Attachment G – Knowledge Sharing Activities

GRID-SOLAR MIX MAY OFFER BEST OF BOTH WORLDS

BUNDABERG TRIAL HAS POSITIVE IMPACT ON PRODUCTIVITY, PROFITABILITY AND GROWER WORK-LIFE BALANCE

By Cindy Benjamin

When growers try to reduce pumping costs by irrigating at night, there can be significant impacts not just on productivity, but on the grower's health and well-being as well.

Feeling constrained to night irrigation times to reduce electricity costs means growers often delay irrigation and frequently do not apply the quantity of water required to maximise productivity in a supplementary growing region such as Bundaberg – also, chasing water winches at night disrupts sleep and can be dangerous.

To overcome these problems many growers have looked for and implemented alternative irrigation systems.

While solar energy has significant advantages and potential cost savings, stand-alone solar systems can have operational limitations.

A new three-year renewable energy project in Bundaberg, which is funded by the Australian Renewable Energy Agency (ARENA) and administered by the Bundaberg Regional Irrigators Group (BRIG), is investigating the feasibility of using a unique hybrid solar and grid energy system to provide all the convenience of grid electricity and the savings offered by solar.

Maurie Haines, Special Projects Officer, Bundaberg Sugar Services Ltd, says the solar array at the demonstration irrigation site has been living up to expectations ever since it was commissioned in mid-January this year.

"This system is designed to be a hybrid irrigation system that blends solar and grid power to maintain seamless operation between clear or cloudy daytime conditions or night time operation," he said.

"Unlike most solar farms, this system does not feed solar energy into the grid. All the decisions the grower makes are based on whether the crop needs water, and not how much will it cost."

"This year we have irrigated ratoons much earlier than we usually would and we are confident that looking after them during the dry winter and early spring will pay off in higher yields at harvest next year."

During peak solar radiation conditions the solar panels can power the pump without drawing on the grid supply.

In the early morning and late afternoon the system draws as much solar energy as is available and draws the rest from the grid. In the evening, the cheaper night tariffs are used if required.

The demonstration site is located on the Killer family farm at Sharon, west of Bundaberg.

Rodney and his son Josh have 58 hectares of cane on this block and use high-pressure water cannons to irrigate.

Other options such as low-pressure lateral booms are not a feasible option for the undulating and oddly shaped farm.

Josh said the new pump system has given them much greater incentive to water when they know it will be beneficial, without worrying about the cost of electricity.

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Pictured: (main) Maurie Haines from Bundaberg Sugar Services Ltd, (above) Josh Killer is impressed with the ease of operation, time savings and extra flexibility the new irrigation system gives him.

"Now I can turn the pump on and off remotely, knowing that there is a safety mechanism to shut everything down if there is a problem. I can really manage my time a lot better between our two farms and can get the most out of every day."

"This year we have irrigated ratoons much earlier than we usually would and we are confident that looking after them during the dry winter and early spring will pay off in higher yields at harvest next year," he said.

The other big benefit for Josh has been the reduced work stress surrounding irrigation. Josh lives about 45 minutes from the farm with the solar demonstration so starting and stopping pumps and checking water winches is time consuming.

"Before the solar system was operating I would need to get to the farm early to shut the pumps off and stay late in the afternoon before starting the pumps so that we only watered on the night tariff," he said.

"Now I can turn the pump on and off remotely, knowing that there is a safety mechanism to shut everything down if there is a problem. I can really manage my time a lot better between our two farms and can get the most out of every day."

The Killers are now able to irrigate all day and all night if necessary during peak water use periods, to keep their crops growing and make the most of the available sunshine and warmth in spring and early summer particularly.

They are also using the extra flexibility with irrigation to water in fertiliser so they eliminate volatilisation losses and get the full benefit of the applied nutrients. Josh has found that the solar system has changed their whole mindset when it comes to the application of water.

The equipment installed at the site includes a 240-panel solar array (81.6 kW), 45 kW electric motor and centrifugal pump designed to operate at varying speeds, and a VSD Ecodrive controller to manage both solar energy (DC power) input as the priority energy source with grid supplied (AC power) as a supplementary source. The Ecodrive controller also manages the input water pressure to maximise pump efficiency.

A new pump was installed as part of the demonstration project but it has the same capacity as the one it replaced.

The changes have centred on improving pump efficiency. The before-and-after energy usage comparison show that the solar/grid pumping demo system uses approximately 78% less energy than the grid-only system it has replaced.

The VSD Ecodrive power blending system monitors the water inflow pressure and manages the motor speed to maintain a constant pressure to the winch irrigator.

This means the pump is always operating at maximum efficiency and not wasting power, unlike the previous system, which relied on a check valve to control pressure to the winch while continuing to operate the motor at maximum speed and energy use.

"Unlike some solar systems, this one never cuts out and does not simply switch to the grid if the solar input drops below the threshold required to run the pump," said Maurie. "The priority-solar with grid back-up system maximises the benefits of solar electricity."

"Given that many growers in the Bundaberg area only use 50% of their water allocation, due in part to concerns over pumping costs, there is plenty of room for additional productivity from the current crop area," he said.

"Avoiding crop stress in July and August and taking advantage of longer days in summer will both pay off in extra yield. The more the grower uses a system like this the better off they will be."

The modular design of this demonstration solar farm is one of the key features that makes it a viable option for other growers. It is possible to start small, installing the Ecodrive system to initiate greater pump efficiencies and then add extra solar panels as funds permit, until the array has the capacity to run the pump on solar energy alone during clear daytime conditions.

Over and over again, Maurie has seen the effect of growers making a change to their irrigation practice and reaping the double benefit of better productivity and reduced costs.

"It is so often the case that the productivity gains even out-weigh the savings in energy costs," he said.

To assist with irrigation scheduling, there are soil moisture probes and an automated weather station installed on the Killer's property. These also contribute data to the area-wide weather monitoring system in Bundaberg, providing growers with more localised weather information.

This demonstration project aims to provide growers and their lending institutions with reliable and field-tested data to support investment in similar systems.

"These systems involve large capital outlay and growers need to be confident that they will deliver productivity gains and cost savings," said Maurie. "Another component of this project is to collect local information about how much solar energy is available throughout the year and how that might vary across the district. This will help growers determine if they can expect the same outcomes or better than what we are achieving at the demonstration site."

All the data collected through the three-year project will be available on the BRIG website (*www.brig.org.au*), including how much solar and grid energy is consumed for each ML of water pumped and all operational costs.

"This information will be of enormous benefit to growers if they get Bundaberg Sugar Services Ltd to conduct a Farm Energy and Irrigation Information Audit for their farm," said Maurie. "This will create a powerful decision-making tool for farm energy and farm water use planning in the lead up to the 2020 tariff changes and beyond." ■

Pictured: Maurie Haines, Bundaberg Sugar Services Ltd is managing the Adapting renewable energy concepts to irrigated sugarcane production at Bundaberg project on behalf of the Bundaberg Regional Irrigators Group.

Dale Holliss

From: Kaitlyn Stewart
Sent: Thursday, 22 November 2018 12:47 PM
To: Dale Holliss
Subject: Patrick - 0419 720 163

Dale,

Patrick has called from NSW regarding the article that he has seen in the Rural Weekly about the Solar set up at the Killer's Farm. He is hoping to have a chat to you about the project when you have a few spare minutes to give him a call back.

Regards,

Kaitlyn Stewart
Receptionist/Administration Assistant

Bundaberg CANEGROWERS Ltd

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Our mission is to provide representation, leadership and services and promote unity in the interest of growers

BUNDABERG REGIONAL IRRIGATORS GROUP

REPRESENTING MEMBER IRRIGATORS IN THE BUNDABERG IRRIGATION AREA

ARENA

Australian Government

Australian Renewable Energy Agency

Impact of Energy Cost on Sugarcane Yield Potential and Energy Options At Bundaberg

Productivity potential

This study of energy cost in the Bundaberg Sugar Industry is based on the main growth period from mid September to mid April which is approximately 200 days. Atmospheric conditions impact on about 40 % of this time which leaves about 120 days for irrigation to influence the annual crop.

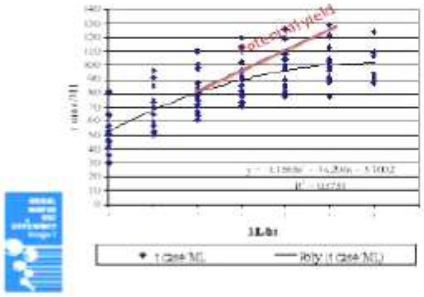
A major cause of low productivity in sugarcane production is the extent of crop stress between rainfall and irrigation events. Sugarcane farming has many variables which influence the yield outcome but moisture availability is the most significant driver of productivity.

The yield to water use data shows that the highest level of production is only achieved by a limited number of farmers which suggests the presence of constraining factors.

When irrigation operations are constrained by external factors (e.g. low water allocation or high energy cost) the focus can shift from producing the crop to saving the crop. It is then often the case that the water pumped is not the determinant factor to achieving potential yield but it is the water that isn't pumped that constrains productivity.

YIELD AND WATER USE RELATIONSHIP

Bundaberg 5 year average



ML/ha	tc/ha
0	53
1	68
2	80
3	90
4	96.5
5	100.5
6	102

To achieve the best production outcome the days in each irrigation cycle need to be no more than 15 days but this means longer peak pumping hours per day and subsequent higher cost per unit of production.

Energy cost impact

Energy cost is a major deterrent to restoring the productivity and profitability of the Bundaberg Sugar Industry. The following calculations were developed from actual production data and irrigation system performance at the Killer Family farm near Bundaberg prior to the commencement of a solar energy trial.

This calculated example shows operating cost scenarios based on the previous farm irrigation system which was a 100% grid option.

Calculated assessment of original system at Killers farm (100% grid supply)

Irrig area (ha)	Irrig applied (ML/ha)	Irrig cycle (days)	Pumped hours /year	Grid Energy use kWh	Opt Tariff	Grid energy cost ($)	Yield tc/ha	Gross yield tc/ha	Grid energy cost / tc ($)	Grid % of gross value
48	1	60	533	20,800	62	3,120	68	**3,264**	0.96	**2.78**
48	2	30	1067	41,600	62	6,816	82	**3,936**	1.73	**4.95**
48	3	20	1600	62,400	65	13,308	95	**4,560**	3.03	**8.65**
48	4	15	2133	83,200	66	20,805	110	**5,280**	3.98	**11.26**
48	5	12	2667	104,000	66	24,828	125	**6,000**	4.14	**11.82**

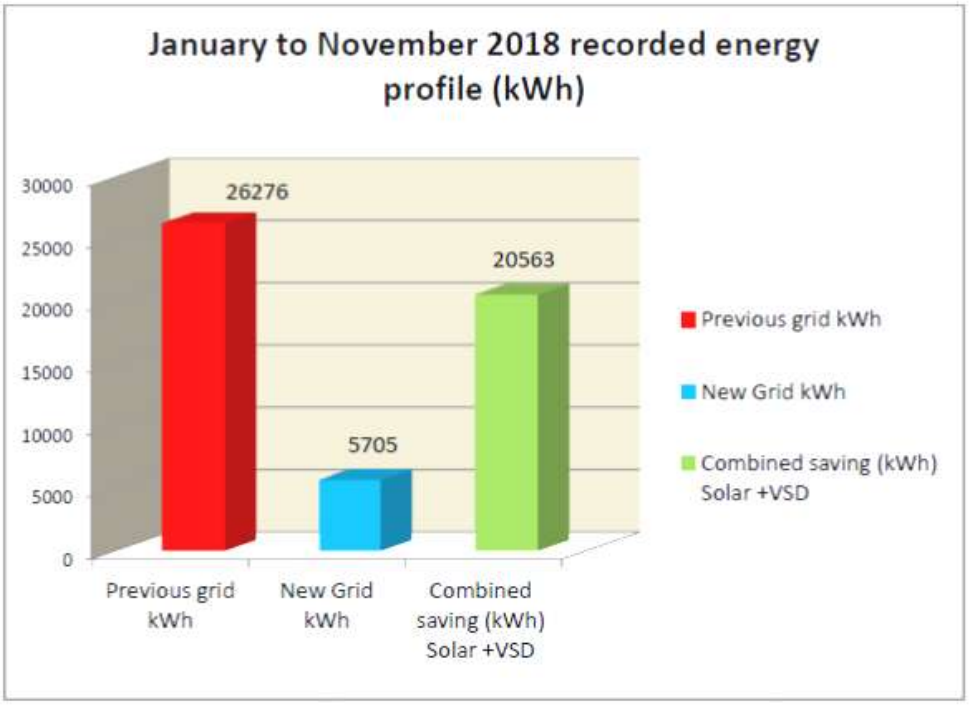
The cost constraints to increased water use are evident. At the highest application rate the cost of energy is 11 to12% of the current gross return per t/cane. The tariff applied to each water use rate was the cheapest daily rate for that scenario but what is evident is the differential cost for the step between the tariffs e.g Tariff 62, 1ML/ha to 2 ML/ha (1-2ML/ha = $3696 p.a.) and T 62 to T65, 2ML/a to 3 ML/ha (2-3ML/ha = $6992 p.a.).

The daily operating hours increased with the volume pumped and consequently more hours where in peak time which made it necessary to switch from T62 to T65 then to T66.

Solar Trial

In January 2018 a hybrid solar/grid trial was established at the Killer Family farm. The new system included 82.6 kw solar array, new 45 kw motor and pump unit suited to variable frequency operation and a VFD drive.

The VFD successfully manages the pump demand and has reduced grid off take from an average of 39 kWh to 27 kWh. The 2018 rcorded energy profile shows that the combination of solar and VFD has reduced grid kWh demand by 78%.



The following calculated example shows the operating cost of the solar/grid trial option over a similar range of water application rates, irrigation cycles and a range of operating hours. The trial site has been set up to operate on a flat rate tariff T20.

Calculated assessment of system at Killers farm (82.6 kw solar + VFD + grid supply)

Irrig area (ha)	Irrig applied (ML/ha)	Irrig cycle (days)	Pumped hours /year	Grid Energy use kWh	Tariff	Grid energy cost ($)	Yield tc/ha	Gross yield tc/ha	Grid energy cost / tc ($)	Grid % of gross value
48	1	60	533	0	20	0	68	**3,264**	0	**0**
48	2	30	1067	0	20	0	82	**3,936**	0	**0**
48	3	20	1600	1,872	20	495	95	**4,560**	0.11	**0.31**
48	4	15	2133	16,272	20	4,303	110	**5,280**	0.81	**2.33**
48	5	12	2667	30,672	20	8,110	125	**6,000**	1.35	**3.86**

The recorded grid energy savings align closely with the 4 ML/ha scenario but there are many additional benefits. The Killers have found that their farm management strategy is no longer constrained by energy cost structures and they are now more willing to irrigate according to crop need than economic considerations.

The question is whether further cost reductions can be achieved. Will the introduction of diesel mean that Bundaberg sugarcane irrigators can become completely independent of the grid energy supply?

Solar/ Diesel

Engine

Manufacturer Cummins Diesel
Engine Model 4BT3.9G2
Type & Cylinder - 4 Stroke - 4 L
Induction Turbocharged
Fuel Consumption 9.4 L @ 100%
6.2 L @ 75%, 4.5 L @ 50% Load
Coolant Capacity 8 L
Governor Electronic
Cubic Capacity 3.9 L
Oil Capacity 11 L
Warranty World Wide as per 3381307 Publication

Controls

Controller SmartGen 6120 with LCD Display
Circuit Breaker Moulded Case 3 Pole
Battery Isolator Fitted with canopy adjacent battery

Canopy

Skid Base Fuel tank with fork lift pockets and skid tie down points
Canopy Centre Lift, lockable doors with control panel viewing window
Paint Finish Heavy duty powder coat finish white canopy with a black base

Many farmers ask if diesel is an option?

If we are talking about a hybrid concept (e.g. solar/diesel generator combination) it appears to be possible. This option was assessed through the same technique applied to the grid and solar grid options.

Particular parameters applied were:

1. Pump demand load is 27 kWh (reduced from 39 kWh by VFD management)
2. Gen set 47 KVA (Prime load 34.4kw)
3. Operating at an average load of 75% (6.2 L/hr)
4. Fuel cost $1.50 – gst – fuel rebate = $0.98 / L

Calculated assessment of system at Killers farm (82.6 kw solar + VFD + Diesel gen set 47KVA)

Irrig area (ha)	Irrig applied (ML/ha)	Irrig cycle (days)	Pump hours /year	Diesel running hours/ year	Diesel Cost ex gst & rebate ($/liter)	Diesel energy cost ($)	Yield tc/ha	Gross yield tc/ha	Diesel energy cost / tc ($)	Diesel % of gross value
48	1	60	533	0	0.98	0	68	**3,264**	0	**0**
48	2	30	1067	0	0.98	0	82	**3,936**	0	**0**
48	3	20	1600	69	0.98	306	95	**4,560**	0.07	**0.19**
48	4	15	2133	603	0.98	2,658	110	**5,280**	0.50	**1.44**
48	5	12	2667	1,136	0.98	5,010	125	**6,000**	0.84	**2.39**

Based on the parameters applied to the calculations used to assess the system installed at Killers Farm there is strong evidence in support of a solar diesel combination which would result in a 100% off grid energy supply.

Projects Report

... by Maurie Haines, Special Projects Officer

As special projects officer I am responsible for overseeing the implementation of important projects that will enhance the future viability of the sugar industry in Bundaberg.

Currently we are working on two (2) significant programs:

1. Localised weather records and forecasting for regional districts at Bundaberg (e.g. Bucca, Qunaba, Fairymead);
2. Analysis of energy efficient irrigation pumping and application options (e.g. VFD's, Solar and low pressure systems).

Weather records and Forecasting

The rainfall data at this time in the current crop growth season (July 2018 to June 2019) indicates that rainfall is well below average. The good rain in late October combined with irrigation has created the prospect of increased production in 2019.

However, as forecasts indicate that the prospect of rain for the remainder of the season is near normal at best there will most likely be a need for considerably more irrigation before the crop is grown.

2018-19 BSSL weather station information — **Progress report to 5 December 2018**

	Monthly totals (mm)								Progress	Long	% of
Location - Farm	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Total	term Av.	LT Av
Alloway (new station at Cayley's New Farm Rd)	4	9	59	143	46	21			261	1018	23.8
Bucca - Cronin (near Bucca Crossing)	6	15	23	166	28	19			238	999	23.8
Elliott - Relmay	9	7	32	137	48	31			233	1018	22.9
Fairymead - Fairydale	9	13	25	145	38	13			230	1042	22.1
Gooburrum		9	15	139	29	12			192	1018	22.1
Moorland	11	15	25	177	47	6			274	1033	26.5
Qunaba Plantation	5	10	35	174	18	19			241	1048	23.0
Yandaran - Steemson	13	7	9	151	27	7			207	1013	20.4
Wallaville	4	14	11	205	18	25			251	918	27.4
Bingera Mill	6	10	21	122	42	35			201	1013	19.9
Manoo	9	10	25	141	38	7			223	1013	22.0
Bundaberg Aero	10	17	7	164	32	11			230	1019	22.6
District average	8	11	24	155	34	17			250	1011	24.7

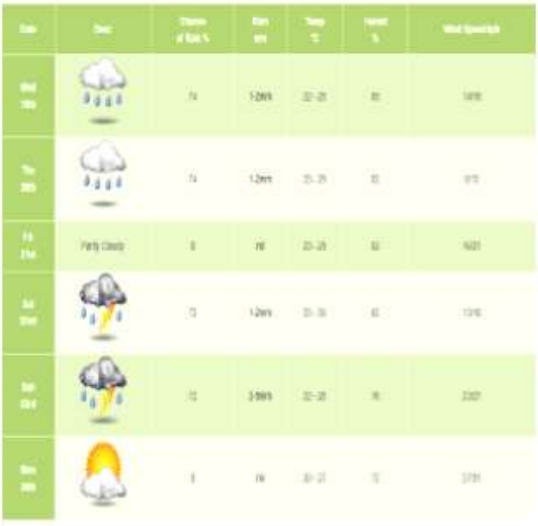
2018-19 Bundaberg district long term average comparison

Location	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
BSSL Av. All stations (2018-2019)	8	11	24	155	34	17					
Bundaberg District Annual LTAv (July - June)	39	34	36	78	85	128	174	158	113	56	67
2018-2019 % of long term average	20	34	67	199	40	13					

Another feature of the weather project is a trial of forecasting systems based on the output of the eleven (11) industry owned weather stations located within the Bundaberg cane production area. Daily data from each station is displayed on the irrigation page at the Bundaberg CANEGROWERS web site https://www.bdbcanegrowers.com.au.

The daily information is also sent to an international weather forecasting agency which produces a six (6) day forecast for each site. The following is an example of a forecast provided for the Qunaba station.

Six Day Forecast for Qunaba



Analysis of energy efficient irrigation pumping and application options

This activity has a high level of priority placed on analysis of the ARENA co-funded solar irrigation trial on Killer's farm at Sharon.




This trial incorporates several efficiency options that may be considered by sugarcane irrigators at Bundaberg. For irrigation sites where a check valve is used to control pressure on the delivery side of the system there are opportunities for considerable savings. At the trial site a new pump and motor fitted with a Variable Frequency Drive were installed to manage demand pressure which has resulted in a 32.75% or $38.00/ML reduction in energy use.

The accompanying table shows the comparison of the previous 45 kw pumping system and the replacement system linked to the solar array. The combined effect of the solar array and the new pump/motor/VFD combination has reduced the energy use for the period from January to December 2018 by 80%.The previous system when used at the same tariff and time of day would have had a mains energy cost $116.00/ML compared to the mains energy cost for the new system which is $23.14/ML.

Old pump	Pumping hrs	ML pumped	Kw hrs mains	Tariff 20	Total cost
Cost of previous pumping system	792	70	30888	26.442 c/kWh	$8167
Pumping cost /ML					$116.00
New pump	**Pumping hrs**	**ML pumped**	**Kw hrs**	**Tariff 20**	**Total cost**
Mains supply	792	70	6129	26.442 c/kWh	$1620
VFD	792	70	-10126		-$2677
Solar	792	70	-14633		-$3869
Total operating cost (energy)					$1620
Total operating saving (energy)					$6646
Pumping cost /ML					$23.14
Equivalent operating cost based on previous pumping system					5.24 c/kWh
Comparative tariff cost (2008/09) =	T62 off peak 7.75 c/kWh T65 off peak 9.63 c/kWh				