north east & yorkshire
NET ZERO HUB

HOW TO DELIVER ONSITE RENEWABLES

North East & Yorkshire Net Zero Hub

Public Sector Estate Decarbonisation Programme

Locogen

Turner & Townsend

OUR PARTNERS

Hull & East Yorkshire LEP, North East LEP, South Yorkshire Mayoral Combined Authority, Tees Valley Combined Authority, West Yorkshire Combined Authority, and York & North Yorkshire LEP

Contents

1 Introduction

1.1 Purpose

This guidance document sets out how an organisation can take advantage of the benefits renewable technology can bring for their buildings and estates. This guidance has been developed as part of the North East and Yorkshire Net Zero Hub's Public Sector Estate Decarbonisation (NEYPED) programme.

Turner & Townsend are working with the Hub to deliver a suite a training, support and guidance to build capacity and upskill the public sector to deliver decarbonisation projects in their buildings.

1.2 The Energy Hierarchy

Renewable energy forms an important step on a building's trajectory to becoming a net zero greenhouse gas emitter.

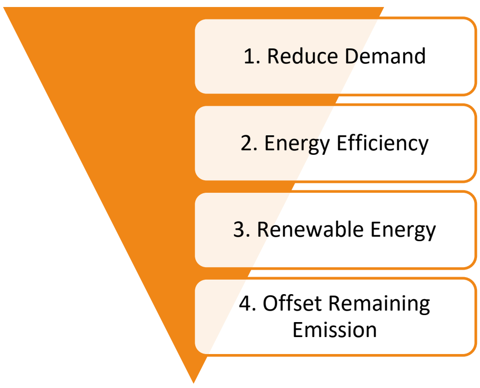

Figure 2: Energy Hierarchy

Once an organisation has reduced its energy consumption, making the move to renewable forms of energy is often the next step an organisation will look to take towards a decarbonised future.

2 What are onsite renewables?

2.1 Background

The UK has been successful in reducing its carbon emissions

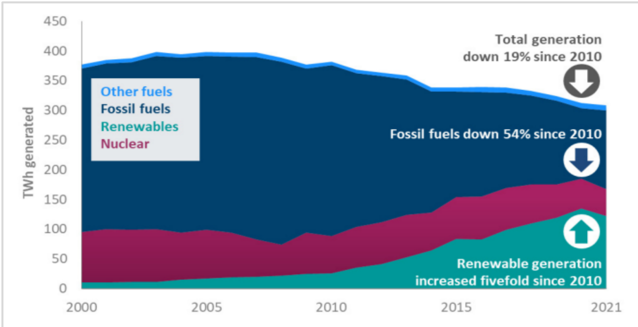

Figure 1: Share of electricity generation fuel sources on the National Grid (2021) Digest of UK Energy

associated with the generation of electricity, primarily through investing in a greater proportion of renewables now generating on the grid. Figure 1 shows that since 2010, renewables have seen a fivefold increase in generation coming on to the grid, leading to a 54% reduction in the amount of fossil fuel power stations.

There is however still great demand for fossil fuels as the primary source of fuel to heat buildings.

Global demand for fossil fuels is depleting our indigenous supplies of oil and gas, creating the need to import more of our fuel. This is leading to concerns over security of supply as well as the country's commitments to reduce its carbon emissions.

The UK has also been subject to increasing fuel-price volatility as we become more exposed to world market fluctuations. This means that UK buildings are facing the prospect of interruptions in the supply of energy and continued uncertainty over its costs.

For these reasons, renewable energy has become more attractive to organisations from an economic, strategic, and environmental viewpoint. Renewables help to mitigate the effects of climate change by decarbonising operational energy use, and significantly reduce the release of greenhouse gases.

Specifically, producing your own renewable energy is no longer just a matter of improving an organisation's environmental credentials; it can offer a wide range of benefits to organisations including:

- Reduced reliance on fossil fuel, lowering energy bills and carbon emissions.
- Providing energy supply resilience if access to other fuels is disrupted or the cost of energy increases sharply.
- Improving an organisation's 'green' credentials.
- Providing the capacity to sell excess renewable energy to a distributor at a premium.

2.2 What is renewable energy?

Renewable energy refers to energy that occurs naturally and repeatedly in the environment. This can be kinetic energy from waves and wind, light and radiation from the sun or geothermal heat from the ground. Renewable energy can also be produced from biological sources such as wood or crops grown specifically as a fuel, as well as organic fuel sources which can also be found in by products from manufacturing and other processes.

Under certain circumstances, these can be converted to renewable energy onsite using environmentally acceptable processes such as:

- Solar Photovoltaic Panels
- Solar Thermal Panels
- Biomass Boilers[1]
- Wind Turbines
- Hydro-Electric Power Turbines

The individual characteristics and location of a building will determine which renewable technologies will best meet the requirements of the specific site – some technologies might better suited than others.

2.3 What do renewables produce?

Renewable energy is typically output as either electricity or thermal energy. This energy is then used to offset or replace the use of grid electricity or the use of fossil fuels when combined with low-carbon heat sources such as heat pumps.

This offsetting of energy from other sources can bring a financial and carbon reduction benefit as the energy generated is considered zero carbon.

[1] Biomass fuels are replaceable and while they liberate CO_2 when they are burnt, this is considered to be the same amount of CO_2 that was taken up when the biomass grew, so they are considered to be carbon neutral.

3 Process of assessing renewable energy options for your building

3.1 General considerations

When first thinking about decarbonising buildings, an organisation can utilise the energy hierarchy in Figure 2. This can be described as a 'whole building approach' which outlines that organisations and individuals should pursue energy issues in the following order:

1. Reduce the need for energy
2. Use energy more efficiently
3. Install low-carbon heating
4. Use renewable energy

The first priority for an organisation is to reduce energy consumption before considering fuel switching to a renewable source.

3.2 Stakeholder engagement

Early engagement with stakeholders can mitigate issue arising further down the line.

It is important to get buy-in early from **senior leadership** so that the organisation can better influence the outcomes throughout the project, including reserving its own capital for investment.

Building occupiers or a representative should be consulted to understand constraints specific to the proposed buildings, if known. Are there any quick wins to reduce energy demand before installing measures?

There may be a usage agreement in place such as a **Private Finance Initiative (PFI)** contract for a leisure centre or hospital where the impact on the energy bills may need to be negotiated.

Building users will need to be considered during the installation period and also for any post installation effects from the new measures. Hospital wards or school classrooms may need to be refurbished as part of the project, so this needs to be considered when planning the installation timetable. When planning measures, the effect on the comfort levels within the building need to be considered as well as lighting levels.

In addition, some organisations have resilience requirements, hospital sites with back up heating systems, running on a different fuel type to the main system need to be considered.

Local residents may need to be consulted for significant works taking place such as a ground-mounted solar PV installation.

The **local council** will need to be considered for planning applications, which can take several months for approval.

3.3 Assessing renewable options

Anyone considering investing in renewable energy technologies should take the following steps to ensure they identify the appropriate renewable energy technology.

3.3.1 Understand your energy mix and energy requirements

- Initially assessing your current energy mix helps an organisation decide which renewable energy technology may be appropriate for them. For example, some renewables, such as wind and photovoltaics just produce electricity. Others, such as solar thermal, just produce heat. Other technologies such as biomass and anaerobic digestion can provide heat and electricity (Combined Heat and Power).
- Calculate heating and electricity demands to see if they can be reduced. Treating energy efficiency measures as a priority means that when the switch to renewable energy is made, it will be more likely to meet the reduced energy need in an affordable way.
- Is it possible to combine renewable generation with a move towards low-carbon heating technologies such as heat pumps? Renewables might offer a compelling solution to offset some of the increased electricity demand that would otherwise need to be supplied from the national grid.
- Is energy demand constant or does it fluctuate between night and day and between seasons? As prioritised with energy audits and decarbonisation studies, being able to optimise a buildings energy use depending on when it is occupied helps to reduce its overall consumption; this can often be achieved efficiently through in-house training and setting appropriate timers for both lighting and heating.
- Many renewable technologies can be successfully paired with storage technologies such as batteries and thermal stores. These technologies help ensure that the peaks and troughs of renewable generation can be smoothed out and better matched to the energy demands of a building.

3.3.2 Understand options specific to your site

- Once energy demand is optimised, consider whether renewable energy is appropriate to meet the remainder of requirements. This overview will help determine whether it may be appropriate to switch to renewable energy and provides information on which technologies may be suitable.
- What installed capacity (i.e. size of renewable installation) does your site need to meet your site's energy demand and what capacity will deliver this in the most cost-effective way. This typically means balancing between a system meeting a base demand but a smaller installation and cost; or a system meeting peak loads and potentially over supplying at non-peak times, but at a higher capital outlay.
- Consider engaging with a renewable technology expert to help you determine the most cost-effective solutions for your building.

3.3.3 Feasibility

- Once a potential renewable energy technology has been identified, a feasibility study can be undertaken to determine the suitability of the technology in terms of its technical, economic, and environmental performance on the building.
- This will also provide knowledge on any planning permissions, regulations, certifications, and insurance you may need to apply for both the building and chosen renewable recourse before installation.
- Depending on the specifics of your site, you may require a structural assessment to understand whether the renewable technology can be installed as planned. For example, is your roof structurally sound to hold the weight of a solar PV array?

3.3.4 Identify a Supplier & Installer

It is recommended that you choose a certified installer and system that are both accredited through the Microgeneration Certification Scheme (MCS).[2]

You should follow your organisation's own procurement guidance to ensure that you receive the best value for money.

3.3.5 Permissions

- Consideration of any planning permission issues, regulations, certifications, and insurance should have also formed part of the feasibility study. Given the range of issues to be covered, these feasibility studies are usually undertaken by experienced consultants.
- Any site which is categorised as a listed building or within the vicinity of a conservation areas will require full planning permission and consent from their local area.
- Local planning authorities are responsible for renewable and low carbon energy development of 50 megawatts or less installed capacity (under the Town and Country Planning Act 1990). Renewable and low carbon development over 50 megawatts capacity are currently considered by the Secretary of State for Energy under the Planning Act 2008[3], and the local planning authority is a statutory consultee.
- Private wire systems involve the connection of privately-owned electrical energy generation equipment to localised energy grids and distribution networks, enabling private organisations such as hospitals to operate on stand-alone energy supplies in the event of a national grid failure.

3.3.6 Monitoring and Maintenance

- Having invested in the adoption of an onsite renewable energy system, ensuring that it is continuously maintained will provide maximum efficiency in production as well as a prolonged

[2] To find an accredited installer in your local area, use the search function on the MCS website: https://mcscertified.com/

[3] The Planning Act (2008) https://www.legislation.gov.uk/ukpga/2008/29/contents

life cycle. You should consult with your selected renewable energy installer and manufacturer for correct maintenance procedures and to understand any ongoing operational costs.

4 Renewable technologies

While there are several renewable technologies an organisation could viably install at their site, this guide will focus on two of the most popular[4] renewable technologies public sector organisations undertake: **Solar Photovoltaic** and **Solar Thermal**.

4.1 Solar Photovoltaic

Figure 3: Solar Photovoltaic installed on a flat roof

Solar Photovoltaic panels (Solar PV) convert sunlight into electricity. A single PV device is usually small, known as a cell which typically produces about 1 or 2 watts of power. These Photovoltaic cells are made of solid-state semiconductor materials which generate a Direct electric Current (DC) when exposed to light.

To boost the power output of PV cells, they are connected in chains to form larger units known as modules or panels which can be used individually, or several can be connected to form arrays. One or more arrays is then connected to complete PV systems; because of this modular structure, PV systems can be built to meet almost any electric power need, small or large. Along with the availability of panels in a variety of glass and plastic based systems, including aluminium-framed panels, plain cladding, solar roof tiles and custom-built glazing with integral PV cells to suit most building types.

Because the electricity used for household appliances is alternating current (AC), an inverter is installed along with the system to convert DC electricity to AC. This electricity can then be used throughout your building, stored in battery cells, or exported to the grid for a premium.

Installations can demonstrate commitment to sustainability as well as providing attractive returns on investment.

4.1.1 Performance

The performance of a solar PV system can depend on many variable factors such as:

- Total number of solar PV panels fitted to building roof.
- The efficiency of the panels and inverters used.

[4] Phase 1 and 2 of the Public Sector Decarbonisation Scheme funded 268 solar PV installations and 16 solar thermal installations. Solar PV, solar thermal, wind turbines and hydropower are all eligible technologies for the most recent phase of the scheme.

- Angle (inclination) and direction roof is facing.

Error! Reference source not found. shows the percentage of the maximum yield that a solar PV array would produce for different angles of orientation and inclination. You can see that in the UK, the annual electricity generation from a solar PV array is highest if it faces due South with an inclination of 35 degrees.

The lowest annual electricity generation would be facing due North with an inclination of 90 degrees. Where possible panels should be placed facing South, SW or SE at and angle of 30-45o to maximise the generation from an array.

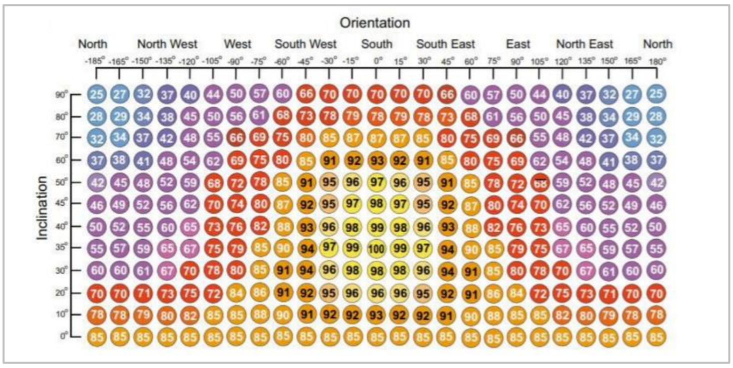

Figure 5: The percentage of maximum yield that a solar array would produce from different angles of orientation and inclination in the UK. https://www.nea.org.uk/who-we-are/innovation-technical-evaluation/solarpv/how-much-electricity-solar-produce/

4.1.2 Seasonality of the weather

Weather seasonality can significantly influence solar PV's efficiency and performance because the cells use light to produce electricity. Solar PV does not require direct sunlight, the panels will generate electricity on a cloudy day, albeit at a much lower level than direct sunlight on clear day. The summer months can represent a high

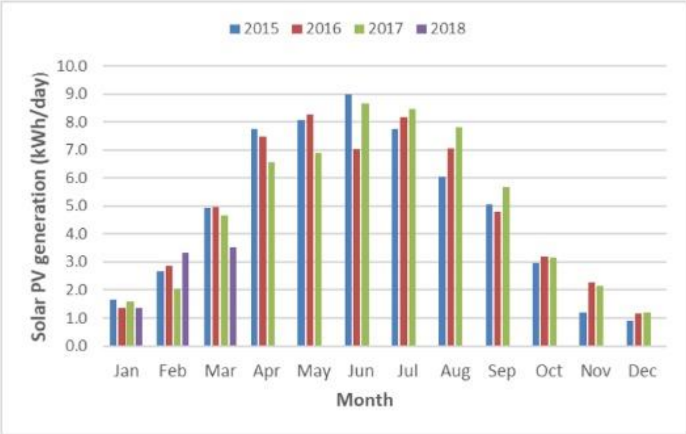

Figure 4: Solar PV generation per day over typical months of the year for a location in London. https://www.nea.org.uk/who-we-are/innovation-technical-evaluation/solarpv/how-much-electricity-solar-produce/

output from the solar PV panels due to longer days and bright sunshine, the winter months may not be as efficient due to shorter days and overcast weather limiting the amount of sunlight which reaches the PV panels.

Figure 4 shows the typical monthly values of solar PV generation for a 2.35kW solar PV system in the South of England. You can see that the peak generation occurs in the summer months when the weather is typically sunnier and there are longer hours of sunshine.

It is useful to consider how much of your electricity loads will be offset in different seasons. If for example your building is electrically heated (e.g. heat pump) and you're looking to offset that load; the winter months are typically higher loads for heating, but lower yielding for solar PV. This will factor into the sizing of your solar PV installation.

4.1.3 Battery Storage

The performance of a solar PV system can vary depending on many factors, as covered in section 4.1.1 and 4.1.2 above. However, due to the anticipated higher returns through the summer months exceeding your buildings energy requirements throughout a typical day; battery storage could be an efficient self-storage system for your generated electricity.

Battery systems are designed to monitor the buildings usage of electricity and store the excess energy from your PV system. The internal battery management system will automatically divert the excess energy to your battery, rather than feed back onto the grid. The battery system will then discharge the stored energy when the system detects a demand in the building greater than the PV system can provide; or when there is no PV generation, providing there is sufficient energy stored in the battery. This helps a building maximise the utilisation of the generated energy.

Figure 6 shows an illustrative example of how battery storage can enable a site to maximise the overgeneration of electricity for use on site.

Battery storage can come at considerable additional capital outlay, so the business case needs to be carefully considered as to whether battery storage will provide a reasonable return on investment.

4.1.4 Planning Permission

Installing solar panels now typically falls under Permitted Development[5], meaning you often do not

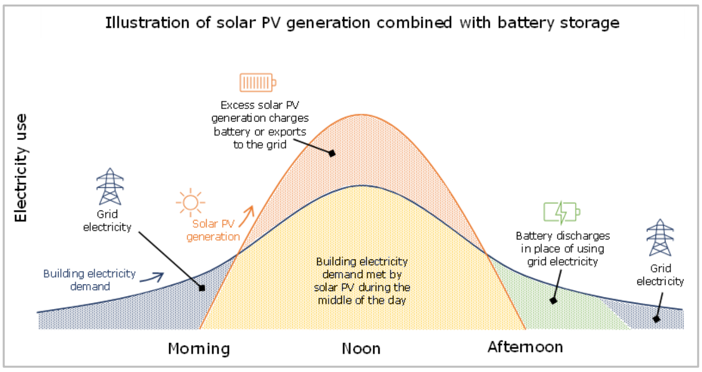

Figure 6: Combining solar PV with battery storage, an illustrative example of building consumption profile. Turner & Townsend.

require planning permission for solar panels on non-domestic and commercial buildings; but may require consultation and planning with building owners.

However, solar panels are subject to normal building regulations, which involves checking that the roof can support the extra load; checked and signed off by your accredited installer. There are also some conditions that solar panels must comply with:

- The system should be installed in such a way that the effect on the external appearance of the building and amenity of the area is minimal.
- The system cannot be higher than the highest part of the roof (excluding any chimney).
- The system cannot protrude more than 0.2 meters beyond the plane of the roof slope.

There are also exceptions, where planning permission is required:

- **Flat roof:** mounted solar PV must not protrude more than 1 metre above the highest part of the rood

[5] Read more about permitted development on the Planning Portal: https://www.planningportal.co.uk/permission/common-projects/solar-panels-non-domestic/planning-permission

(excluding the chimney). This includes any mountings or frame to support an angled PV array.

- **Listed buildings:** Whilst it may be possible to install solar panels on a building that is located within the grounds of a listed building or on a site that is a scheduled monument; it required listed building consent followed by planning permission.
- Ground-mounted panels cannot be installed within 5m of the boundary of the curtilage of a listed building. If they are, they're likely to require planning permission
- **Conservation areas:** If the building is within or near a conservation area it may be possible to install solar systems under permitted development rights; however, planning permission would be required.
- **Ground mounted:** solar PV array can total no more than 9m^2 and extend no more than 3m in any one direction and reach no higher than 4m from the ground.
- Only one ground-mounted system can be present in any-one building.
- **Larger installations:** cannot exceed 1,000 kWp (1 megawatt) of capacity across the whole site if the entire array is located on a roof.

4.1.5 Private Wire Connections

To work without subsidy, solar set ups on the building will either need a private wire connection or to be larger than 20 MW. Private wire systems involve the connection of privately-owned renewable electrical energy generation equipment

through to the demand user, without the need for exporting all of the energy generated to the grid. This enables private buildings to have full control of their electrical production and consumption, as well as larger sites such as hospitals, buildings to operate on stand-alone energy supplies in the event of a national grid failure.

4.1.6 Cost and payback of Solar PV

There are many factors which affect the overall cost of solar PV panels, these include:

- Type of solar panels installed material, quality, and efficiency of ancillary components (inverters)
- Size of the system installed
- Building operational patterns
- Combination with other technologies such as battery storage

Table provides some representative figures for the costs and paybacks of solar PV arrays at different generation capacities (kWp). The calculation uses data from the European Commission Photovoltaic Geographical Information System (ECPGIS) [6] to generate an annual kWh output based on the system size, losses of 14% for a location in London with a roof-mounted solar PV array, at a slope angle of 35° and facing directly south (180° azimuth).

To calculate a bill saving, you can apply the cost of grid electricity to the

[6] European Commission Photovoltaic Geographical Information System: https://re.jrc.ec.europa.eu/pvg_tools/en/

annual kWh generation (we have assumed 25p/kWh in Table). We have provided some indicative costs for different solar PV sizes, but actual costs will be dependent on individual site circumstances. Table assumes that all generated electricity will be used on site where in practice, this will often not be the case.

Table 1: Costs and benefits associated with different solar PV array sizes

System Size (kWp)	Estimated Cost (£)	Annual kWh generation	Annual Savings on Electricity Bill (£)	Payback Period (Years)	Savings after 25 Years (£)	Annual Carbon Saving (tCO_2e)
10 kWp	£12,000 - £17,000	10,300	£2,580	5 to 7 years	£64,500	2.17
20 kWp	£24,000 - £34,000	20,500	£5,130		£128,250	4.33
50 kWp	£60,000 - £85,000	51,300	£12,830		£320,750	10.83
100 kWp	£120,000 - £170,000	102,600	£25,650		£641,250	21.66

4.1.7 Maintenance

Solar PV systems generally require little maintenance with a lifespan of about 25 years; however, the inverter and battery stores may require replacing after about 7 to 10 years. Although, there is likely to be some deterioration in performance over time – solar panels are typically guaranteed to provide 90% power output after 10 years.

Cleaning of any noticeable algae and moss build up will ensure the solar panels are not being limited on the amount of sun exposure; however, UK's rain this is unlikely to be a regular procedure.

4.1.8 Challenges

- High initial set up costs incurred with buying the necessary panels, hardware, installation, and maintenance.
- Generation is dependent on roof space, angle, and local weather conditions.
- Combining with battery storage to maximise consumption in your buildings can be expensive.
- A general rule of thumb, around 6,000-8,000m^2 of sloping roof space is required per 1,000 kWp of capacity installed (also known as a megawatt). A flat rooftop will accommodate less capacity, as

spacing must be left in between each row of panels to avoid self-shading. Slope selection, and number of panels on the roof is a compromise between promoting greater yield and better water run-off and reducing wind loading.

4.2 Solar Thermal

Figure 8: Evacuated tube solar thermal collector installed on a roof.

The great majority of solar thermal systems now in use belong to detached or semidetached houses. But solar thermal systems are increasingly being used in larger buildings, apartment blocks, hotels and catering establishments, and public buildings. Solar thermal panels are devices containing a mix of water and glycol, as sunlight passes through a panel it is refracted by the glass. This changes its wavelength, essentially trapping it and producing heat which is captured in the fluid and conveyed to a hot water cylinder which is used to heat a home or building. Unlike solar PV, solar thermal technology produces heat, not electricity.

Solar thermal provides hot water at 55-65°C which is well-suited to replacing fossil fuel sources of hot water heating for domestic uses such as showers, taps and catering. There are two main types of solar thermal panels:

- **Flat-plate collectors:** these devices

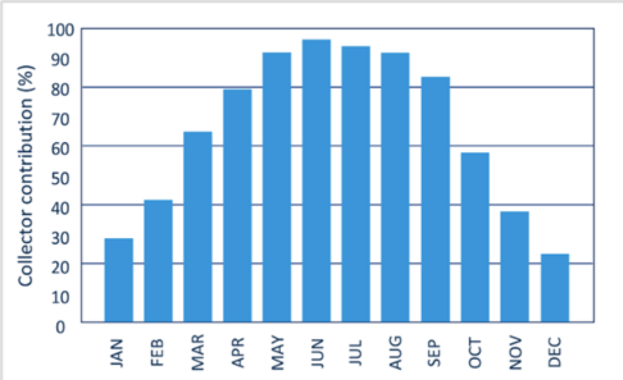

Figure 7: Annual Solar Thermal Hot Water Contribution, department for Business, Energy and Industrial Strategy – Solar Thermal Systems and Collectors

(https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/879765/Solar_Thermal_TIL_-_April_2020.pdf)

  look very much like solar PV panels. They are composed of a dark absorbing surface, a transparent cover, a heat insulating backing, and most importantly a fluid that transports heat from the absorber to a water tank. The absorber can be made of different materials, namely polymers; copper, aluminum, or steel. Copper is the most expensive, but it's also a better, more durable conductor. Polymer collectors are indicated for colder climate since materials such as silicon are much more freeze-tolerant than metal.
- **Evacuated (or vacuum) tube collectors:** unlike solar panels, these collectors are made up of several glass tubes through which the transfer fluid flows, specifically a mirror is mounted below the individual tubes to focus the sunlight on the absorber pipe to generate more heat. These systems are more efficient than flat-plate

panels, especially in cold climates, but lose efficiency in warm weather due to the risk of overheating. That is because vacuum tubes avoid heat loss, while flat panels tend to lose some heat.

4.2.1 Performance

Solar thermal systems are only suitable for domestic hot water preparation (e.g. hot tap water or shower) or requests of small renewable demand and are seldom suited to central heating applications, which limits the application of these systems.

Solar thermal installations have similar considerations to those of solar PV:

- **Angle and direction the panels face:** solar thermal power generation captures radiation energy from the sun. Therefore, the optimal position to be situated is somewhere with direct sunlight for the most part of the day. This could be on a roof space which faces through south; although different placement is still possible, the efficiency of heating water will decrease. Evacuated tube panels don't necessarily need to be placed on a roof, other possible places could be on a flat roof or hang from a wall, as long as it gets direct sunlight.
- **Total number of panels:** a solar thermal system will heat any volume of water as long as the number of panels is sufficient, they work best when the system is designed to meet the output in order to maximise efficiency. The more panels allow a greater volume of water to be heated, but at greater capital outlay.

The percentage of hot water requirement that is provided by the solar panel is known as your 'solar fraction'. This is defined as the percentage of the total thermal load satisfied by solar energy, reducing the use of the back-up boiler; and ultimately maximising the return on investment.

Generally, solar water heating systems are more economical for organisations with a high demand for hot water. Often these building might be characterised by having loads such as catering or swimming pools.[7]

The size of system (the number of collectors and water cylinder capacity) depends on the hot water demand of your building. A well designed solar thermal system can provide up to 60% of a building's annual hot water demand however, achieving a higher solar fraction may lead to solar thermal system operational issues.[8]

4.2.2 Seasonality of weather

Due to solar thermal heating systems using direct sunlight, optimal efficiency and water heating output can be achieved most effectively during the summer months. **Error! Reference source not found.** shows that solar thermal systems could provide up to 95% of a buildings hot water during the

[7] Carbon Trust (2018) Renewable Energy Guide

[8] CIBSE Journal (2009) https://www.cibsejournal.com/cpd/modules/2009-02/

summer, whilst a significant decrease to 22% during the winter. This means that an auxiliary heat source is likely to still be required to heat the water during the winter months.

Over the course of a year, a solar thermal systems is able to save between 40% and 60% of the energy that would have been required annually to heat up the hot water using conventional energy sources. This often means displacing fossil fuel use such as gas used by a conventional boiler.

The panels need to be protected from freezing temperatures, so it is therefore necessary to have a closed loop of fluid between the panel and the storage cylinder that contains anti-freeze. All systems installed in the UK have this as standard.

4.2.3 Cost and payback of solar thermal

The typical cost of installing solar thermal is £1,500 per kW installed.[9]

In most cases, solar thermal would only be designed to provide a proportion (e.g. 60%) of a site's total hot water demand, with the rest being met by another heating method.

If you are running a large thermal store or combining with another low-carbon technology (e.g. heat pump), there may be times when an oversized solar thermal array could be beneficial, but careful design is required as the panels will be sized according to the volume of the thermal store rather than building usage in order to achieve the best efficiency and payback.

4.2.3.1 Evacuated Tube Solar Thermal Collectors

Evacuated tube solar collectors are typically the most expensive, but also provide the highest efficiencies.

The cost of an evacuated tube solar array will differ depending on the number of collector needed, design, and water storge requirements of a commercial building. Savings will depend on your hot water usage, the system design, and the fuel you are replacing (e.g. gas).

4.2.3.2 Flat Plate Solar Collector

Flat plate solar collectors have always been popular due to their cost-effective pricing compared to solar evacuated tube collectors. While they are not as efficient at higher temperatures this is often overcome by faster paybacks based on smaller initial capital investment due to their lower price points. Typically, a solar flat plate collector is about ½ the price of a solar evacuated tube collector at £2,000 - £3,000 including installation costs and all parts (solar collectors, control panel, pipes, hot water tank).

4.2.4 Maintenance

Solar hot water systems are typically low maintenance, but it is important to follow your installer's guidance. Solar water heating systems installed by an MCS contractor will come with a five-year workmanship warranty and 10 years or more for the panel warranty.

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[9] International Energy Agency: https://www.iea-shc.org/countries/unitedkingdom/report

You should check with your contractor what level of maintenance is required so that you understand any ongoing operational costs for the system. It might be that you can agree a service contract with the supplier of the installation.

4.2.5 Challenges

- The amount of heat you can expect to generate is easier to manage in smaller installations, so solar thermal might not be appropriate for larger sites.
- Does not provide high-temperature hot water that might be necessary for some processes in your buildings.
- It is recommended that water is heated to 65^{0}C to ensure that the temperature of the water is sufficient to kill Legionella bacteria (that cause Legionnaire's disease), therefore if your solar thermal system is only heating water up to 60^{0}C for example, then your existing boiler can provide the 'top-up' to achieve 65^{0}C.
- You may require a thermal store at additional capital outlay, especially in buildings that have larger hot water demands.
- It is worth remembering that temperature of the water produced by your system is dependent on the weather – you obviously produce more hot water in hot sunny weather – and the season, with most of the hot water produced during the summer months.
- Do you have space to accommodate the size of solar thermal installation you need, especially if you're also looking to install solar PV?
- Similarly, do you have space to install the ancillary equipment needed, such as larger/ additional thermal storage?

As a result, we would not suggest solely relying on solar thermal collectors for all your hot water. Instead, it should be designed to work in conjunction with your existing hot water system.

5 Grants and Funding

This section covers some of the funding streams where renewables form part of the eligibility criteria at the time of publishing this guide. For the most up-to-date information about each scheme, please visit the links provided for each section.

5.1 Public Sector Decarbonisation Scheme (PSDS)

- Phase 1 - £1bn [Complete]
- Phase 2 - £75m [Complete]
- Phase 3a - £550m [Complete]
- Phase 3b - £635m [In Delivery]
- Phase 3c - £235m [Expected]

The Public Sector Decarbonisation Scheme (PSDS) supports the aim of reducing emissions from public sector buildings by 75% by 2037 by encouraging green investment. This is achieved by providing grants to public sector organisations to install measures that decarbonise heat in their buildings alongside energy efficiency and renewable measures.

5.1.1 Eligibility

The scheme is open to all public sector organisations in England. This includes:

- Central government departments
- Emergency services
- Further and higher education institutions
- Local authorities
- Schools
- NHS trusts

There are specific exclusions to the scheme eligibility such as social housing. You should consult the latest eligibility list on the Salix Finance website.

The renewable technologies eligible for the PSDS are:

- Solar PV
- Solar thermal
- Wind turbines
- Small-scale hydro power
- Anaerobic digestion

Please visit the Salix Finance website for the latest information on funding availability: https://www.salixfinance.co.uk/Salix_Funding

5.2 Smart Export Guarantee (SEG's)

The Smart Export Guarantee (SEG) makes sure that small-scale, low-carbon generators receive payment for any electricity they export to the grid. The obligation came into force on 1 January 2020 following on from the Feed-in Tariff (FIT) scheme that closed on 31 March 2019.

The SEG is a market-led initiative, requiring electricity supply licensees to offer export tariffs to eligible generators. Suppliers are free to set their own SEG compliant tariff1 price (provided it is above zero pence at all times) and decide how their tariffs work.

The scheme is managed by Ofgem and further information can be found on their website:

https://www.ofgem.gov.uk/environmental-and-social-schemes/smart-export-guarantee-seg

5.2.1 Eligibility

The scheme requires licensed electricity suppliers to offer export tariffs to owners (generators) of small-scale renewables (installed capacity of less than 5MW) who have the following technologies:

- Anaerobic digestion
- Hydro
- Onshore wind
- Solar PV
- Micro-CHP

To receive payments from the scheme as a generator of renewable energy, you must:

- Operate an installation with a total installed capacity of up to 5MW (or up to 50kW for micro-CHP installations).
- Have a SMETS1 or SMETS2 smart meter, or a meter capable of measuring at half-hourly intervals.
- For PV, wind, and micro-CHP installations up to 50kW, you must be able to show both the installation and installer are accredited in

accordance with EN ISO 17065:2012 or EN45011. This can be in the form of, but not limited to, a Microgeneration Certification Scheme or Flexi-Orb certificate.

- Demonstrate for all renewable capacity that the installation has been suitably certified.
- Not be receiving an export tariff payment for your installation under another renewable scheme.

There are no set or minimum tariffs for the SEG – the only requirement is that the tariff must be always greater than zero. In practice, this means that it is up to energy suppliers to decide what tariffs to offer their customers. They may choose to offer multiple tariffs or just one.

SEG tariffs can be fixed or variable. A fixed SEG tariff will pay a determined rate per kWh of electricity exported over the length of the contract. A variable SEG tariff will vary the price based on market demand, with the only requisite that prices never fall below zero.

Ofgem publishes a list of SEG licensees every year.[10] You should contact the energy supplier directly for information on their available SEG tariffs.

5.3 Solar Power Purchase Agreement

A Power Purchase Agreement (PPA) refers to a contractual agreement between two parties, typically a power producer and a customer.

The producer usually arranges the design, gains the necessary permissions, and manages the installation of a solar PV system on the customer's property at little to no cost. Whilst under contract, the customer receives a significantly reduced electricity tariff, offsetting the costs from their utility provider, whilst the developer receives income from the sale of the generated electricity.

The PPA characterizes the nature of said agreement, such as negotiated prices and the amount of electricity to be supplied. PPA contracts can vary, and each contract is adapted to the requirements of both parties.

PPA's are usually longer-term contracts in the range of 10-25 years. Whilst under contract, the developer remains responsible for the operations and maintenance of the system. When the contracts come to an end the customer can choose to remove the system, extend the PPA or purchase the energy system.

It is also possible for commercial or industrial energy consumers to contract directly with a nearby renewable generator via a private wire arrangement, but these arrangements are more complex and remain relatively rare. By their very nature, on-site PPA structures are location and situation specific.

[10] List of SEG licensees: https://www.ofgem.gov.uk/publications/seg-supplier-list

5.3.1 Eligibility

To be successful, most on-site PPAs with solar PV should meet the following requirements:

- The consumer's electricity demand profile must be sufficiently large, consistent, and time-matched for the solar PV generated electricity to be well suited to meeting it – for example, a cold storage facility with stable round-the clock demand, or a manufacturing plant with its highest demand during daylight hours.
- A suitable physical location (whether ground-mounted or roof-mounted) must be available to host the site on-site or near site. As a rule of thumb, at least 1 square meter of roof space would be required per kW of solar PV capacity, but this will vary considerably depending on the shape and configuration of the roof (angled or flat) and whether it is obstructed by ventilation units or similar. A large-scale ground-mount PV installation will require at least 1.6 hectares (4 acres) per MW.
- Any on-site electricity generation development of 1 MW or more, whether rooftop or ground-mounted, will almost certainly require planning permission from the relevant local authority in England.
- An affordable connection to the local distribution grid must available.
- The consumer must be deemed sufficiently credit-worthy to facilitate the financing of the generator's assets.

6 Case studies

This section will cover previous project success stories fulfilled by Turner and Townsend.

6.1 Western International Market

Hounslow Council, supported by the Mayor of London's Retrofit Accelerator programme, has installed the largest roof-mounted solar PV array of any UK local authority, totalling 6,069 panels and the first to incorporate battery storage; at an investment of £2.05 million.

Figure 9: Ariel view of solar PV array installed on the Western International Market supported by Hounslow Council.

The array was installed at Western International Market, West London's largest flower and produce wholesale market – serving 80 wholesalers and buyers across London. The site is electricity intensive, consuming 3.5MW of electricity per year in providing climate-controlled facilities, demonstrating the importance supplying the site with green electricity.

- £247k saved on energy consumption each year
- 780 tCO_2e saved per year

6.2 London Borough of Lambeth

In 2019, Lambeth was the first London borough to declare a climate emergency. As a result, the council pledged a climate response to mitigate climate change with a target to reach net zero across the its estate by 2030. In 2018/19, energy use from council buildings accounted for 98.9 per cent of its emissions, making retrofitting its buildings a key step in achieving the target. Emissions from schools contributed significantly to the council's carbon footprint, leading Lambeth to initiate an ambitious programme to retrofit school buildings across the borough.

Figure 10: Solar PV array installed on a school building roof as part of the Borough of Lambeth Council's pledged climate response.

The Retrofit Accelerator – Workplaces supported Lambeth in delivering a range of energy conservation measures, including advising in the installation of LED lighting upgrades and building management controls, totalling an investment of £884k. The team also provided guidance for the installation of solar PV, new insulation, and air source heat pumps.

In the 23 schools that Lambeth is currently working with, the decarbonisation measures will reduce total carbon emissions by an estimated 42% per year. The measures will cut electricity and gas use by 10% and 57% respectively, with the solar panels generating an estimated 13% of each school's electricity. This reduction in use of fuel has the potential to save a total annual amount of:

£313,700 across all 23 schools

An average of £13,600 for each school.

By taking advantage of the Retrofit Accelerator's guaranteed energy and carbon reductions, Lambeth has made significant carbon and energy savings:

300.2 tCO_2e per year

total 1,204,300 kWh.

6.3 London Borough of Hounslow

Hounslow Council supported by the Retrofit Accelerator – Workplace appointed a pre-procurement service provider to complete energy efficiency improvements and guaranteed the levels of energy savings across 21 schools.

Figure 11: Solar PV array installed on a school building roof as part of Hounslow Councils successful Retrofit Accelerator – Workplace project.

The project focused on effective energy conservation measures which delivered significant saving, whilst minimising ongoing maintenance costs and user interactions. This composed of a £1.6 million investment into:

- Lighting replacements and lighting controls optimisation and control strategy improvements for Building Management Systems (BMS)
- Solar PV panels

This strategy allowed Hounslow to successfully retrofit and accumulate savings of:

- 600 tCO_2e per year
- £172,500 on energy costs each year
- 2 MWh electricity consumption saved per year

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