East Hanningfield Village Hall

Solar Panel Project

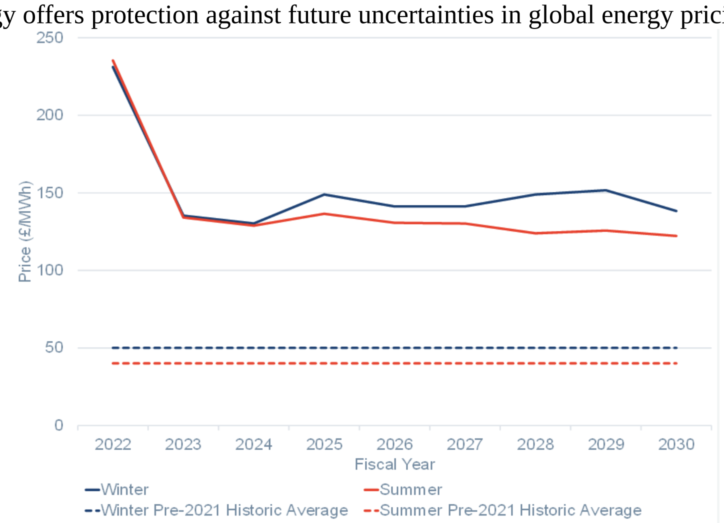
A PROJECT TO INSTALL SOLAR PHOTO VOLTAIC (PV) PANELS ON THE VILLAGE HALL ROOF

The purpose of this document is to describe the process the Charity Trustee management committee went through in installing a Solar Panel system in our Village Hall. There is no right and wrong way with going about making decisions for installing a Solar Panel system.
Each hall's circumstances will be different. This is what we did for our Village Hall. In explaining our approach, we hope it may be useful to other Village Halls considering solar panels and we are happy to share our experience here.

The rising cost of energy

The Charity has been aware of the rising cost of energy since the Hall was built more that 30 years ago. It has prompted regular changes to improve insulation and move to more energy efficient devices. The urgent need to go further became apparent in early 2021.

The Hall is 100% reliant on electricity for all heating, hot water and lighting and although the Charity had a fixed price 3-year supply contract SSE it was clear rising energy prices represented a threat to the future viability the Village Hall and its' community Shop/Post Office once the current contract expires on 1st May 2024.
The Cornwall Insight Institute provides energy market intelligence and analysis for global energy prices. Although energy prices have fallen recently, they are still twice what they were in 2021 and no guarantee they will not rise in future given recent turmoil in the Middle East. Solar Energy offers protection against future uncertainties in global energy pricing.



The impact of rising energy costs

In 2022, our energy bill was nearly £6,000 / annually, within an overall expenditure of approximately £30,000 for operating the Hall. This meant that electricity accounted for about 20% of our running costs, our largest expense after caretaker and maintenance fees.
Furthermore, with the ending of the present 3-year energy contract with SSE in May 2024, the energy bill was likely to double. Such a significant rise in energy costs was unsustainable. It would necessitate a 20% increase in hall hire and shop rents, or significant cuts in services. This was the trigger in November 2022 to investigate Solar Panels.

How to reduce energy costs?

As a first step in 2022 we explored areas for energy efficiency savings. We pinpointed areas where energy consumption was highest, and with the assistance of Utility Aid energy consultants we conducted a " building energy survey" to assess potential improvements to reduce our energy consumption. A key focus was was whether further enhancing building insulation was possible. Cost-effective measures to minimize heat loss and energy wastage in buildings should always be first consideration before implementing more advanced energy management strategies!

Our survey identified several potential improvement areas, along with estimates of cost savings associated with each measure. We carefully evaluated these options. We considered the nature of our building's construction, usage patterns, and also significant past energy conservation efforts (such as installing new double-glazed windows/doors, enhancing wall and ceiling insulation, and transitioning to LED lighting). We determined further improvements in this direction would only yield limited energy cost savings.

The analysis highlighted space heating as the major expense, prompting us to explore alternative energy sources like gas (too far from a gas-main but also not very carbon neutral) and renewable energy recommendations from the survey, particularly using solar power to generate free electricity from sunlight (worth further enquiry)
The Village Hall has a large East/West-facing roof and installing solar panels would be comparatively easy. Based on initial projections with a Solar Panel system Installer, we realised we could generate approximately in the order 45 kW per side. Calculations indicated that, with a favourable export rate for surplus energy, the solar installation could potentially achieve a Return On Investment (ROI) in approximately five years (we thought a time frame of better than 10 years for the Village Hall payback time would be acceptable).

In fact with a large enough system on the roof, and factoring out grant funding, the Return on our Investment (ROI) calculations, showed the ROI could be less than 5 years.

Factors we considered

Before investigating Solar Panels and the economics we identified there were five important things questions to be answered:

a) The Hall's actual **Energy Consumption** (a "Smart" meter-based profile over time of Hall energy use - a year's worth is essential for future energy saving projections)
b) The **Roof Suitability** (dimensions, angle, orientation, shading and allowable weight loading)
c) The **Size** of **System** needed (basically how big a system do you need - the more panels the more energy generated but obvious constraints are cost and roof space available!)
d) The **Affordability** (the system cost, mainly determined by system size and where will funding it come from)
e) **Energy Export Limit**, the amount of energy the Hall site will be allowed to export to the grid by your local Distribution Network Operator (important if you expect to sell your surplus energy and there are limits set by the local DNO).

What is a solar voltaic system?

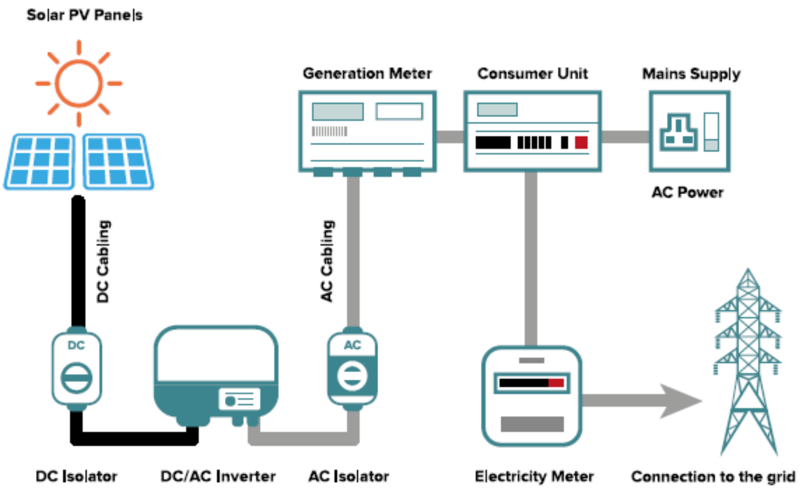
If you've decided to investigate a solar panel system you will need to talk to a contractor that installs systems so it's worth understanding a bit about a solar photovoltaic panel system includes:

Solar panels – these convert sunlight into Direct Current or DC electricity. There are quality differences in terms of long-term production but the real difference is small. In 15-20 years, panel tech will have moved on and it will make good financial sense to upgrade. Consider this a small item

Inverter – this converts the DC electricity from the solar panels into Alternating Current or AC electricity which can be used in the home. The key for us is long warranty, 20 years

Isolators – these are switches which can be turned off to allow an electrician to safely work on the system.

Generation meter – this records the amount of electricity generated by the solar PV system. A SMRTS2 Smart meter will automatically send meter readings back to the utility provider for imported and exported energy.



Battery

The diagram does not show a battery. While batteries can store excess solar energy for use during periods of low sunlight or at night, and therefore intuitively may seem a good idea, they add significantly to the overall system cost and are they are a lifelong item ?(a battery may only have a lifespan of about 10 years so will need to be replaced periodically). This cost therefore can be as high as, or higher than, buying electricity from the grid and the financial savings of adding a battery to the system outweighed when cost of battery replacements over the system's lifespan is considered.

Without a battery, excess solar energy can be fed back into the grid and the Hall owner receives as a credit on their energy bill. This for us makes more sense economically at present (unless grant funding can cover the cost of battery so its free in terms of an ROI).
Suffice to say after doing the sums, we decided not to have a battery in the design but instead to be paid credits for exporting surplus energy to the grid.

Solar PV Panel Design - String Vs Optimised Panel Connection

In the solar system diagram, there are shown two solar panels but in reality, there will be many more of course. These panels are connected in "strings". It is worth understanding a bit about the system design here when talking to the solar panel contractor because decisions here can impact system performance in service. In traditional string design, multiple panels are connected in a series, meaning that if one panel experiences a reduction in performance, such as due to shade or a fault, the entire string's power output is limited to that of the lowest-performing panel.

On the other hand, in an Optimised system (using Micro Inverters on each panel), each panel adjusts its production independently. This means that if one panel is not functioning correctly, only that specific panel's output will be affected, while the other panels continue to produce power as expected. This design simplifies the process of identifying and addressing faulty panels, thanks to the granularity provided by Micro Inverters.

One advantage of the Optimised system is that it requires minimal ongoing support beyond monitoring production. The system itself can automatically detect and report any faults to the equipment provider. Under warranty, the equipment provider should be responsible for providing a fix for any issues (except for panels themselves, which are typically covered separately by manufacturer's warranty).

With the system we decided upon if a Solar Panel fails the system will identify the failure down to one of two panels.

Metering Energy

To be able to compare savings with a solar system once installed your System Installer will need to know your energy consumption for the building over time before the changes. It might be as simple as reading your energy bills and number of units consumed over a year but to really understand consumption over time needs a **Smart Meter** on the building's incoming grid supply (fortunately we had got one installed on this Hall).
The Smart meter will provide half-hourly usage data. A solar system installer will ask for this to provide projections to you for energy used against saving over time.

To export energy and receive credit payments for this from an energy provider you will need a **2nd Generation Smart meter** (a "SMETS 2" meter) installed - if exporting your energy, the company purchasing the energy will want to check this.

The Village Hall Roof

Roof construction, size orientation and angle are important for determining whether solar panels are suitable. In our case this Hall with roof angle at about 20 degrees and facing east and west was suitable for solar energy generation. Shading from trees on east side meant the west facing roof is preferred here).

We decided, after some debate, to include in the specification, bird nesting protection around the roof solar panels and to stop squirrels attacking cables.

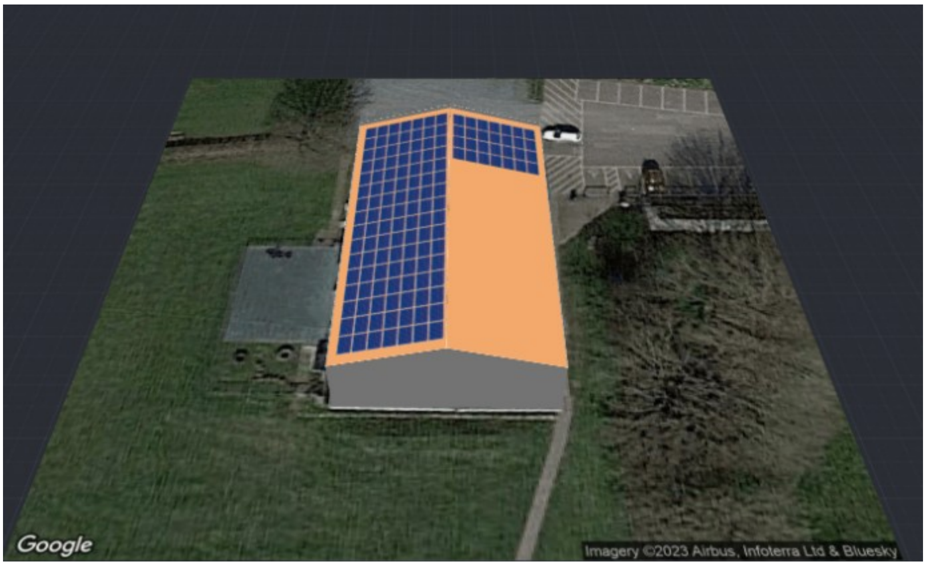
We asked the Solar Panel installers for evidence that the roof loading was within the roof design's loading tolerance and checked with our Hall insurers about fire risk cover.

Solar panel system sizing

The maximum system size achievable will always be determined by how many panels you can fit on the roof and how much sun they are exposed to daily throughout the year. Obviously this exposure will change over 24 hours, month to month and year to year.

Ideally you want to generate as much (free) energy from solar as you can to cover what you use, rather than using energy from the national grid but the profile of energy generated from solar probably will not match the profile of energy use in your building as we discovered. There will be times when you have a surplus and want to store or export this and times when you are forced to use the grid supply when there is no sun. You must decide how you want to manage this.
We knew from looking at our Hall use profile that for a lot of the time we could not match energy being generated from sun against when energy was needed in the Hall by hirers. Our Hall energy consumption profile is not a steady load – it increases in winter, falling away in the summer. We calculated typical energy consumption over a year.
We decided we needed at least this much energy from solar if we were to significantly impact our energy bills. We decided on a large system (by domestic house standards of typically 10 or 12 panels). I n fact we have decided on 140 panels, which more or less fill the west roof and with another 24 to catch morning sun on the East Roof. We decided the surplus we generate will offset the cost of energy consumed from the grid when there is no solar energy.

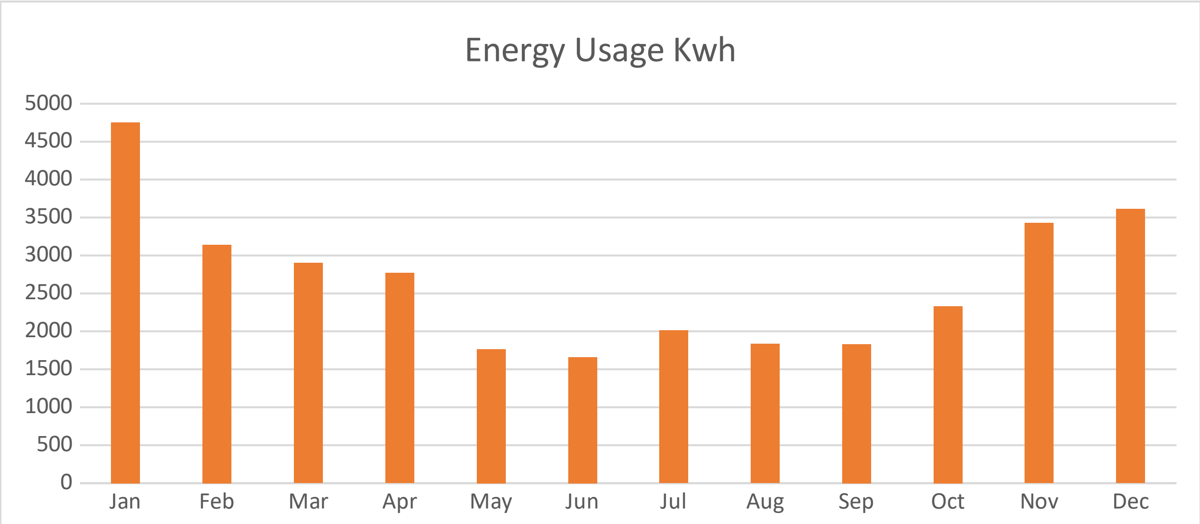
In the end though this calculation of system size is a judgement, with system affordability and available roof also having to be considered. You probably will not be able to entirely cover the cost of energy from the grid by installing solar energy because of the capital cost, roof size or other factors but it is a good aiming point.



A key consideration was whether a battery was needed, and if surplus energy is exported, what payment would we receive for it, set by a Smart Export Guarantee (SEG).
Energy providers are offering different rates for their import and export tariffs and it depends on your contracted Utility provider. Some rates for exported energy are as low as 5p/KWh! You have to shop around.
We evaluated Scottish Power and Octopus import and export rates and decided for our import and surplus export predictions Octopus offered the best solution for us but Octopus require a quarter's energy bill up front as a returnable deposit.
(Octopus Energy Quotes - April 2024: Export 15p per kilowatt-hour (KWh)/Import 19p/KWh).

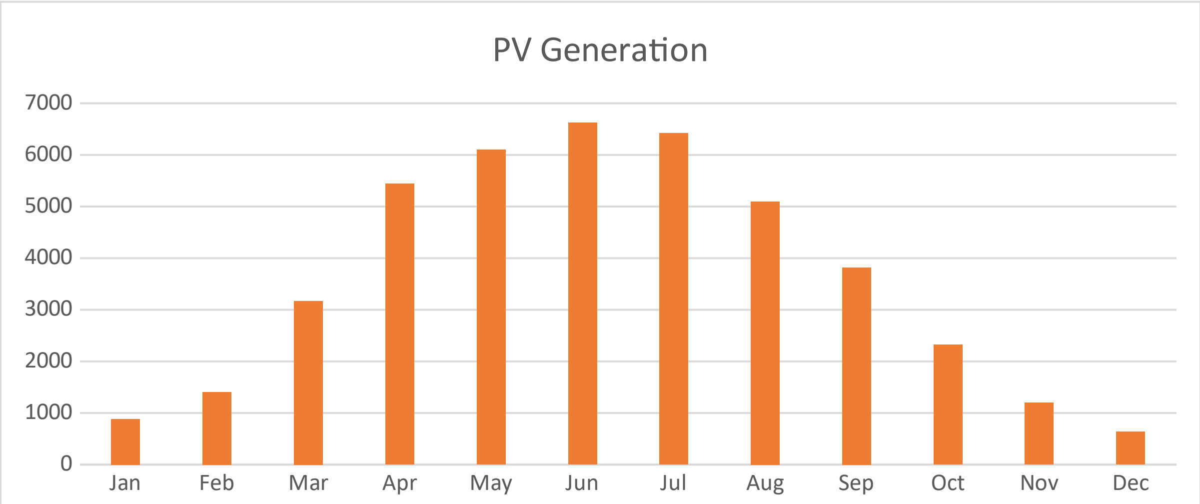
Energy usage

Probably, like most village halls, we have an unpredictable usage pattern and as you can see from the usage graph we use more energy in winter than in summer.



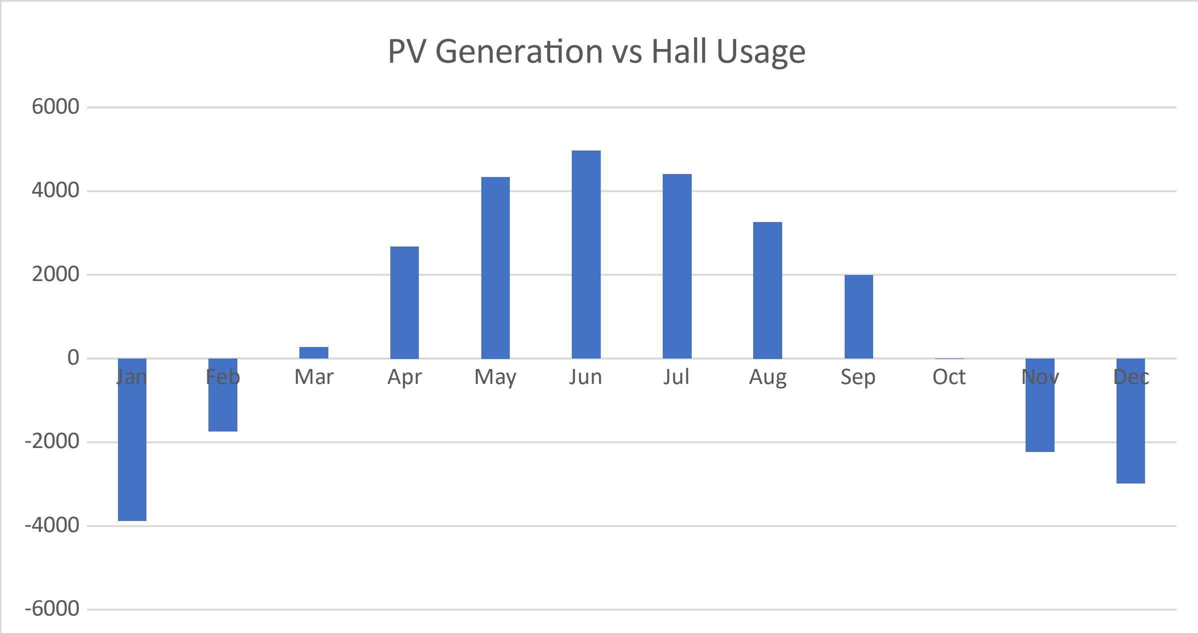
Solar Panel Generation

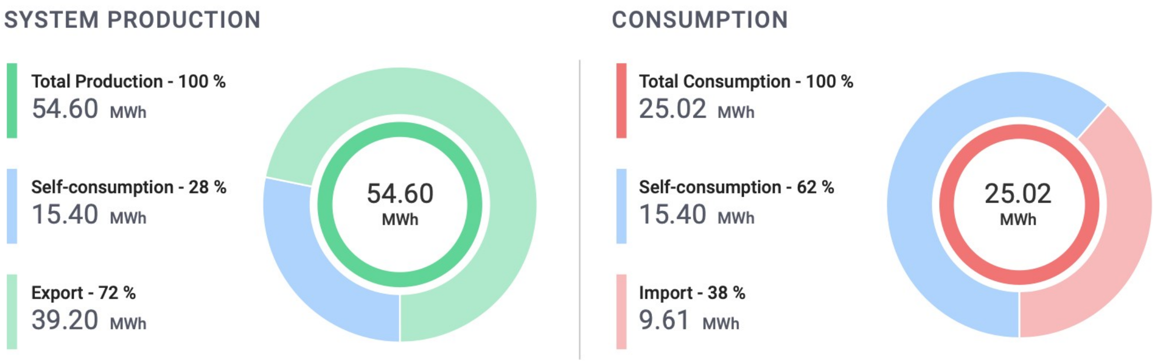
As we know solar generates more in the summer than the winter, based on EU standards we have this generation profile



Balancing

As you can see, we will always generate more in summer than needed, but we also have a time-of-day issue. Our system will not always generate at the times we need the electricity, but good data combined with a good Solar Estimating tool, will generate your usage pattern based on your half hour data (SMART2 meter needed) creating your own self consumption percentage.
In our case we based our ROI model on a conservative 20% as you have to buy off the grid what you cannot generate (and we wanted to be safe in our ROI model assumptions). In fact our initial operation suggests performance is much better than 20%.





Project costs

Typical costs for a system vary depending on a variety of factors (mostly system size, but also whether changes are needed to an existing power board to connect a solar system (the size of a battery if one is wanted), a roof structural analysis (and physical changes needed for a roof perhaps), installation scaffolding, the quality grading of selected solar system parts, the need to fit bird protection, and ,of course, the supplier's profit margin.

We went out to four local (Essex) contractors specialising in Solar Panel systems for our size of building (rather than domestic market) and asked for cost estimates and projections of annual energy savings, and over the system life, for our Hall energy usage, using the estimates to decide what we could afford.

Prices varied as the design requirement change. As an example, a quote for the proposed system with 50kW output, 140 Solar Panels system on our Village Hall's roof was in the order of £40,000 (without Vat) .

Solar Panel System Installer Quotations

On the back of making grant applications which require supporting system cost estimates, we went out to three companies with a specification for competitive quotes for supply and installation of complete system.

Solar System Component Manufacturers

We found Solar Panel system installer will probably work with a number of Solar System component providers. Without a battery a Solar Panel System is essentially the PV roof panels and Optimisers connecting them to the Inverter and Control Circuit.
In our case we wanted proven products with a good reputation and warranty. With our system installers we identified two competent providers we considered met the standard we wanted. For the Optimisers and Inverter and Control Circuit these companies were SolarEdge and SMA. These companies do not manufacture solar panels themselves.
In the end the decision between Solar Edge and SMA was driven by stock availability and we selected SolarEdge.
https://solarfast.co.uk/blog/best-rated-solar-inverters/

With our Solar Panel system installer we chose a know supplier for the solar panels themselves.

After evaluation we down-selected the two contractors that we offering the best value for money and that met our specification to provide a "best and final" quote. After working with the bidders we selected 50Kw SolarEdge system installed complete for £42,000 (no Vat).

Intent To Purchase Order / DNO Licence /MCS Certificate
These are considerations that come to the fore as you come to the end of deciding what system to install and the selection of a supplier.

There are important restrictions you must be aware of on who can export what energy onto the National Grid network (for residential properties installing smaller systems there is no licence requirement but with larger systems there are).

With a system of around 50kW as installed at our Village Hall it cannot be connected to the National Grid without a District Network Operator (DNO) licence.
The system installer is required to apply for a licence from the District Network Operator for your national grid area to connect the new system. The DNO for the Southeast and East Anglia is UK Power Networks.

If you intend ,like us, to maximise your roof to generate income to balance usage, understanding any DNO constraint with the Solar Panel Installer at the start of your project to prevent problems is essential (in some areas exporting is limited as the grid cannot cope). Check with your Installer and the DNO. If an unrestricted export licence was not granted by the DNO, the economic argument for installing solar panels in our case would have been severely dented (we would then be forced to put all the surplus solar energy into batteries) and it would probably mean a rethink for system size and or battery decisions.
Since the Installer must apply for the DNO approval we made our Purchase Order an "intent" only and subject to the contractor obtaining a DNO licence.

For a system to be connected to the national grid the contractor installing the system must also be MCS qualified and provide an MCS certificate (system under 50Kw) as proof that the installation has been designed, installed & commissioned to the required standard using only MCS certified products. We will therefore hold payment back to supplier until a system MCS is provided and warranties agreed. Even if you system is over 50Kw ask for MSC certificate

Warranty

A typical Solar Panel system consists of two main components: photovoltaic (PV) panels and inverters. PV panels are usually of good quality and come with long-term warranties, often exceeding 20 years as a standard. PV panels tend to be quite reliable (there is not much inside to go wrong and they are not under stress). In the case of a single panel malfunction, it is generally not cost-effective to send it back to the manufacturer for testing and replacement. Considering that individual PV panels can be acquired for under £200; it makes more financial sense to remove the faulty panel and replace it, resulting in a straightforward and economical solution at a cost of around £500.

The warranty provided with PV panels becomes crucial if there is a batch manufacturing defect, though such instances are rare. In the experience of our solar installers, such issues have occurred only rarely, and in that case, the PV provider covered the costs for replacing an entire roof's worth of PV panels (approximately 50 in total).

In contrast, Inverters which convert Direct Current output of panels to Alternating Current, for use in the building are made up electronic components, and come with a higher price tag, typically around £3,000.
Quality inverters generally have a lifespan of around 10 years and some reputable companies offer warranty for inverters of 10 years and extensions, allowing them to be covered for up to 20 years. For instance, the SolarEdge manufacturer of inverters offers a warranty extension at a cost of £230. Peace of mind and added protection for your PV system's inverter may be worth considering.

Project funding

Our Project funding breakdown:
We found specific solar panel funding hard to find but looking for capital project improvement funding was easier. We are grateful to the following organisations for their generous support:

- ACRE (Queen's Platinum Jubilee VH Fund); £8,000
- Tom Amos Charity: £5,000
- Chelmsford City Council ("Greener Chelmsford"); £4,000
- EH Parish Council: £6,000
- J Gard's Centenary Fund: £5,000
- EH Women's Institute: £10,000
- Hanna's Field Charity Fund Raising: £5,000

Return on investment (ROI)

Before we started the project, we wanted to understand what our Return on Investment would be so we made a number assumption and created a ROI spreadsheet calculator with extremes of energy import and export values. We assumed a 30% self-consumption (ie we use 30% of energy generated).

Total Electricity

	KWh	Cost Pence/KWh	Cost
Solar Generated	15,000	0.15	£2,250
Imported from Grid	9,610	0.19	£-1825
Unused Exported	39,200	0.15	£5880
		Net Income	£6,304

Note: the above is a simplified version of the ROI calculator we used in this project

Excluding grants, the Village Hall invested £20,000 into the project, so against this the figures above show an ROI of just over 3 years (and beyond this over a total life of 25 years an income of £138,000) assuming the export value of 15p/KWh were to remain unchanged.

Over the span of 20 year estimated life of a solar panel system, we estimated we could generate electricity at 2p per kilowatt-hour (kWh) compared to an import cost of 30p per kWh in early 2023, providing substantial long-term savings and financial benefits for the Hall and Shop through embracing solar energy.

Project timescales

- Project Planning Start: Nov 2022
- Initial Quotes in support of Grant applications: Apr 2023
- Grant Applications: Apr 2023 onwards
- Best & Final Quote: Sep 2023
- Purchase Order: Nov 2023
- Final Funding Place: Feb 2024 (Vat Notice change)
- System Installed: Mar 2024
- System Open Day: April 20th 2024
- Octopus Energy Contract Start: May1st 2024

Conclusions

We hope to significantly reduce our energy costs and help the environment by reducing our carbon footprint.

- By combining basic energy efficiency measures with renewable energy, we will not only be addressing the electricity cost issue but also contributing to a more sustainable future for the Hall and the environment.
- By keeping our hall and community shop viable we will be able to continue supporting the rural community we live in and allow them to Hall facilities and services (rather than being forced to travel outside the parish for them).
- We expect to have a return on our investment in less than 5 years and to reduce our energy cost to approaching zero based on initial results.
- With the energy savings we achieve we will be able to keep our Hall hire charges and shop rent affordable, allowing us to put funds into expanding the hall activities and facilities we provide for the community.
- By setting an example to the local community in “going green” we hope to inspire more residents to also install renewable energy solutions in their own homes and help us all towards achieving the country’s goal of net zero carbon emissions in future.

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