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Solar Photovoltaic Appraisal – Ganger Farm

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1 Introduction

1.1 Background to review

In September 2015 Local Partnerships carried out a brief high-level appraisal is to determine whether a solar photovoltaic (PV) array on the roof of a Sports Pavilion at the proposed Ganger Farm development at Romsey would present a viable outline business case. The report was presented to Test Valley District Council (TVDC).

However, the planned sports pavilion has not been finalised yet and in November 2017 TVBC asked LP to carry out a further 'check appraisal' to consider any changes since 2015 which may affect the financial viability of the proposed solar PV installation e.g. changes in the Feed-In Tariff payable and prices of solar PV technology.

To do this Local Partnerships has again reviewed planning documents available on the Test Valley Borough Council portal. These included drawings, master plan and design and access statement for the Ganger Farm development. A recheck of these indicated that none of these documents had been updated since the planning application was approved.

1.2 The proposed building and site

According to plans submitted, the Sports Pavilion is to have a floor area of 2,020 m2. It is to be in the development as shown in Figure 1 above and is oriented with the longer side running east to west. The area of the roof is approximately 992 m^2. As can be seen from the elevation drawing (Figure 2) and the artist's impression (Figure 3) the roof has a reverse pitch, i.e. slopes in towards the middle. This angle is approximately 7 degrees from the horizontal on each side.

Figure 1 - Location of sports pavilion

Whilst the orientation of the building is very compatible with the optimum positioning of a solar PV installation, there are some issues which could affect the installation. These are:

- The optimum angle for solar PV panels in the southern part of the UK is approximately 30 degrees to the horizontal reverse pitch of the roof on the south (artificial pitch) side and

the 7-degree pitch 'away' from the sun would need to be corrected by installation frames, whereas the 7-degree pitch towards the sun would need less correction.

- Figure 1 seems to indicate a 'tree line' to the eastern side and this is confirmed by Figure 2. It is anticipated that these trees represent new planting as part of the landscaping of the development and the potential full-grown height of the species chosen needs to be established. If this is above 7 metres, then the installation could be subject to shading for part of the day and this would need to be taken into consideration in output calculations over a 20-year period. The species of trees to be planted at the corners of the pavilion has been checked with TVBC and these are Betula pendula (Silver birch) 15 – 25 m and Acer campestre (Field maple) 15 – 25 m. Whilst these are to be provided as saplings, both species will grow to an estimated 15 – 25 metres in height with significant canopies. Therefore, if not positioned carefully they will present a significant shading risk. However, this could be mitigated by positioning of saplings and pruning of mature trees. No shading effect has been assumed in output calculations.

Figure 2 – Elevation drawings of new sports pavilion

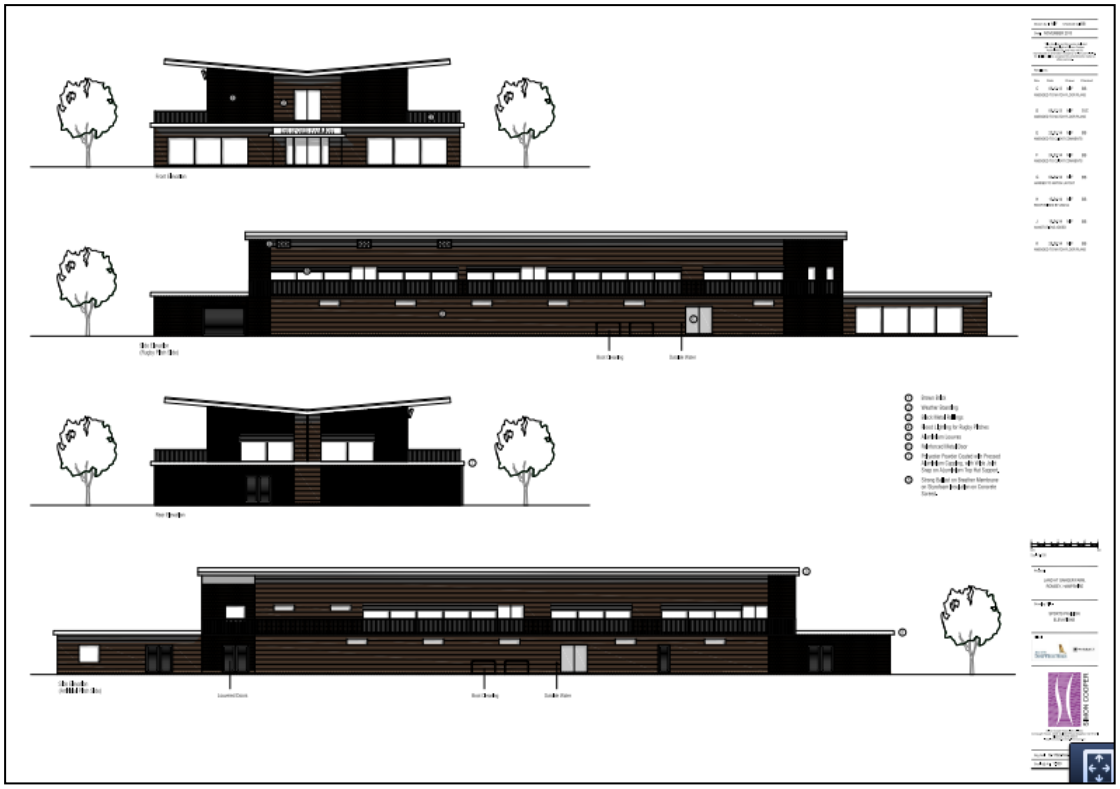


Figure 3 - Artists impression of new sports pavilion

1.3 The proposed solar array

The total area of the roof has been estimated at 992 m^2. The plans show the first floor of the building to have a floor area of 632 m^2 but the roof has substantial 'overhang' on all four sides.

A typical 'rule of thumb' is that half the available area is estimated as total potential panel area for a solar array to allow for mounting, prevention of over-shading and access. This equates to 496 m^2 giving a 'maximum' array size of around 70 – 80 kWp based on estimations of panel sizes.

However, in this appraisal solar array sizes of 49 kWp to 70 kWp have been evaluated as there is a step change downwards in the Feed-In Tariff rates offered for arrays above 50 kWp.

Note:

kWp is kilowatt peak – i.e. the maximum electrical output in kilowatts of the array

2 Assumptions for appraisal

2.1 General

The roof of the sports pavilion at the proposed Ganger Farm development presents an opportunity for installation of a solar PV generation installation with a generation output of 70 kWp.

The following have been considered in this re-appraisal:

I. The reduction in Feed-In Tariff for solar PV generation, particularly in the range 50 – 250 kWp – i.e. those applicable to the original 70 kWp proposed installation.

II. Prices of solar PV modules

III. Price of displaced grid electricity

IV. Other component and installation costs

It has been assumed that the solar PV installation will be commissioned in the period July to September 2018 and that the Feed-In Tariffs currently advertised by Ofgem will apply.

2.2 Business case

Two business cases have been evaluated as follows:

a. Base case – current 70 kWp installation

b. Reduced case – a 49 kWp installation to take advantage of higher Feed-In Tariffs

As the design of the sports pavilion is apparently unchanged then the estimate of solar photovoltaic (PV) generation is unchanged and this is presented again below.

To make an estimate of potential solar PV generation at this location the EU JRS Photovoltaic Geographical Information System (PVGIS) has been used.

This allows the location of the installation and the orientation (direction and inclination to horizontal) of the panels to be input to determine a projected input per kWp (kilowatt peak) of installed generation capacity. (1 kWp will be approximately 6 m^2 of polycrystalline silicon panels).

The inclination angle of the panels has been input at zero degrees to the horizontal to get a conservative estimate of generation from the PVGIS software. However, an inclination to optimum (30 – 40 degrees to horizontal is optimum for maximum generation in this part of the UK.

However, it is important to recognise what this would mean in practice, i.e. to utilise both north and south parts of the roof (496 m^2 each) then some degree of framework would be required to support the panels and allow air circulation to control temperature (output decreases at higher ambient temperatures). This appraisal does not consider the following

- The capacity of the planned roof structure of the pavilion to bear the extra load of a panel installation.

- The effect of a roof mounted installation on the aesthetic design of the building.

2.3 Estimated solar panel area

Solar panel area for a 70 kWp installation is estimated at 417 m^2. This appraisal also considers a 49 kWp alternative installation and this would require a panel area (excluding spacing, access, etc.) of 292 m^2.

2.4 Estimated solar module/panel costs

Solar PV modules vary widely in price according to efficiency. In the original appraisal a price of £400 per kWp was used and after a re-check of module pricing this was found to be representative of published list price for a standard efficiency PV module. Although, this price could probably be improved upon slightly with active procurement. Higher efficiencies (>19%) are available but the cost of the modules is much higher (i.e. greater than £800 per kWp).

2.5 Estimated solar module/panel costs

Inverters are a key component of a solar PV installation and published prices indicate around £225 per kW. The lifetime of the inverters has been taken as 20 years (i.e. equal to the evaluation period) as extended warranties are available for this duration. As the inverters are costed at published list price it is assumed that this price could be reduced, and an extended warranty purchased.

2.6 Estimated installation costs

This includes panel support frame and all work to install, connect and commission the solar PV installation and has been estimated as £15,000 for the 49 kWp array and £20,000 for the 70 kWp array. The estimated costs per kWp for each installation are comparable to the latest UK Government statistics collected from the Feed-In Tariff programme of £1,153 per kWp installed.

2.7 Estimated contingency

A 20% contingency has been applied to the sum of the capital costs for both installations.

2.8 Solar panel degradation of output

An annual output degradation of 0.75% (in keeping with published estimates) has been applied to the generated electricity from both installations.

2.9 Grid electricity price

The displaced grid electricity price (daytime unit rate) has been reset from the original 10.5p/kWh to 10p/kWh (reflecting price change since 2015). Assumed price inflation of 2.5% over 20 years has been used for both business cases.

2.10 Displacement of grid electricity

A projection of the use of energy in a sports pavilion has been made using the Chartered Institute of Building Services Engineers (CIBSE) Guide F (2012) published benchmarks for good practice for a 'sports ground changing facility'. These are 93 and 141 kWh/m^2.year for electricity and fossil fuel use respectively giving a projected energy use of 187,860 kWh electricity and 284,820 kWh of fossil fuel. With a projected first year solar PV power generation of 43,218 kWh and 61,740 kWh for the 49 kWp and 70 kWp arrays respectively there appears to be capacity to use all the electricity generated.

However, it is important to note that generation from a solar PV array is not flat as it obviously varies on a diurnal and seasonal basis. For example, peak generation could be a summertime weekday at midday when the facilities have low usage. This could be offset using some form of energy storage. Considering that there appear, from the published plans, to be 58 showers and at least 24 sinks. This, together with the kitchen facilities means that at peak use there is probably a substantial hot water load – which means that solar PV generated electricity could be used to power an immersion heater in a well-insulated storage tank.

However, it may be that hot water storage is not sufficient to align generation and use of energy. For this reason, it has been assumed that only 80% of the 43,218 kWh generated by the 49 kWp solar PV array and 75% of the 61,740 kWh generated by the 70 kWp array is capable of being used and the rest needs to be exported.

It should be noted that the capacity to export (even small amounts) electricity to the grid should be checked with the distribution network operator (DNO) Scottish and Southern Electricity Networks.

The export assumptions have been incorporated into the business case.

2.11 Maintenance of array

Maintenance of the array will be relatively low cost, i.e. simple panel cleaning (similar in skill level required to window cleaning) and say a bi-annual electrical system check by a technician. A level base cost of £350 per year has been assumed and inflated at 2.5%.

3 Summary

3.1 Cost benefit of the evaluated solar PV arrays

Table 1 below presents the evaluation of the two solar arrays. Although the larger array is supported by a substantially reduced solar PV Feed-In Tariff (FIT), the displaced grid electricity (at daytime unit rate) largely compensates for this. However, the larger array has a slightly longer simple payback period of 12 years over the business case as opposed to 11 years for the smaller array.

Table 1 - Year 1 business case analysis

	49 kWp	70 kWp
Approximate area per kWp (m^2)	5.95	5.95
Estimated potential generation capacity (kWp)	83	83
Installed generation capacity (kWp)	49	70
Estimated generation (kWh/kWp/year)	882	882
Esimated annual generation (kWh)	43,218	61,740
FiT Generation tariff (p/kWh)	4.01	1.72
Displacement (day rate) (p/kWh)	10.0	10.0
FiT Export tariff	5.03	5.03
FiT - Generation income	£ 1,733	£ 1,062
Displacement factor (weekdays/weekends)	1.00	1.00
Displacement (kWh/year)	34,574	46,305
Value of displaced electricity	£ 3,457	£ 4,631
Export (kWh)	8,644	15,435
FiT - Value of exported electricity	£ 435	£ 776
Maintenance	£ 350	£ 350
Netl income	**£ 5,275**	**£ 6,119**
Estimated capital cost		
Typical panel price	£ 400	400
Estimated cost of PV panels	£ 19,600	£ 28,000
Estimated cost of inverters	£ 11,042	£ 15,459
Estimated installation cost	£ 15,000	£ 20,000
Contingency (20%)	£ 9,208	£ 12,772
Total capital investment	**£ 54,851**	**£ 76,231**
Total installed cost per kWp	**£ 1,119**	**£ 1,089**
Estimated simple payback period	10.4	12.5
Energy savings (kWh/year) - 1st year	34,574	46,305
Annual benefit - 1st year	£ 5,275	£ 6,119
Total benefit (over 20 years)	£ 58,405	£ 58,636

A business case over 20 years has also been calculated and this is presented as a separate spreadsheet (as format does not allow clarity of presentation in an A4 format report) indicating an internal rate of return (IRR) of 8% and 6% for the 49 kWp and 70 kWp respectively. Projected cash flows are shown in Figures 4 and 5.

Figure 4 - Cash flow - 49 kWp installation

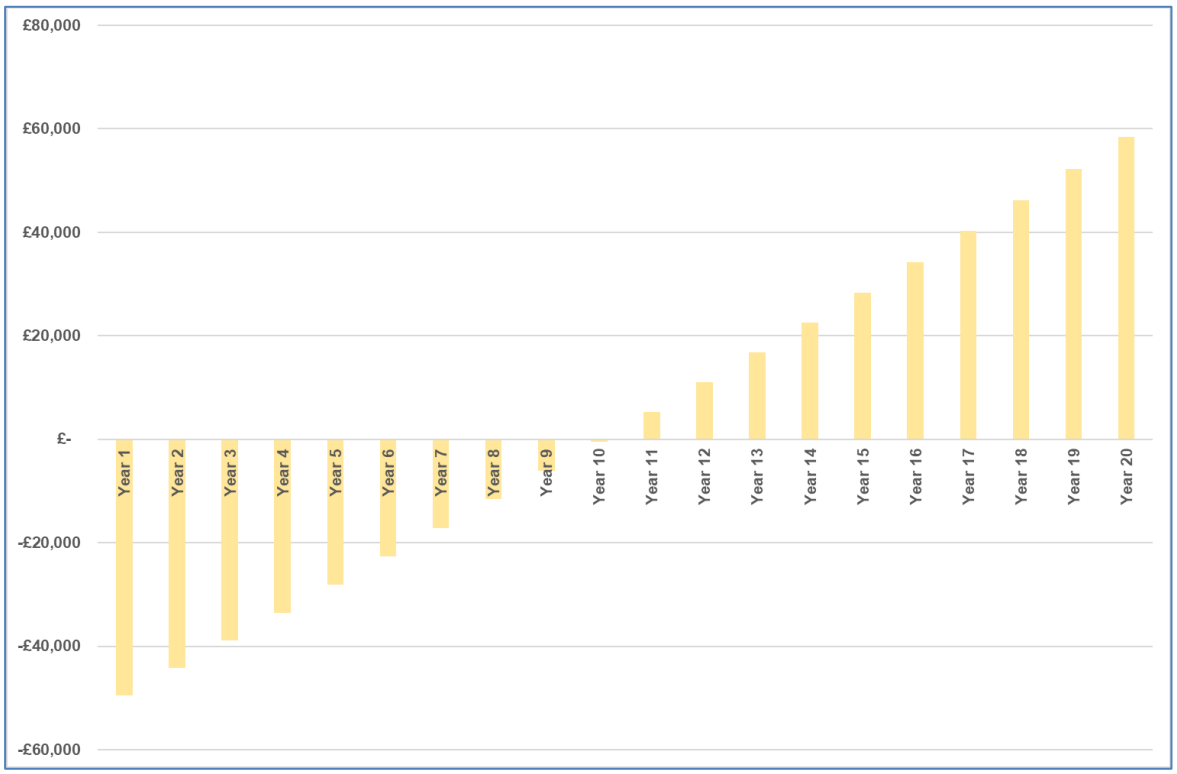
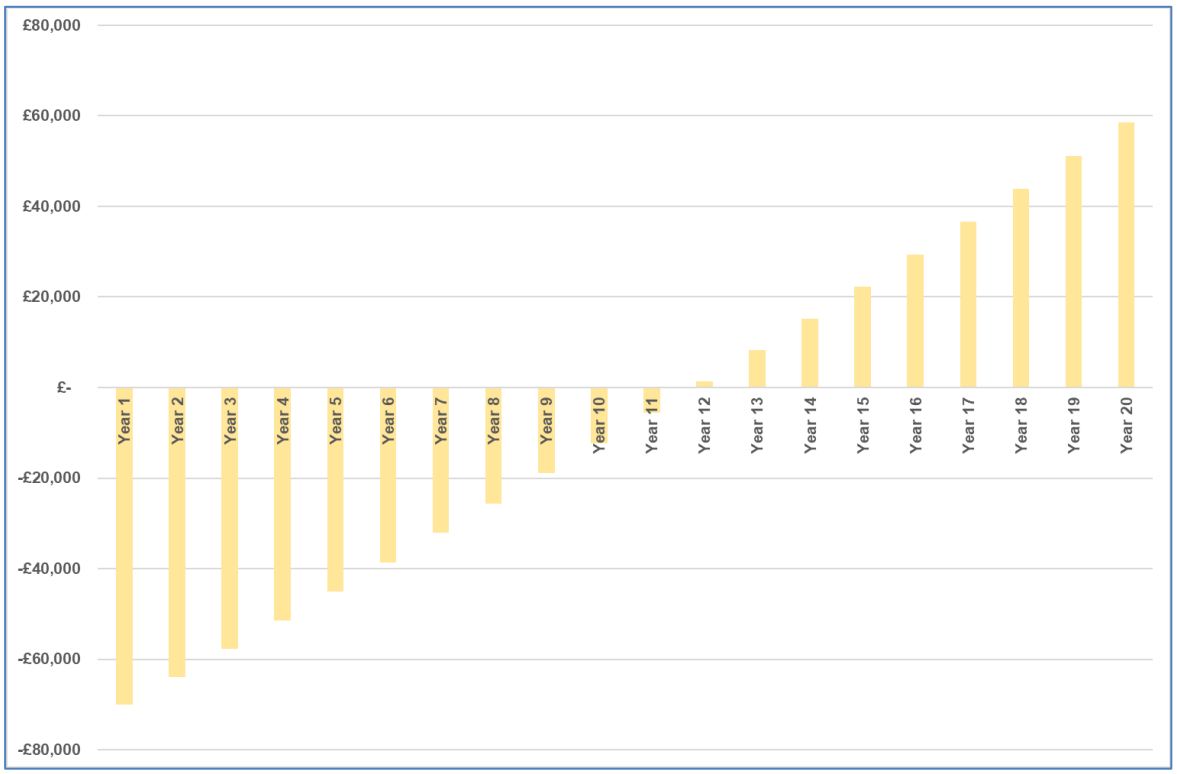


Figure 5 - Cash flow - 70 kWp installation



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