CASE STUDY
State-of-the-art egg producer finds new energy savings opportunity in sheds

The Glenwarrie Partnership near Tamworth recently invested in a state of the art caged egg laying system with packing machines and highly efficient automated feed and watering systems. However a significant cost savings opportunity was missed. T8 fluorescent lighting used in the sheds are around one third more expensive to run than new lighting technologies such as T5s or perhaps LEDS.

"We selected dimmable T8 tubes for our lighting but our main focus was on the layer and sorting systems when we went ahead with the new shed two years ago," says co-owner Bede Burke.

Pilot site: "Glenwarrie" - Tamworth, NSW
Date of visit: 22 July 2015
Authors: Gerry Flores, David Hoffmann, Leigh Rostron and Phil Shorten

Recognised for innovation

Narelle and Bede run Glenwarrie Partnership - a 1400 hectare mixed farming operation close to Tamworth, NSW. Together, they have been recognised in the agricultural industry receiving accolades such as winning the 2011 Tamworth Business Chamber's Best Regional Business Award and being a finalist for 2009 Farmer of Year.

Their success is directly related to their innovative and sustainable approach to farming which is achieved without compromising profitability. They have incorporated strategies such as installing a state-of-the-art cage production system; growing winter and summer crops; storing grain and selling it when they have the opportunity, or using it as feed; and incorporating an integrated feed milling system and pullet replacement enterprise. The Burkes are also heavily involved in industry and community groups.

With the operation's ability to use waste to grow grain and mill the grain for feed, Glenwarrie is near best practice in closed loop egg production. Chook waste nurtures the soil that supports crops that in turn provide feed for the layers which produce the waste as well as the eggs. The eggs are sold directly to the local community as well as to major Australian retailers.

"We use 100% of our chook waste and combine the waste with a mixture of soil types and trash from our crops to nurture our pasture and our crops. We might even consider generating our own power from this waste," says Bede "We will get the numbers from NSWF Energy Innovation Team, but the numbers need to stack up because the fertiliser is currently doing a great job."

Glenwarrie's energy profile

Table 1: Glenwarrie energy source breakdown

Fuel Type	Energy Consumption p.a.	Units	Conversion to GJ factor	GJ	Cost	Cost per Unit	Cost per GJ
Diesel	80,000	litres	0.0386	3,088	$90,000	$1.13	$29
Electricity	311,643	kWh	0.0036	1122	$100,000	$0.32	$89
LPG	14,285	litres	0.0257	367	$10,000	$0.70	$27
Totals/Averages					Total: $200,000	Average: $0.72	Average: $49

The farm's largest energy expenses are related to the daily operation of the chicken sheds as well as the farm vehicles used in cropping operations around the property.

Table 2: Glenwarrie's energy breakdown by end-use purpose

Fuel Type	Purpose	Energy Used (GJ)
Diesel	Tractors	1,505
Diesel	Harvesters	1,158
Diesel	Transport	425
Electricity	Lighting	412
LPG	Heating	367
Electricity	Homestead and other	252
Electricity	Motors & Drives	222
Electricity	Fans & Aeration	161
Electricity	Refrigeration	76
Totals		Total: 4,577

How is energy used?

One of the first jobs of the NSWF Energy Innovation Team was to establish the energy end use break up so that the team could focus on those areas that would provide material savings.

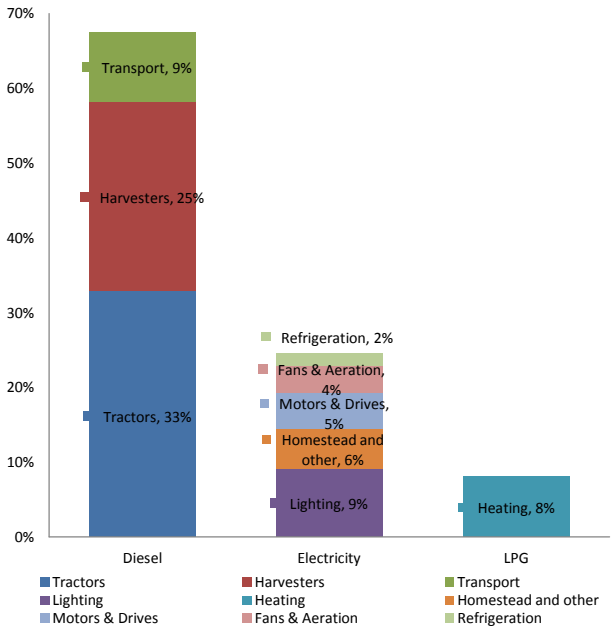

Figure 1: Glenwarrie energy end use breakup– with 30 percent of the energy used for housing of the layers. Heating, lighting, and ventilation, sheds are a significant focus for savings.

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Cost reduction opportunities

The NSWF Energy Innovation Team toured the facility and reviewed available data - mainly electricity invoice data - and came up with a list of 10 opportunities (see table 3) from which three were prioritised by Bede and Narelle.

- ***Quick win:*** Lighting upgrade
- ***Strategic:*** Mill conversion
- ***Strategic*****:** Gasification of waste to service whole farm

The lighting upgrade from T8s to T5s will inform the design of lighting systems for the new sheds currently being considered to expand the business. Should additional sheds be built the extra waste may support the business case for gasification (waste to energy for heating and other uses).

As the sheds currently operate up to 16 hrs per day seven days a week, for almost every week of the year, they provide a load that supports a healthy business case.

There are plenty of options for upgrades ranging from a T5 conversion kit through to LED strips, equivalent to T8 tubes. Some of the lights are fitted with dimmable ballasts. LEDs now come in dimmable formats. LED technology is mature with widespread uptake in offices and across retailers. Bede and Narelle are checking on the availability of installers/suppliers in the Tamworth region. Ideally they want to use their current sparky as their installer. The T5 or LEDs will deliver savings of $6000 a year and up to, or around, 25% of the energy costs of lighting the sheds on this farm with a four year payback. LEDs will provide greater savings but will typically be more expensive, however they are specified to last around 10 years based on average usage patterns.

Figure 2: LED light "tube" can be retrofitted into existing fluorescent fittings

Mill conversion - The Burkes are considering a change from their current hammer mill to a disc mill but are not fully clear of the energy use implications. The change is driven by Bede's desire to improve their grinder technology and increase automation. The advantages of moving to a disc mill also include:

- reducing noise,
- reducing dust,
- having better control over the size of grain pellets,
- permitting expansion and increased capacity, and
- reducing reliance on labour.

In general terms some of the disc mill suppliers claim energy efficiencies over the hammer mills but fail to quantity potential savings. Energy savings, if they exist, will support the business case for a new mill and further investigation of this opportunity will be undertaken during 2015. Meanwhile, Scottish research into mill efficiency provides some evidence that disc mills have cost savings potential assuming that when making a comparison, a larger motor is being used by the hammer mill to produce a similar quality, size and volume of feed. This is instanced in the table 3, below.

Table 3: Scottish research of comparative energy use of hammer and disc mills in piggeries shows that disc mills may offer energy savings over hammer mills

	Disc Mill	Hammer Mill
Feed tonnage (tonnes)	1,825	1,825
Energy consumption per tonne (kWh/tonne)	6	11
Total energy consumed (kWh)	10,950	20,075
Cost of power (£/kWh)	0.12	0.12
Total energy cost per year (£)	£1,314.00	£2,409.00

Annual savings from conversion to disc mill	**£1,095.00**

The gasification of waste is an idea that must be compared with benefits associated with the current use of waste which is used to improve pastures and cropping for feed. Excess waste beyond fertiliser could be used for gas engines but may require neighbours' waste to achieve the minimum waste volumes required. Importing waste from other chook farms poses a challenge due to biosecurity issues (pathogens) so other waste streams need to be assessed for volume and calorific value.

Currently there are several streams of waste being generated in varying intervals and quantities:

- Approximately 96 tonnes of chook manure is generated every week
- Approximately 70 tonnes of euthanised chooks are obtained on a 19 week cycle
- Barley and wheat straw from harvesting activities is combined with wood shavings from bedding sourced from the Tamworth equine centre as well as wet egg (broken eggs from operations) and daily chook mortalities

At the moment these residue and waste streams are moved to a dedicated processing area where it is composted for eventual use as fertiliser on the cropping fields . The compost is rich in nutrients and provides the carbon requirements for their crops.

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Could biogas be the future for chook sheds?

Most growers agree it's not a simple solution but waste needs to be managed especially given Council requirements, EPA regulations and rising energy prices, making this business difficult for most growers.

So where do the opportunities lie in waste management?

Some of the growers have income streams derived from their waste in the form of fertiliser. Others close the loop and return compost and waste water rich in nutrients to pastures, while some farmers send it off for disposal. If and when Glenwarrie expands it will potentially have sufficient solid waste to consider an onsite biogas operation to provide fuel for heating or a gas for injecting into a gas genset to produce electricity for the site.

Meanwhile some of the questions being investigated by NSW Farmers for Glenwarrie include:

Does the site have the ability in space and operating conditions to stockpile waste on site?
Yes, Glenwarrie has excellent stockpile facilities including front end loaders and other materials handling equipment and bays. Glenwarrie also actively monitors the temperature of piles using a grading system and undertakes tests for pathogens. This is a contentious issue in poultry and requires careful consideration eg would soluble waste be more acceptable, rather than stockpiled as a dry waste for gasification?

What level of investment is required to set up a waste treatment plant and capture the gas?

Recent investigations in the red meat industry suggest $1m is a minimum, however European examples of small scale generation are common. Gasification of dry waste is very scalable but cases in Australia are limited and generally only at a large scale (e.g. some of the larger scale egg or meat processing plants). See Darling Downs eggs biogas project

What budget and or existing staff are available to attend to the waste treatment required?
Glenwarrie already manages waste and has allocated time, resources and equipment for this purpose. Therefore additional resources and budget would be limited for the gasification process. For others, waste management and materials handling can often be a hidden cost.

Another consideration is that directing waste to gasification would mean purchasing additional quantities of fertiliser.

What to do with the excess waste?
Over 4000 tonnes of waste is currently generated per year which is all used for fertiliser on the fields. Depending on the choice of the waste-to-energy process (e.g. anaerobic digestion or gasification), there is still some solid waste that requires disposal. Fortunately this could still be used on the fields as fertiliser but would require supplementing as it would not be as rich as the nutrients as the current composted waste.

Is the set-up scalable with expansion?
Is it feasible to source an additional, reliable amount of waste (biomass) from surrounding farms to achieve greater economies of scale? Imported chicken waste has higher biosecurity issues which need to be managed.

Glenwarrie has excellent waste handling facilities, practices and testing protocols making energy from waste a more viable option. However first estimates suggest the business case doesn't stack up.

Figure 3:Phil Shorten from Energetics and the Ag innovators team gets the word on waste management from Bede at Glenwarrie. Note the mounds of waste enhanced by various soils that are quarried on the farm to form highly valuable fertiliser

If the business case could be made more palatable, the next step would be to set up a gasifier to produce the gas to fuel a generator in order to service the energy needs of the farm. See below.

Figure 4: A typical industrial scale gasifier, gas fired engine and generator that can power a whole farm. Masssive energy cost savings but big capital upfront as well as ongoing maintenance

To summarise, the NSW Farmers Energy Team found a number of energy efficiency and cost saving opportunities. The priorities decided by Narelle and Bede after considering the effort and impact on his business plans are highlighted in the following table.

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Optimising pullet shed temperature control by covering most of the shed with Insuldeck insulation

Insulation is a key consideration for animal health optimum growth rates as well as cost savings. At Glenwarrie, Bede had begun to improve the insulation on all sheds. One day he observed the chicks in the nursery congregating where the insulation had been improved in the shed prompting him to accelerate the roll out of his insulation upgrade.

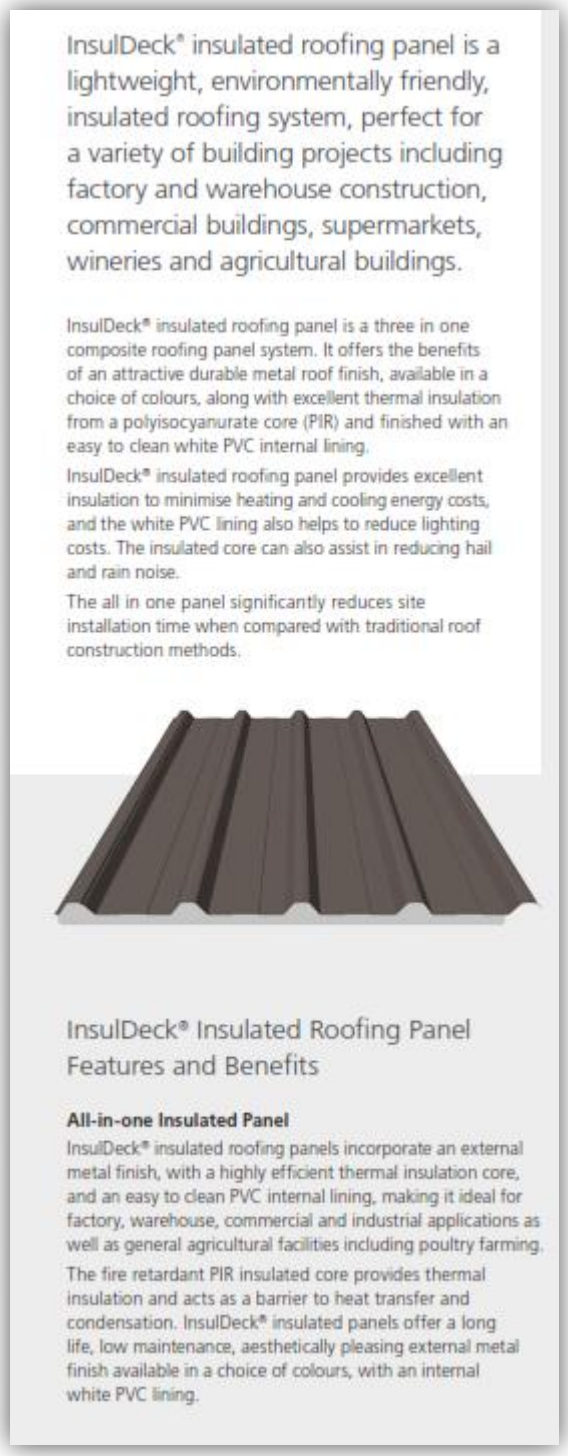
"I understood the benefits of insulation but when I saw the birds crowded under the insulated half of the shed one hot day I immediately knew we needed to accelerate our upgrade to protect the birds as well as reduce our heating and cooling costs" says Bede.

The cost of insulation is estimated to be around $50,000 for the larger shed that remains to be upgraded. Bede estimates that this improvement will results in several benefits which will directly and indirectly help outweigh the costs such as:

- Better structure (improve longevity and resilience of facility)
- savings in feed, estimated at 5-10 %
- benefits in growth rates, estimated at 5%
- savings in gas for heating, around 5%
- savings in cooling fans, around 5%

For more information on insulation visit NSW Farmers' Information Paper 'Insulating farm buildings'

Figure 5:InsulDeck product information[1]



InsulDeck® insulated roofing panel is a lightweight, environmentally friendly, insulated roofing system, perfect for a variety of building projects including factory and warehouse construction, commercial buildings, supermarkets, wineries and agricultural buildings.

InsulDeck® insulated roofing panel is a three in one composite roofing panel system. It offers the benefits of an attractive durable metal roof finish, available in a choice of colours, along with excellent thermal insulation from a polyisocyanurate core (PIR) and finished with an easy to clean white PVC internal lining.

InsulDeck® insulated roofing panel provides excellent insulation to minimise heating and cooling energy costs, and the white PVC lining also helps to reduce lighting costs. The insulated core can also assist in reducing hail and rain noise.

The all in one panel significantly reduces site installation time when compared with traditional roof construction methods.

[1] This product description is supplied by Zammit. For more information, go to: http://www.stramit.com.au/sites/default/files/download-file/insuldeck_insulated_roofing_product_brochure_september_2014.pdf

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Table 4 : Full list of opportunities with priority opportunities highlighted. Note: 'UI' denotes 'Under Investigation'.

key — Priority opportunity; Non-priority opportunity

Opportunity Name	Description	Savings ($)	Est Capex ($)	Payback (yrs)
Electricity discount	Obtain Origin discount through NSW Farmers.	5,000	0	< 1 yr
Lighting upgrade in chook sheds	Upgrade from T8 to T5 fluorescent lights for main chook shed lighting. Good savings given long operating hours 7 days/wk.	5,900	23,600	4 yrs
Lighting upgrade in packing room	Upgrade lighting in packing from T8 -> T5 fluorescents.	400	1,600	4 yrs
Lighting upgrade in Mill shed	Upgrade lighting in mill room. Currently there is a mix of mercury vapour / metal halide globes. A range of LED alternatives available.	120	480	4 yrs
Solar PV 40kW	Install Solar PV to offset daytime operation energy use (lighting, motors & fans). Initial estimate of ~40kW with minimal exports.	16,000	80,000	5 yrs
Tractor Tyre Pressure	Farmers can often be concerned about achieving maximum life for tyres without considering the potential fuel savings that may be gained by adjusting tyre pressure to suit application at the expense of reduced lifetime (assumes 1% saving).	900	1,000	1 yr
Ballastering per application	When towing equipment, tractors often need additional ballast on front and / or back of the tractors in order to achieve optimal stability and operations, particularly if different style operations and implements are being undertaken by the same vehicle (assumes 1% saving).	900	1,000	1 yr
Mill Conversion	The Bourke's are considering a change from their current disc mill across to a hammer mill and are not aware of the energy use implications.	UI	4,000	UI
High efficiency mill motor	Upgrade motor to a higher efficiency motor. Generally not cost effective by itself, but should be considered when replacing or repairing the motor.	200	3,000	15 yrs
Adding insulation to remaining pullet shed	Optimising pullet shed temperature control by covering most of the shed with Insuldeck insulation	1,700 from energy savings alone. Less feed requirements and better growth will improve savings	50,000	<30
Gasification / Waste to Energy	All chook manure currently composted onsite and subsequently used as fertiliser for cropping. Understand scale of potential costs and benefits to going to an onsite gasification / waste to energy system.	UI	UI	UI
Total		**31,120**	**164,680**	**~ 5 yrs**

Solar sets up life time of cost savings

The business case for new sheds should compare operating costs with and without solar over the life of shed.

Glenwarrie has some of the essentials to support a strong business case for solar PV including vast roof space with more than 3000m^2 per shed, a sizable daily peak load that varies from 20kW in winter up to 60-70kW through summer, and good alignment during daylight hours. Glenwarrie has the opportunity to install a solar PV system to offset energy use during daytime operation (lighting, motors and fans), with an initial estimate of ~40kW with minimal exports.

The result is $16,000 in savings.

Figure 6: Solar could provide as much as 15- 20% of the electricity load for this fam. Batteries could make a grid connection redundant especially if the biogas fired generator become a reality in the longer term to manage any supply risks

The practice of no till reduces cost as well as increasing yield - another energy productivity opportunity

Significant savings in diesel usage were achieved by adopting 100% 'no till' using a four season staged introduction. The following results were obtained:

Table 4: Fuel savings achieved through reduced tillage practices

Year	Area tilled %	Diesel cost	Acres under crop
2010/11	100%	$112k	2500
2011/12	50%	$108	2500
2012/13	0%	$96k	3800
2013/14	0%	$91	3800

Although other factors influence use, decreased tillage has been the major contributor to this reduction in diesel costs.

The Ag Innovators team will require more information to expand on the ancillary benefits of lower tillage. Aspects such as chemical costs for weed control, capital required to purchase new equipment, labour costs, tractor maintenance costs and other business drivers such as soil moisture retention and yield will be investigated in the context of increasing energy productivity on the farm.

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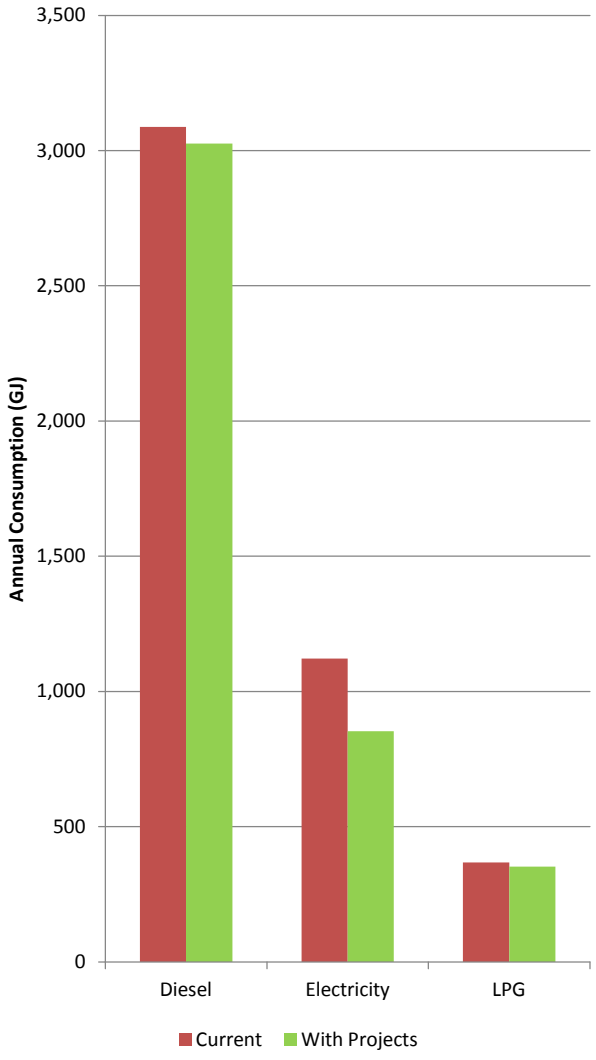
Outcomes

When Glenwarrie implements the new lighting system, the solar PV and the electricity discount via NSW Farmers group purchasing arrangements, more than $25-30,000 will be added to Bede and Narelle's discretionary spending. They will save around 10% on their energy costs year on year.

The next time Bede flicks the switch on the lights in the shed he will know that he is saving around $6,000 a year having upgraded his lighting system from T8s to T5s or LEDs

Figure 7: Expected energy savings from continuing implementation of projects.



Savings per year (GJ)	345
Savings per year (percent)	7.5 percent
Savings per year ($)	$31,120

NB Solar savings will reduce if other opportunities are implemented prior to installing solar

Enhancing business plans with improvements in energy productivity

Bede was able to identify two business opportunities that can incorporate improving the way he uses energy in order to increase farm output.

1) **Expansion by doubling the number of birds and sheds**
An additional pullet rearing shed is on the drawing board for Glenwarrie. If energy savings measures from the old sheds can be applied to the new sheds, the Burkes will improve their profit margin for their new venture rather than just increasing revenue.

2) Increase local sales as a percentage of total sales
This will depend on marketing their eggs as a niche product to compete with the local retailers. Promotion of their closed loop egg production system including the possibility of waste to energy technologies will strengthen the argument for a premium price on their product.

Planning for a long term future in family farming

With the assistance of NSW Farmers' Energy Innovation Program, Narelle and Bede will continue to explore energy generation and energy efficiency options that secure the future of a family farm with an award winning history.

Over the **short term**, in addition to optimising his tractor set up and operating practices, Bede has applied for the 18% electricity discount and will see a lower charge from his next electricity bill. He will also be moving forward and installing insulation on the remaining large pullet shed still requiring the full fit-out.

In the **medium term**, Bede will convert his mill from a disc to hammer operation, knowing that while this will result in an increase in electricity use, it will also support an investment in solar PV especially if leasing arrangements can be put in place to achieve a cash flow positive result each month. The lighting system will be upgraded probably via a replacement policy that demands T5 replace the T8s at end of life rather than a one off mass replacement program.

Long term opportunities include the use of biomass to generate sufficient syngas to meet 80 percent or more of the electricity load of the farm. This opportunity is unlikely to stack up financially especially if the solar option is taken up. However other business opportunities via expanded waste management may affect these decisions in the long term.

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For help to identify ways to reduce your energy costs, contact the Energy Team at NSW Farmers:

ENERGY INFO LINE

02 9478 1013

EMAIL

R&D@nswfarmers.org.au

WEB

www.AgInnovators.org.au

www.NSWFarmers.org.au

http://www.qmscotland.co.uk/news/new-report-highlights-energy-saving-opportunities-pig-producers

http://www.cleanenergyfinancecorp.com.au/media/63281/20130731-cefc-pdf-factsheet-darlingdownsfresheggs_lr.pdf