Case study Farm 1 – Dairy Farm

Summary Table

Location	[redacted]
Load size and variability	Dairy farm with milking every day from 5-7am and 2-5pm. Milk is pre-cooled using borehole water and then cooled in a refrigerated tank. Cooling during milking and for up to an hour after milking. Cattle are inside from late Nov till Feb.
Suitable roof areas	There are a range of sheds, some fairly new, others older. All have a slope of 15°, Orientations are: South facing - 10° east of south West facing - 80° west of south East facing - 80° west of north

	New Milking shed - south facing roof • Area around 42m by 10.3m but with a row of windows in the middle of the roof • Space for 15-30 kWp New Shed – west facing roof • Area – not yet completed • Possibly space for another 15 - 30 kWp Further space is available on some of the older sheds
Maximum feasible array size on roofs	There would be space for 80-100 kWp if 4 roofs were used, access for scaffolding would limit access to the other roofs.
Array sizes considered	20 kWp minimum used for calculations 40 kWp mid-size system 60kWp used as a reasonable maximum given roof sizes, and loads.
Current electricity supply	The current supply is a 2 wire HV line from a pole mounted transformer. The transformer size was increased a few years ago and the size needs checking by ENW. It may be a 50kVA split phase transformer. The closest 3 phase supply is approx. 800 away.
Network limitations on generation capacity	If the supply is a split phase system this could be problematic for generation, this requires further investigation by ENW.
Potential annual energy output	• 20 kWp system - Annual total 15837 kWh (16% of annual electricity use) • 40 kWp system - Annual total 31675 kWh (32% of annual electricity use) • 60 kWp system - Annual total 47512 kWh (53% of annual electricity use)
Preliminary cost estimates	20 kWp PV system without a battery approx. £24000 20 kWp PV system with a battery approx. £ 29000

	40 kWp PV system without a battery approx. £48000 40 kWp PV system with a battery approx. £ 56000 60 kWp PV system without a battery below £72000 60 kWp PV system with a battery below. £ 80000
Cost savings and export income. Lower end of range is with an electricity cost of 35p/kWh. Higher end is at 55p/kWh.	Without a battery • 20 kWp system - Annual total £3215 - £4800 • 40 kWp system - Annual total £4102 - £5686 • 60 kWp system - Annual total £4337 - £5477 With a battery • 20 kWp system - Annual total £5543 - £8711 • 40 kWp system - Annual total £10621 - £16639 • 60 kWp system - Annual total £15931 - £24958
Electric vehicles	The available spare capacity for EV chargers will depend on the size of the transformer which needs to be checked.

Network Upgrading Possibilities

There is a pole mounted transformer next to some of the sheds which supplies the farm, farmhouse, bungalow and BT exchange. The transformer is reported to have been replaced a few years ago with a larger one. However, the ENW records seem to be out of date as they suggest it is only a 25 kVA transformer. This will be checked by ENW when they visit the farm in January. It may in fact be a 50kVA split phase transformer. This is basically 2 x 25kVA transformers, giving the farm a split phase supply (460V) or two single phase supplies (2 x 230V).

A split phase supply could be problematic for generation, this requires further investigation from ENW. It should at a minimum be possible to install 3.68kWp on the farmhouse and another 3.68kWp on the farm as that fits within the G98 recommendations for generation that is generally permitted to be installed.

The above information is based on a preliminary discussion with ENW. The Customer Engagement team at ENW connections department offer surgery sessions in which they can look at the network to a site in a bit more detail and provide a steer of what is in the art of the possible. Once you are in a position to submit an application, they can guide you through the process and submit an offer to you in line with your needs. Contact person: Simon Taylor Simon.Taylor@enwl.co.uk

Potential Solar Generation

The results from the PVGIS tool are attached. This gives the monthly energy output from a:

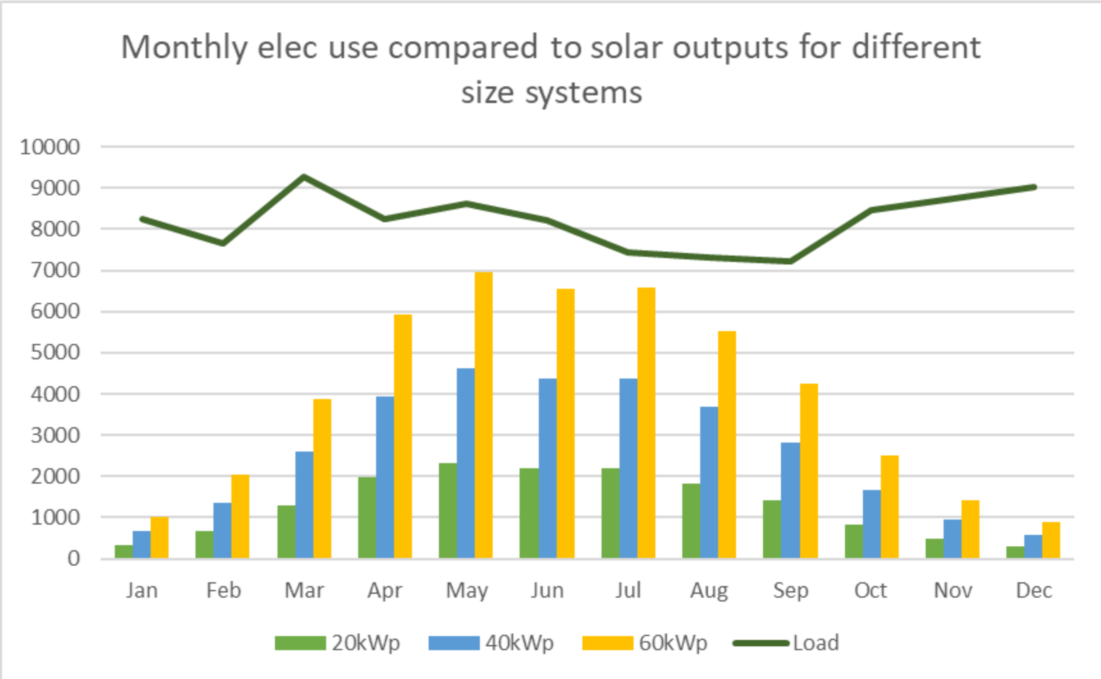
- 20kWp system 2200 kWh per month in summer dropping to around 300 kWh in December. Annual total kWh 15837 kWh. (16% of the annual electricity use)
- 40kWp system 4500 kWh per month in summer dropping to around 600 kWh in December. Annual total 31675 kWh (32% of your annual electricity use)
- 60kWp system 6600 kWh per month in summer dropping to around 900 kWh in December. Annual total 47512 kWh (53% of the annual electricity use)

Comparison of loads and Generation

The data on monthly electricity use since 2019 provided showed that the average daily energy use on the farm supply varies between 170 and 335 kWh/day, with the late summer months tending to have the lowest energy use and Nov/Dec having the highest energy use. I have used the mean monthly energy use for 2020-2022 to draw the graph below. This has monthly energy use varying from 7210 to 9250 kWh, and the annual consumption is around 98380 kWh. Energy use in 2019 was slightly lower.

The major loads identified related to milking and milk cooling all year round. There will also be lighting and possibly automatic muck scrappers in winter for indoor cattle. If a solar system was installed it would be beneficial to run any loads with flexible operating times (possibly muck scrappers) mainly in the middle of the day when solar power was most likely to be available.

The graph below compares monthly energy use with potential PV energy generation for 3 different size PV systems for each month of the year.



Options and Benefits

The smallest system (20kWp) is the green bars. Generation is consistently well below electricity consumption. However, as the main loads occur during milking at the beginning and end of the day it is possible that some of the solar energy generated in the middle of the day in summer is not required at the time and hence ends up end up being exported to the grid. In this case a small battery storage system would allow surplus energy to be stored for use during afternoon milking. It may be useful to read the meters every couple of hours (in the daytime only) for a few days (preferably in spring/ summer) to check how much electricity consumption occurs over the middle of the day. If there is minimal electricity consumption in the middle of the day adding a small battery to the solar system may be worthwhile but does add to the cost.

The mid-size system (40kWp) is the blue bars. Generation is still consistently well below consumption. However, with the main loads occurring at the beginning and end of the day it is now likely that most of the solar energy generated in the middle of the day will not be required at the time and will be exported to the grid unless it is stored in a battery storage system. So, for this mid-size system installing a battery is likely to be worthwhile. This could increase the savings by £6500 to

£11000 per year, which would need to be balanced out against the additional cost of the battery system.

The large-size system (60 kWp) is the yellow bars. Generation is approaching the level of daytime consumption from May to July, but below for the rest of the year. The solar should be able to supply the majority of the farm load in the summer if a suitably sized battery system is fitted. Without a battery system most of the solar energy generated in the middle of the day will be exported to the grid, in this case it is only worth what can be achieved with the Smart Export Guarantee (currently often about 5.6p/kWh). So, for a large system installing a battery is needed to make full use of the energy generated.

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