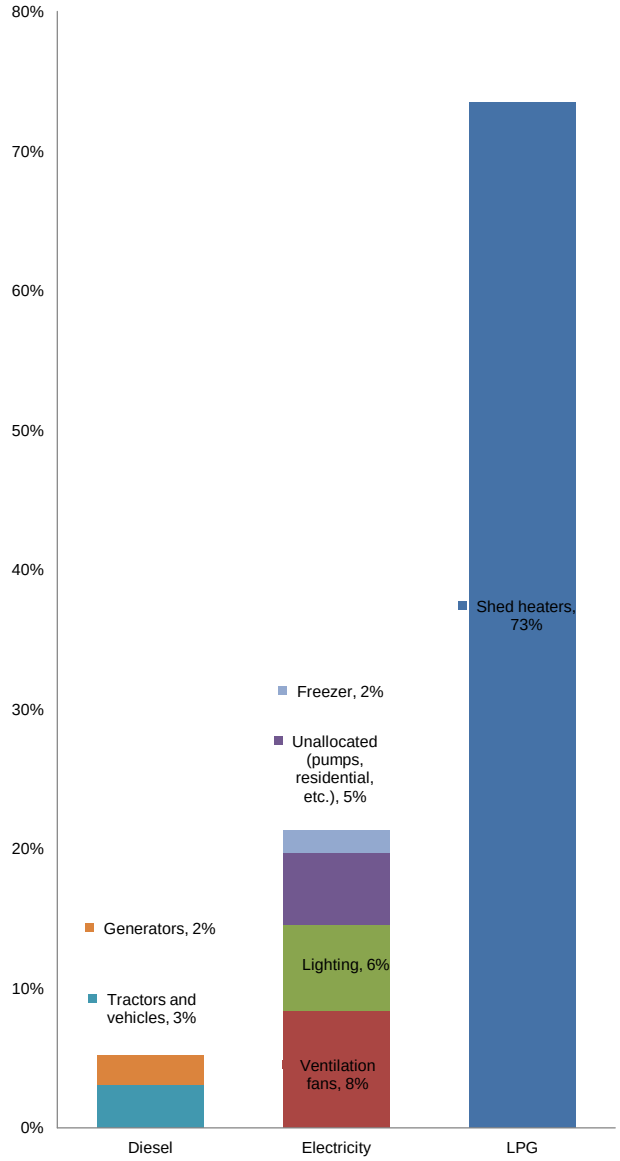
Fuel Type	Energy Consumption p.a.	Units	Conversion to GJ factor	GJ	Cost	Cost /Unit	Cost /GJ
Diesel	7,100	litres	0.0386	274	$11,147	$1.57	$40.67
Electricity	310,779	kWh	0.0036	1,119	$83,910	$0.27	$75.00
LPG	150,000	litres	0.0257	3,855	$100,000	$0.67	$25.94
Totals/Averages				**Total: 5,248**	**Total: $195,097**	**Average $0.84**	**Average: $47.20**

The farm's largest energy expenses lie in heating, ventilating and lighting the sheds, which ensure the welfare of the birds. Although LPG is the biggest source of energy on-farm and the largest energy expense, the high cost of electricity means that even though it comprises only 21% of the energy used, it amounts to 43% of the farm's total energy costs.

Table 2: Energy breakdown by end-use purpose

Fuel Type	Purpose	Energy Used (GJ)
Diesel	Tractors and Vehicles	162
Diesel	Generators	112
Electricity	Freezer	83
Electricity	Lighting	323
Electricity	Ventilation Fans	440
Electricity	Unallocated (pumps, residential, etc.)	273
LPG	Shed Heaters	3,855
Total		**5,248**

Figure 1: Stratheden Glen's energy use 'baseline' by type and purpose



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Cost reduction opportunities

Eight energy savings opportunities were identified by the team with the potential to save around $23,000 in energy costs. Will prioritised six opportunities for investigation with assistance from NSW Farmers. These are highlighted in *Table 3*.

Table 3: Full list of opportunities with priority opportunities highlighted.

key ☐ Priority opportunity
☐ Non-priority opportunity

Note: 'UI' means 'under investigation'

Opportunity	Description	Savings	Est. Capex	Payback (years)
Digester to create biogas from on-site waste (UI)	Currently, LPG is used to heat sheds. There is no natural gas pipeline available and there is potential to use manure/waste to generate biogas. Currently, 1,000m^3/batch fertiliser is sold – 40% manure/60% sawdust. LPG has issues with moisture control. Biogas has less moisture, but may require scrubbing.	UI	UI	UI
Voltage optimisation	Estimated 10% savings from kWh use. Voltage optimisation is an electrical energy-saving technique that is mainly installed in series with the mains electricity supply to provide a reduced supply voltage for the site's equipment. Typically, voltage optimisation can improve power quality by balancing phase voltages and filtering harmonics and transients from the supply, although not always. Voltage optimisers are essentially transformers used to deliver power at a reduced voltage from the raw mains supply, and are available from a range of suppliers and energy service companies.	$8,391	$20,607	2.5
Lighting upgrade (I)	Currently 250 x T8 fluoros; should be upgraded to T5. From (36+4 ballast to 25+4W).	$3,252	$7,500	2.3
Lighting upgrade(I)	150 incandescent lights; upgrade to LEDs (from 70W to 30W).	$7,096	$4,500	.6
Adaptive driving (UI)	"Modern tractors are equipped with advanced telemetry such as tractor management systems (TMS), which enable the farmer to assess the actual fuel efficiency of a tractor as it is being used. Strategies for adapting operating techniques are typically devised based on the assessed performance (i.e. on performance reports from the TMS).	$769	$0	0
Improving the building envelope	Some of Will's sheds currently use curtains as opposed to insulated walls as part of their building envelope. An improved envelope consisting of insulated panels will prevent undesired heat gains or losses and could reduce the energy required for heating and cooling drastically.	UI	UI	UI
Upgrade mortality freezer (UI)	Under investigation.	UI	UI	UI
	Totals (where costed):	**$19,508**	**$32,607**	**1.67**

In a two-hour discussion with the Energy Team, Will considered his business plans and energy innovation priorities.

Will's business priorities include:

- reducing energy costs and improving energy security on-farm;
- building capacity to manage the operation remotely; and
- improving the market value of the assets.

Therefore, the priority energy-efficiency opportunities Will intends to investigate (and in the case of the third-ranked priority, implement) are:

1) the business case for voltage optimisation to reduce energy costs;
2) ia lighting upgrade to maintain lighting quality while reducing costs; and
3) improvements to the building envelope of the farm's older sheds.

Lighting options being considered could deliver more than $10,000 in cost savings, but the quality must be right

"LEDs continue to evolve and have much wider application to farming situations," says Phuong Tang, Senior Consultant with Energetics, energy specialist, and advisor to NSW Farmers. "Sometimes it takes a little trial and error to get it right before investing in a total solution."

This was the case for Will at Stratheden Glen. "The first batch didn't have sufficient light or throw to meet the requirements of our shed," he explains. "We are now trying out some new B22-style LED lights which cost between $60 and $70 each, and are also looking into financing to help cover initial costs."

Often, NSW Energy Savings Certificates are also factored in at the point of sale, providing additional savings for farmers. Financing, with repayments incorporated into electricity bills, is also available. NSW Farmers is investigating these and other financing options.

Power factor correction (PFC) implemented: voltage optimisation next?

As part of Will's plan to reduce peak demand charges and improve the quality of his grid power, he installed a power factor correction system in 2013 (see *Figure 2*). This device has helped reduced his electricity bills by helping to match the phase shift resulting from his power use to the grid's supply. More information is available in NSW Farmers' information paper on power factor correction.

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Figure 2: Power factor correction (PFC) device installed in 2013

Having ticked the box on addressing his 'kVA' demand charges by installing power factor correction, Will is now investigating the savings he could derive from a voltage optimisation device that will improve the life of his equipment and permit it to run more efficiently. He has contacted his electrician to see if this measure will be useful, and to ascertain the type of savings he can expect if he implements it.

The Energy Innovation Team has provided Will with preliminary findings to inform his discussions with the electrician. It was estimated that 10% reductions are achievable with PFC, which amounts to around $8,000 p.a. in savings, at a cost of around $20,000 upfront and a payback period of approximately 2-3 years.

Voltage optimisation is an electrical-energy-saving technique that is typically installed in series with the mains electricity supply to provide a reduced supply voltage for the site's equipment. Typically, voltage optimisation can improve power quality by balancing phase voltages and filtering harmonics and transients from the supply. Voltage optimisers are essentially transformers, used to deliver power at a reduced voltage from the raw mains supply, and are available from a range of suppliers and energy service companies. For more information, refer to the NSW Farmers fact sheet on voltage optimisation.

Biogas-fired heaters

Is biogas feasible for a small poultry operation?

With no supply of natural gas available to the property at the present time, Will's chook sheds are currently kept warm by LPG-fired heaters. LPG represents a significant energy cost to the business (see *Figure 2*), and during the site walkthrough, the team discussed the opportunity Will has to create alternative energy from the existing waste on site.

Approximately 1,000m^3 per batch of waste is available – this consists of 400m^3 of chicken manure and 600m^3 of litter and is currently sold off-site as compost. In total, 5,800m^3 of waste equating to approximately 2,900 tonnes is created per annum.

This waste could be co-digested with other organic waste in an anaerobic digester to produce biogas to fire the sheds' heaters; however, the business case for anaerobic digestion of waste depends on several factors.

From an initial review of the opportunity, the key factors that make anaerobic digestion inappropriate for small poultry operations at the present time are:

1. the high capital costs of anaerobic digesters for small-scale applications, with long payback periods, typically exceeding six years; and
2. high levels of ammonia in chicken waste impacting biogas yields.

As the technology to manage ammonia improves and capital costs reduce, the business case for converting on-site waste to energy at small-scale poultry operations may improve.

Figure 3: LPG dominates Stratheden Glen's energy costs and as this is an expensive option, alternative energy sources are being investigated

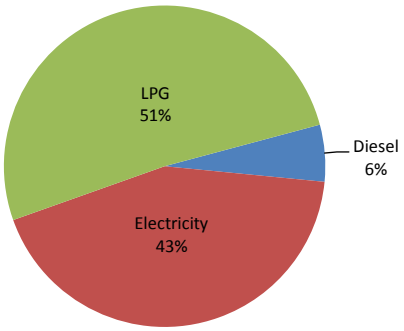

Figure 4: LPG-powered heaters will need conversion to biogas if the business case for Stratheden Glen's waste-to-energy opportunity is realised. These heaters use 50% of the farm's energy use and account for 70% of the farm's energy costs.

Improvements to the building envelope could reduce heating and cooling costs dramatically

Currently, some of Will's poultry sheds have curtains as opposed to insulated walls as part of their building envelope. An improved envelope consisting of insulated panels would prevent undesired heat gains or losses.

Figure 5: Left:One of Will's older sheds, with a polymer curtain providing part of the lateral building envelope. Right: One of Will's newer sheds, with insulated panels on the walls.

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Two of Stratheden Glen's poultry sheds are newer and have been constructed to meet more recent energy-efficiency standards. Now, Will is exploring ways in which he could renovate his older sheds to make them more energy-efficient, such as by making improvements to the sheds' roofing and wall structures. These measures could reduce the energy required for heating and cooling the sheds significantly.

More information on this opportunity is available in NSW Farmers' information paper 'Insulating farm buildings'.

Ventilation efficiency

Other improvements in ventilation technology hold promise to reduce the energy required to cool the sheds at Stratheden Glen. These include measures such as:

- adding discharge cones to the ventilation shutters;
- using actuators to hold shutters open when fans are operating (as opposed to using the pressure generated by the fans to keep them open); and
- identifying and reducing air leaks.

Figure 6: Some of Will's sheds lack discharge cones and actuators to hold shutters open

More information on possible ways to save energy in poultry ventilation is available in NSW Farmers information paper 'Energy-efficient poultry shed ventilation'.

Solar PV is providing stability and substantial savings to Stratheden Glen

In 2013, after experiencing power outages and overall poor-quality grid power, Will commissioned the installation of a solar PV system consisting of 90kW of amorphous silicon solar PV panels.

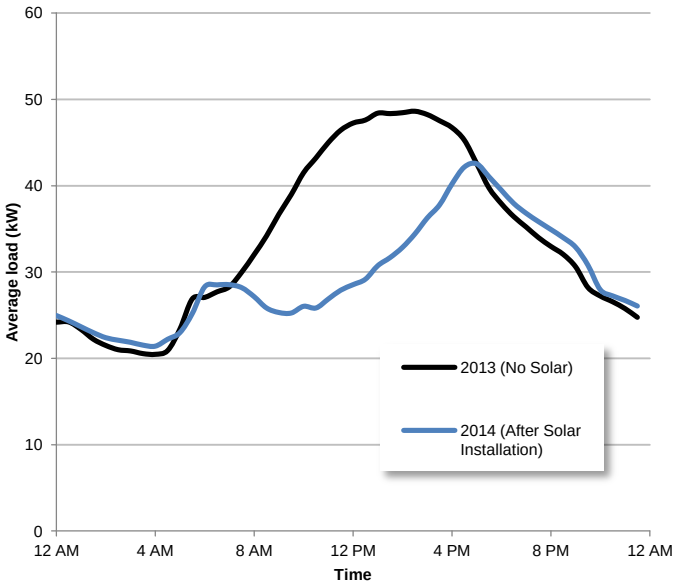
His solar PV system was installed across the north-facing rooftops of three of his sheds and began producing power in September 2013.

Figure 7: Some of the panels that make up Will's 90kW solar PV system

Will's sheds were a perfect location for solar PV panels, which work to offset a large portion of Will's on-farm electricity needs from cooling loads on hot and sunny days. In addition, by reducing the load on the grid, the PV system helps to prevent overheating of the transformer at Will's grid connection point. This will help reduce the likelihood of the farm property experiencing power outages in the future.

A year after installation, an analysis of metered interval electricity consumption data revealed that savings from the solar PV system were real and substantial.

*Figure 8: Average daily electricity consumed from the grid before and after the installation of Will's 90kW solar PV system**



**This figure depicts a comparison of the average daily electricity use during the months of January through September of each respective year (2013 and 2014). The months of October through December have been excluded deliberatively as the PV system was operational from 21 September 2013 and hence including these months would not provide a suitable before/after comparison. Given this exclusion, if the data were available, a full-year analysis would likely show even greater savings, as solar generation during the excluded months is typically above average.*

The gap between 2013's and 2014's daily consumption profiles can be attributed to the electricity that is now being provided by Will's solar PV system. A calculation of this difference showed that Will is saving more than $25,000 per year from this installation, meaning that his investment should pay for itself in around five years.

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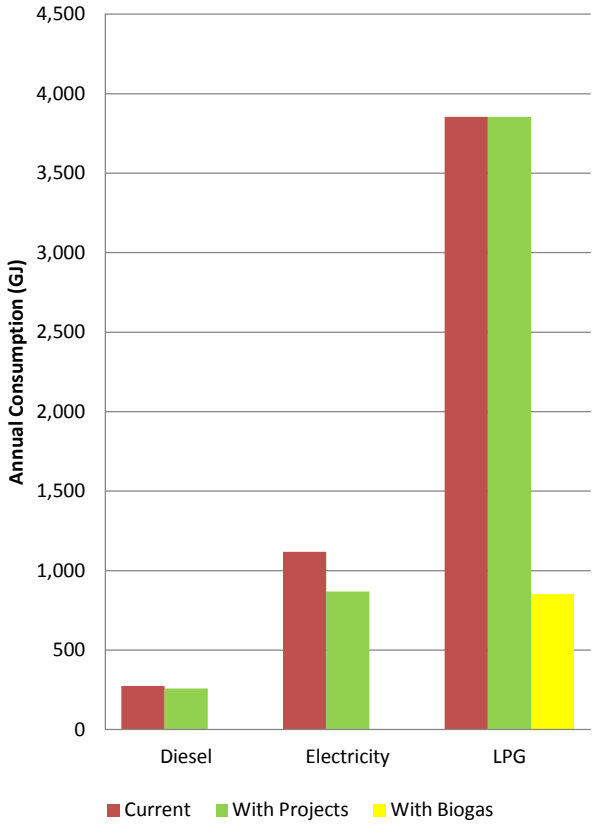
Outcomes

Solar pumping, upgraded lighting in sheds and improving the quality of the power delivered to the site could deliver more than $20,000 in energy cost savings to Stratheden Glen.

Currently, the option of generating biogas on site for use in place of LPG has technical and capital limitations for small-scale poultry operations; however, this could change over the years as the technology advances.

Figure 9: Expected energy savings from continuing implementation of projects at Stratheden Glen



Savings per year (GJ)	266.
Savings per year (%)	5%
Savings per year ($)	$19,400

(Note: these savings exclude conversion to biogas)

Future energy plans for Stratheden Glen

Will, with the assistance of his advisors, will continue to explore waste-to-energy options that help to secure the future of his poultry business and capitalise on growth in the domestic market and potential export opportunities.

In the **short term**, in addition to upgrading the lights in his poultry sheds, Will plans to progress improvements in the building envelope of his older sheds.

In the **medium term**, he will explore the option of voltage optimisation as well as more efficient ventilation technologies.

Long-term opportunities include installing batteries that could be charged via surplus electricity from the existing solar PV system and could provide the farm with stored solar power after dark and on cloudy days. The cost savings could be as much as 100% if the investment can be justified.

In addition, subject to industry support and Will's production and expansion plans, alternative technologies for converting waste to energy will be reviewed. Gasification and pyrolysis are emerging technologies with the potential to become attractive options in the future. At present there are no known commercial-scale, economically viable plants operating on poultry litter.

To identify ways of reducing your energy costs, contact the Energy Team at NSW Farmers:

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MORE INFORMATION ON BIOGAS IN POULTRY FARMS

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