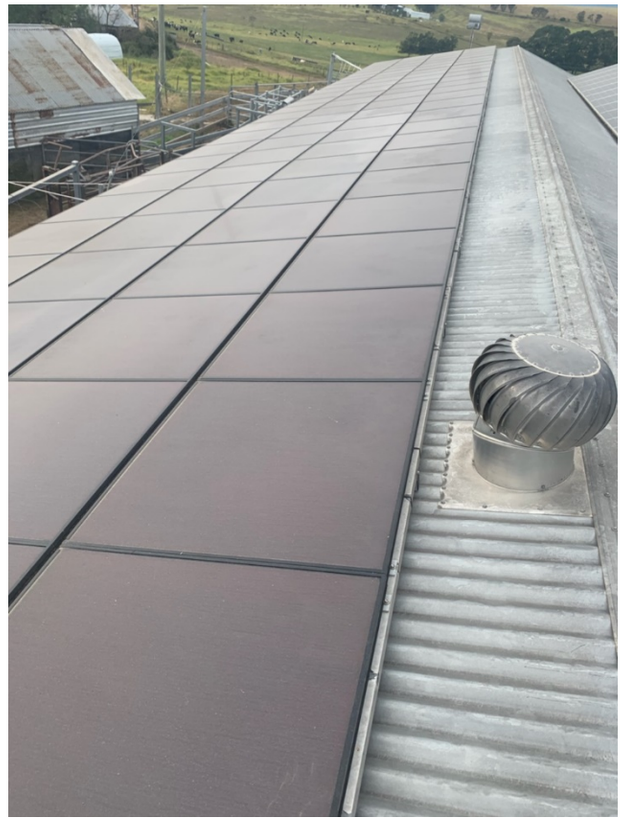
# Reviewing your energy options

Check the cost effectiveness of energy saving measures.



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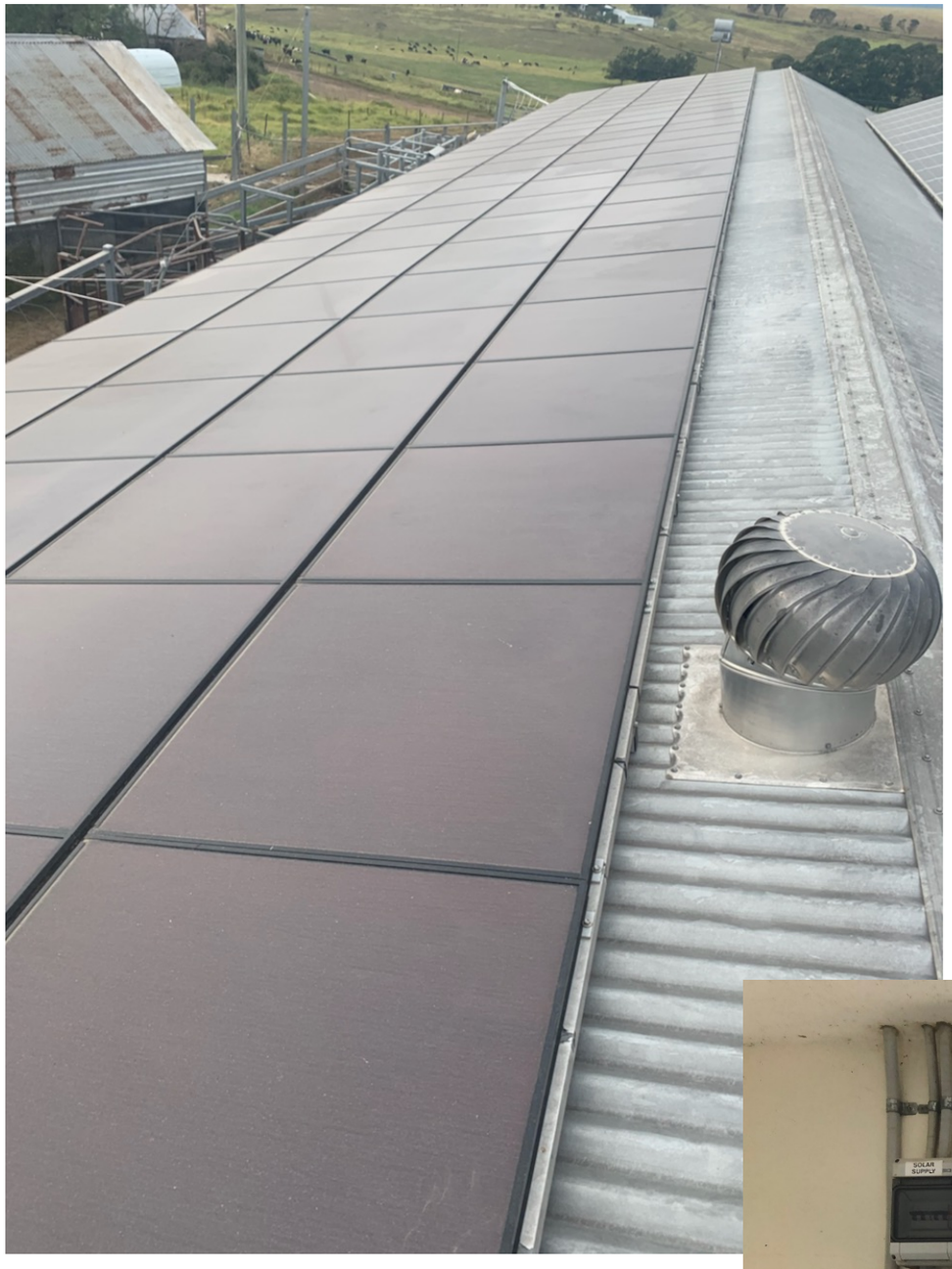
The energyguys
practical energy solutions

## Michael Shipton, Bega

**Milks 350 cows**

Has a number of energy saving systems:

- 10 kW solar PV system
- Heat recovery unit
- VFD on vacuum pump
- Upgraded 1½” poly to 2”, saving pump time
- Trialling use of spare vat to chill water during daytime to use up solar




SOLAR SUPPLY
SHUTDOWN PROCEDURE
DANGER
SUNNY BOY


ABB
LAB
ADAM
ROGER
ESSENT
HYDRUS
0438 284 431 - DAVE
PETE
GREG


Frigrite

# Energy Use at dairy

| | |
|---|---|
| Used from grid | 86,337 kWh |
| Used from solar PV | 6,480 kWh |
| Feed-in to grid | 5,982 kWh |

| | PV generated |
|---|---|
| Used at dairy | 52% |
| Fed-into grid | 48% |

| | % total used |
|---|---|
| Peak | 18% |
| Offpeak | 45% |
| Shoulder | 18% |
| Flat tariff | 18% |

Costs/ income for energy at dairy

| | |
|---|---|
| Used from grid | $ 19,828 |
| Used from solar PV | ($ 1,606) |
| Feed-in to grid | ($ 479) |

| | Tariffs | **Net rates** |
|---|---|---|
| Peak | 36.45 | **24.79** |
| Shoulder | 35.20 | **23.94** |
| Offpeak | 21.43 | **14.57** |
| Stockpump | 28.47 | **22.00** |
| | average | **18.46** |

# Benchmarks

Consumption

91,393 kWhr/ year

→ 41 kWhr/ kL

Cost

$ 19,828/ year

→ $ 9.0/ kL

Tariff

$ 0.185 / kWhr average

NSW Dairy farmers

Average 51kWhr/ kL

23- 83kWhr/kL

Average $ 14.7 kL

$ 8.1 – 22.7/ kL

Average $ 0.298/ kWhr

$ 0.211 – 0.406/ kWhr

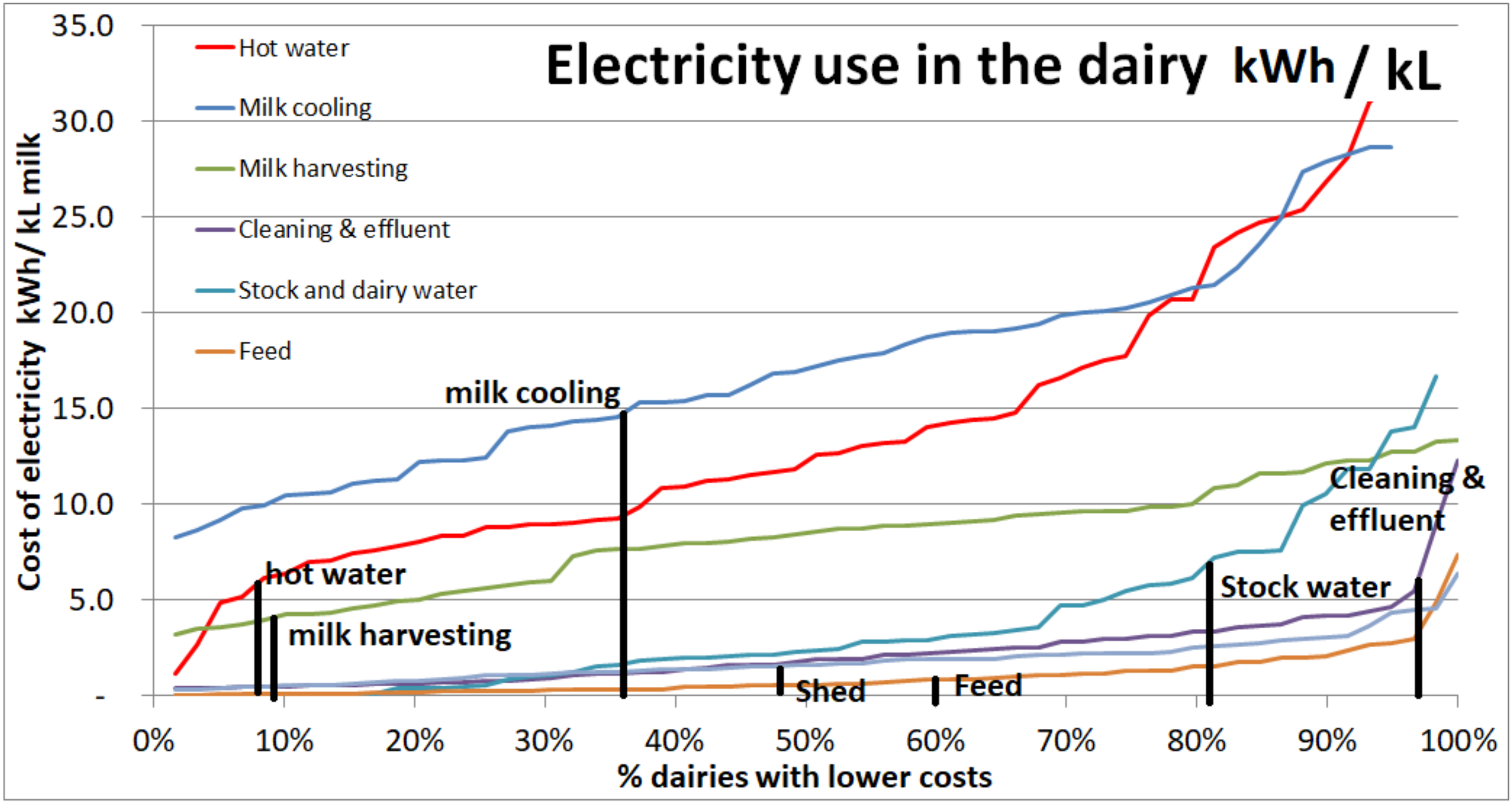
## “Over-the phone” audit

JOC went on farm and took photos

Phone calls to work out run times, temperatures and volumes

- Ideally  check temperatures on farm during milking,

| *Estimates based on run times and temperatures reported* | kWh/ year | | *From bills and estimates of solar PV generate* | kWh/ year |
|---|---|---|---|---|
| Milk harvesting | 7843 | | Used from grid | 70760 |
| Milk cooling | 32508 | | Use at stockwater pump | 15577 |
| Hot water | 12064 | | Used from solar PV | 6480 |
| Cleaning and effluent | 13031 | | | |
| Stock water pump | 15577 | | | |
| Feed | 3541 | | | |
| Shed and lights | 2412 | | | |
| Total | 86976 | | Total | 92818 |
| | | | Difference | 5842 |
| | | | Error | 6% |


Electricity use in the dairy kWh / kL
Hot water
Milk cooling
Milk harvesting
Cleaning & effluent
Stock and dairy water
Feed
Cost of electricity kWh/ kL milk
35.0
30.0
25.0
20.0
15.0
10.0
5.0
-
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
% dairies with lower costs
milk cooling
hot water
milk harvesting
Shed
Feed
Stock water
Cleaning & effluent

# HOT WATER HEATING

Has 500 L rapid flow tank

Uses 600L/ day at 90 °C

- 200L morning = heats up on peak after milking
- 400L afternoon = on timer so only fills and heats up on offpeak overnight

Cost of hot water with 500L boiler

- 200L heated 18°C to 90°C = 72°C on peak = 19 kWh/ day
- 400L heated 18°C to 90°C = 72°C on off-peak = 38 kWh/ day
- Cost = 19 x 25c/ kWh + 38 x 15 c/ kWh = $ 10.45/ day

*OPTION 1 = replace with 800 L boiler*

- Saving = 19 kWh/ day moves to offpeak = saving 10c/ kWh = $ 1.9/day
- Cost = $ 6,800 (ex gst)
- Payback = 9.7 years

# OPTION 2  Heat recovery unit

## 3 x 300L = 900 L tanks:

Average 60 °C

**With HRU :** Boiler 60°C to 90°C =  30°C

Cost of hot water with HRU installed

- 200L heated 30°C on peak = 8 kWh/ day
- 400L heated 30°C on off-peak = 16 kWh/ day
- Circulating pump = 0.37kW x 5 hours =1.9kWh/day
- Cost = 8 x 25c/ kWh + 16 x 15 c/ kWh +1.9x 20c/kWh = $ 4.78 day
- Saving = $ 5.67/ day  = $ 2,070/ year

| 600 L/ day | COST | kWH | SAVING | PAYBACK |
|---|---|---|---|---|
| HRU + extra thermal storage | $ 9,000 | 12,045 | $ 2,070 | 4.3yrs |

# **Hot Water Options** Solar panels


**300 L, 400L, or custom sized**

Typically pre-heats to 60 °C.

<u>For plant 600 L/ day used</u>

*1 x 630L unit + 60 tubes + frame*

Cost $ 10,000 incl STC's rebate

Savings: similar to HRU $ 2, 070/ year

Payback 4.8 years

# Hot Water Options  Heat Pumps

## 300 L to 400 L  Heat to 60 °C

- similar to reverse cycle aircon
  - O heat from ambient air to water
- mechanical equipment
- uses electricity to operate
- energy to heat water, approx:
  - o 1/3 from electricity
  - o 2/3 from air

| For avg 600 L/ day | COST | kWh | SAVING | PAYBACK |
|---|---|---|---|---|
| 2 x 300 L | $ 11,000 | 9,322 | $ 1,771 | 6.2 yrs |

# Milk Harvesting

Variable Speed Drive (VSD) ⇨ speed of pump

**Measured benefits:** 30-60% energy savings

*(monitoring in NSW dairies)* Low noise levels

Estimated savings with VSD @ 45% $ 1220/ yr

Typically cost $8-12000 Payback 6 -10 years

**Other factors**

- ✓Minimum speeds for vane & liquid ring pumps
- ✓Longer payback for small units, short run times
- ✓Size of reserve

# Milk Harvesting

## VSD considerations

- Single phase supply require 3 phase motor replacement
- May be difficult to access set-up information if components are not of an “authorised” brand
- After market VSD may void warranty on other equipment
- New vacuum pumps may require other equipment to be upgraded also. Increased capital cost

# Milk Harvesting:  dairies in NSW

- ✓ 85% of dairies have VANE pumps;  14% have Lobe pumps
- ✓ 15% of dairies have VSD:
  - ❑ 60% of Lobe pumps have VSD

# Milk Cooling


- ✓ 9000 L + 7500 L Direct expansion
- ✓ Double bank plate cooler;
- ✓ estimated temperatures:

- water from river 6- 27 °C average 18°C
- milk entering vat (ties in with run times) 22°C

- If no plate cooler vat must cool from 36 to 4 °C
  - ➡ plate cooler saving = $ 18,250 kWh/ year
  - ➡ mixture tariffs, average 20c/ kWh = $3,650/ yr

BEST BET for plate coolers

- ✓ Use coldest water
- ✓ Water flow rate 1:3 or 1:2
- ✓ Correctly sized & number of plates

# On-farm trial to use more solar PV generated

Recently during dry period, total milk production down

- 7500L vat not required for milk
- filled with water and chilled using solar PV during the day
- Double bank plate cooler used to chill milk

Chilled water

- Cooled for 4 hours in afternoon to 4°C
- Rises to 8 °C after afternoon milking
- Rises to 14 °C after milking milking
- Cooled to 4°C in afternoon

Idea is not to reduce electricity use, but to shift to “free energy”.
But is it solar PV used or peak power? Or both?

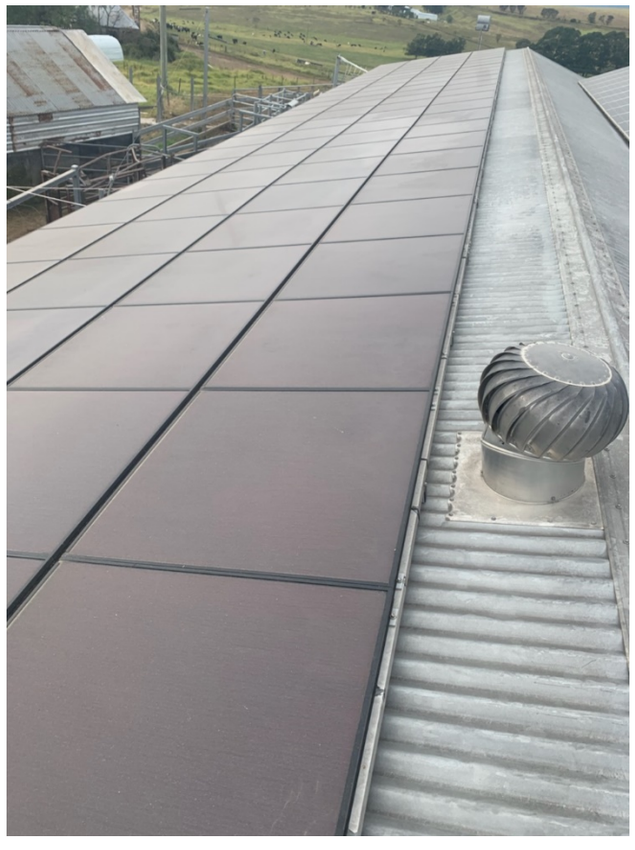
# Solar PV systems

21 panels 190W  = 4kW
monocrystalline panels
3.8 kW inverter

100 panels 60 W =  6 kW
thin film panels
total 6.1 kW inverter

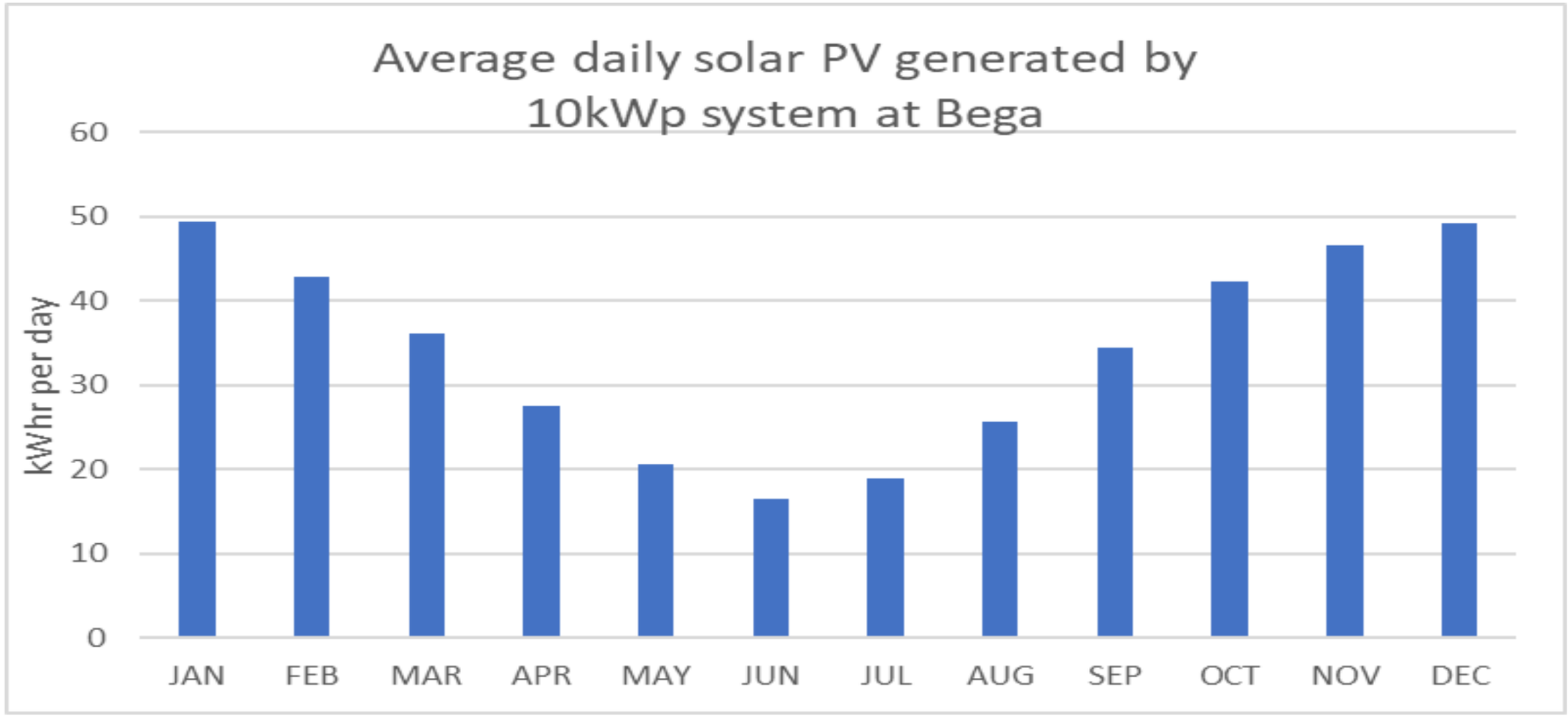
Face north

No easy to use data interface to check performance



# On-farm trial (continued)

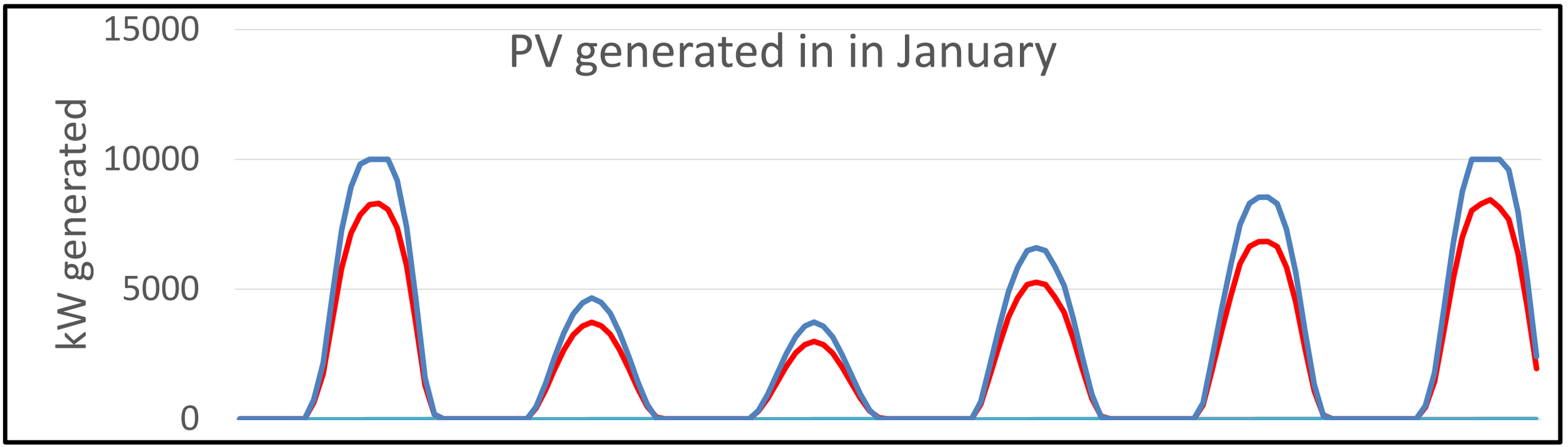
10kW system can generate an average of 12,500 kWh/ year

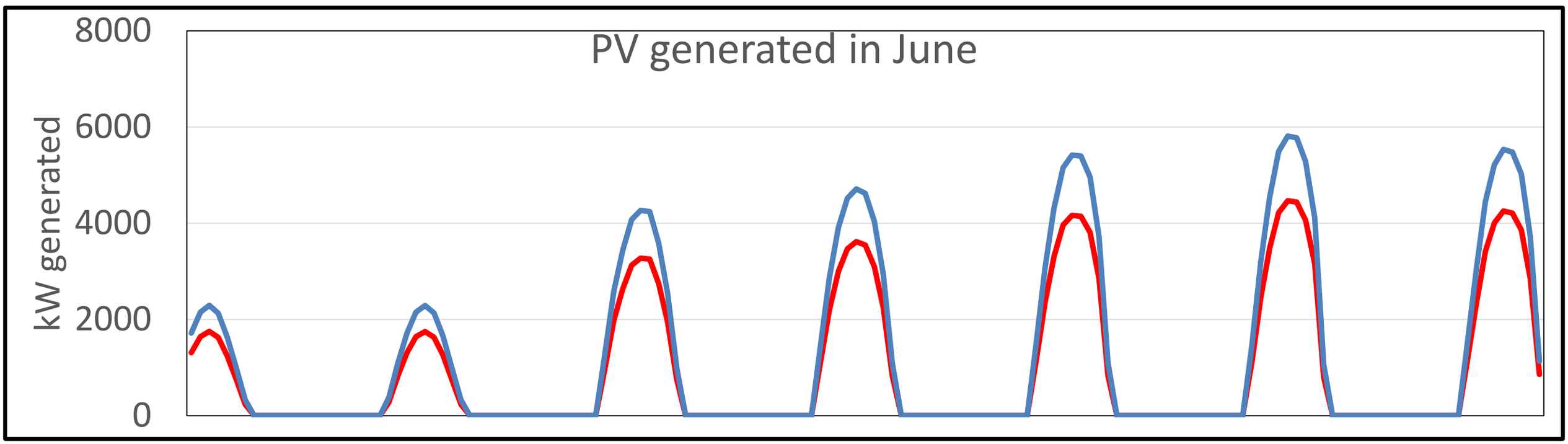



Vat compressor and fans use approx. 40 kWh in 4 hours of operation

- Daily production OK in summer, but in winter not enough will be generated in the day by PV

# Compressors and fans draw approx. 10 kW when operating



## Solar PV (no batteries)

| | |
|---|---|
| 33 kW 3 Phase | Can generate 35-40,000 kWh/ year |
| JA Panels M315 | |
| SMA inverters | $ 14,900 incl GST |
| Output restriction (if required) | $ 1,650 incl GST |

## Is it worth it?

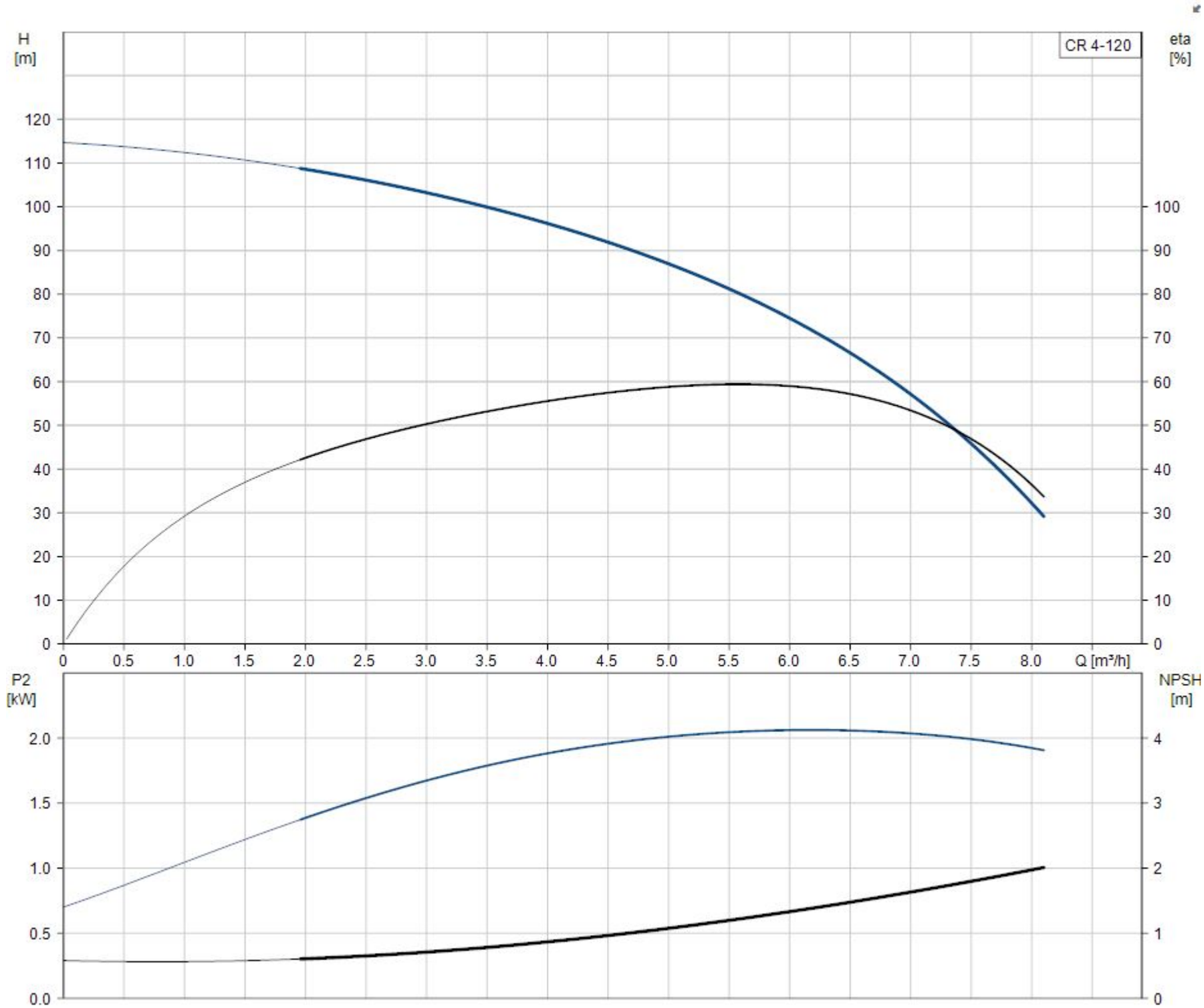
- peak power use for 5/7 days
- offpeak for 2/7 days
- Average 22c/ kWh, feed-in 8c/ kWh

| % used at dairy | 30% | 40% | 50% | 60% | 70% |
|---|---|---|---|---|---|
| Saving | 2475 | 3300 | 4125 | 4950 | 5775 |
| Feed-in | 2100 | 1800 | 1500 | 1200 | 900 |
| Total | 4575 | 5100 | 5625 | 6150 | 6675 |
| Payback | 3.3 | 2.9 | 2.6 | 2.4 | 2.2 |

# Solar PV and Battery systems

## All use JA M315 panels and SMA inverters (high quality)

| | |
|---|---|
| 6.3 kW solar PV with 8 kWh storage | $ 19,000 |
| 13.2 kW solar PV with 16 kWh storage | $ 32,900 |
| 99.8 kW solar PV with 96 kWh storage | $ 185,000 |




| FLOW RATE | FRICTION LOSS METRES per 100 METRE | |
|---|---|---|
| l/sec | 40mm 11/2" | 50mm 2" |
| 0.02 | | |
| 0.04 | | |
| 0.06 | | |
| 0.08 | | |
| 0.1 | | |
| 0.2 | 0.15 | |
| 0.3 | 0.29 | |
| 0.4 | 0.48 | 0.13 |
| 0.5 | 0.71 | 0.19 |
| 0.6 | 1 | 0.26 |
| 0.7 | 1.28 | 0.34 |
| 0.8 | 1.65 | 0.43 |
| 0.9 | 2.1 | 0.52 |
| 1 | 2.5 | 0.62 |
| 1.2 | 3.4 | 0.85 |
| 1.4 | 4.4 | 1.15 |
| 1.6 | 5.6 | 1.45 |
| 2 | 8.5 | 2.1 |
| 2.5 | 12.2 | 3.2 |
| 3.5 | 23 | 5.7 |
| 4 | 29 | 7.3 |
| 4.5 | 35 | 9 |
| 5 | 44 | 10.5 |
| 5.5 | 52 | 13.1 |
| 6 | 58 | 14.3 |
| 7 | 75 | 20 |
| 8 | | 25 |

# PUMPING

## Useful formulae

kW drawn from grid

$$= \frac{\text{VOLUME (L/ day)} \times \text{Total HEAD (m)}}{\text{hours pumped (hrs)} \times \text{pump effic (\%)} \times \text{motor effic (\%)} \times 36}$$

kWhrs/ day = kW drawn from grid x hours pumped/ day

## Effect of pump efficiency

250 cows x 200 L/ cow/ day = 50,000 L/ day

60m total head (= 650 kPa)
4.5 hours pumping / day

| Pump efficiency | kW required at pump | Motor efficiency | kW drawn | kWhr/ day | $/ kWhr | $/ year | Savings $/ year |
|---|---|---|---|---|---|---|---|
| 25% | 16.7 | 90% | 8.2 | 37.0 | 0.25 | $ 3,380 | |
| 50% | 8.3 | 90% | 4.1 | 18.5 | 0.25 | $ 1,690 | $ 1,690 |
| 75% | 5.6 | 90% | 2.7 | 12.3 | 0.25 | $ 1,127 | $ 2,253 |

# PUMPING

## Working out pump efficiency

$$\text{Pump efficiency (\%)} = \frac{\text{VOLUME (L)} \times \text{Total HEAD (m)}}{\text{kWhrs drawn from grid} \times \text{motor effic (\%)} \times 36}$$

**<u>DATA recorded on farm when pumping</u>**
(eg to fill tank of known volume)

1. **VOLUME pumped** = 22,500 L
2. **Total head** = pressure gauge at pump + estimate of suction head
   = 60m ( = 600 kPa) + 5m = 65m
3. **kWhr from meter** = 11.9 kWhr
4. **Motor efficiency** = 85 % (from name plate on motor)

**Pump efficiency** = $\frac{22{,}500 \times 65}{11.9 \times 85 \times 36}$ = **40%**