GREATER MANCHESTER
DOING THINGS DIFFERENTLY FOR THE ENVIRONMENT

north west net zero hub

School's guide to maintaining Solar Power Systems

October 2023

Contents

01

Introduction

Why maintain solar power systems?

Introduction

Why should we maintain solar power systems?

Schools across Greater Manchester are investing in solar power systems to help them reduce both carbon emissions and their electricity bills. But to get the most out of solar power systems over their lifetime, they need to be operated and maintained correctly.

This guide is intended to support schools and other stakeholders to understand the operational and maintenance (O&M) requirements for roof mounted solar power installations.

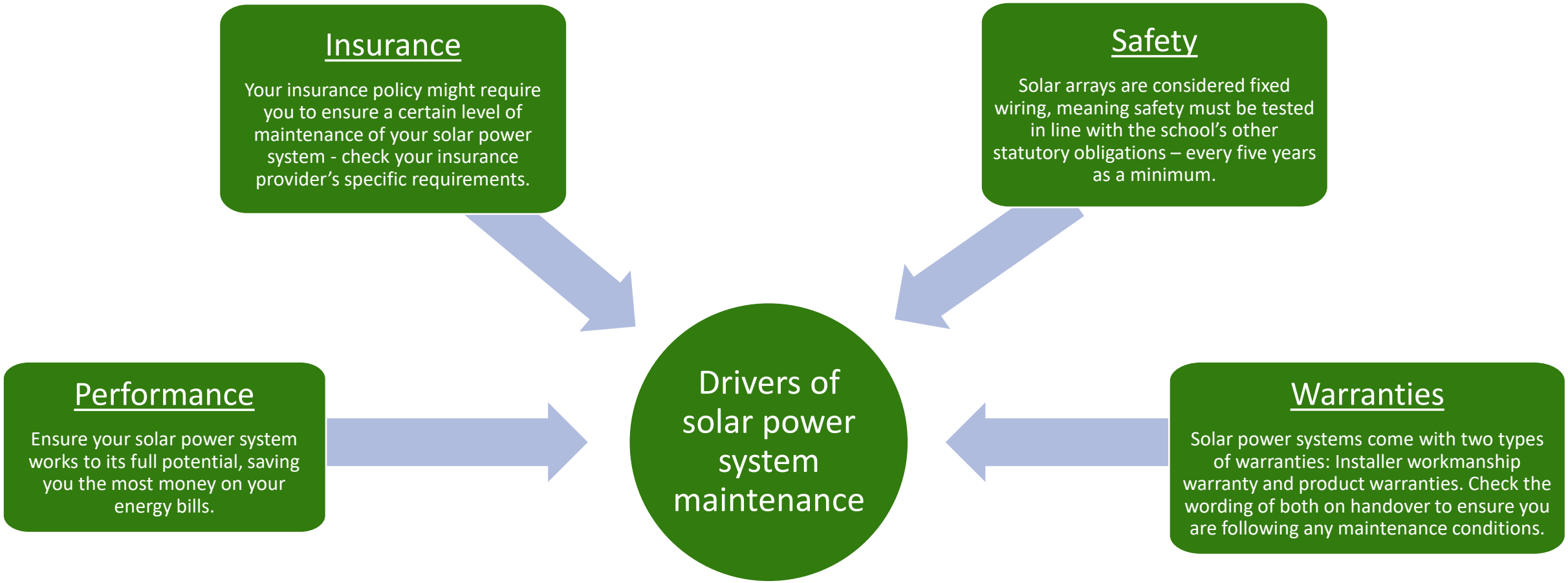
Solar power is often thought of as a ‘fit and forget’ technology, meaning faults can go unnoticed leading to a decline in performance, energy bill savings and carbon emission reductions.

Like other fixed electrical installations, maintenance is also important to ensure safety of the equipment itself and the school.

Once you know what is required, it is straightforward to integrate solar power system maintenance into your school’s normal maintenance responsibilities.

A flat roof solar PV installation in need of maintenance – the green roof underneath has become overgrown and is creating shade over the solar panels.
Photo credit: Joju Solar.

What are the drivers of maintaining your solar power system?



What does operation and maintenance cover?

Performance monitoring

Keeping an eye on how much electricity your solar power system is generating and if it is lower than expected, investigating why.

Preventative maintenance

Regular checks on your system, to minimise the potential for issues to arise, or catch any issues early and avoid future problems.

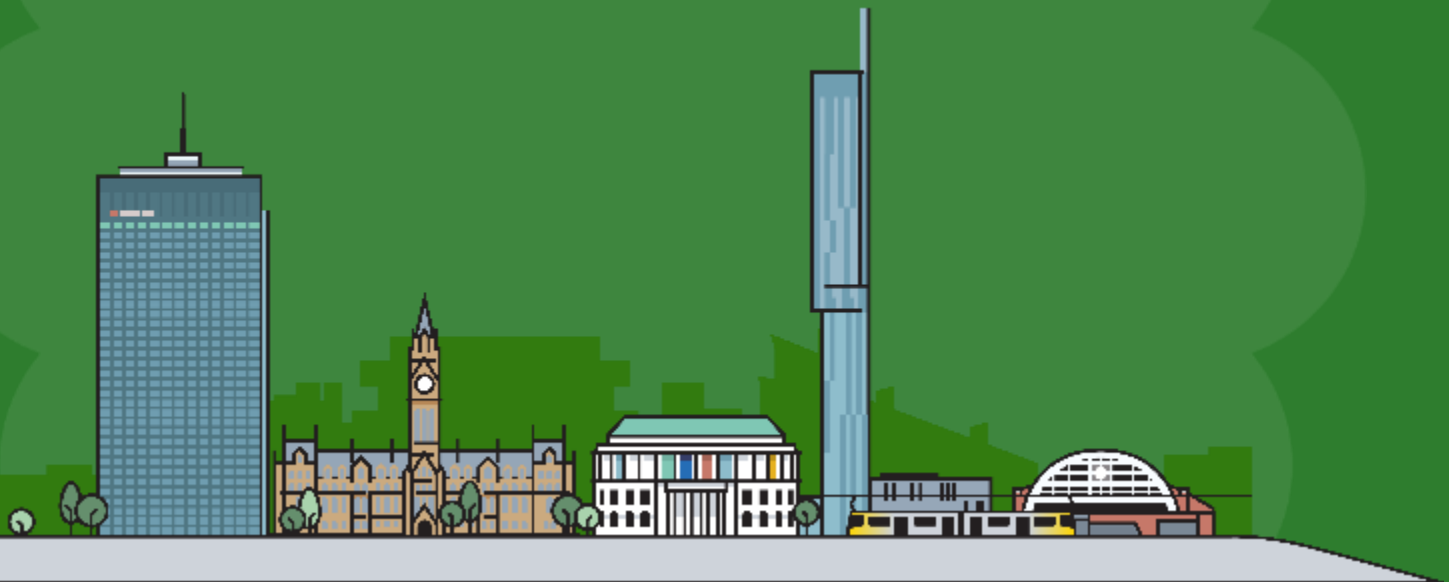
Reactive maintenance

Making repairs when you discover problems.

02

Performance and monitoring

Get to know your solar power system



Performance targets

How much electricity should my solar power system be producing?

Performance

Understanding your solar power system's performance is a crucial first step to knowing when your system might need attention. Performance is simply measured by the quantity of electricity the system generates, in kilowatt hours (kWh), over a given period.

Each system is unique

Each solar power system will have an estimate of annual electricity generation, specific to the angle of the panels, level of overshadowing, location in the UK and equipment installed. To find your system's target, look at the MCS certificate provided by your installer at handover.

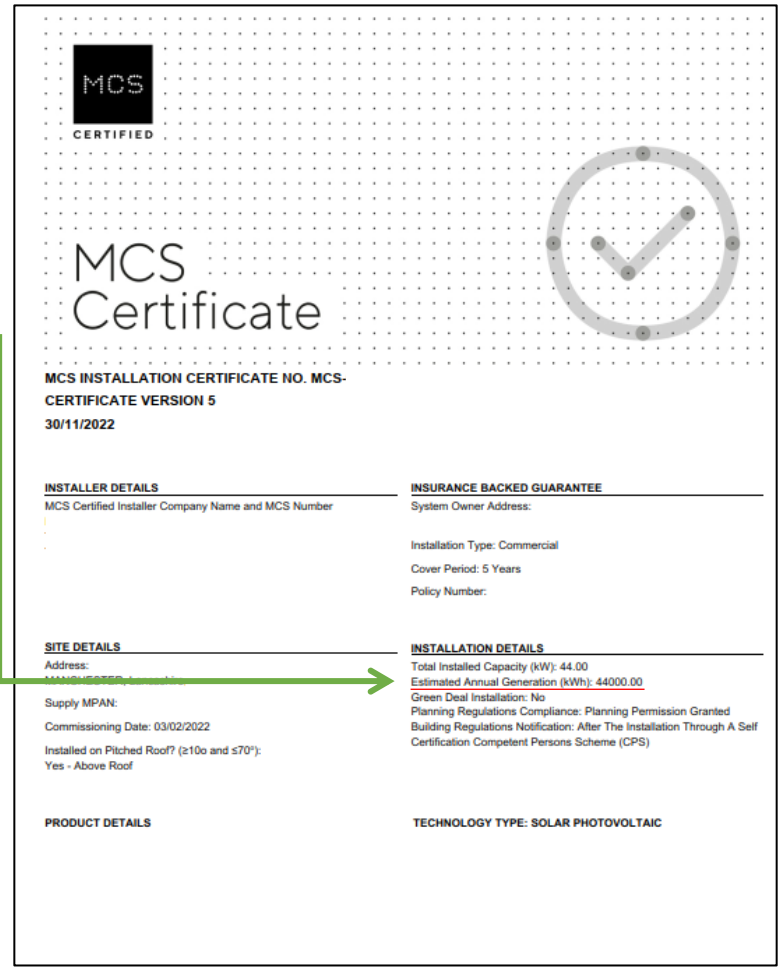
Always bear in mind that some months and years are sunnier than others, so consider the recent weather when judging performance (see table below).

Natural degradation

Aside from weather conditions or other faults, the performance of solar panels naturally degrade over time. This isn't significant year to year, typically only 0.5% reduction in kWh, but it's important to note that your target generation will gradually reduce.

Depending on the product installed, solar panels should still produce 80-85% of their original output by the end of their 25 to 30-year lifespan.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average percentage of annual electricity generation	4%	5%	8%	12%	13%	13%	12%	11%	10%	6%	4%	3%



MCS CERTIFIED

MCS Certificate

MCS INSTALLATION CERTIFICATE NO. MCS-
CERTIFICATE VERSION 5
30/11/2022

INSTALLER DETAILS
MCS Certified Installer Company Name and MCS Number

INSURANCE BACKED GUARANTEE
System Owner Address:

Installation Type: Commercial

Cover Period: 5 Years

Policy Number:

SITE DETAILS
Address:

Supply MPAN:

Commissioning Date: 03/02/2022

Installed on Pitched Roof? (≥10o and ≤70°):
Yes - Above Roof

INSTALLATION DETAILS
Total Installed Capacity (kW): 44.00
Estimated Annual Generation (kWh): 44000.00
Green Deal Installation: No
Planning Regulations Compliance: Planning Permission Granted
Building Regulations Notification: After The Installation Through A Self Certification Competent Persons Scheme (CPS)

PRODUCT DETAILS

TECHNOLOGY TYPE: SOLAR PHOTOVOLTAIC

Know your solar power system

Are you monitoring performance?

Generation meter

All solar installations have a generation meter, which measures how much energy the system has generated, in kWh. This is usually located near the inverter(s), but this will be documented in the installer's handover materials.

Depending on your installation, you might have the ability to monitor generation remotely via an internet portal, but it's good to know your 'manual' options too.

Frequency

It is good practise to monitor your solar power system generation **monthly**, so that any issues don't go undiscovered for long periods. Subtract last month's meter reading from today's, and you will have calculated your system's electricity generation over that period.

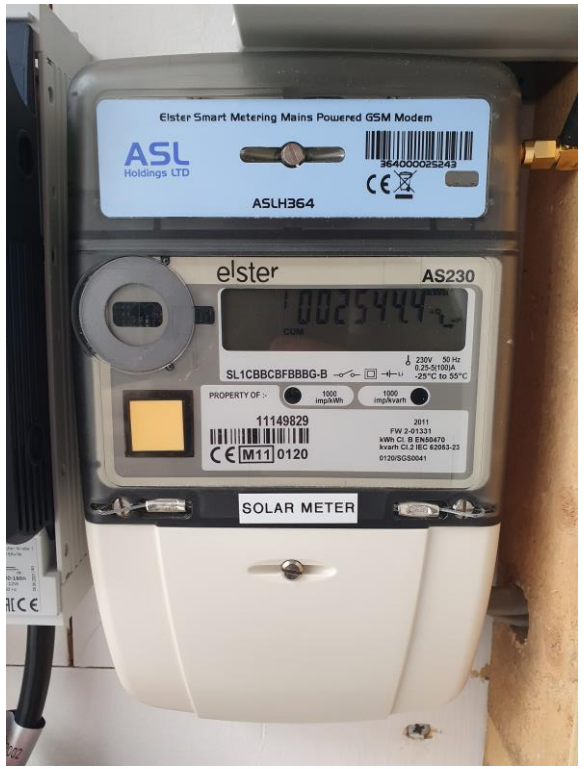
Records

Keeping a record of the energy generation using a simple spreadsheet of the date and meter readings will let you easily calculate the month's generation and compare against previous months. You can also use this to work out how much of your school's electricity usage comes from the solar panels. It's best to take a time stamped photo of the meter too.

Remote monitoring & alarms

If your system has remote monitoring it is much quicker and easier to monitor your system from a computer. Monitoring services will typically give you access to historical data and usually take a meter reading every day.

Some monitoring systems will have the ability to generate 'alarms' – automated messages or emails that alert you if the system generates significantly less electricity than normal or stops completely. It is worth making use of these services if you have them so any corrective actions can be taken sooner.



Above: A typical example of a generation meter, which records the electricity generated by the solar power system.

TIP: Generation meters

It's worth double checking you are reading and recording the correct meter. The MCS certificate will list the generation meter make, model and serial number – this information will also be written on the generation meter.

Check you know where the generation meter is, even if you have remote monitoring capabilities – just in case these monitoring systems go down.

Remote monitoring systems

Communicate either via 2G/3G mobile networks, WiFi, or a wired ethernet connection. You may need to re-connect your solar array to your school internet, if undergoing wider IT changes within the school.

Case study: bringing solar into the classroom

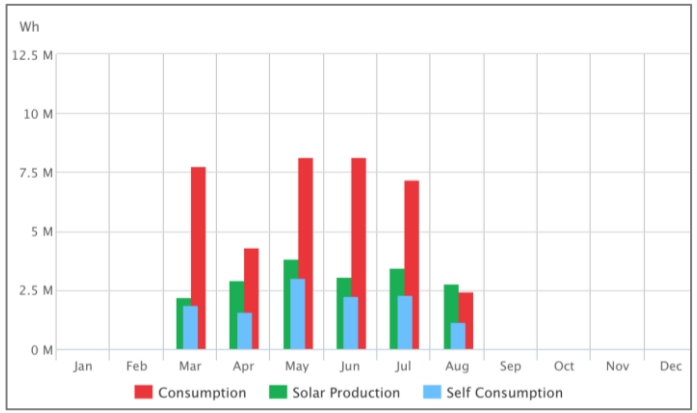
Unlock the added value

Solar power systems can be excellent teaching aids and the inspiration behind a host of engaging classroom projects. Consider also how pupils can get directly involved in system monitoring, to support STEM development.

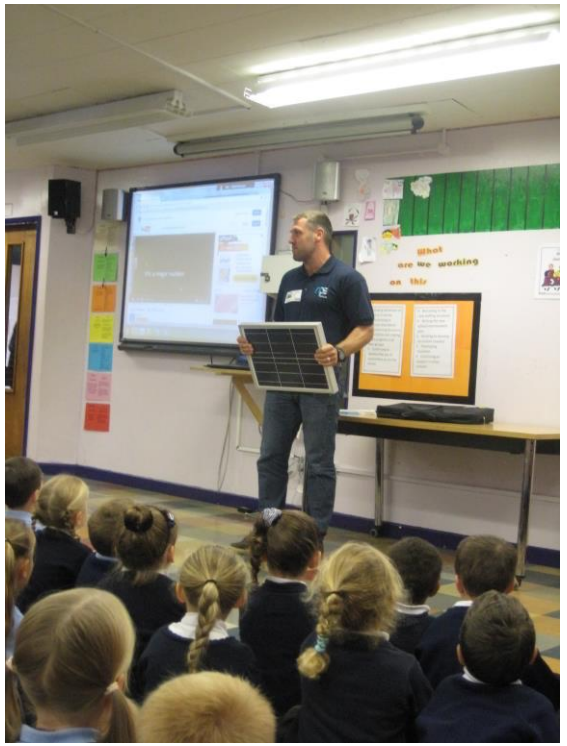
NPS Solar in conjunction with Greater Manchester Community Renewables (GMCR) installed 90kW of solar panels and educated 300 pupils about renewable energy and the solar panels installed.

The installation came with an online monitoring system, which allows the pupils to look at the data and carry out classroom projects relating to how the solar panels are making a difference to the school.

Solar panels installed on a Greater Manchester school.



Extract of the data available through the remote monitoring system installed at the school, including tracking how the solar energy is being used on site.



Engaging and educating pupils about the solar power system installed at their school. Credit: NPS solar.

03

Preventative maintenance

How to keep your solar power system in top shape

Preventative maintenance

What are the benefits?

Preventative maintenance activities are pre-planned activities carried out at scheduled intervals over the solar power system's lifespan. What are the benefits of carrying out a preventative maintenance schedule?

Avoiding major faults

Preventative maintenance can stop the build-up of minor issues, to prevent them causing a much more serious and avoidable problem in the future. Inevitably, repairing this more serious problem is likely to be significantly more expensive than preventative maintenance.

Cost premium

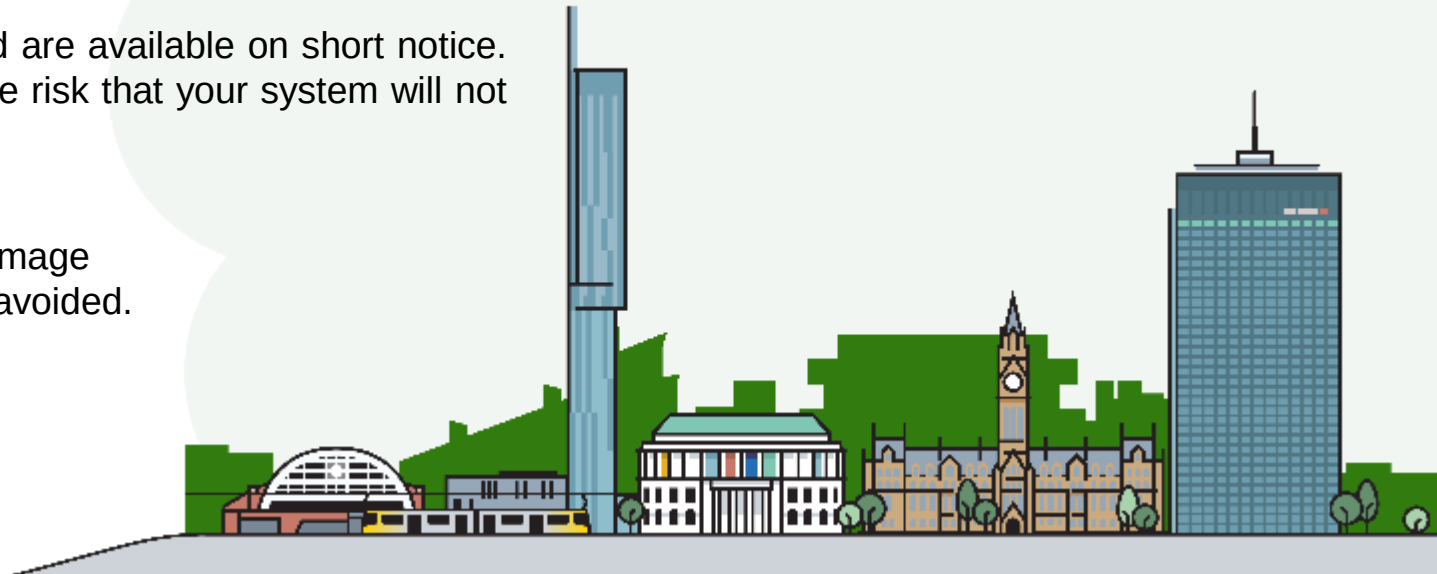
If your solar power system needs urgent repair to restore functionality, you can pay a premium for a call-out service rather having the luxury of shopping for the best deal on non-urgent repairs.

Time

There is no guarantee that the parts your system may need are available on short notice. By failing to plan maintenance, you are more exposed to the risk that your system will not be generating.

Knock-on effects

In some cases, major faults can have knock-on effects to damage otherwise 'healthy' components, which could be completely avoided.



Preventative maintenance overview

Which parts of the system need maintaining?

There are five main elements of solar power systems. Each will need some degree of preventative maintenance over their lifespan. Depending on your installation, you might also have site-specific ancillary equipment, which you should consider for maintenance too.

Below is a summary of the preventative maintenance activities required for each part. Find out more details in the appendix to this guide.

Installation element	What needs doing?	Who can do it	How often is it needed?
Panels	Cleaning	Cleaning contractor	Site specific, every few years
	Visual inspection	Anyone	Annual (from ground level).
		Qualified competent person	Every 5 years (major inspection)
DC wiring	Inspection & test, isolator switch test	Qualified competent person	Every 1-5 years*
Panel mounting system	Visual inspections & torque testing	Qualified competent person	Every 5 years
Inverter	Visual inspections	Qualified competent person	Manufacturer specific
	Check error messages	Anyone	Annually
AC wiring	Testing	Qualified competent person	Every 1-5 years*

**Please refer to the appendix for more information on this range.*

Solar power system on Peel Hall Primary School, Little Hulton. Photo credit: Greater Manchester Community Renewables.

Image credit: Trusted reviews

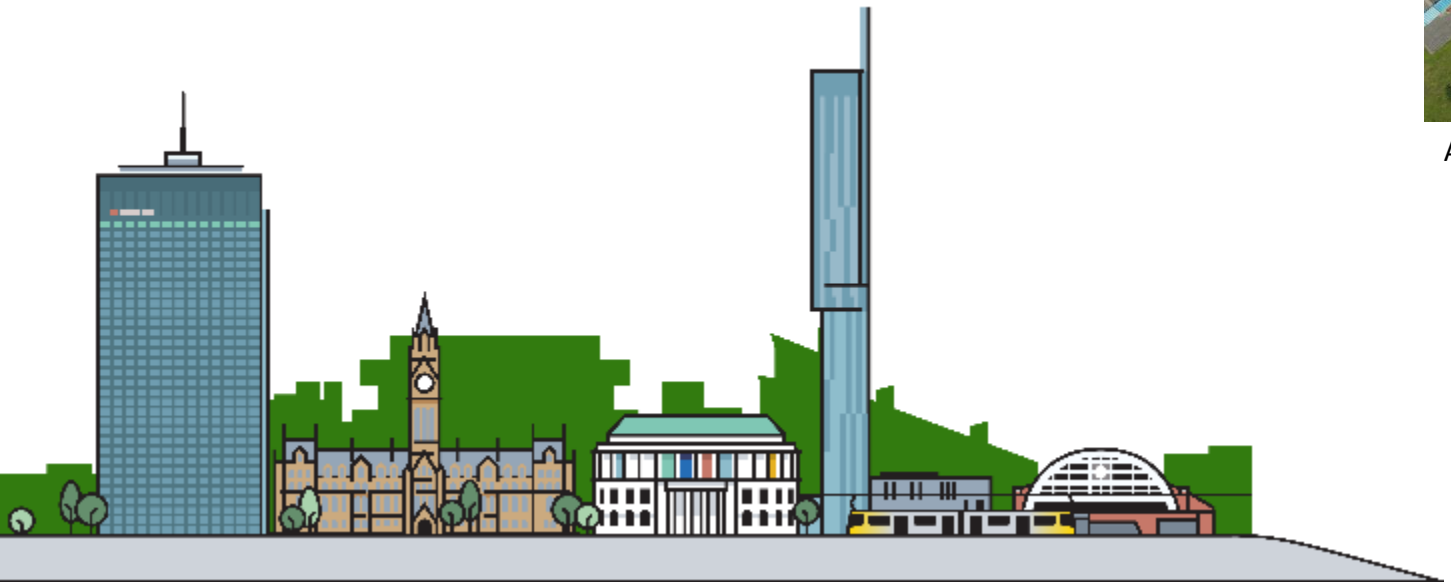
Timing your preventative maintenance

Get the most bang for your buck

On average, 70% of the year's sun will fall in the six months between April and September. So, arranging your preventative maintenance schedule to be completed by March will deliver the best value.

This period of the year is also the most crucial to ensure you are regularly monitoring performance of your solar power system.

Above: A solar power system on a school in Stockport



04

Reactive maintenance

Risks of leaving it too late

Reactive maintenance

Routine inspection and preventative maintenance can help to reduce the risk of a fault occurring with the solar power system. However, sometimes a fault can happen that will require reactive maintenance.

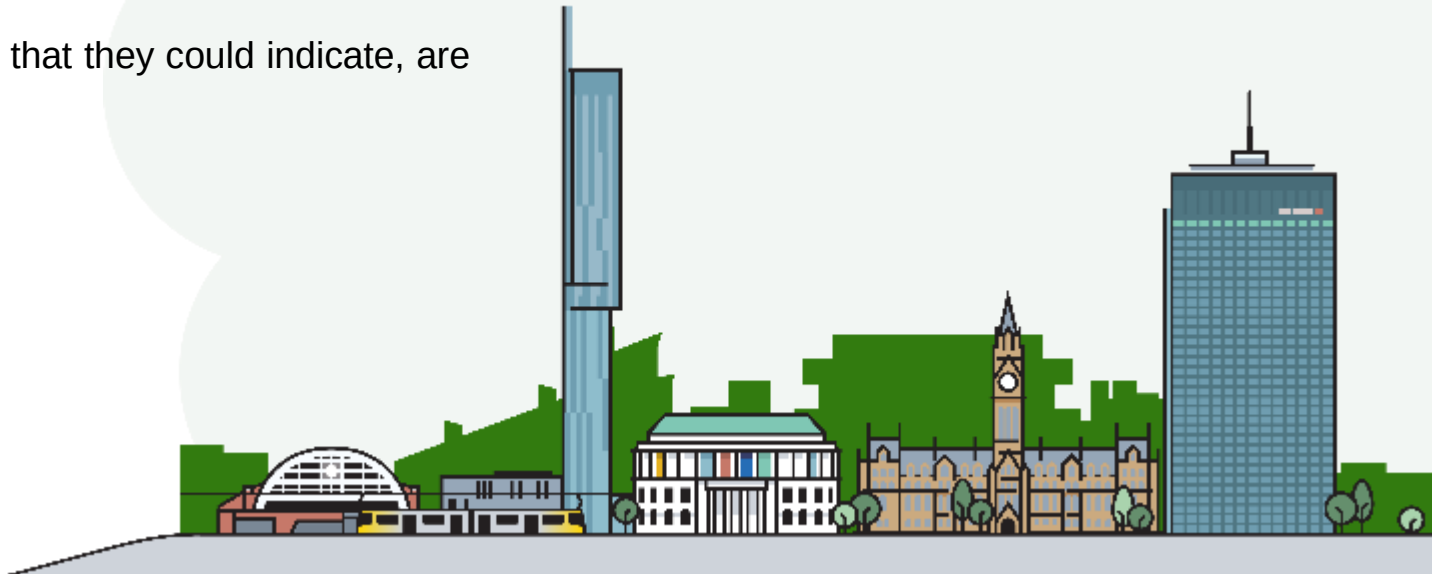
Robust monitoring of your solar power system can help you identify when a problem is occurring. Patterns of electricity generation that can indicate issues include:

1. Consistently reduced electricity generation.

2. Sudden drops in electricity generation.

3. Inconsistent on/off patterns of electricity generation.

More details on what these patterns look like and the issues that they could indicate, are included in the following pages.

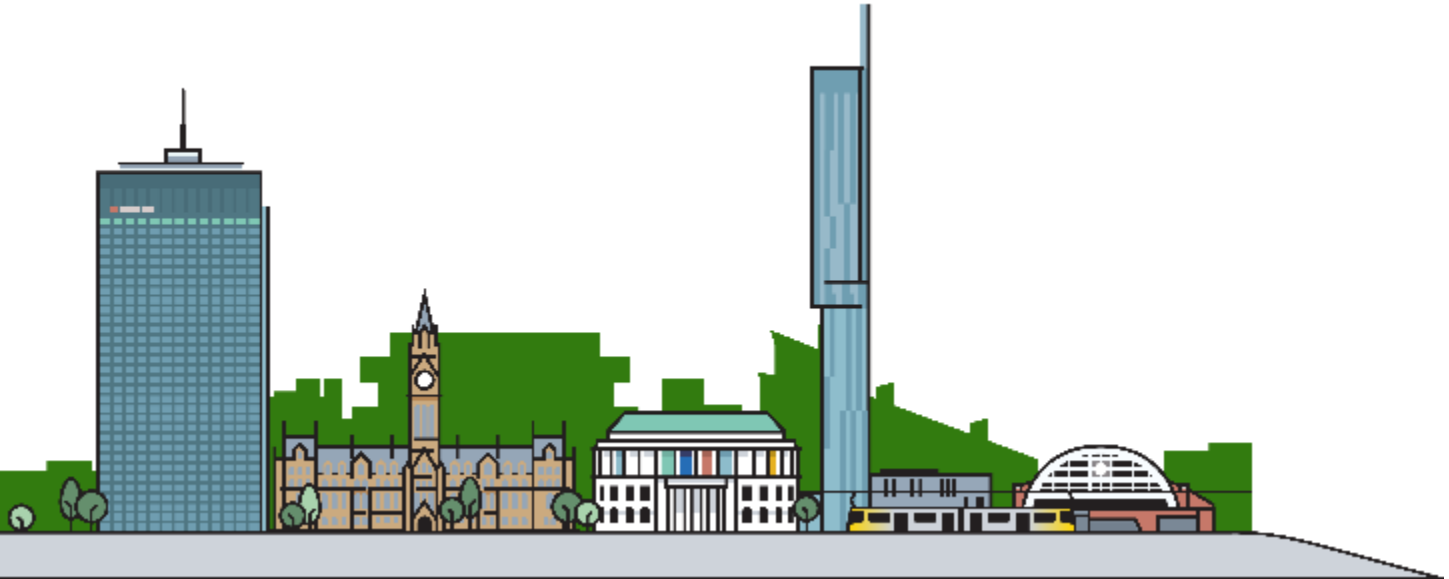


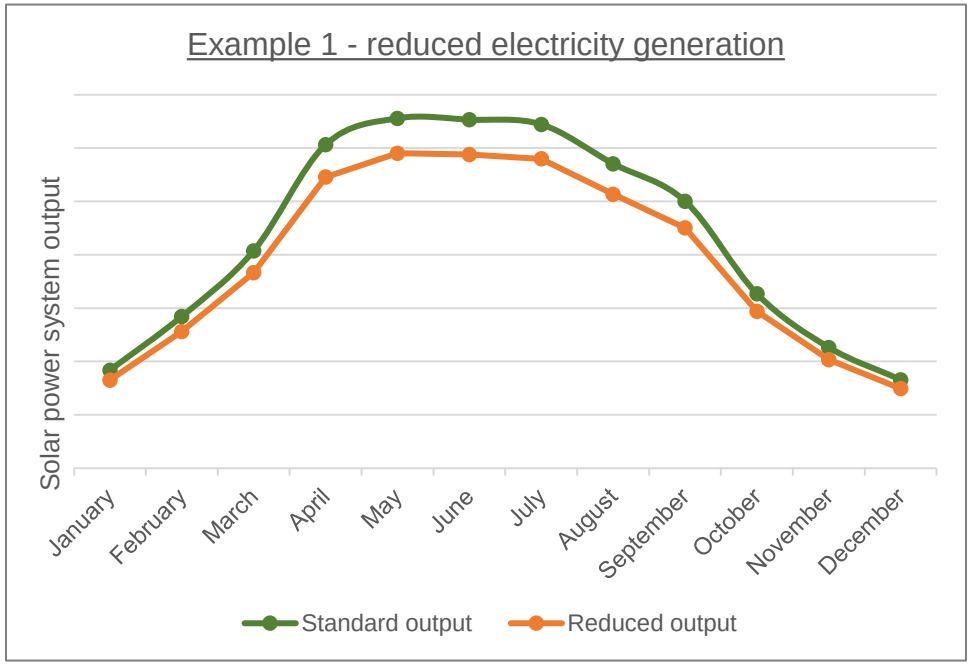
1. Reduced electricity generation

If you notice that your solar panels are performing at a consistently reduced output, it could indicate your solar panels would benefit from a clean. Try and confirm with a visual check of the panels.

Dirty solar panels can reduce output by up to 10%. If your system is under-performing by more than this amount, there are likely other factors in play.

Shading of panels, such as shading from growth of newly overhanging trees, can cause a similar pattern.





2. Sudden drops in electricity generation

Sudden, sustained drop in output

This behaviour typically indicates that either an inverter has stopped working (in multi-inverter installations), or a ‘string’ of solar panels has failed (in multi-string inverter installations).

Check your monitoring system and inverter for the presence of any fault codes.

Full function can sometimes be restored by simply turning the inverter off and back on again.

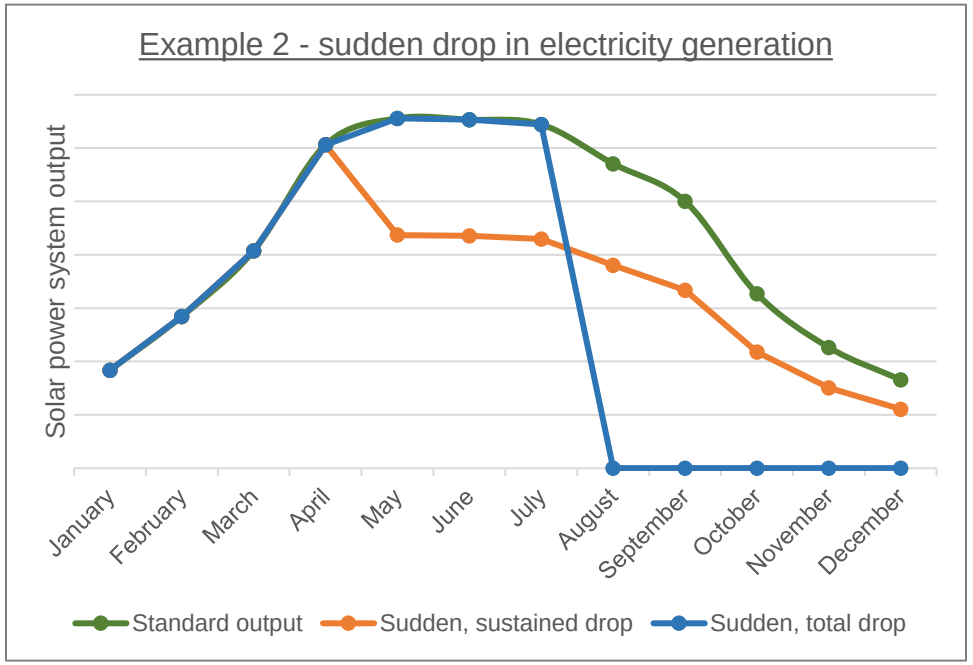
Sudden, total drop in output

A total drop in output could indicate a few different problems:

a) Problem with remote communication system only – the solar array could still be producing.

b) Tripped circuit breaker or G99 relay – function can be restored by resetting these switches, if safe to do so.

c) Inverter failure (usually only in single inverter installations) – the inverter might need fixing or replacing.

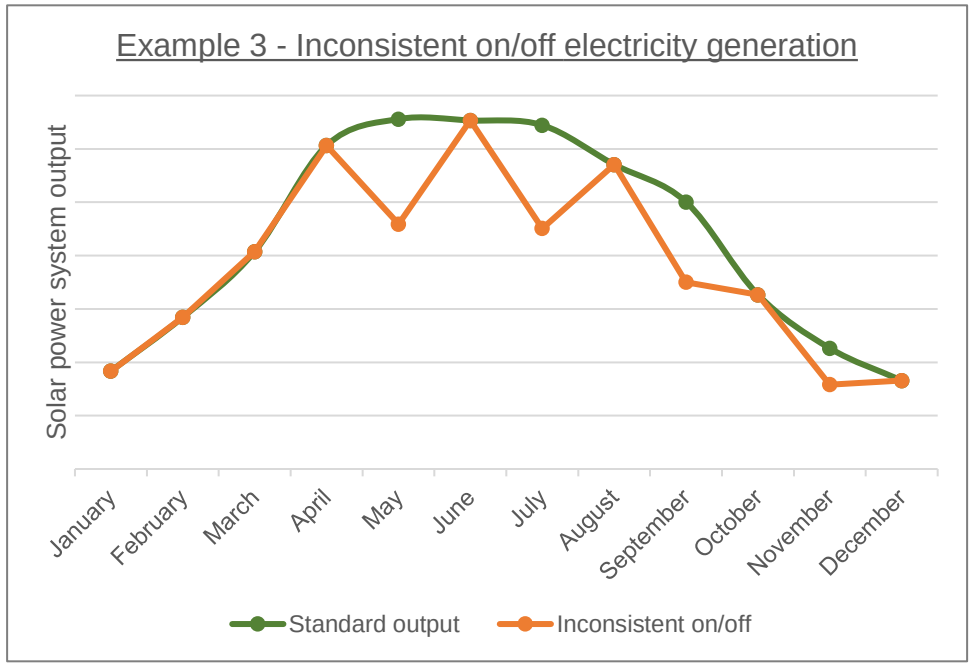


3. Inconsistent on/off electricity generation

Solar power system generation will always be variable with the weather, but if your solar array is still generating inconsistently after taking this into account, it, this is indicative of overheating.

Inverters will ‘trip’ when overheated – these should reset on their own, but ventilation should be improved to prevent reoccurrences.

Ensure that the inverters have plenty of space around them so air can move freely, this includes removing any items stored close to the inverters and checking that any vents in the room are unrestricted.



05

Maintenance contracts

What to look out for and how much to pay

Potential approaches

What is right for your school

There are options for approaching solar power system maintenance. Consider what is the right balance for your school – a few example approaches are below.

	School actively involved	*Comprehensive but outsourced*	*Reactive maintenance only*
Monitoring	Regularly carried out by staff and involving pupils where possible.	Monitoring carried out by external contractor, results reported back to the school regularly.	Not carried out at any regular intervals. Occasional spot checks may occur.
Preventative maintenance	Maintenance staff support with regular visual inspections and maintenance contract responsible for regular system testing.	External firm contracted to carry out all maintenance activities and testing.	None carried out.
Reactive maintenance	Maintenance contractor pre-engaged to respond to faults when detected.	Maintenance contractor pre-engaged to respond to faults when detected.	External contractor engaged if/when faults are detected to remediate issues.

Costs of maintenance

Get the right deal for your school

It's important to remember that the cost of maintaining a solar power system should be outweighed by the reduction to your school's energy bills, but it should be factored into your energy bill saving calculations. Maintenance costs should always be proportionate to the size and complexity of your system too.

Here are general guidelines to the cost of a comprehensive maintenance schedule for typical roof-mounted solar power systems (see appendix 1). These example costs include access requirements, such as the use of scaffolding or cherry-picker, but not maintenance of any equipment classed as ancillary to the solar power system, such as mansafe systems.

Opportunities to reduce these costs exist where activities can be incorporated into existing maintenance activities, such as building inspections or fixed wiring testing.

Some sites may have more unusual site conditions that will place the maintenance costs toward the lower or upper limits of the ranges below. For example, if a solar power system has been designed with a large number of smaller output inverters rather than a single larger multi-string inverter, the upper end of maintenance estimates will be more appropriate. Conversely, if the panels are installed on a flat roof without the need for any access equipment, maintenance costs are expected to be lower.

Size of solar power system (kW peak)	Estimated maintenance cost range per year (excl. VAT)
20 to 100	£20 - £30 per kWp
100 to 200	£10 - £20 per kWp
200+	£5 - £15 per kWp

These cost ranges are different market price points, for the same maintenance specification of works.

Solar power systems not well represented by these guidelines include:

- Roof integrated solar panels including tile systems.
- Novel solar technology such as thin film modules.
- Solar panels modules fixed outside of the typical range of inclination (10°-45°).
- Micro-inverter systems.
- Installations with a very high cost of safe access

Prices as of 2023.

06

Glossary of terms

Glossary of terms

Alternating current (AC) is the form of electricity that is used in nearly every electrical installation – lighting, appliances etc.

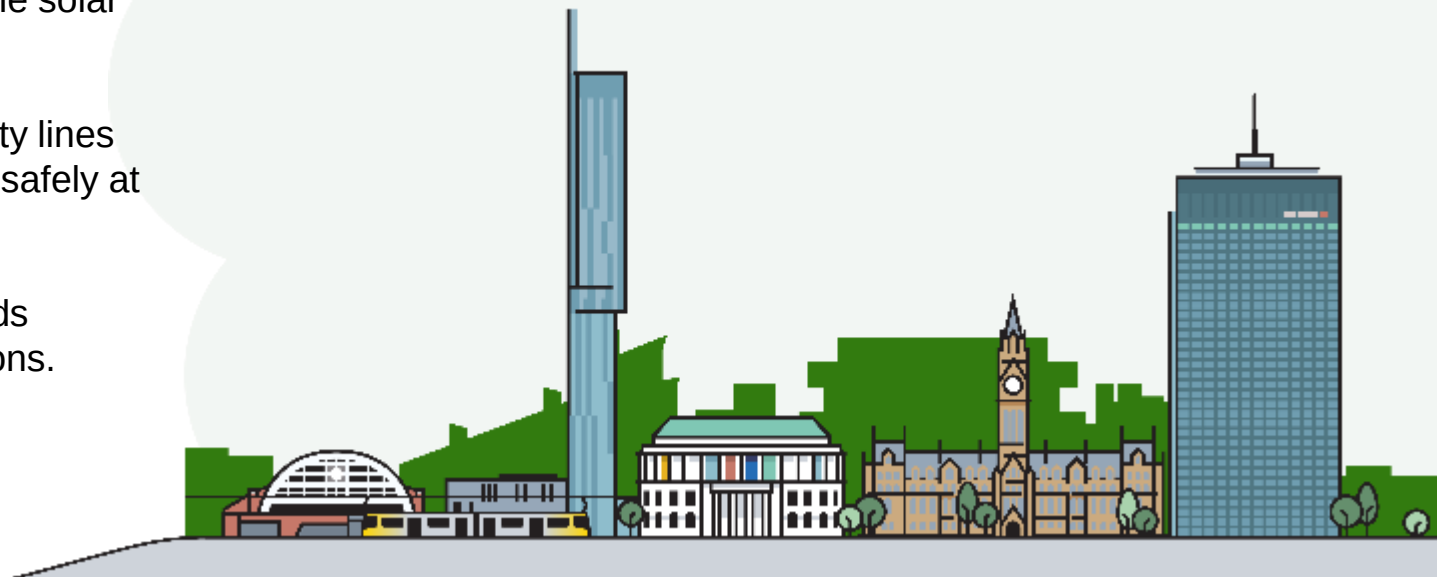
Direct current (DC) is the form of electricity that is generated by solar panels

G99 relay is a standard safety device used in all solar power system installations that automatically shuts off the solar power system system when there is a loss of supply from the national grid.

Inverter is the equipment that converts DC electricity from the solar panels, to AC electricity that is used by the school

Mansafe systems come in a number of forms, such as safety lines attached to roofs, which allow maintenance workers to work safely at height.

Microgeneration certification scheme (MCS) is a standards organisation that certifies low-carbon products and installations.



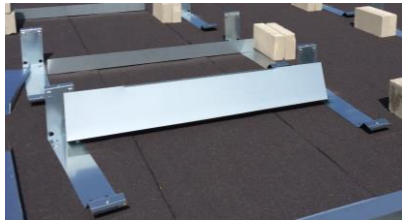
07

Appendix

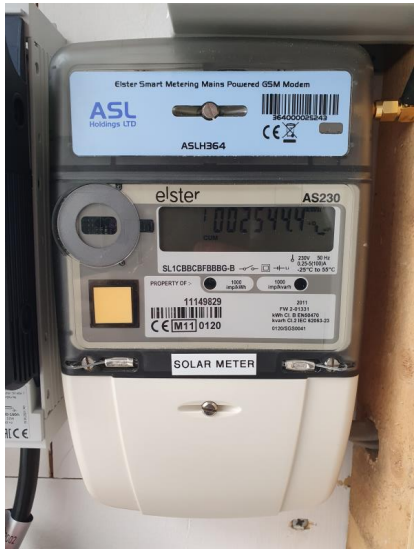
Maintenance checklist

Checklist for solar power system maintenance

Installation element	What needs doing	Why is it important	Who can do it	How often is it needed
Panels ☑	Clean the entire array when visibly dirty – site specific frequency. Obtain before & after photographs from your contractor. Monitor growth of any nearby trees that could overhang the solar panels and cut back if necessary.	Dirty panels will operate at a reduced output, so ensure they are cleaned when dirt builds up. Bird droppings shading a small area can lead to local 'hot spots', so must be cleaned to prevent any related issues. PV panels are self-cleaning to a degree, but some dirt can still build up particularly when installed at an angle of 10° or less. Panels situated under overhanging trees, coastal areas, in proximity to chimneys or kitchen extracts will benefit from cleaning more often.	Typically, an external contractor, due needing specialist equipment and purified water. Anyone can monitor growth of overhanging trees. Tree surgeon for any interventions.	Site specific, every few years
	Visual inspection of panels to identify: ○ Scratches ○ Cracks ○ Impact damage ○ Discolouration Obtain photographic records of panels inspected, from your contractor.	Damaged or loose panels can create a hazard and/or stop generating electricity.	Anyone	Annual (from ground level) and following extreme weather events (wind, hail etc).
			Qualified competent person	Every 5 years (major inspection) at roof level, also to include inspection under panels.
DC wiring ☑	Major test and inspection (including isolator switch) Obtain records of inspections and results from your contractor.	The wiring can be damaged by heat, UV, pests, modifications to the building or other related damage (e.g. from a roof leak). Build up of leaves, especially on flat roof systems, could increase likelihood of fire. The DC isolator switch is a safety device that enables safe maintenance of the inverter.	Qualified competent person	Every 1-5 years Some installers may stipulate more regular testing in order to maintain their workmanship warranty, but major inspections should be at least every 5 years.



Installation element	What needs doing	Why is it important	Who can do it	How often is it needed
Panel mounting system ☑	Major inspections & torque testing. Obtain records of inspections and results from your contractor.	Mounting systems are typically guaranteed for the lifespan of panels, but could be subject to: ○ deformation ○ corrosion ○ cracking Evidence of panel misalignment or slip, could suggest an area for closer inspection.	Qualified competent person School maintenance staff can regularly examine from ground level for evidence of panel slippage.	Every 5 years
Inverter ☑	Inspection of components Obtain records of inspections and results from your contractor. Software updates	Inverters may be subject to: • Corrosion • Damage • Discoloration • Blown fuses • Tripped switches • Overheating These may reduce the inverter efficiency and electricity generation, lead to more major inverter failures, or create fire hazards if not remediated. Manufacturers can update the inverter software, in response to legislative changes or to add functionality.	Qualified competent person	Frequency specified by the inverter manufacturer. Software updates to be checked with other 5-year major inspections. Inverters have a typical warranty periods of 5-10 years, so you may like to increase the attention paid to these towards the end of warranty periods, with more regular inspections.
	Check error messages	Modern inverters can sometimes identify faults and record them in an error message log. This can provide an early warning to more serious faults.	Anyone	Annually
AC wiring ☑	Major test and inspection (including isolator switch). Obtain records of inspections and results from your contractor.	The wiring can be damaged by heat, UV, pests, modifications to the building or other related damage (e.g. from a roof leak). Updates in related general standards e.g. UK wiring regulations, could trigger changes to the AC wiring installation	Qualified competent person This could be carried out as part of the school's existing electrical safety obligations.	Every 1-5 years Some installers may stipulate more regular testing in order to maintain their workmanship warranty, but major inspections should be at least every 5 years.



Installation element	What needs doing	Why is it important	Who can do it	How often is it needed
Generation meter ☑	Annual inspection – check function of display and low battery indicator. Take a time stamped photograph as a record.	Meters are virtually zero maintenance, but don't forget about them as they are crucial to monitoring solar power electricity generation.	Any school maintenance staff	Annually
	Torque test of connections.	Loose connections can be a safety hazard	Qualified competent person	Every 5 years
Communications system ☑	Check from your online monitoring portal each month when taking meter reads. Set up any 'alarms' if you have the option.	These come in a wide range of different forms & often with a small annual subscription fee.	Any school maintenance staff	Monthly when taking meter readings.
G99 Relay ☑	Major test and inspection. Re-instate any export limitation settings after any works to the inverter. Obtain records of inspections and results from your contractor.	This is a safety feature of all solar power systems. Many inverters will have a G99 (or older G59) relay built in, but it can be a separate device. Export limitation settings could be lost through software updates so this should be checked.	Qualified competent person	Every 5 years, or after any major works to the inverter.
Surge protection device ☑	Major test and inspection. Obtain records of inspections and results from your contractor	This is a safety feature of some solar power systems, but malfunction can cause nuisance tripping which stops the solar panels from generating electricity.	Qualified competent person	Every 5 years, with school's existing fixed wiring inspection.
Mansafe systems ☑	Inspection and certification. Obtain records of inspections and results from your contractor	These safety devices require recertification under Working at Height regulations. This is not strictly part of a solar PV array but is sometimes installed where no safe roof access exists already.	Qualified competent person, specific to the mansafe system you have installed.	Annually.

Further reading

There are other great resources online if you want to find out more, some of which are linked below.

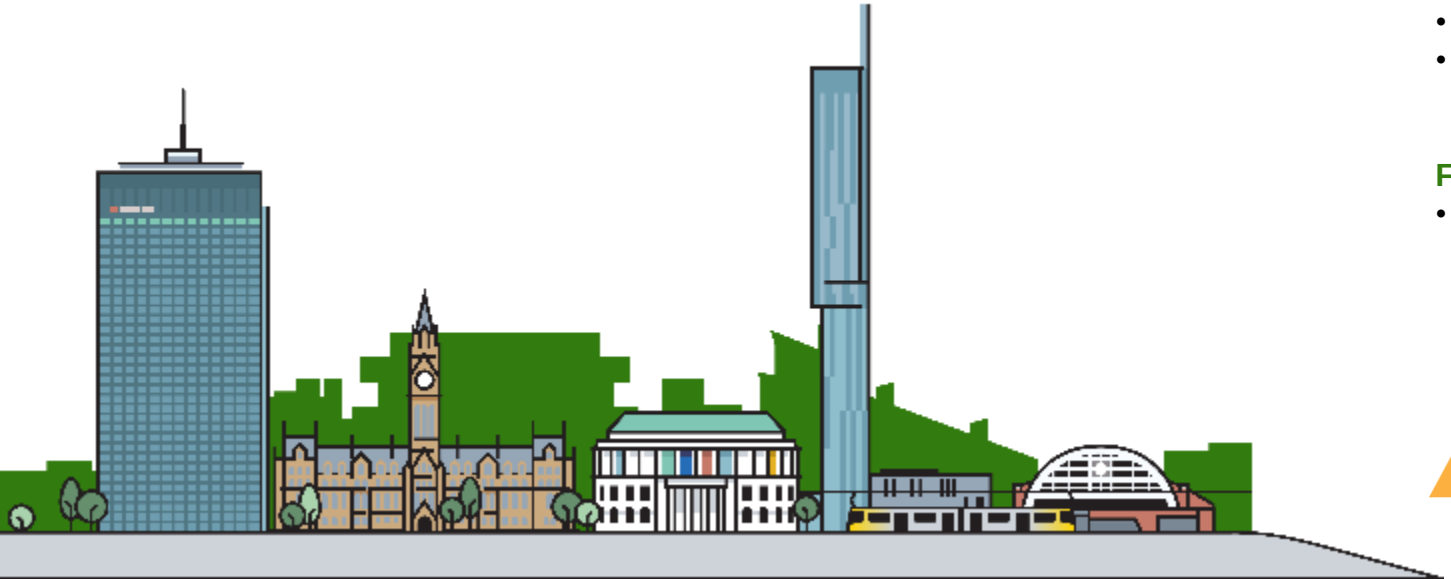
Though keep in mind, many online resources are typically written with a focus on household-scale solar power installations, which have different considerations, risks and costs - so not everything will be directly relatable to solar power installations on schools.

Which?
Solar Panel Problems And How To Solve Them - Which?

Energy Savings Trust
A comprehensive guide to solar panels - Energy Saving Trust

Solar trade organization
Operation and maintenance guide - STA

With thanks to…



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Technical content:

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- Bury Council
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- Stockport Council
- Tameside Council
- Trafford Council
- Greater Manchester Community Renewables
- Atlantic renewables
- Joju Solar
- NPS Solar
- Cor Energy

Funding support:

- North West Net Zero Hub

north west net zero hub

GMCA GREATER MANCHESTER COMBINED AUTHORITY