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Delivering, unlocking & advancing the low-carbon economy

Solar PV

CASE STUDY	
Business Type:	Factory
Location:	Middlesborough
Measure	98.25kWp, made up from 262 x 375Wp solar modules, with 67% self consumption
Orientation	Azimuth +76°, with a tilt of 9° on pitched roof
Installed cost:	£86,687
Simple payback period:	9 years

ANNUAL SAVINGS	
Electricity:	88,550kWh
Cost:	£9,654
Carbon:	26.3tCO_2e
Lifetime years	25

WHAT IS SOLAR PV?

Solar PV systems generate electricity whenever there is light shining on them. The sunnier it is, the more they generate. The electricity that is generated reduces the amount of electricity you have to buy. If you've got a big solar PV system, you'll sometimes generate more than you're using and some electricity will be exported to the grid and used by other nearby buildings.

WHY SHOULD I GET SOLAR PV?

With a solar PV system, you'll save money by making your own electricity, instead of having to buy it, and you can also get a small payment for any electricity that you export. Your greenhouse gas emissions will be reduced because you will be consuming less electricity from the grid.

WHAT PARTS DOES A SOLAR PV SYSTEM HAVE?

MODULES AND CELLS

The panels in Solar PV systems are called solar modules. Solar modules consist of a number of solar cells which look like dark blue of black squares. A typical solar module be about 2.0m x 1.0m.

Solar cell

Solar module

Solar array

ARRAYS AND INVERTERS

Solar cells generate direct current (DC) electricity which must be converted using an inverter into alternating current (AC) for use within a building. A number of modules are connected together in a series string to form a solar array. The AC power from the output of the inverter is normally connected to the building's electrical supply at a convenient distribution board. For larger systems, the connection can be made directly into a switch panel close to the incoming supply.

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SYSTEM SIZE AND EFFICIENCY

The rating of a solar module is described by its power output (measured in Watts) when the module has a specific intensity and quality of light shining on it. These are known as **Standard Test Conditions (STC).**

For a solar module with a rating of 450W, it will produce 450W of power under STC. These are ideal conditions for solar panels to run in, which are similar to a clear, bright, sunny day. If you have ten 450W modules, you will have an array with an output of around 4,500Wp (or 4.5kWp). The "p" suffix means peak; another way of referring to the output under STC.

Solar Module Efficiency measures how large the module needs to be to produce a specific electrical output. At STC, a typical solar module with an efficiency of 20% can generate about 200W of DC electrical power for every square metre of module area. 20% seems low, but it comes from a free and inexhaustible fuel source (the Sun).

There are many different techniques used by solar module manufacturers to improve module efficiency and you'll often see acronyms and phrases like PERC, HIT, n-type, PID-free. Installers tend to stick to one or two trusted brands and solar module types so it's not usually necessary to learn about all of the different module technologies. Decerna are experts in this area and can provide independent advice.

CAN I PUT PV ON ANY BUILDING?

Most buildings with a good sized unshaded roof should be suitable. However, there are a few things that you need to be aware of.

- Check with your local authority to find out if you're likely to need planning permission.
- Not all buildings are strong enough to support the extra weight and wind loading from adding solar PV. A structural engineer will need to check this before work starts. Sometimes this is taken care of by the installer.
- Think about how the system could be accessed in future if any maintenance was required. Some buildings have safety handrails or fixed fall-arrest safety wires that operatives can clip onto. If a planning application is required, this type of information is normally included within a Design and Access Statement.
- There may be issues with the electricity distribution network (i.e. the local power grid) that could make it uneconomic to install a solar PV system. If your building has a 3 phase electrical power supply, you can install a solar PV system up to 11kWp without needing permission from your Distribution Network Operator (DNO). For bigger systems, an application under the G99 Engineering Recommendations is required and this can be a lengthy process.

ROOF TYPES

SLOPING ROOFS

If your building has a southerly facing sloping roof, it's usually possible to install solar PV on it using a range of proprietary fixing systems. Fixing systems are available for all most kinds of roofs including traditional slate, tiled, profiled steel roofs and aluminium standing seam roofs.

STANDING SEAM CLAMP FOR ALUMINIUM ROOFS

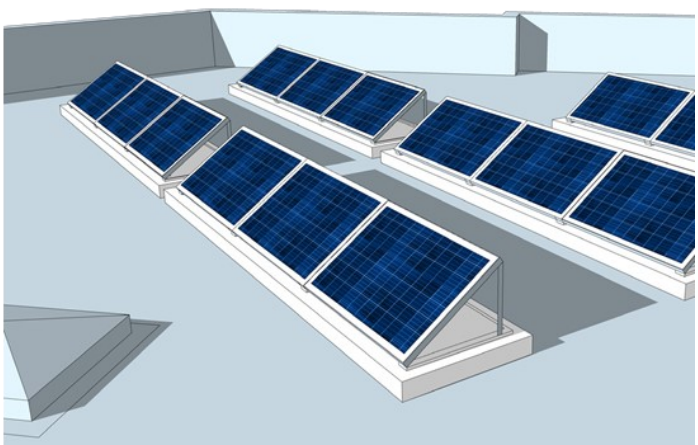
TYPICAL ROOF MOUNTING SYSTEM

FLAT ROOFS

If you're installing solar PV on a flat roof you have to put the solar panels at an angle so that they can capture more energy. It also helps to keep dust off them as the rain washes it away. There are a lot of different ways to mount them panels on a flat roof but it's quite common to have A-frames held down with ballast weights. A structural engineer will need to calculate the wind loading to make sure the system stays put during stormy conditions.

FLAT ROOF WITH A-FRAME SOLAR

A-FRAMES FIXED TO CONCRETE PLINTHS



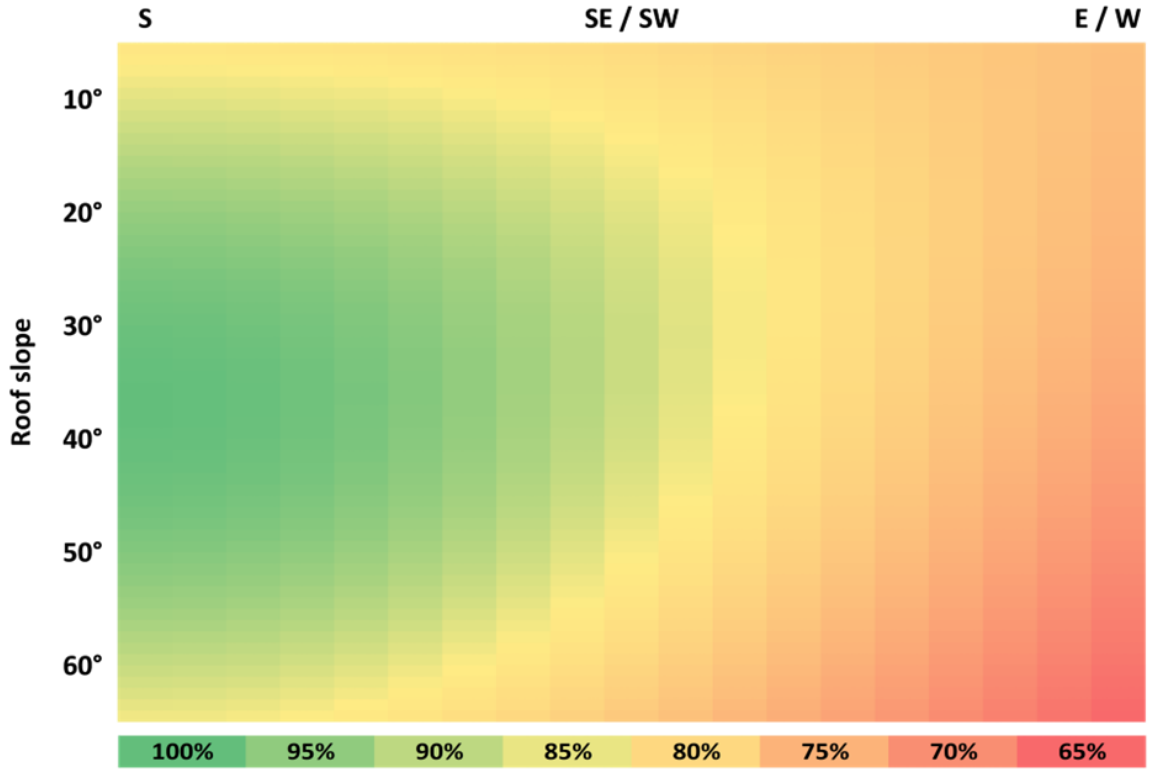
DOES THE ARRAY HAVE TO FACE SOUTH?

To get the most energy from a solar PV system system the modules should face south and be tilted at an angle. Theoptimum tilt angle depends on your geographical location; the further north you are, the steeper the angle should be. In the North East of England, the optimum tilt for solar PV panels is about 40°.

One of the most important considerations for a solar PV system is the amount of energy in kWh it will generate. Because of the ever changing weather conditions, this is normally done using software models which predict the future energy yield over a period of a year. The software models use historical average meteorological data to create their predictions.

A solar PV system installed in the North East of England on a south facing roof pitched at 40° would produce around 900kWh of electricity per year for every kWp of installed solar PV capacity so a 10-panel 3kWp system would produce about 2,700kWh electricity per year.

Of course, not every building has a perfectly south facing pitched roof and the amount of electricity generated will be lower for other orientation and pitches. The chart below shows roughly how much difference there would be at different angles for an installation in the North East of England. You can use the chart to estimate what the electricity yield would be at different angles of installation. For example, a south east facing installation pitched at 60° would have an electricity yield of about 80% of the reference case.

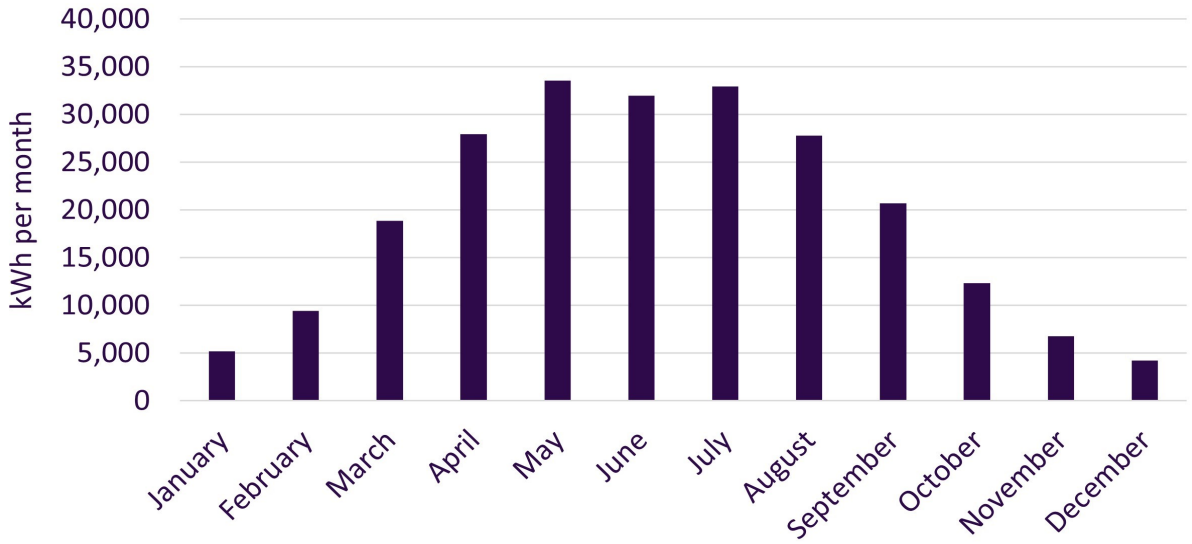


HOW BIG SHOULD MY SOLAR PV SYSTEM BE?

There's no feed in tariff anymore for solar PV systems, but there is a new incentive called the Smart Export Guarantee (SEG). Launched in 2020, the SEG obliges licensed electricity suppliers to pay for electricity exported by solar PV systems, at a tariff of around 5.5p per kWh.

The best applications for Solar PV are where you can use most of the electricity the system generates yourself. This is ideal if your business uses most of your electricity during the daytime and operates 7 days per week. A solar PV system will reduce the amount of electricity you have to buy. You buy electricity at a higher tariff(around 50p per kWh) than the electricity you sell. It doesn't make sense to have a solar PV system that's grossly oversized because you'll be exporting most of the electricity it generates and the system may not be cost effective. You also need to take into account the fact that the majority of the electricity generated will be within the summer months.

The chart below shows the annual generation profile for a 60kWp system facing south and pitched at 40° in the North East of England. This generation profile affects the proportion of the generated electricity you will be able to use within your building. The solar industry often talks about this as the self consumption. Although energy yield predictions for solar PV systems are based upon historical weather data, experience shows that the results tend to be quite accurate. However, when you are evaluating the financial benefit of a solar PV system, an accurate assessment of the expected self-consumption is also needed. If you have access to historical half hourly electricity consumption data for your building, it is possible to make a very accurate prediction of the self-consumption from a proposed solar PV system - this is something that Decerna can assist with.



Accurately estimating what the self-consumption is likely to be is really important because it makes a significant difference to the viability of solar PV on your building. It's best to get some expert independent advice about it and consultants can make well informed estimates based upon an understanding of your business activities and electricity consumption profile. In some cases, very accurate estimates can be made by analysing your historical half hourly electricity consumption data.

COST AND PAYBACK PERIODS?

The cost of solar PV has fallen a lot in recent years, typically costing about £1000 per kWp of installed capacity. A PV system with 100 modules on a factory roof would have a capacity of around 45kWp and cost about £45,000 to install. If the system is located in the North East of England on an unshaded south facing roof it could be expected to generate about 45,242kWh of electricity per year.

The value of the generated electricity depends upon the level of self-consumption. Assuming this business has a large electrical load and the building is operated for 5 days a week, the self-consumption might be around 71%. This means you'd avoid having to buy 85% of 45,242kWh of electricity, while getting paid for the remaining 29% that you export to the grid. With average electricity prices for small businesses, the combination of those two sources of saving/income would be about £16,783. This gives a simple payback time of 2.7years.

With systems that aren't exactly south facing or where the panels can't be pitched at the optimum angle the energy yields will be lower and the payback time a little longer. The energy yield of the solar PV system can be affected if there's any shading from nearby trees, buildings or other objects so it's best to pick sites which are not shaded. If shading can't be avoided it is important to accurately model the impacts of the shading. Decerna are experts in this type of shadow modelling.

Because of the variations in system orientation and shading, there is a range of simple paybackperiods that can be achieved but most systems installed on commercial premises in the north east of England tend to have a simple payback time of between 8 and 12 years. In some buildings, it can be helpful to divert any surplus solar generated electricity to an immersion heater within a hot water storage cylinder.This gives a better utilisation of the solar energyby increasing the self-consumption. Where this isn't possible, consideration could be given to installing a battery energy storage system.

WHAT ABOUT MAINTENANCE?

Solar PV systems are very reliable. The modules themselves tend to come with very long warranties, and good quality modules can be expected to last at least 25 years. The power output from solar cells falls slightly over time due to natural degradation, but the energy loss is really small. If your premises are in very dusty industrial areas then it may be necessary to introduce a cleaning regime for the solar modules but most systems in the UK are effectively self-cleaning in the rain provided they're sloped a little.

On flat roof systems it will be necessary to periodically inspect the A-frames and other fixings for signs of damage or degradation. It is important to consider how this will be done safely when a system is designed and there are a variety of options including handrails and fall arrest systems which can be installed.

As with all electrical installations, it's important to have the installation periodically inspected to ensure there are no damaged cables or signs of overheating.

Last, but not least, you need to consider fire safety. It's recommended to seek specialist advice on this subject to ensure that the solar PV system does not impact on any fire safety arrangements.

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ABOUT US

Decerna provides a wide range of consultancy and development services, to ensure that the right decisions are made, to support our customers in the whole journey, from initial concept through to implementation of low carbon systems and infrastructure. Please get in touch to find out how we can help your organisation to de-carbonise.

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